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Nexus Between Corporate Sustainability Reporting and Risk Mitigation: Evidence from Chinese Listed Firms

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Abstract: This study examines how corporate sustainability reporting affects the corporate risk-taking of Chinese firms based on a sample size of 5356 companies for the period 2011–2023. We examined the overall impact of CSR on CRT, as well as the individual impact of CSR subcomponents such as environmental (CESR), social (CSSR), and governance (CGSR). We further examined how this relationship is affected by moderating variables such as employees' education and financial flexibility. We used the PCSE technique for cross-sectional dependence and heteroscedasticity in our analysis. But to ensure robustness and address the potential endogeneity, we used the 2SLS and two-step system GMM dynamic panel methods. This study also checks the mechanism analysis and heterogeneity analysis based on revenue growth and firm sizes, respectively. The results states that CSR and its subcomponents (CESR, CSSR, and CGSR) reduce the CRT of the Chinese companies, and this reducing impact becomes stronger when moderated by the employees' education and financial flexibility of the firms. These results show why sustainability reporting and practices are important for reducing CRT. This research underscores the need for firms to adopt sustainable corporate governance frameworks and highlights the pivotal role of organizational factors in reinforcing the risk-reducing benefits of sustainability initiatives.

Keywords: corporate sustainability reporting; corporate risk-taking; financial flexibility; employees' education

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1. Introduction

Sustainability, sustainable development, corporate sustainability, and the triple bottom line are common challenges that businesses face; these are related to various environmental, economic, social, and ethical issues [1]. Corporate sustainability reporting (CSR) is the process by which a business discloses information about how its strategies affect the environment, society, governance, and economy [2]. The economic performance of a company is primarily reflected through financial statements, while its environmental, social, and governance aspects are communicated through sustainability disclosures [3]. A past study highlights shifts in sustainability reporting requirements, particularly the transition from single to double materiality, which promotes integrated reporting for a more comprehensive evaluation of firm performance [4]. CSR plays a crucial role in enhancing a company's reputation, reflecting its commitment to responsible and sustainable business practices.

The notion of CSR has become a crucial element in molding contemporary business methodologies, mostly due to the growing consciousness of environmental, social, and governance factors. The importance of CSR in promoting long-term company sustainability has been highlighted by several recent studies. In recent years, the awareness of CSR has seen a rise in the public and academics, as companies are expected to contribute towards social welfare and society's sustainable growth and maximize their profit [5]. As a result, firms are changing their corporate strategies to allocate resources to increase their CSR rather than focusing solely on economic performance, which leads to adjusting their corporate risk-taking (CRT) levels [6]. CRT is defined as the pursuit of risky assets in business activities aimed at achieving higher long-term corporate value and maximizing shareholders' interests [7]. To better understand this complexity, it is essential to consider the findings of previous studies on the factors affecting CRT, which have examined and analyzed both the internal and external attributes of firms. Building on this context, it is crucial to explore how these attributes influence CRT, including the shareholding structure of a firm, characteristics of the CEO [8], internal corporate governance [9], the legal system [10,11], and the cultural differences of a firm [12]. These characteristics tend to change with time; hence, CRT strategies are continuously adjusted accordingly based on internal and external factors [13].

CSR enhances a firm's risk-taking capacity by aligning CEO incentives with sustainability, although this does not always lead to higher overall CRT [14]. In China, mandatory CSR disclosures have encouraged firms to integrate sustainability practices, building external trust and operational advantages [15]. However, the pursuit of a good reputation through social responsibility often results in more conservative risk management to protect social capital. [16]. Some firms misuse CSR to obscure misconduct, leading to varied outcomes in CRT [17]. Proper risk-taking, essential for firm development, may be hindered by excessive CSR activities that divert resources and increase managerial caution in decision-making. While sustainability efforts attract resources and improve transparency, they can also limit managerial risk appetite, as managers may avoid high-risk projects to safeguard their reputation and career [8,18]. This can result in overinvestment in CSR at the expense of stakeholder interests, as managers prioritize personal reputation over optimal risk-taking [19].

CSR engagement attracts external stakeholders and enhances corporate financial performance by increasing access to resources and government trust [20,21]. It acts as an investment in social capital, offering insurance against poor market performance and boosting public reputation through transparency [17,22]. However, managers may become risk-averse to protect their reputation, potentially overcommitting to CSR at the expense of stakeholders due to limited resources and personal career motivations [8,19]. Recent studies state that firms these days spend more resources on their sustainability reporting to gain public confidence instead of only focusing on the economic performance of the company, which affects the risk-taking of the firms [6]. This would ultimately reduce CRT by safeguarding against various types of risks [17]. However, if a firm's objective is to enhance economic performance through CSR, it may increase its risk-taking by pursuing higher-profit-earning projects to offset the reduced profit from CSR investments [23]. Consequently, the overall impact of CSR performance on CRT remains unclear [24]. This ambiguity highlights a significant research gap in that there is still a need to examine how corporate sustainability reporting overall and its subcomponents (environmental, social, and governance) affect CRT, and how this relationship is moderated by unexplored organizational factors such as financial flexibility and employee education. Therefore, it is very important to address this gap because it can provide insights into the mechanisms through which CSR can increase or decrease the CRT behavior of a company.

The literature on the relationship between CSR and ERT is limited and results are inconsistent, especially in emerging markets [25]. Previous studies have focused mainly on the USA and other developed markets, neglecting emerging economies [26]. China is the leading emerging market today in the world. Therefore, a study from China's perspective offers a unique setting. Recently, China has seen a rapid growth in CSR adoption, but the effectiveness of sustainability reporting is often constrained by weak corporate governance. This makes it an ideal context to explore the impact of CSR on CRT.

This study makes several contributions. Firstly, it empirically examines the relationship between CSR and CRT levels. Unlike previous studies that analyze changes in CRT based on the internal and external characteristics of firms, we focus on firms' overall CSR performance, identifying it as a new influencing factor of CRT [8,10,27]. In addition to overall CSR, we examine the separate impact of corporate environmental sustainability reporting (CESR), corporate social sustainability reporting (CSSR), and corporate governance sustainability reporting (CGSR) on CRT. Secondly, this study extends the literature by examining the impact of CSR, CESR, CSSR, and CGSR on CRT, with the moderating effect of financial flexibility and employees' education. Incorporating financial flexibility (FF) and employee education as moderators is crucial when examining the impact of corporate sustainability on corporate risk-taking. Financial flexibility allows firms to absorb shocks and invest in growth opportunities, making it a significant factor in risk management [28,29]. Similarly, employee education enhances human capital, fostering better decision-making and innovation, which can mitigate risks [6]. Together, these moderators provide a nuanced understanding of how corporate sustainability influences risk, offering a more comprehensive view of the firm's risk-taking behavior. Thirdly, we introduce the panel-corrected standard error (PCSE) as a base estimation technique in this area of research. Moreover, complementing existing studies on the impact of ESG on financial performance, this paper empirically shows that CRT is influenced by corporate sustainability through different channels [21,30,31]. Lastly, we present empirical evidence on the economic implications of sustainability with respect to risk-taking, thereby providing a policy foundation for enhancing sustainability's positive impact. Additionally, our empirical findings from China, a key emerging economy, have broader implications for understanding corporate sustainability effectiveness in markets with relatively weak corporate governance. These insights are crucial for investors aiming to understand the economic outcomes of corporate sustainability indicators in China.

The paper is structured as follows. Section 1 presents the introduction. Section 2 covers the literature review and hypothesis formulation. Section 3 details the research design and methodology. Section 4 presents the findings, discussion, and robustness checks. Section 5 provides some conclusions, limitations and future study direction.

2. Literature Review and Hypothesis Development

CRT is defined as the pursuit of risky assets in business activities aimed at achieving higher long-term corporate value and maximizing shareholders' interests [7]. According to stakeholder theory, which focuses on the importance of addressing the stakeholders' needs, sustainability reporting plays a very important role in shaping CRT behavior [32]. The CRT level reflects the extent to which a firm can control risk in an uncertain business environment, indicating managers' motivation, willingness, and attitude towards risky business decisions, or their degree of risk aversion. There are different internal and external factors that influence CRT. External factors such as positive market feedback and investor protection mechanisms increase CRT, but good creditor protection can reduce CRT by ensuring assured CRT [14,33]. Internally, corporate governance elements like CEO heterogeneity, board size, power concentration in family firms, and shareholder nationality diversity

influence CRT [27,34–36]. Firms' equity structure diversification is directly proportional to their risk-taking level [15]. Later studies explored how foreign ownership affects firms' risk-taking [27]. Equity incentives can modify managerial attitudes towards risk, aligning them with shareholder interests and increasing risk-taking [9,37,38]. As per upper echelons theory, different managerial attributes such as age, gender, experience, and psychological characteristics play a very crucial role in influencing CRT [8,39–41]. Furthermore, investing in corporate sustainability such as ESG and excelling in ESG performance can attract public attention and enhance reputation, giving stakeholders a sense of higher transparency [42]. Managers become risk-averse because of external evaluation and giving more priority to their career reputation [43]. From the perspective of agency cost, firm managers are typically seen as risk-averse due to concerns about external reputation and career risk [8,18]. CRT may be reduced when there is a proper external evaluation mechanism in place, as managers may adopt more a conservative risk attitude either to protect their personal reputation or due to concerns about their future reputation [44]. These diverse factors highlight that there is a need to further explore the important factors that influence the CRT of the firms.

2.1. Corporate Sustainability Reporting and Corporate Risk-Taking

Because of concerns about external reputation and career prospects, firm managers are generally viewed as risk-averse according to modern corporate governance theory [18]. Managers often make investment decisions that protect their self-interest and future career plans. A factor analysis based on three characteristics, personal, financial, and professional, revealed that successful managers tend to be risk-takers and adept at seizing opportunities. In contrast, mature managers are generally more conservative and risk-averse in their investment decisions [45]. Other studies have explored the factors that influence CRT in order to reduce the agency costs. A manager's risk aversion and moral hazard behavior can be effectively mitigated by implementing a reasonable and effective equity incentive and compensation mechanism, which would encourage better investment choices and enhance firm value [9,46].

