

Does More Voluntary “Green” Information Disclosure Cut Down the Cost of Equity: Heavy Pollution Industries in China

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2 Equity: Heavy Pollution Industries in China

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18 **Abstract**

19 Focusing on the unique background of the coexistence of mandatory and voluntary disclosure of
20 environmental information by domestic companies in heavy pollution industries for which is lost
21 sight of in the existing literature. The purpose of this paper is to identify, under the premise of
22 compulsory disclosure of environmental information in the financial report and separate
23 environmental report, whether the further voluntary environmental information disclosure in the
24 corporate social responsibility (CSR_E) captures the discount from investors during equity
25 financing. Employing the sample of 4390 China’s A-share listed companies in the heavy pollution
26 industries between 2010 and 2018, we adopt Python to conduct texture analysis and image
27 recognition, applying the fixed effect regression model to text hypothesizes, within the robust
28 analysis, our empirical results show that the CSR disclosure, higher quality of CSR reports, greater
29 extent of CSR_E disclosure including accurate environmental investment information as well as the
30 amount of graphs and texts all have the positive impact on the cost reduction of equity financing.
31 Moreover, the degree of CSR_E disclosure in reducing cost of equity is 30 times that of CSR
32 disclosure, which indicates that voluntary disclosure of environmental information is better to get
33 extra discount of equity financing by satisfying favor of investors instead of keep silent on the basis
34 of compulsory disclosure of environmental information. In addition, the charts have specific
35 positive effects that’s not available for the text, the accurate quantitative environmental information
36 creates more values for those enterprises disclosed. This study offers guidelines for regulatory
37 authorities to explore the coordination effect of mandatory and voluntary disclosure policies, and
38 achieve environmental governance and sustainable development of enterprises by improving their
39 corporate governance.

40 **Keywords:** corporate social responsibility, heavy pollution industry, environmental information,
41 cost of equity

42 Introduction

43 As an economic organization, the original goal of an enterprise is to maximize its profits. However,
44 the company's operating philosophy and its thought of business have been advancing in changing
45 times accompanied with economic development and corporation system evolution, in addition to
46 the economic benefits, enterprises should also consider ecological benefits, social benefits, and
47 social ethics, and undertake corresponding social responsibilities, especially for the heavy polluting
48 industry (Letizia and Hendrikse, 2016; Luo et al., 2019). In view of this, environmental information
49 is required to disclose mandatorily in the separate environmental report and financial report for
50 those enterprises from heavy polluting industry (EHPIs) in China (the "*Guidelines on Strengthening
51 the Supervision and Management Work of Listed Companies in Environmental Protection*" issued
52 by China Securities Regulatory Commission, 2008; the "*Guidelines for Environmental Information
53 Disclosure of Listed Enterprises*" issued by Ministry of Ecology and Environment of the People's
54 Republic of China, 2010), which is the crucial institutional transition for information disclosure
55 policy of China's capital market (Chen et al., 2018). Meanwhile, China's corporate social
56 responsibility (CSR) disclosure has developed into a stage of compulsory and voluntary coexistence
57 after the implementation of mandatory disclosure of CSR for three types of listed enterprises¹.
58 Moreover, CSR has been recognized as a strategic tool for enterprises. EHPIs that face greater
59 pollution treatment costs have more financing constraints and pressures, and they should not only
60 consider how to obtain funds, but also weigh the financing cost. Then it is worthy of exploration
61 whether the disclosure of CSR is easier to become a strategic tool for such enterprises to exert their
62 reputation mechanism for financing (Reverte, 2009). Compared with the various constraints on debt
63 financing of EHPIs, such as the company's past debt and credit records will affect subsequent bank
64 loans, the disclosure of CSR exerts greater autonomy in the equity financing process, especially to
65 provide enterprise-level decision-making information for the selection behavior of stakeholders and
66 market investors to meet the needs of their own equity investment motivations, which will
67 create more opportunities of financing for EHPIs (Jin et al., 2021). Due to the institutional
68 background in China that capital market is developing primarily, the cost of equity (CE) in China is
69 usually lower than the debt financing cost (DFC), and Chinese listed enterprises have significant
70 equity financing preferences (Hu et al., 2018). Therefore, whether and how the CSR disclosure,
71 especially the environmental information disclosure in CSR (CSR_E) that reflects the characteristics
72 of the industry, affects the CE of EHPIs deserves more attention.