Sustainable corporate engagement increases corporate risk-taking and benefits external financing and operations, increasing risk-bearing capacity [17,47]. These conclusions are derived from the analysis conducted on developed markets. Shareholders can minimize their investment risk by diversifying their shareholdings, while anticipating that the level of CRT remains relatively high in pursuit of the firm's value maximization objectives, which contrasts with the typically conservative strategies of managers and management [8]. ESG information can exacerbate agency conflict in markets with weak governance like China, as managers might use it to conceal negative events or spread high risk [48]. Therefore, analyzing managers' attitudes and behavior is crucial for understanding corporate sustainability's influence on CRT [19].

Firms with higher institutional shareholding tend to avoid investing in ESG, raising questions about the claim that ESG enhances corporate value. Further analysis revealed that the level of CEO compensation is more closely related to their reputation than their ability. Consequently, management reputation being enhanced by ESG performance benefits managers personally, leading to higher compensation and career advancement [49]. ESG primarily promotes managers' external reputation and personal gain rather than adding corporate value. Managers prioritize personal interests and gains, becoming more conservative and cautious in making risky investment decisions to maintain operational and financial advantages, along with the good reputation derived from the social capital of ESG. This results in a corresponding decrease in the firm's risk-taking level [50]. On the other hand, managers often adopt a prudent investment strategy to avoid risks that

could jeopardize their future career development, even if it comes at the expense of the company's future growth. [44].

Furthermore, participation in corporate sustainability reporting is focused on promoting social welfare and achieving sustainable long-term growth. As a result, the resources dedicated to corporate sustainability activities may displace those allocated to other business operations, leading to a reduction in corporate risk-taking in the short term. From the preceding analysis, we derive the following hypothesis:

H1: *Corporate sustainability reporting decreases CRT.*

Employee education, as a proxy for human capital, may enhance a firm's ability to manage risk effectively by improving decision-making processes and innovation capabilities [51]. Employees who are educated are quick learners when it comes to dealing with complexity, which has a major impact on the overall effectiveness of significant business procedures [52]. More educated staff members can enhance organizational wisdom in decision-making due to their improved capacity to gather and absorb information and their participation in decision-making at a higher level [52].

The relationship between FF and CRT has been widely debated [53]. Agency theory suggests that firms with greater financial flexibility may be more cautious in their risk-taking behavior, as managers seek to preserve their financial cushion to align with shareholder interests and mitigate potential agency conflicts [54]. Pecking order theory also supports this view, positing that firms prioritize internal financing over external options, leading to more conservative financial strategies, particularly in uncertain environments like emerging markets [55]. While some studies report a positive association [56], suggesting that firms with greater financial resources can afford to take more risks, others find a negative relation [29,57,58]. This is particularly relevant in the context of emerging markets, where firms may adopt more conservative strategies due to heightened economic and political uncertainty. Prospect theory suggests that firms with greater financial flexibility may adopt more conservative strategies to avoid losses, prioritizing stability over aggressive growth [59]. Firms with greater FF in these markets may prioritize maintaining their financial cushion to buffer against potential volatility, thereby reducing their risk-taking behavior. Consequently, we hypothesize the following:

H2: *The decreasing impact of corporate sustainability reporting on CRT is strengthened by higher financial flexibility and higher employee education.*

2.2. Corporate Environmental Sustainability and Corporate Risk-Taking

Corporate environmental sustainability reporting (CESR) involves the disclosure of a company's strategies and activities related to environmental protection, thus improving transparency and trust with stakeholders [60]. According to signaling theory, firms that engage in environmental reporting signal their commitment to sustainability, which enhances their reputation and strengthens stakeholder relationships [61]. This increased transparency can lower uncertainty in business activities, ultimately reducing corporate-risk-taking [62]. However, the relationship between CESR and financial reputation is debated in the literature. Past studies found a minimal effect, while others found a positive correlation between environmental disclosure and firm reputation [60,63,64]. Moreover, environmental activities such as reducing emissions can positively impact stakeholders' perceptions [48], which supports the hypothesis that CESR reduces CRT by mitigating uncertainties and enhancing reputation [65].Consequently, we hypothesize the following:

H3: *Corporate environmental sustainability reporting reduces CRT.*

In addition to CESR, factors such as financial flexibility and employee education enhance the impact of sustainability on corporate risk-taking. Financial flexibility allows firms to adapt to environmental initiatives without straining their financial position, thus reducing the risk associated with long-term investments [48]. Firms with higher financial flexibility are better equipped to handle external shocks, further reducing CRT. Meanwhile, employee education ensures that environmental practices are effectively integrated into business operations. Educated employees are more adept at managing environmental challenges, fostering innovation and further reducing corporate risks [65,66]. Thus, both financial flexibility and employee education strengthen the positive impact of environmental sustainability reporting on reducing corporate risk-taking. Consequently, we hypothesize that

H4: *The decreasing impact of corporate environmental sustainability reporting on CRT is strengthened by higher financial flexibility and higher employee education.*

2.3. Corporate Social Sustainability and Corporate Risk-Taking

Corporate social sustainability reporting (CSSR) involves companies disclosing social responsibility initiatives that enhance their reputation and trustworthiness among stakeholders [67]. Social disclosure increases transparency, positively impacting investors' perception, which leads to reduced corporate risk-taking [68]. Firms engaged in CSR activities often experience better stakeholder engagement and a strengthened reputation, mitigating business risks [69]. Moreover, corporate social reporting reflects accountability, promoting long-term trust between the company and its stakeholders, ultimately reducing uncertainty in business environments [70]. Positive stakeholder relationships resulting from these disclosures can also enhance the firm's reputation and reduce CRT [71,72]. Consequently, we hypothesize that

H5: *Corporate social sustainability reporting reduces corporate risk-taking (CRT).*

The effectiveness of CSSR reporting in reducing CRT is enhanced when financial flexibility and employee education are considered as moderators. Financial flexibility allows firms to allocate resources toward social initiatives without compromising operational stability, further reducing risk [73]. Financially flexible companies are better able to withstand market uncertainties while still maintaining CSR commitments [74]. Employee education, on the other hand, helps in the effective integration of social responsibility practices within a firm's operations. Educated employees can better align corporate goals with sustainability efforts, resulting in more informed decision-making and lower risk exposure [75]. These moderating factors enhance the firm's ability to reduce CRT through its commitment to corporate social sustainability. Consequently, we hypothesize that

H6: *The decreasing impact of corporate social sustainability reporting on CRT is strengthened by higher financial flexibility and higher employee education.*

2.4. Corporate Governance Sustainability and Corporate Risk-Taking

Corporate governance sustainability reporting (CGSR) involves disclosing corporate governance practices that improve transparency and accountability, leading to a reduction in corporate risk-taking (CRT). Effective governance fosters investor confidence and strengthens market credibility, resulting in lower CRT [76]. Governance sustainability reporting provides a signal of strong governance mechanisms, reducing information asymmetry between managers and stakeholders, which minimizes conflicts and lowers risk [77].

Companies that adopt robust corporate governance practices create a stable environment for decision-making, which mitigates CRT [62]. Consequently, we hypothesize that

H7: *Corporate governance sustainability reporting reduces corporate risk-taking (CRT).*

The moderating effects of financial flexibility and employee education enhance the role of corporate governance sustainability reporting in reducing CRT. Financial flexibility allows firms to adapt quickly to changes in governance requirements without compromising their operations [78]. This enables firms to maintain stronger governance systems, reducing risk. Moreover, well-educated employees can implement governance policies more effectively, making governance reporting more impactful in reducing CRT [52]. Together, these moderating factors amplify the benefits of governance sustainability reporting in risk reduction. Consequently, we hypothesize that

H8: *The decreasing impact of corporate governance sustainability reporting on CRT is strengthened by higher financial flexibility and higher employee education.*

3. Research Methods and Model

3.1. Data Sample and Source

For this study, we used "A"-listed Chinese companies for the period of 2011–2023 for the following primary reasons. Firstly, it is connected to a more recent past. Secondly, it has to do with how accounting data are standardized and made consistent. The Chinese equities market was not subject to laws and standards governing the compilation and reporting of financial data until 1999 [79]. Thirdly, the availability of data for one of the major factors influencing sustainability reporting in research has an impact on the selection of this specific time range.

This study focused exclusively on "A"-listed companies because comprehensive data for most companies became available only after 2011, justifying the chosen timeframe for the study. The annual financial data were gathered from the official data stream Wind, and firm-level data and sustainability data were taken from Hexun.com, which is considered a transparent, accurate, and dependable database.

3.2. Measurement of Variables

3.2.1. Corporate Risk-Taking

In this study, CRT is the dependent variable. Based on previous studies, the standard deviation of return on assets (ROA) was used as a proxy for CRT [33,78,80,81]. In the risk-taking literature, the standard deviation of ROA is often used as a proxy for CRT. We used the standard deviation of ROA for the past three years as a measure of CRT. We used the below formula for CRT.

$$CRT_{i,t} = \frac{\sqrt{\sum_{i=1}^{n}(ROA - X)2}}{\mathrm{n}} \quad (1)$$

where CRT stands for corporate risk-taking, n is number of observations (in our case, it is 3 for each year), ROA is the return on asset, and X is the average mean of ROA values.

For the robustness check, we used another proxy of risk-taking that is commonly used in the literature as well [82–84]. We used the Z-score value as an alternative proxy for our robustness check in our analysis.

3.2.2. Corporate Sustainability Reporting (CSR)

CSR is measured by using the ESG rating index provided by Hexun.com, which assesses corporate social, environmental, and governance responsibility performance [6,85].

This ESG score is derived from five dimensions: shareholder responsibility, employee responsibility, supplier, customer, and consumer responsibility, environmental responsibility, and social responsibility. Together, these five dimensions provide a comprehensive assessment of a company's ESG performance. A higher ESG score indicates superior sustainability performance by the firm. This approach is consistent with the methodology used by [86]. Therefore, we used the ESG reporting index for the measurement of CSR. In the case of its subcomponents, such as CESR (corporate environmental sustainability reporting), CSSR (corporate social sustainability reporting), and CGSR (corporate governance sustainability reporting), we used the environmental reporting index, social reporting index, and governance reporting index provided by hexun.com.

CSR = ESG reporting index, environmental reporting index, social reporting index, and governance reporting index.

3.2.3. Financial Flexibility (FF)

Following methodologies from prior studies [28,29,87–89], we estimate the following leverage model (Equation (2)) for the measurement of FF. These FF values are then used in the primary models.

$$LEV_{i,t} = \alpha_0 + \beta_1 LEV_{it-1} + \beta_2 MLEV_{i,t} + \beta_3 MTB_{i,t} + \beta_4 FS_{i,t} + \beta_5 TANG_{i,t} + \beta_6 PROF_{i,t} + \beta_7 INF_t + \varepsilon_{i,t} \quad (2)$$

where LEV is leverage, MLEV is the median of the industry-wide leverage, MTB is the market-to-book ratio, FS basically represents the firm size, TANG represents asset tangibility, PROF represents probability, which can be calculated through return to total assets, and INF stands for expected inflation. Specifically, to measure FF for corporate firms included in the sample of this study, first of all, the leverage model presented in Equation (2) is estimated. Next, the residuals are obtained from the estimated leverage model, which are then used as a proxy of FF in our empirical models.

3.2.4. Employees Education

We have also used employee education (Eduscore) as moderator in this, study which measures the human capital of a firm's workforce. To compute the Eduscore, we used the following formula [6,52].

$$Eduscore = \frac{\sum(\text{Number of employees in category} \times \text{Education level code})}{\text{Total number of employees}} \quad (3)$$

To ensure consistency and accuracy, we coded education levels as follows.

1 = high school graduate or lower.

2 = two- or three-year college or technical school graduate.

3 = bachelor's degree from a four-year college or university.

4 = postgraduate degree (master's or doctoral).

These data are available on the Wind data stream. As a result, a higher education score indicates that the employee received a better education.

3.2.5. Control Variables

Past studies incorporate control variables to account for firm financial indicators and managerial characteristics [13–15]. These variables include firm size (FS), sales growth (SG), return on assets (ROA), leverage ratio (TL), firm age (Age), ownership structure (SP), Tobin-Q, and board size (Board) [29,87,90]. Table 1 contains the list of all variables.

Table 1. Variable description and measurement.

Variables	Acronyms	Measurement	References
Corporate risk-taking	CRT	Equation (1)	[29,82]
Corporate sustainability reporting	CSR	ESG reporting index	[6,85,86]
Corporate environmental sustainability reporting	CESR	Environmental reporting index	[6,85,86]
Corporate social sustainability reporting	CSSR	Social reporting index	[6,85,86]
Corporate governance sustainability reporting	CGSR	Governance reporting index	[6,85,86]
Financial flexibility	FF	Equation (2)	[28,88,89]
Employee education	Eduscore	Equation (3)	[52]
Firm size,	FS	The natural log of total year-end assets	[82,90]
Sales growth	SG	The sales growth ratio, calculated as the change in sales divided by last-year sales	[89,91]
Leverage ratio (TL)	TL	Total debt to total assets	[82,87,89]
Firm age	Age	The natural log of the number of years from the establishment of the firm to the year of observation	[52]
State-owned	SP	A dummy variable (1 for state-owned and 0 otherwise)	[52]
Tobin-Q	Tobin-Q	The market value of a firm divided by the cost of its assets.	[89]
Board size	Board	The natural log of the number of directors sitting on the board	[52]

Note: This table shows the variable list. The annual data of all variables are taken from official data stream Wind, but sustainable reporting data and their subcomponents' data are taken from Hexun.com.

FS is calculated by taking the natural log of total assets at the end of the year. Large firms are normally more diversified and have more resources as compared to small-size firms, which can reduce risk-taking. But on the other hand, they are also engaged in aggressive risk-taking as well because they have more capital and a dominant role in the market [82,90]. We used the sales growth ratio for the measurement of SG. It is calculated by computing the change in sales, and then dividing the difference by the last year sales [89,91]. High sales growth reflects high market demand, which can lead to high risk-taking. But on the other hand, a firm may also adopt conservative strategies to protect their market position. We have used the total-debt-to-total-assets ratio for the leverage (TL). Firms who have high TL may have high risk-taking as well, because they have more pressure of generate return and meet financial obligation [82,87,89].

Age is computed by calculating the total number of years from the date of the firm's incorporation. Older firms will have a lower CRT because they have more stable cash flows, but to maintain a competitive advantage they might have high risk-taking as well [52]. State-owned (SP) is also used as control variable, which is identified by a dummy variable. We assigned 1 for state-owned firms and 0 for others. SP may have decreasing impact on CRT because government oversight and management might have risk-averse strategies [52]. We used Tobin-Q because it serves as a proxy of growth opportunity and firm performance. It is calculated by the ratio of market value to book value of the company. Firms with a higher Tobin -Q have higher CRT to exploit growth opportunities [89].

3.3. Econometric Model

Table 2 shows the main models based on our hypothesis, which we used to investigate our hypothesis.

Table 2. Regression models.

Models	Details	
Model 1	$CRT_{i,t} = \alpha_0 + \beta_1 CSR_{i,t} + \delta_1 FS + \delta_2 SG_{i,t} + \delta_3 Board_{i,t} + \delta_4 TL_{i,t} + \delta_5 Age_{i,t} + \delta_6 SP_{i,t} + \delta_6 TobinQ_{i,t} + \varepsilon_{i,t}$	(4)
Model 2	$CRT_{i,t} = \alpha_0 + \beta_1 CSR_{i,t} + \beta_2 Eduscore_{i,t} + \beta_3 CSR * Eduscore_{i,t} + \beta_4 FF_{i,t} + \beta_5 CSR * FF_{i,t} + + \delta_1 FS + \delta_2 SG_{i,t} + \delta_3 Board_{i,t} + \delta_4 TL_{i,t} + \delta_5 Age_{i,t} + \delta_6 SP_{i,t} + \delta_6 TobinQ_{i,t} + \varepsilon_{i,t}$	(5)
Model 3	$CRT_{i,t} = \alpha_0 + \beta_1 CESR_{i,t} + \delta_1 FS + \delta_2 SG_{i,t} + \delta_3 Board_{i,t} + \delta_4 TL_{i,t} + \delta_5 Age_{i,t} + \delta_6 SP_{i,t} + \delta_6 TobinQ_{i,t} + \varepsilon_{i,t}$	(6)
Model 4	$CRT_{i,t} = \alpha_0 + \beta_1 CESR_{i,t} + \beta_2 Eduscore_{i,t} + \beta_3 CESR * Eduscore_{i,t} + \beta_4 FF_{i,t} + \beta_5 CESR * FF_{i,t} + \delta_1 FS + \delta_2 SG_{i,t} + \delta_3 Board_{i,t} + \delta_4 TL_{i,t} + \delta_5 Age_{i,t} + \delta_6 SP_{i,t} + \delta_6 TobinQ_{i,t} + \varepsilon_{i,t}$	(7)
Model 5	$CRT_{i,t} = \alpha_0 + \beta_1 CSSR_{i,t} + \delta_1 FS + \delta_2 SG_{i,t} + \delta_3 Board_{i,t} + \delta_4 TL_{i,t} + \delta_5 Age_{i,t} + \delta_6 SP_{i,t} + \delta_6 TobinQ_{i,t} + \varepsilon_{i,t}$	(8)
Model 6	$CRT_{i,t} = \alpha_0 + \beta_1 CSSR_{i,t} + \beta_2 Eduscore_{i,t} + \beta_3 CSSR * Eduscore_{i,t} + \beta_4 FF_{i,t} + \beta_5 CSSR * FF_{i,t} + \delta_1 FS + \delta_2 SG_{i,t} + \delta_3 Board_{i,t} + \delta_4 TL_{i,t} + \delta_5 Age_{i,t} + \delta_6 SP_{i,t} + \delta_6 TobinQ_{i,t} + \varepsilon_{i,t}$	(9)
Model 7	$CRT_{i,t} = \alpha_0 + \beta_1 CGSR_{i,t} + \delta_1 FS + \delta_2 SG_{i,t} + \delta_3 Board_{i,t} + \delta_4 TL_{i,t} + \delta_5 Age_{i,t} + \delta_6 SP_{i,t} + \delta_6 TobinQ_{i,t} + \varepsilon_{i,t}$	(10)
Model 8	$CRT_{i,t} = \alpha_0 + \beta_1 CGSR_{i,t} + \beta_2 Eduscore_{i,t} + \beta_3 CGSR * Eduscore_{i,t} + \beta_4 FF_{i,t} + \beta_5 CGSR * FF_{i,t} + \delta_1 FS + \delta_2 SG_{i,t} + \delta_3 Board_{i,t} + \delta_4 TL_{i,t} + \delta_5 Age_{i,t} + \delta_6 SP_{i,t} + \delta_6 TobinQ_{i,t} + \varepsilon_{i,t}$	(11)

Note: This table states the four main models based on our hypothesis, which we used to investigate the impact of education on CRT by using fixed effect, 2SLS and 2-step system GMM dynamic panel models.

3.4. Estimation Methods

In this study, we used both static and dynamic panel estimation techniques to make sure that we obtain robust and reliable results. These techniques were selected on the basis of different diagnostics testing and also to address the common issues that normally exist in panel data, such as autocorrelation, heteroscedasticity, and endogeneity problems.

Firstly, on the basis of different tests, such as the Hausman test and Breusch and Pagan Lagrangian test, it was decided whether we had to use a fixed-effects or random-effects model for estimation. Based on these results, we decided to use a fixed-effects model because it was more appropriate for controlling unobserved heterogeneity across the firm level. We performed different diagnostic tests for heteroscedasticity and autocorrelation. Cameron and Trivedi's decomposition of the IM-test (1990) and the Breusch–Pagan/Cook–Weisberg test (1979) for heteroscedasticity detection were used. The modified Wald test for group-wise heteroscedasticity in the fixed-effect regression model was also applied.

Then, on the basis of the results of the Pesaran (2004) and Wooldridge tests (2002), which are significant, we used the panel-corrected standard error (PCSE) technique because it effectively addresses cross-sectional dependence and heteroscedasticity [92–94], which are common issues in panel data and can lead to biased standard errors in fixed-effects models [95]. Furthermore, PCSE provides more efficient estimation by correcting for potential biases due to autocorrelation, leading to more reliable statistical inference compared to standard fixed effects, which may overestimate the significance of variables [96]. Additionally, PCSE offers flexibility in model specification, allowing the inclusion of both time-invariant and time-varying variables [97].

It is also very important to address the potential endogeneity. Therefore, firstly we used 2SLS to handle potential endogeneity [98,99]. Because of the instrumental variable approach, 2SLS helps in mitigating the potential endogeneity. We also employed the two-step system GMM to effectively manage dynamic panel data and further mitigate potential endogeneity issues [100,101].