73 Social responsibility has become a new opportunity for enterprises' growth in competitiveness. CSR
74 disclosure can make an effect of "communication" by alleviating information asymmetry,
75 significantly reducing the CE, among which there is a significant effect of "first disclosure". The
76 voluntary disclosure of CSR no longer comes entirely from the external pressure of regulations and
77 investors, and has already reflected the internal driving force dictated by interests (Hagenberg, 2021).
78 High-quality CSR disclosure can improve price efficiency as well as form corporate reputation

¹ The Shanghai Stock Exchange (SSE) has required since 2008 that three types of listed enterprises should disclose CSR, including 230 enterprises as a sample of the corporate governance board, 50 enterprises owning foreign shares overseas, and 21 financial enterprises. In the same year, the Shenzhen Stock Exchange (SZSE) required listed enterprises included in the "Shenzhen Stock Exchange 100 Index" to disclose CSR in accordance with the provisions of the "Guidelines for Social Responsibility of Listed Enterprises" of the Exchange.

79 capital, and help enterprises obtain lower CE (Khan et al., 2020). However, the increasingly
80 stringent environmental regulations have intensified the financing constraints of the industry for
81 EHPIs, and with the introduction of environmental information disclosure regulations for such
82 enterprises (2010, Ministry of Ecology and Environmental of the PRC, "*Guidelines for*
83 *Environmental Information Disclosure by Listed Enterprises*"), relevant research on whether the
84 additional CSR disclosures of EHPIs is few. In this regard, the "re-disclosure" of CSR_E can be
85 favored by many investors and obtain greater discounts on cost of equity than other enterprises
86 (Kalkanci and Plambeck, 2020; Ren et al., 2020), notice.

87 Recent studies have found that CSR disclosure has an insurance effect on enterprises. In other words,
88 CSR disclosure helps enterprises deal with crises or negative events (Cain et al., 2011; List and
89 Momeni, 2021). Good social responsibility performance makes investors less likely to believe that
90 the company will engage in financial fraud, etc. However, CSR disclosure can incur negative effects
91 to enterprises. once the company has fraudulent incidents such as false disclosures, CSR disclosure
92 will bring strong psychological contrasts to investors, which will cause serious problems like stock
93 sell-offs at the market (Liu et al., 2021). It is precisely because enterprises with better performance
94 of social responsibilities obtain a higher "reputation premium" from investors, and once hypocrisy
95 and fraud occur, this reputation premium will no longer exist (Marquis and Qian, 2014), but will
96 cause a "backfire effect". Therefore, compared with completed events, promised events in CSR
97 reports are considered to be hypocritical. These hypocritical enterprises often use vague expressions
98 to disclose CSR, which makes it difficult to gain the trust of investors and increases disgust (Bartov
99 et al., 2021; Basu and Palazzo, 2008; Pinnuck et al., 2021). CSR disclosure of EHPIs, where
100 environmental information disclosure involves specific quantitative information such as
101 environmental protection investment, besides, chart or picture is adopted to varying degrees
102 compared with that environmental information in financial report or environmental report, in
103 addition to meeting the disclosure requirements of regulatory authorities, the statement style of such
104 CSR_E information may form a reputation mechanism through "good faith" in the equity financing
105 process. To obtain additional premiums for enterprises in this field (Kuzey et al., 2021), especially
106 under the development trend of sustainable development and responsible investment, this issue is
107 worthy of further exploration.

108 Therefore, EHPIs during 2010-2018 in China's stock market were selected as the research sample
109 in this paper. First of all, the method of PSM is used to test whether EHPIs choose to disclose CSR
110 and obtain cost discounts in the equity financing process, and we find that EHPIs gain the lower CE
111 in the capital market through disclosing CSR with separate report. The further test result shows that
112 the higher the quality of CSR disclosure of EHPIs, the more recognition of investors will be received
113 and the lower-cost equity financing will be obtained. Secondly, on the basis of mandatory disclosure
114 of environmental information for EHPIs, in view of the flexibility of CSR disclosure, the number
115 of charts, pages, and words are taken as text analysis measurements for CSR_E disclosure richness
116 using Python text collection and analysis technology, in the meanwhile, the detail level of
117 environmental protection investment disclosure in the CSR_E is also considered, distinguishing
118 whether environmental protection investment amount is disclosed, whether the investment amount
119 is disclosed vaguely or accurately. And examine the impact of this type of CSR_E disclosure on the
120 CE. The result is that the higher the degree of disclosure of corporate environmental protection
121 investment and CSR_E disclosure richness, the lower CE the company obtain. Compared with the

122 overall disclosure of the CSR, the CSR_E disclosure has a greater contribution to reducing the cost
123 of equity capital, CSR_E disclosure reaches the level of 0.6% to reduce CE, 30 times as much as
124 CSR disclosure's 0.02%, indicating that CSR_E highly related to heavy pollution industries is an
125 area of focus for investors. Specifically, the contribution of CSR_E disclosure pages to CE
126 decreasing achieves 0.37%, and the environmental protection investment information in which can
127 lower CE at the level of 0.17%, especially accurate quantitative information with "sincerity"
128 characteristics, which can gain greater trust from investors, and thus take shape the "reputation" or
129 "halo image" of corporate equity financing. That is, enterprises are benefit from more styles of
130 CSR_E disclosure through supplying the further environmental information with CSR report. In
131 addition, considering the macro needs of current environmental regulations, financing measures
132 aiming at environmental protection in China are provided from debt financing market, such as green
133 credit and bonds. In the further analysis, the impact of CSR, especially CSR_E, on the DEC of
134 EHPIs is also examined. It is found that the debt financing market and equity capital market of
135 EHPIs are consistent in their response to CSR_E disclosure, that is, the higher the degree of CSR
136 and CSR_E disclosure in the enterprise, the lower DFC or CE can be obtained. which shows that
137 CSR and the disclosure of environmental information in it will not result in the complementation of
138 financing costs with different financing channels and the substitution of financing markets.
139 Moreover, although the positive effect of the DFC reduction from CSR disclosure and the CSR_E
140 disclosure, are 0.1 percent and 2.16 percent greater obvious than that of the CE respectively, which
141 fails to adequately bring EHPIs benefits for the higher credit threshold and fewer credit scales.

142 Two contributions of this paper are made to the literature as follows: First of all, our findings
143 contribute to recent research that the influence of mandatory and voluntary disclosure to the capital
144 market are connected. This paper is based on a special research sample of enterprises in the heavy
145 pollution industry, focusing on the particularity of information disclosure in this type of industry,
146 that is, listed enterprises in this field are required to disclose environmental information such as in
147 their financial reports which need to be audited. The CSR report belongs to the scope of voluntary
148 disclosure by enterprises, and there is no mandatory assurance requirement for disclosed
149 information (Nishitani et al., 2020). Based on this particularity, we examined the impact of voluntary
150 CSR disclosure and the quality of disclosure on the CE under the premise that EHPIs disclose
151 environmental information mandatorily in other reports. Besides, the effect of CSR_E disclosure
152 degree on CE is examined furtherly, which is the critical expansion of existing research that
153 separately examines the impact of voluntary information disclosure or CSR disclosure on financing
154 costs. It is also the verification of a market response to voluntary disclosure of CSR information
155 related to industry characteristics under the demand for environmental regulations, and find that
156 proactive disclosure of information related to environmental regulations can indeed win investors'
157 favor.

158 Second, this study extends texture management of CSR and CSR_E disclosure to the financing
159 motivation and behavior. In addition to paying attention to the CSR and CSR_E disclosure, it also
160 further examined the disclosure styles of the CSR_E. That is the impact of text length (Buehlmaier
161 and Whited, 2018), chart number (Obaid and Pukthuanthong, 2021), especially the vagueness or
162 accurate quantitative information for environmental protection investment on the CE. Exploring the
163 disclosure styles which is taken analogous to text manipulation in corporate information disclosure
164 and expanding it to the fields of non-financial information disclosure and voluntary disclosure

165 deriving from the earnings manipulation or earnings management ideas in corporate financial
166 information disclosure (Kim et al., 2012). The result is found that accurate environmental protection
167 investment information disclosure obtains higher discounts on CE compared with vague disclosure,
168 this is also a further proof of CSR hypocrisy existing, and indirectly proves that professional
169 investors can identify effectively corporate hypocrisy in CSR reports for the component information
170 (that is, non-precise quantitative information), unwilling to supply a discount on corporate equity
171 financing. On the contrary, the disclosure of accurate information reflects the “sincerity” of the
172 enterprise and capture investors’ recognition and trust. Research on text manipulation behavior
173 based on text analysis is so a new trend in voluntary information disclosure research.