4. Results and Discussion

Appendix A shows the descriptive statistics, correlation and other diagnostic testing. To decide whether the fixed-effects or random-effects estimator is appropriate, we performed the Hausman test. Based on the Hausman specification test, we found that the fixed-effect model is more appropriate for our analysis. For our base line analysis at first, we estimate the fixed-effects model by controlling both firm and year.

Table 3 examines how CSR influences CRT, moderated by Eduscore and FF. Two different econometric techniques, fixed effects and PCSE, are employed across the two models to control for firm and year fixed effects. Model 1 and Model 2 both show a significant negative relationship between CSR and CRT. In the case of fixed effects and PCSE, the results of Model 1 show a CSR coefficient with a significant standard error, indicating that CSR has a significant and negative impact on CRT [6]. Firms that engage in sustainability reporting are less likely to engage in high-risk activities. This supports stakeholder theory, which posits that companies prioritizing sustainability are more conservative in their business strategies to align with stakeholder expectations [32]. Managers should enhance CSR activities as a strategy to mitigate risk and build investor confidence. Increased transparency in environmental, social, and governance practices can reassure stakeholders of the firm's long-term sustainability.

Model 2 shows results of introducing Eduscore and FF as moderators. Both Eduscore and FF have a significant and negative impact on CRT [57,65]. Better-educated employees are more cautious and risk-averse, likely due to enhanced knowledge and understanding of the potential long-term consequences of risk. This finding aligns with human capital theory, which emphasizes the importance of skilled employees in fostering responsible and informed decision-making [51]. Investing in employee education can be a key risk-reduction strategy for firms. Firms that foster knowledge and expertise in their workforce are more likely to implement careful, long-term strategies. Combining CSR efforts with employee education strengthens the firm's ability to manage risk, ensuring that sustainability goals are met while minimizing excessive risk-taking. FF firms are better able to withstand financial shocks, enabling them to take fewer risks. This aligns with pecking order theory, which suggests that firms with greater financial resources are less dependent on external financing, thus avoiding risky behavior [102]. Firms should maintain FF to reduce their vulnerability to risk. By conserving cash reserves and managing their debt ratios, firms can buffer themselves against market volatility. Firms that want to mitigate risk should adopt a dual approach of enhancing CSR while maintaining financial flexibility, creating a safety net against both operational and financial risks.

Table 4 examines how CESR influences CRT, moderated by Eduscore and FF. Two different econometric techniques, fixed effects and PCSE, are employed across the two models to control for firm and year fixed effects. Model 3 and Model 4 both show a significant negative relationship between CESR and CRT. In the case of fixed effects and PCSE results, Model 3 shows a CESR coefficient with a significant standard error, indicating that CESR has a significant and negative impact on CRT. Firms engaging in environmental sustainability reporting are less likely to take on excessive risks [48]. This is consistent with stakeholder theory, which suggests that firms actively reporting their environmental efforts may be more risk-averse to align with stakeholder expectations of sustainable and responsible operations [32]. Managers should promote CESR practices as a risk-reducing strategy. Transparent environmental reporting can lower uncertainty and promote trust among stakeholders, potentially leading to lower capital costs and less volatile earnings.

Table 3. CSR impact on CRT.

CRT	Model 1		Model 2	
Technique	**Fixed Effects**	**PCSE**	**Fixed Effects**	**PCSE**
CSR	−0.002 ***	−0.002 ***	−0.037 **	−0.009 **
	(0.000)	(0.000)	(0.017)	(0.004)
Eduscore			−0.156 ***	−0.018 ***
			(0.022)	(0.002)
CSR*Eduscore			−0.001 **	0.000 *
			(0.001)	(0.000)
FF			−0.818 ***	−0.747 ***
			(0.066)	(0.125)
CSR*FF			−0.957 ***	−0.156 ***
			(0.059)	(0.022)
FS	0.030 ***	0.030 *	−0.043	−0.009
	(0.005)	(0.017)	(0.030)	(0.031)
SG	0.075 ***	0.075 ***	0.318 ***	0.078 ***
	(0.002)	(0.005)	(0.024)	(0.005)
ROA	0.096 ***	0.096 ***	1.584 ***	0.096 ***
	(0.000)	(0.002)	(0.005)	(0.002)
TL	1.514 ***	1.514 *	1.612 ***	1.420 *
	(0.099)	(0.716)	(0.601)	(0.711)
Age	−0.041 ***	−0.041 **	0.915 ***	−0.046 **
	(0.006)	(0.015)	(0.074)	(0.016)
SP	−0.006	−0.006	−0.713 ***	−0.001
	(0.010)	(0.014)	(0.128)	(0.012)
TobinQ	0.030 ***	0.030 ***	−0.017	0.033 ***
	(0.002)	(0.006)	(0.027)	(0.006)
Board	−0.089 ***	−0.089 ***	−0.818 ***	−0.063 ***
	(0.005)	(0.009)	(0.066)	(0.007)
Constant	−1.436 ***	−0.544 ***	−0.122 ***	−0.071 ***
	(1.56)	(0.127)	(0.018)	(0.017)
Obs	54,565	54,565	64,272	54,565
Groups	0	5327		5327
R-squared	0.582	0.5822	0.756	0.5833
F-test	3266.231	1841.92	7618.078	2451.12
Prob > F	0.000	0.000	0.000	0.000
Firm Fixed	Yes	Yes	Yes	Yes
Year Fixed	Yes	Yes	Yes	Yes

Note: This table shows how CSR affects the CRT of the companies. We used the fixed effects and PCSE techniques. The significance level is designated by *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Source: author estimation.

Model 4 shows the results of introducing Eduscore and FF as moderators. Both Eduscore and FF have a significant and negative impact on CRT [48,65]. Better-educated employees are more likely to understand the potential consequences of risk and favor cautious decision-making. This supports human capital theory, which states that higher levels of education in the workforce can lead to more informed and risk-averse strategies [51]. The combination of CESR and employee education further amplifies the reduction in CRT. Educated employees may better understand the nuances of sustainability and its importance in risk management, further lowering the firm's risk profile. Financial flexibility reduces risk-taking in Model 3, aligning with pecking order theory [102], which posits that financially flexible firms can avoid high-risk external financing. However, the positive effect in Model 4 suggests that firms with financial flexibility may also have the capacity to take on moderate risks in a controlled manner. The combination of strong environmental sustainability practices and financial flexibility leads to even lower levels of risk-taking. Financially flexible firms that are committed to environmental sustainability tend to adopt

more conservative strategies, as they are better positioned to manage risks. Managers should not only focus on environmental sustainability reporting but also maintain financial flexibility to maximize their risk-reducing strategies. By doing so, firms can strengthen their reputation for stability and responsibility in the eyes of investors and stakeholders. Firms that engage in CESR, educate their workforce, and maintain financial flexibility are less likely to take on excessive risks, aligning with stakeholder expectations and ensuring long-term sustainability.

Table 4. CESR Impact on CRT.

Technique	**Model 3**		**Model 4**	
CRT	**Fixed Effects**	**PCSE**	**Fixed Effects**	**PCSE**
CESR	−0.003 *** (0.000)	−0.003 *** (0.000)	−0.011 *** (0.002)	−0.010 * (0.005)
Eduscore			−0.014 *** (0.002)	−0.017 *** (0.002)
CESR*Eduscore			−0.713 *** (0.128)	−0.818 *** (0.066)
FF			−0.062 *** (0.017)	0.822 * (0.458)
CESR*FF			−0.933 *** (1.733)	−0.062 *** (0.017)
FS	0.030 *** (0.005)	0.030 * (0.017)	0.023 *** (0.006)	−0.008 (0.031)
SG	0.074 *** (0.002)	0.074 *** (0.005)	0.076 *** (0.002)	0.078 *** (0.005)
TL	1.523 *** (0.099)	1.523 * (0.715)	1.339 *** (0.101)	1.420 * (0.708)
Age	−0.040 *** (0.006)	−0.040 ** (0.014)	−0.025 *** (0.006)	−0.044 ** (0.015)
SP	−0.005 (0.010)	−0.005 (0.014)	−0.005 (0.011)	−0.001 (0.012)
TobinQ	0.030 *** (0.002)	0.030 *** (0.006)	0.033 *** (0.002)	0.033 *** (0.006)
Board	−0.089 *** (0.005)	−0.089 *** (0.009)	−0.075 *** (0.005)	−0.063 *** (0.008)
Constant	−0.544 *** (0.127)	−0.062 *** (0.017)	−0.245 * (0.141)	−0.75 *** (0.005)
Obs	54,565	54,565	51615	54,565
Groups		5,327		5,327
R-squared	0.583	0.5826	0.578	0.5836
F-test	3271.190	3568.06	2638.337	2339.59
Prob > F	0.000	0.000		0.000
Firm Fixed	Yes		Yes	Yes
Year Fixed	Yes		Yes	Yes

Note: This table shows how CESR affects the CRT of the companies. We used the fixed effects and PCSE techniques. The significance level is designated by *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Source: author estimation.

Table 5 examines how CSSR influences CRT, moderated by Eduscore and FF. Two different econometric techniques, fixed effects and PCSE, are employed across the two models to control for firm and year fixed effects. Model 5 and Model 6 both show a significant negative relationship between CSSR and CRT. In the case of fixed effects and PCSE results, Model 5 shows a CSSR coefficient with a significant standard error, indicating that CSSR has a significant and negative impact on CRT [70]. Firms that report social sustainability practices tend to reduce their corporate risk-taking. Social sustainability reporting may reflect a focus on stakeholder welfare, diversity, and community engagement,

aligning with stakeholder theory [32], which suggests that firms considering their broader social impact are more risk-averse. Managers should incorporate social sustainability initiatives into their corporate strategies, as this can lead to reduced risk. Transparent reporting on social responsibility also signals stability to investors, enhancing the firm's reputation and long-term sustainability.

Table 5. CSSR impact on CRT.