174 The remained of this paper is organized as follows. Section 2 reviews the literature and develops
175 hypotheses, in section 3, we describe the research design containing sample and methodology
176 applied to test. Section 4 provides sample descriptive statistical analysis, hypotheses test results and
177 robust test. Section 5 is the discussion to empirical results combining reality, then the last section
178 concludes with the main results and implications.

179 Literature review and research hypotheses

180 The research hypothesis of this paper is formed based on literature review, the theoretical logic that
181 the relationship between CSR, CSR_E disclosure and corporate CE is inferred as follows, and the
182 specific hypotheses framework is shown in Fig.1.

183 CSR disclosure and CE

184 Information asymmetry affects the CE alone and significantly. After dividing the degree of market
185 competition, the alleviation of information asymmetry can effectively reduce corporate financing
186 costs when the market is in imperfect competition. From the perspective of information asymmetry,
187 information disclosure in the capital market, on the one hand, weakens the information asymmetry
188 between information owners and investors within a company, reduces investors’ risk assessment of
189 the company’s expected returns (Kuo et al., 2021), investors supply the lower hurdle rate of return
190 for which enterprises win a discount on CE. On the other hand, it helps the level of information
191 obtained by different investors tend to consistent, reducing information discrepancy between
192 different investors, and improving stocks liquidity (Zhang and Zhang, 2021). And then the demand
193 for stock trading increases under such circumstances, thereby CE is reduced for the enterprise.

194 Different from the disclosure of social responsibility information referring environment in other
195 mandatorily documents. For example, compared with environmental information in financial
196 reports, the CSR report disclosed by a listed company does not necessarily mean that it is a high-
197 quality report, but an independent CSR report shows that the company has paid more effort for the
198 performance of social responsibility and its disclosure, by which to transmit positive and responsible
199 signal for investors and meet the information needs of investors for decision-making. For EHPIs,
200 even if there are already mandatory requirements for environmental information disclosure, it can
201 be used as a supplement and confirmation of environmental information under mandatory disclosure
202 for further voluntary disclosure of CSR, giving investors more incentive to believe that this is a
203 positive trend, thereby the expected return on investment could be cut down (Dhaliwal et al., 2011).

204 Furthermore, compared with the timeliness characteristics of the short-term repayment of debt
205 financing, the sustainable development trend of enterprises is paid more attention for the equity
206 financing, and the nature of responsible investment is more prominent. which is also the preference
207 of responsible investment (Gillan et al., 2021). Therefore, CSR disclosure is more in line with the
208 equity investors' inclination, it enables enterprises pick up investors that think mainly in terms of
209 the "social responsibility approach" (Ng and Rezaee, 2015). In addition, EHPIs need
210 undertake more obligations for their industry features and are more affected by CSR, CSR
211 disclosure plays a greater role in information transmission in equity financing to decrease the cost
212 of exchange. Compared with enterprises that do not disclose CSR, one of the prime motivations for
213 EHPIs' CSR disclosure is to reduce CE. Hence, the first hypothesis is formulated as follows:

214 **Hypothesis 1.** EHPIs that discloses CSR will obtain lower CE than undisclosed companies.

215 The quality of CSR disclosure and CE

216 As the CSR disclosure by listed enterprises begin to accumulate, for all enterprises that have
217 announced CSR, the CE will affected with the quality of their CSR disclosure by the market
218 information friction. After disclosing separate CSR reports for enterprises that possess better CSR
219 performance, investors are admitted to obtain social responsibility related information they need for
220 the investment decision more efficiently, which is conducive to increase information resource
221 availability. In the meanwhile, these enterprises will get more attention from investors, especially
222 analysts and institutional investors (Simpson, 2010). It has correspondence between the CSR_E
223 information and the environmental information disclosed in the annual reports of EHPIs, reflecting
224 the comparability and verifiability of the information. And then, this is more advantageous for
225 information users to track and inspect the quality of CSR disclosure, which is critically contribute
226 to alleviate the information friction of equity investors, reducing information processing cost during
227 investor's decision-making, primarily the information acquisition cost (Blankespoor et al., 2020).
228 Thus, enterprises acquire the lower equity investment pricing.