Technique	**Model 5**		**Model 6**	
CRT	**Fixed Effects**	**PCSE**	**Fixed Effects**	**PCSE**
CSSR	−0.002 ***	−0.002 ***	−0.038 **	−0.009 **
	(0.000)	(0.000)	(0.016)	(0.003)
Eduscore			−0.148 ***	−0.020 ***
			(0.021)	(0.002)
CSSR*Eduscore			−0.001 *	0.000 **
			(0.001)	(0.000)
FF			−0.002 ***	−0.748 ***
			(0.000)	(0.125)
CSSR*FF			−0.043 ***	−0.094 ***
			(0.006)	(0.005)
FS	0.028 ***	0.028	−0.039	−0.012
	(0.005)	(0.017)	(0.029)	(0.030)
SG	0.075 ***	0.075 ***	0.317 ***	0.078 ***
	(0.002)	(0.005)	(0.024)	(0.005)
TL	1.564 ***	1.564 *	1.54 **	1.453 *
	(0.099)	(0.736)	(0.601)	(0.723)
Age	−0.043 ***	−0.043 **	0.924 ***	−0.049 **
	(0.006)	(0.016)	(0.074)	(0.017)
SP	−0.004	−0.004	−0.721 ***	0.000
	(0.010)	(0.014)	(0.128)	(0.012)
TobinQ	0.026 ***	0.026 ***	−0.002	0.031 ***
	(0.002)	(0.005)	(0.027)	(0.005)
Board	−0.094 ***	−0.094 ***	−0.798 ***	−0.064 ***
	(0.005)	(0.009)	(0.066)	(0.007)
Constant	−0.539 ***	−0.065 **	−1.419 ***	−1.148 ***
	(0.127)	(0.026)	(0.156)	(0.137)
Obs	54,565	54,565	64,272	54,565
Groups		5,327		5,327
R-squared	0.582	0.5817	0.756	0.5831
F-test	3259.793	2152.05	7616.552	1942.77
Prob > F	0.000	0.000	0.000	0.000
Firm Fixed	Yes		Yes	Yes
Year Fixed	Yes		Yes	Yes

Note: This table shows how CGSR affects the CRT of the companies. We used the fixed effects and PCSE techniques. The significance level is designated by *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Source: author estimation.

Model 6 shows the results of introducing Eduscore and FF as moderators. Both Eduscore and FF have a significant and negative impact on CRT [57,75]. Better-educated employees contribute to a more risk-averse corporate culture, likely due to their enhanced understanding of business risks and opportunities, consistent with human capital theory [51]. Firms should invest in employee education to reduce risk-taking behaviors. A well-educated workforce can mitigate risks by making informed decisions, thus enhancing the firm's resilience. FF reduces risk-taking, supporting pecking order theory [102], which suggests that firms with greater FF are less reliant on risky external financing. The combination of CSSR and FF leads to a substantial reduction in risk-taking. Firms that are socially responsible and FF are better able to balance long-term goals with short-term risks.

The interaction of CSSR with both employee education and FF further strengthens risk reduction [70,75]. Firms committed to social responsibility, supported by well-educated employees and financial flexibility, are less likely to engage in high-risk activities.

Table 6 examines how CGSR influences the CRT, moderated by Eduscore and FF. Two different econometric techniques, fixed effects and PCSE, are employed across the two models to control for firm and year fixed effects. Model 7 and Model 8 both show a significant negative relationship between CGSR and CRT [68,70]. In the case of fixed effects and PCSE results, Model 7 shows a CGSR coefficient with a significant standard error, indicating that CGSR has a significant and negative impact on CRT. CGSR significantly reduces CRT, indicating that companies with stronger governance practices tend to adopt more risk-averse behaviors. This finding aligns with agency theory [54], where improved governance reduces managerial discretion, leading to more cautious decision-making. Firms should strengthen their governance mechanisms and transparency in governance-related disclosures to reduce CRT. Strong governance can mitigate excessive risk-taking and reassure investors of the firm's stability.

Table 6. CGSR impact on CRT.

Technique	**Model 7**		**Model 8**	
CRT	**Fixed Effects**	**PCSE**	**Fixed Effects**	**PCSE**
CGSR	−0.002 *** (0.000)	−0.002 *** (0.000)	−0.009 *** (0.001)	−0.008 * (0.004)
Eduscore			−0.015 *** (0.002)	−0.018 *** (0.002)
CGSR*Eduscore			−0.721 *** (0.128)	−0.798 *** (0.066)
FF			−0.059 *** (0.017)	−0.043 *** (0.006)
CGSR*FF			−0.089 *** (0.005)	−0.059 *** (0.127)
FS	0.029 *** (0.005)	0.029 (0.017)	0.022 *** (0.006)	−0.008 (0.031)
SG	0.075 *** (0.002)	0.075 *** (0.006)	0.076 *** (0.002)	0.078 *** (0.005)
TL	1.506 *** (0.099)	1.506 * (0.713)	1.328 *** (0.101)	1.415 * (0.709)
Age	−0.043 *** (0.006)	−0.043 ** (0.016)	−0.027 *** (0.006)	−0.048 ** (0.017)
SP	−0.006 (0.010)	−0.006 (0.014)	−0.005 (0.011)	−0.001 (0.012)
TobinQ	0.030 *** (0.002)	0.030 *** (0.006)	0.033 *** (0.002)	0.032 *** (0.005)
Board	−0.089 *** (0.005)	−0.089 *** (0.008)	−0.076 *** (0.005)	−0.063 *** (0.007)
Constant	−0.072 *** (0.027)	−0.509 *** (0.127)	−0.033 *** (0.002)	−0.027 *** (0.006)
Obs	54,565	54,565	51,615	54,565
Groups	-	5,327	-	5327
R-squared	0.582	0.5822	0.578	0.5832
F-test	3265.440	3867.42	2635.202	6979.74
Prob > F	0.000	0.000	0.000	0.000
Firm Fixed	Yes	Yes	Yes	Yes
Year Fixed	Yes	Yes	Yes	Yes

Note: This table shows how CSR, CESR, CSSR, and CGSR affect the CRT of the companies. We used the fixed effects and PCSE techniques. The significance level is designated by *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Source: author estimation.

Model 8 shows the results of introducing Eduscore and FF as moderators. Both Eduscore and FF have a significant and negative impact on CRT [57,75]. Educated employees contribute to more risk-averse decision-making, potentially due to their ability to make more informed judgments about risk. This supports human capital theory [51], which emphasizes the value of investing in employee education to enhance decision-making and reduce risky behavior. Firms can lower their risk by investing in employee education. Educated employees are better equipped to handle uncertainties, which can result in more sustainable and cautious corporate strategies. When combined, CGSR and employee education have a stronger risk-reducing effect. Firms with both strong governance and a well-educated workforce are more likely to engage in conservative risk management. Companies should focus on enhancing both governance practices and employee education to reinforce their risk management strategies. Financially flexible firms are less prone to taking risks, as they can rely on internal financing or reserves rather than resorting to riskier external funding sources. This aligns with pecking order theory [102], where firms with greater financial flexibility are less inclined to pursue risky ventures. The combination of CGSR and financial flexibility leads to a significant reduction in risk-taking. Firms with strong governance and FF have more capacity to absorb potential shocks, leading to more prudent risk management. The interaction of CGSR with employee education and FF amplifies the risk-reducing effects [68,73,75]. Firms with stronger governance, better-educated employees, and greater FF are less likely to engage in risky corporate behavior.

4.1. Mechanism Analysis

The findings of two regression models examining the relationship between corporate sustainability reporting (CSR), which includes environmental sustainability (CESR), social sustainability (CSSR), and governance sustainability (CGSR), and corporate risk-taking (CRT) and revenue growth (TRG) are shown in the table below. After adjusting for a number of important factors, the mechanism analysis looks at how revenue growth and sustainability reporting affect business risk-taking behavior.

Table 7 shows the positive and significant coefficient for CSR on TRG, which is 0.101. This implies that companies who report more on corporate sustainability may have increased revenue. This may indicate that while greater openness in sustainability initiatives may slow development in the near term, it may have long-term advantages for stakeholder trust and brand reputation [103].

Environmental sustainability reporting does not seem to have a substantial direct influence on revenue growth, as indicated by the coefficient for CESR on TRG of −0.001, which is not statistically significant. This finding may suggest that even while businesses adopt environmentally sustainable policies, their income growth may not be immediately impacted, maybe because implementation takes time to show results. With a coefficient of 0.04, CSSR significantly improves TRG. This suggests that socially conscious businesses may have more consumer loyalty and better market prospects as a result of social sustainability initiatives, such as labor practices and community participation, which have a favorable impact on revenue growth [104]. TRG is positively impacted by CGSR, as indicated by its 0.036 coefficient. Strong corporate governance procedures have been linked to faster revenue growth for businesses, most likely as a result of increased investor, regulatory, and stakeholder trust in the business's operations [105].

Table 7. Mechanism analysis.

Variable	TRG	CRT
CSR	0.101 ***	−0.071 ***
	(0.001)	(0.007)
CESR	−0.001	−0.006 ***
	(0.002)	(0.001)
CSSR	0.040 ***	−0.095 ***
	(0.002)	(0.009)
CGSR	0.036 ***	−0.003 **
	(0.003)	(0.002)
FS	0.092 ***	0.023 ***
	(0.004)	(0.004)
TRG	-	0.075 ***
		(0.002)
TL	−2.051 ***	1.572 ***
	(0.092)	(0.098)
Age	−0.223 ***	−0.056 ***
	(0.010)	(0.005)
SP	0.008	0.017 *
	(0.019)	(0.009)
TobinQ	0.01 **	0.028 ***
	(0.004)	(0.002)
Board	0.699 ***	−0.092 ***
	(0.009)	(0.005)
Constant	0.038 **	−0.494 ***
	(0.018)	(0.119)
Observations	54,565	69,628
F test	5707.511	2652.266
Prob > F	0.000	0.000
R-Square	0.582	0.312

Note: This table shows the mechanisms. Here, we have used revenue growth to check the mechanisms. The significance level is designated by *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Source: author estimation.

Then, we examined how sustainability reporting affects CRT along with TRG. The results show a CSR coefficient with a significant standard error, indicating that CSR has a significant and negative impact on CRT [6]. Firms that engage in sustainability reporting are less likely to engage in high-risk activities. This supports stakeholder theory, which posits that companies prioritizing sustainability are more conservative in their business strategies to align with stakeholder expectations [32]. Managers should enhance CSR activities as a strategy to mitigate risk and build investor confidence. Increased transparency in environmental, social, and governance (ESG) practices can reassure stakeholders of the firm's long-term sustainability. A CESR coefficient with a significant standard error indicates that CESR has a significant and negative impact on CRT. Firms engaging in environmental sustainability reporting are less likely to take on excessive risks [48]. This is consistent with stakeholder theory, which suggests that firms actively reporting their environmental efforts may be more risk-averse to align with stakeholder expectations of sustainable and responsible operations [32]. Managers should promote CESR practices as a risk-reducing strategy. Transparent environmental reporting can lower uncertainty and promote trust among stakeholders, potentially leading to lower capital costs and less volatile earnings. A CSSR coefficient with a significant standard error shows that CSSR has a significant and negative impact on CRT [70]. Firms that report social sustainability practices tend to reduce their corporate risk-taking. Social sustainability reporting may reflect a focus on stakeholder welfare, diversity, and community engagement, aligning with stakeholder theory [32], which suggests that firms considering their broader social

impact are more risk-averse. Managers should incorporate social sustainability initiatives into their corporate strategies, as this can lead to reduced risk. Transparent reporting on social responsibility also signals stability to investors, enhancing the firm's reputation and long-term sustainability. Results show a significant negative relationship between CGSR and CRT [68,70]. CGSR significantly reduces CRT, indicating that companies with stronger governance practices tend to adopt more risk-averse behaviors. This finding aligns with agency theory [54], where improved governance reduces managerial discretion, leading to more cautious decision-making. Firms should strengthen their governance mechanisms and transparency in governance-related disclosures to reduce CRT. Strong governance can mitigate excessive risk-taking and reassure investors of the firm's stability.

The findings imply that company risk-taking and revenue growth are impacted differently by sustainability reporting and its subcomponents, such as environmental, social, and governance forms of sustainability reporting. Sustainability reporting and its subcomponents tend to deter risk-taking on one side. Similarly, on the other side, they encourage revenue development. Furthermore, revenue growth itself significantly increases corporate risk-taking, suggesting that it may operate as a mediator in the link between risk behavior and sustainable policies.

4.2. Heterogeneity Analysis

Table 8 examines the relationship between CSR and CRT across different firm sizes (large, medium, and small). The table includes the coefficients and standard errors of variables and provides insight into how CSR and other factors influence CSR depending on the size of the firm.

Table 8. Impact of CSR on CRT based on firm sizes.

Variable	Large	Medium	Small
CSR	−0.002 ***	−0.002 ***	−0.001
	(0.001)	(0.001)	(0.001)
FS	0.038 ***	−0.028 ***	−0.079 ***
	(0.005)	(0.009)	(0.021)
SG	0.077 ***	0.075 ***	0.062 ***
	(0.002)	(0.004)	(0.010)
TL	1.77 ***	1.481 ***	2.725 ***
	(0.135)	(0.154)	(0.442)
Age	−0.049 ***	−0.095 ***	−0.114 ***
	(0.006)	(0.009)	(0.027)
SP	0.009	0.05 **	−0.067
	(0.010)	(0.022)	(0.072)
TobinQ	0.029 ***	0.019 ***	0.04 ***
	(0.002)	(0.004)	(0.009)
Board	−0.089 ***	−0.083 ***	−0.076 ***
	(0.006)	(0.008)	(0.024)
Constant	−1.049 ***	0.672 ***	0.545 *
	(0.157)	(0.225)	(0.329)
R-Square	0.568	0.620	0.638
F-test	5230.432	2146.032	283.735
Prob > F	0.000	0.000	0.000
Obs	39,597	13,271	1638

Note: this table shows how CGSR affects CRT in different firms depending upon their small, medium, or large size. The significance level is designated by *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Source: author estimation.

The results show a negative and significant coefficient value of −0.002 in the case of large firms. This suggests that large firms who have more stable and developed sustainability practices have reduced CRT because they focus on long-term sustainability

goals instead of short-term riskier projects. We can see the same results in the case of medium-size firms. This means that medium-size firms may be under more pressure to maintain stability and stakeholder trust. For small firms, the coefficient for CSR is −0.001 (not statistically significant, *p*-value > 0.05). This suggests that CSR may not significantly influence risk-taking in small firms, possibly because smaller firms have less formalized sustainability reporting and may prioritize growth over sustainability, making them less risk-averse. These results are in line with a past study, which showed a negative impact on CRT [6]. From an agency theory perspective [54], larger firms may have more resources to engage in sustainability efforts, leading to a more risk-averse approach as they aim to safeguard their established reputations and mitigate risks. In contrast, small firms may not view CSR efforts as a primary driver of decision-making. Firms should tailor their sustainability strategies based on size. Large firms may focus on sustainability to reduce risk, while smaller firms might use CSR to enhance growth opportunities without overly restricting risk-taking.

Table 9 examines the relationship between CESR and CRT across different firm sizes (large, medium, and small). The table includes the coefficients and standard errors of variables and provides insight into how CESR and other factors influence CRT depending on the size of the firm.

Table 9. Impact of CESR on CRT based on firm sizes.

Variable	Large	Medium	Small
CESR	−0.003 ***	−0.003 ***	−0.001
	(0.001)	(0.001)	(0.001)
FS	0.041 ***	−0.024 **	−0.08 ***
	(0.005)	(0.010)	(0.021)
SG	0.077 ***	0.074 ***	0.062 ***
	(0.002)	(0.004)	(0.010)
TL	1.763 ***	1.466 ***	2.734 ***
	(0.135)	(0.154)	(0.441)
Age	−0.046 ***	−0.091 ***	−0.113 ***
	(0.006)	(0.009)	(0.027)
SP	0.011	0.052 **	−0.067
	(0.010)	(0.022)	(0.072)
TobinQ	0.029 ***	0.021 ***	0.04 ***
	(0.002)	(0.004)	(0.009)
Board	−0.088 ***	−0.081 ***	−0.076 ***
	(0.006)	(0.008)	(0.024)
Constant	−1.11 ***	0.621 ***	0.544 *
	(0.157)	(0.225)	(0.329)
R-Square	0.568	0.621	0.638
F-test	5240.085	2151.821	283.718
Prob > F	0.000	0.000	0.000
Obs	39,597	13,271	1638

Note: this table shows how CGSR affects CRT in different firms depending upon their small, medium, or large size. The significance level is designated by *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Source: author estimation.

The results show a negative and significant coefficient value of −0.003 in the case of large firms. This suggests that large firms who have more stable and developed sustainability practices have a reduced CRT because they focus on long-term sustainability goals instead of short-term riskier projects. They want to maintain a positive reputation among stakeholders. We can see the same results in the case of medium-size firms. This means that medium-size firms may be under more pressure to maintain stability and stakeholder trust. For small firms, the coefficient for CSR is −0.001 (not statistically significant, *p*-value > 0.05). This suggests that CESR may not significantly influence risk-taking in small firms, possibly

because smaller firms have less formalized sustainability reporting and may prioritize growth over sustainability, making them less risk-averse. These results are line with past studies [6,106].

The results for CESR in large and medium firms align with agency theory, suggesting that more transparent sustainability practices lead to more conservative strategies. These firms aim to reduce risk to protect their reputation and long-term viability. However, for small firms, CESR does not significantly affect risk-taking, which could be due to the less formal nature of sustainability reporting in these firms [54].

Table 10 examines the relationship between CSSR and CRT across different firm sizes (large, medium, and small). The table includes the coefficients and standard errors of variables and provides insight into how CSSR and other factors influence CRT depending on the size of the firm.

Table 10. Impact of CSSR on CRT based on firm sizes.

Variable	Large	Medium	Small
CSSR	−0.002 ***	−0.027 ***	0
	(0.001)	(0.010)	(0.001)
FS	0.037 ***	−0.002 ***	−0.083 ***
	(0.005)	(0.001)	(0.021)
SG	0.077 ***	0.075 ***	0.063 ***
	(0.002)	(0.004)	(0.010)
TL	1.824 ***	1.495 ***	2.795 ***
	(0.135)	(0.154)	(0.443)
Age	−0.05 ***	−0.094 ***	−0.12 ***
	(0.006)	(0.009)	(0.027)
SP	0.008	0.05 **	−0.069
	(0.010)	(0.022)	(0.072)
TobinQ	0.026 ***	0.018 ***	0.037 ***
	(0.002)	(0.004)	(0.009)
Board	−0.093 ***	−0.084 ***	−0.079 ***
	(0.006)	(0.008)	(0.024)
Constant	−1.103 ***	0.654 ***	0.556 *
	(0.157)	(0.226)	(0.329)
R-Square	0.567	0.620	0.638
F-test	5221.199	2144.567	283.473
Prob > F	0.000	0.000	0.000
Obs	39,597	13,271	1638

Note: this table shows how CGSR affects CRT in different firms depending upon their small, medium, or large size. The significance level is designated by *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Source: author estimation.

The results show a negative and significant coefficient value of −0.002 in the case of large firms. This suggests that large firms who have more stable and developed social sustainability practices have reduced CRT because they focus on long-term social sustainability goals (community and labor practices) instead of short-term riskier projects. They want to maintain a positive reputation among stakeholders [32]. We can see the same kinds of significant and negative impact results in the case of medium-size firms. This means that medium-size firms may be under more pressure to maintain stability and stakeholder trust. For small firms, the coefficient for CSSR is −0.001. This suggests that CSSR may not significantly influence risk-taking in small firms, possibly because smaller firms have less formalized social sustainability reporting as they have less resources to engage in sustainability practices and may prioritize growth over sustainability, making them less risk-averse. These results are line with past studies [6,106]. Agency theory and stakeholder theory suggest that firms engage in sustainability reporting to reduce agency costs and align with stakeholder expectations [32,54]. In larger firms, the negative relationship between

CSSR and risk-taking may reflect a strategic choice to mitigate risks and maintain long-term sustainability, as they are more scrutinized by stakeholders.

Table 11 examines the relationship between CGSR and CRT across different firm sizes (large, medium, and small). The table includes the coefficients and standard errors of variables and provides insight into how CGSR and other factors influence CRT depending on the size of the firm.

Table 11. Impact of CGSR on CRT based on firm sizes.

Variable	Large	Medium	Small
CGSR	−0.002 ***	−0.029 ***	−0.001
	(0.001)	(0.009)	(0.001)
FS	0.035 ***	−0.002 ***	−0.078 ***
	(0.005)	(0.001)	(0.021)
SG	0.077 ***	0.075 ***	0.062 ***
	(0.002)	(0.004)	(0.010)
TL	1.768 ***	1.483 ***	2.696 ***
	(0.135)	(0.155)	(0.443)
Age	−0.053 ***	−0.099 ***	−0.112 ***
	(0.006)	(0.009)	(0.027)
SP	0.009	0.05 **	−0.066
	(0.010)	(0.022)	(0.072)
TobinQ	0.029 ***	0.019 ***	0.041 ***
	(0.002)	(0.004)	(0.009)
Board	−0.089 ***	−0.083 ***	−0.074 ***
	(0.006)	(0.008)	(0.024)
Constant	−1 ***	0.708 ***	0.545 *
	(0.157)	(0.225)	(0.329)
R-Square	0.567	0.620	0.638
F-test	5228.692	2144.639	283.925
Prob > F	0.000	0.000	0.000
Obs	39,597	13,271	1638

Note: this table shows how CGSR affects CRT in different firms depending upon their small, medium, or large size. The significance level is designated by *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Source: author estimation.

The results show a negative and significant coefficient value of −0.002 in the case of large firms. This suggests that large firms who have more stable and developed governance sustainability practices such as board oversight have reduced CRT because they focus on long-term governance sustainability goals. These finding align with agency theory [54]. We can se the same kinds significant and negative impact results in the case of medium-size firms, whose coefficient is −0.029. This means that medium-size firms may be under more pressure to maintain stability and stakeholder trust. For small firms, the coefficient for CSSR is −0.001. This suggests that CGSR may not significantly influence risk-taking in small firms, possibly because smaller firms may not have a comprehensive corporate governance structure as they have fewer resources to engage in sustainability practices and may prioritize growth over sustainability, making them less risk-averse. These results are line with past studies [6,106]. CGSR, especially in highly regulated or competitive industries, may be a strategy for big and medium-sized businesses to decrease executive discretion, attract stakeholders, and maintain risk control. But for small businesses, other elements (such budgetary limitations or expansion prospects) may be more important in influencing risk-taking behavior.

4.3. Robustness

In the robustness test, to address the potential endogeneity we used two different techniques. We used the 2SLS and two-step systems GMM techniques. The reason for using these two techniques is because when a variable is not exogenous, results under the 2SLS technique are considered to be biased. Therefore, to handle this issue we also used the GMM technique to deal with the potential endogeneity, which commonly occurs in economics, corporate finance, and econometrics valuation [107]. We also used different proxies, such as Z-score CRT.

In Table 12, the results of 2SLS regression and two-step system GMM for Model 1, 2, 3, 4, 5, 6, 7, and 8 are also shown. We used asset tangibility and leverage as instrument variables [108,109]. As per the 2SLS results, CSR, CESR, CSSR, and CGSR coefficients with a significant standard error show that corporate sustainability has a significant and negative impact on CRT. Firms that engage in sustainability reporting are less likely to engage in high-risk activities. This supports stakeholder theory, which posits that companies prioritizing sustainability are more conservative in their business strategies to align with stakeholder expectations [32]. Managers should enhance CSR activities as a strategy to mitigate risk and build investor confidence.

The results of two-step system GMM for each model are also presented. The results show that CSR, CESR, CSSR, and CGSR reduce CRT, and this impact is stronger when we use FF and employee education as moderators. These results support human capital theory and pecking order theory [51,102]. We take the lag of the dependent variable (L.CRT) to further control for the possible endogeneity problem. Past studies state that inconsistent and misleading results are obtained when we ignore the lag of dependent variable or when endogeneity bias is allowed [110,111]. These results are in line with the PCSE techniques used in our main analysis, stakeholder theory, human capital theory, and pecking order theory [32,51,102]. In the case of control variables for Model 1, 2, 3, 4, 5, 6, 7, and 8, their results are also similar to the PCSE techniques. We used asset tangibility and leverage as instrumental variables [108,109]. Additionally, it is observed that the AR (1) value is 0.000, which is significant and means there is a first-order condition. On the other side, the AR (2) value shows that there is no second-order serial correlation among the error terms. Based on the Sargan and Hensen test value, it can be observed that it is insignificant to question the instrument's legitimacy or validity due to the lack of over-identification, which means GMM has been properly specified.

We can be highly confident that this relationship is not due to random chance. The consistent negative and significant effect across all three models (PCSE, 2SLS, and two-step system GMM) suggests that the relationship among higher CSR, CESR, CSSR, and CGSR and lower CRT is robust to different estimation techniques. Each model accounts for different potential issues (e.g., endogeneity and omitted variable bias), reinforcing the reliability of the results [92–94,107].

Table 12. CSR, CESR, CSSR, and CGSR impact on CRT.

CRT	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6		Model 7		Model 8	
Technique	**2SLS**	**GMM**	**2SLS**	**GMM**	**2SLS**	**GMM**	**2SLS**	**GMM**	**2SLS**	**GMM**	**2SLS**	**GMM**	**2SLS**	**GMM**	**2SLS**	**GMM**
L.CRT		−0.092 ** (0.036)		−0.152 *** (0.049)		−0.083 ** (0.036)		−0.102 ** (0.047)		−0.079 ** (0.036)		−0.122 ** (0.050)		−0.095 *** (0.36)		−0.152 *** (0.049)
CSR	−0.003 *** (0.000)	−0.001 ** (0.001)	−0.020 *** (0.001)	−0.009 *** (0.001)												
CESR					−0.009 *** (0.002)	−0.002 *** (0.001)	−0.023 *** (0.001)	−0.089 *** (0.005)								
CSSR									−0.004 *** (0.002)	−0.002 *** (0.001)	−0.02 *** (0.001)	−0.057 *** (0.016)				
CGSR													−0.003 *** (0.000)	−0.001 * (0.001)	−0.015 *** (0.001)	−0.037 ** (0.017)
Eduscore			−0.017 *** (0.002)	−0.097 *** (0.020)			−0.016 *** (0.002)	−0.065 *** (0.017)			−0.019 *** (0.002)	−0.074 *** (0.019)			−0.023 *** (0.002)	−0.097 *** (0.019)
CSR*Eduscore			−0.015 *** (0.002)	−0.059 *** (0.017)												
CESR*Eduscore							−0.067 *** (0.013)	−0.041 *** (0.006)								
CSSR*Eduscore											0.066 ** (0.027)	−0.002 *** (0.000)				
CGSR*Eduscore															−0.001 ** (0.001)	−0.089 *** (0.005)
FF			−0.069 *** (0.019)	−0.076 *** (0.005)			−0.07 *** (0.190)	−0.533 *** (0.127)			−0.067 *** (0.019)	−0.957 *** (0.059)			−0.818 *** (0.066)	−0.713 *** (0.128)
CSR*FF			−0.072 *** (0.017)	−0.031 * (0.160)												

Table 12. *Cont.*

CRT	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6		Model 7		Model 8	
Technique	**2SLS**	**GMM**	**2SLS**	**GMM**	**2SLS**	**GMM**	**2SLS**	**GMM**	**2SLS**	**GMM**	**2SLS**	**GMM**	**2SLS**	**GMM**	**2SLS**	**GMM**
CESR*FF							−0.060 *** (0.016)	−0.071 *** (0.017)								
CSSR*FF											−0.747 *** (0.125)	-0.554 *** (0.148)				
CGSR*FF															−0.003 *** (0.000)	−0.040 *** (0.006)
Controls								Yes Applied								
Constant	1.372 *** (0.145)	1.243 *** (0.272)	1.837 *** (0.179)	1.034 *** (0.143)	1.018 *** (0.249)	2.041 *** (0.171)	1.320 *** (0.137)	1.486 *** (0.153)	0.214 *** (0.041)	1.017 *** (0.029)	0.905 *** (0.068)	0.583 *** (0.029)	0.962 *** (0.059)	0.678 *** (0.107)	0.506 *** (0.014)	0.436 *** (0.009)
Obs	54,565	46,706	51,615	46,706	69,628	46,706	51,615	46,706	69,628	46,706	51,615	46,706	54,565	46,706	54,656	46,706
Groups		5310		5310		5310		5310		5310		5310		5310		5310
Instruments		49		49		49		49		49		49		49		49
Prob > chi2		0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000
R-squared	0.630		0.632		0.765		0.632		0.765		0.631		0.630		0.632	
F-test	10,319.092		6804.917		25,188.395		6811.563		25182.103		6797.595		10,321.082		7207.625	
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000		0.000	0.000	0.000	0.000
Firm Fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes
Year Fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes
AR (1) (*p*-value)		0.000		0.000		0.001		0.000		0.000		0.000		0.000		0.000
AR (2) (*p*-value)		0.247		0.327		0.197		0.210		0.713		0.527		0.911		0.009
Sargan test		0.223		0.151		0.031		0.103		0.224		0.886		0.998		0.509
Hansen test		0.313		0.174		0.167		0.143		0.321		0.922		0.992		0.791

Note: This table shows how CSR, CESR, CSSR, and CGSR affect the CRT of the companies. We used the 2SLS and 2-step systems GMM techniques for the robustness check. The significance level is designated by *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Source: author estimation.

5. Conclusions, Policy Implications, Limitations, and Future Study Directions

5.1. Conclusions

This study analyzes the impact of corporate sustainable reporting, corporate environmental sustainable reporting, corporate social sustainable reporting, and corporate governance sustainable reporting on corporate risk-taking. We used employees' education and financial flexibility as the moderators in this study. Our methodology included fixed effects, PCSE for the main analysis, and 2SLS and two-step GMM dynamic panel for robustness. PCSE was used to address cross-sectional dependence and heteroscedasticity, while GMM reduced the inconsistency of estimates and addressed potential endogeneity by using lagged values of CRT. Our results confirm that CSR and its subcomponents significantly reduce CRT (supporting H1, H3, H5, and H7). Furthermore, the moderating effects of financial flexibility and employee education enhance this risk-reduction effect (H2, H4, H6, and H8), highlighting their vital roles in strengthening the influence of sustainability practices. These findings demonstrate that corporate sustainable reporting and its subcomponents play a critical role in reducing CRT, with robust interactions between employee education, financial flexibility, and sustainability metrics amplifying these effects. The negative coefficients for CSR, CESR, CSSR, and CGSR across models underscore their importance in curbing corporate risk. Moreover, the interaction terms between sustainability metrics and moderators like employee education and financial flexibility further reduce CRT, indicating their crucial role in mitigating risks. Overall, this research offers a comprehensive understanding of how sustainable practices, when combined with organizational factors, significantly reduce corporate risk, supporting the argument for adopting sustainable governance and reporting practices.

5.2. Policy Implications

This study's conclusions have significant policy ramifications for frameworks related to corporate governance and risk management. To improve risk reduction, regulators and legislators ought to support or require corporate sustainability reporting (CSR), particularly in developing nations. Furthermore, it is recommended that companies give precedence to employee education and financial flexibility, since research indicates that these elements enhance the effectiveness of sustainability programs in mitigating company risk. For the purpose of encouraging a more risk-averse and sustainable corporate environment, regulatory frameworks should incorporate ESG criteria, such as environmental, social, and governance sustainability reporting. Given that sustainable corporate governance principles have been demonstrated to support long-term risk management strategies, organizations ought to think about updating their internal rules to conform to these principles as well.

5.3. Limitations and Future Study Direction

There are a few limitations of this study that can be resolved in future studies. First off, the analysis's applicability to other situations or geographical areas may be limited because it is predicated on sustainable reporting data from a single source, Hexun.com. Furthermore, by concentrating on a small number of key moderator variables, such as financial flexibility and employee education, for example, future research on additional moderators or mediators, including company culture or outside market conditions, may be conducted. Lastly, although this study provides a thorough analysis of the influence of sustainability reporting on business risk-taking, longer-term studies that look at these dynamics may shed more light on the causal connections. To further understand the global applicability of these findings, future studies might also compare the effects of sustainability reporting in developed versus emerging markets.

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Appendix A

Table A1 provides descriptive statistics for the main variables. The maximum and minimum values of CRT are 4.038 and −4.605, respectively, with a standard deviation of 0.986. CSR, CESR, CSSR, and CGSR, used as the independent variables, have maximum values of 90.28, 78.75, 94.61, and 90.280 and minimum values of −3.880, 0.010, 0.056, and 0.101, respectively, highlighting significant differences among firms. The distribution patterns of the other control variables are consistent with those reported in previous studies [40,52,78,112,113].

Table A1. Descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
CRT	69,628	2.237	0.986	−4.605	4.038
CSR	69,628	48.461	38.773	1.585	90.28
CESR	69,628	37.358	30.102	0.010	78.75
CSSR	69,628	45.827	36.998	0.056	94.61
CGSR	69,628	48.461	38.773	0.101	90.28
Eduscore	69,628	4.837	3.492	0.000	2.325
FF	69,628	0.836	0.305	−0.048	1.25
FS	69,628	19.08	7.228	7.828	26.761
SG	69,628	1.619	1.517	−0.361	4.688
TL	69,628	0.836	0.314	0.020	0.998
Age	69,628	1.187	1.292	−1.623	3.333
SP	69,628	0.181	0.385	0.000	1
TobinQ	69,628	1.291	1.773	0.857	9.409
Board	69,628	1.604	0.902	0.609	2.639

Note: this table shows the summary of our sample data for the period of 2011 to 2023 for companies from China.

Table A2 presents the correlation coefficients among the variables in this study. The results indicate that the correlation coefficients are not high. Specifically, it is observed that CRT and CSR, CESR, CSSR, and CGSR are negatively related, with a correlation coefficient of −0.439, −0.441, −0.428, and −0.439, respectively, which aligns with our hypotheses. The correlation values fall within the acceptable range, as demonstrated by the figures. To maintain brevity, we have omitted the discussion of the remaining correlations.

Table A2. Correlations.

Variable	CRT	CSR	CESR	CSSR	CGSR	Eduscore	FF	FS	SG	ROA	TL	Age	SP	TobinQ	Board
CRT	1.000														
CSR	−0.439 ***	1.000													
CESR	−0.441 ***	0.970 ***	1.000												
CSSR	−0.428 ***	0.966 ***	0.967 ***	1.000											
CGSR	−0.439 ***	1.000 ***	0.970 ***	0.966 ***	1.000										
Eduscore	−0.325 ***	0.733 ***	0.740 ***	0.734 ***	0.733 ***	1.000									
FF	−0.216 ***	0.496 ***	0.530 ***	0.516 ***	0.496 ***	0.560 ***	1.000								

Table A2. *Cont.*

Variable	CRT	CSR	CESR	CSSR	CGSR	Eduscore	FF	FS	SG	ROA	TL	Age	SP	TobinQ	Board
FS	−0.233 ***	0.531 ***	0.562 ***	0.548 ***	0.531 ***	0.591 ***	0.986 ***	1.000							
SG	0.123 *	0.236 ***	0.227 ***	0.251 ***	0.236 ***	0.294 ***	0.185 **	0.204 ***	1.000						
ROA	0.749 ***	−0.448 ***	−0.458 ***	−0.449 ***	−0.448 ***	−0.351 ***	−0.400 ***	−0.409 ***	0.048	1.000					
TL	0.009	−0.009	0.037	0.028	−0.009	0.101 *	0.420	0.383 ***	0.017	−0.194 ***	1.000				
Age	−0.409 ***	0.677 ***	0.694 ***	0.685 ***	0.677 ***	0.586 ***	0.536 ***	0.557	0.057 ***	−0.398	0.211	1.000			
SP	−0.135 **	0.198 ***	0.197 ***	0.179 ***	0.198 ***	0.184 ***	0.308 ***	0.310 ***	−0.003	−0.182 ***	0.163 ***	0.303 ***	1.000		
TobinQ	−0.095 *	0.486 ***	0.439 ***	0.454 ***	0.486 ***	0.291 ***	−0.042	−0.016	0.201 ***	−0.038	−0.304 ***	0.120 ***	−0.047	1.000	
Board	−0.297 ***	0.608 ***	0.605 ***	0.601 ***	0.608 ***	0.670 ***	0.387 ***	0.429 ***	0.362 ***	−0.308 ***	0.003	0.436 ***	0.149 ***	0.299 ***	1.000

Notes: This table reports the correlation matrix between the dependent, independent, and control variables of this study. It shows the relationship between the variables and their direction as well. Asterisks indicate significance level. *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.10$.

Diagnostic Testing

Table A3 presents the results of the multicollinearity test, confirming that our data are free from multicollinearity issues. Past studies state that a VIF equal to 1 indicates no correlation between the explanatory variables, whereas a VIF greater than 10 suggests the presence of multicollinearity [114]. The value of the VIF score must be less than 10. If its value is more than 10, it means there is multicollinearity in the data and there is a need to include or exclude some variables [89,115]. The individual and aggregate VIF test results shown in Table A3 verify that there is no multicollinearity among any of this study's explanatory variables.

Table A3. Multicollinearity test.

Models	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6		Model 7		Model 8	
CSR	3.917	0.255	4.387	0.228												
CESR					3.65	0.274	4.071	0.246								
CSSR									3.606	0.277	3.995	0.25				
CGSR													3.784	0.264	4.211	0.237
Eduscore			2.98	0.336			2.967	0.337			2.947	0.339			2.96	0.338
FF			2.261	0.442			2.818	0.355			2.804	0.357			3.239	0.309
Age	2.376	0.421	2.401	0.417	2.33	0.429	2.36	0.424	2.335	0.428	2.366	0.423	2.321	0.431	2.35	0.425
FS	2.115	0.473	2.092	0.478	2.121	0.471	2.092	0.478	2.099	0.476	2.115	0.473	2.092	0.478	2.115	0.473
Board	1.789	0.559	2.096	0.477	1.784	0.561	2.094	0.477	1.767	0.566	2.089	0.479	1.787	0.56	2.096	0.477
TobinQ	1.683	0.594	1.683	0.594	1.594	0.627	1.595	0.627	1.616	0.619	1.617	0.618	1.701	0.588	1.702	0.588
TL	1.367	0.731	1.437	0.696	1.357	0.737	1.427	0.701	1.357	0.737	1.427	0.701	1.375	0.727	1.445	0.692
SG	1.266	0.79	1.272	0.786	1.261	0.793	1.269	0.788	1.272	0.786	1.277	0.783	1.264	0.791	1.27	0.787
SP	1.149	0.87	1.151	0.869	1.149	0.87	1.151	0.869	1.153	0.868	1.154	0.867	1.147	0.872	1.15	0.87
Mean VIF	**1.899**	**.**	**2.108**		**1.852**	**.**	**2.11**		**1.847**	**.**	**2.11**		**1.878**	**.**	**2.17**	

Note: To confirm that our data are free from the problem of multicollinearity, the VIF test is performed. According to Vorosmarty and Dobos (2020) [114], there is no correlation between the explanatory variables if the VIF is equal to 1, but multicollinearity exists if the VIF is more than 10 (Wooldridge 2015, Duho 2021) [89,115].

Table A4 details the outcomes of our diagnostic testing. The initial test, Cameron and Trivedi's decomposition Inoue–Matsusaka (IM) test, revealed chi-square values of 1279.48 for heteroscedasticity, 284.31 for skewness, and 59.63 for kurtosis, all with *p*-values of 0.0000. These low *p*-values reject the null hypotheses of constant variance, symmetry, and normality in the residuals, indicating heteroscedasticity in the model. The second test, the Breusch–Pagan/Cook–Weisberg test, showed a chi-square value of 178.64 and a *p*-value of 0.0000, further confirming heteroscedasticity in the residuals. The third test, the Modified Wald test, identified unequal variances across groups within the fixed-effects regression model, suggesting heteroscedasticity among the groups.

Table A4. Diagnostic testing.

Cameron and Trivedi's Test			
Source	Chi2	df	*p*-value
Heteroskedasticity	1279.48	53	0.0000
Skewness	284.31	9	0.0000
Kurtosis	59.63	1	0.0000
Total	1623.42	63	0.0000
Breusch–Pagan Test			
Assumption: Normal error terms Variable: Fitted values of CRT1			
H0: constant variance		Chi2(1) 178.64	Prob > Chi2 0.0000
Modified Wald Test			
H0: no first-order autocorrelation		Chi2 (2678) 1.0×10^{35}	Prob > Chi2 0.0000

Note: This table presents the results of various tests conducted to examine the existence of heteroscedasticity. We performed three different tests for this purpose: firstly, Cameron and Trivedi's test; secondly, the Breusch–Pagan test; and thirdly, the Modified Wald test. Source: authors' Estimation.

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