229 High-quality CSR disclosure can not only reduce the cost of information processing for investors,
230 but also reduce the cost of corporate equity capital by mitigating valuation risks. For EHPIs, equity
231 investors are more concerned about the company's sustainable development potential and are
232 therefore more sensitive to social responsibility information (Hussaini et al., 2021). Less
233 information asymmetry appears between information owners and investors within the company, if
234 enterprises have better performance and information disclosure of CSR, which allows investors to
235 understand more about the company's responsibilities to different stakeholders, and strengthen their
236 confidence for such companies in sustainable development capabilities. The effectiveness of co-
237 governance for enterprises and their stakeholders is promoted within improvement of CSR
238 disclosure quality, and the foundation for the company to establish a strong stakeholder relationship
239 derives from better stakeholder's common governance (Grosser, 2016). When the company
240 encounters a crisis such as financial distresses, these business risks can be dissolved by obtaining
241 the support from stakeholders, which prompts the company achieve greater future valuations.
242 Therefore, the lower company's future risk assessment afforded by investors enables the company
243 capture current equity financing at a lower pricing stem from future responsible investment benefits.
244 This leads to our second hypothesis:

245 **Hypothesis 2.** For EHPIs that disclose CSR reports, the higher the quality of their disclosure, the
246 lower the CE they can obtain.

247 CSR_E disclosure and CE

248 The CSR_E disclosure of EHPIs has attracted the attention of investors in the process of equity
249 financing. The content of CSR reports is complex and the corresponding social responsibility
250 management system is huge, making it difficult for investors to make an overall assessment of the
251 quality of CSR reports from a professional perspective. For EHPIs, environmental information that
252 is highly related to their industries and operation activities is easier to understand by investors and
253 as the basis for decision-making (Zheng et al., 2020). Since environmental information is an
254 important part of the CSR report, especially for EHPIs, directly related to the dominant business of
255 the company. This type of information has accumulative characteristics, which implicitly reflects
256 the future development of the company's operation activities and the level of renovation and
257 improvement. A higher degree of CSR_E disclosure is related to stable and sound long-term
258 business amassing. Compared with occasional and sudden responsibility information on social
259 welfare activities such as donations (Kim and Ji, 2021), CSR_E is more reliable and authentic on
260 the premise of mandatory disclosure of environmental information for EHPIs, which is also the most
261 relevant information for investigating the development potential of the company in the industry. In
262 view of the accumulation and authenticity of CSR_E, it has become a key focus area for investors
263 and enterprises in the equity financing negotiation process. Therefore, when a company is willing
264 to disclose more CSR_E information, it is generally considered that, the operating risk is lower in
265 the future development of the industry (Kuo et al., 2021), and the relative equity financing risk that
266 needs to be compensated is also smaller, and then it is lower for the CE of the company.

267 The accuracy of environmental investment in the CSR_E has supposed to be a key factor for
268 investors to weigh financing costs. As a kind of non-financial information, the active disclosure of
269 CSR_E sends a positive signal to investors in the capital market (Nishitani et al., 2020). However,
270 CSR is still a new thing in China. CSR reports and the environmental information in them have not
271 yet formed a more unified disclosure format and content system. Because each industry owns
272 different specialties for EHPIs, and enterprises have more flexibility about how they disclose
273 CSR_E, the difficulty for investors to identify and interpret CSR_E information is aggravated.
274 Reducing the amount of uncertainty information disclosure, that is augmenting exact quantitative
275 information, can significantly reduce the CE through lessening the investment risk. Thus, such
276 accurate environmental information or qualitative information instead of qualitative information,
277 for instance, the amount of environmental investment, can be quickly grasped and understood by
278 investors, The example of accurate and vague information disclosure in CSR_E is following:

279 ***Accurate disclosure:** A company disclosed in 2018 that “the amount of environmental
280 investment in 2018 was 4 million yuan”.*

281 ***Vague disclosure:** B company disclosed in 2018 that “the amount of environmental
282 investment in 2018 was close to 5 million yuan”, or partially disclosed in 2018 that
283 “continue to increase environmental investment in 2018, of which the expense of sewage
284 treatment was 2 million yuan”].*

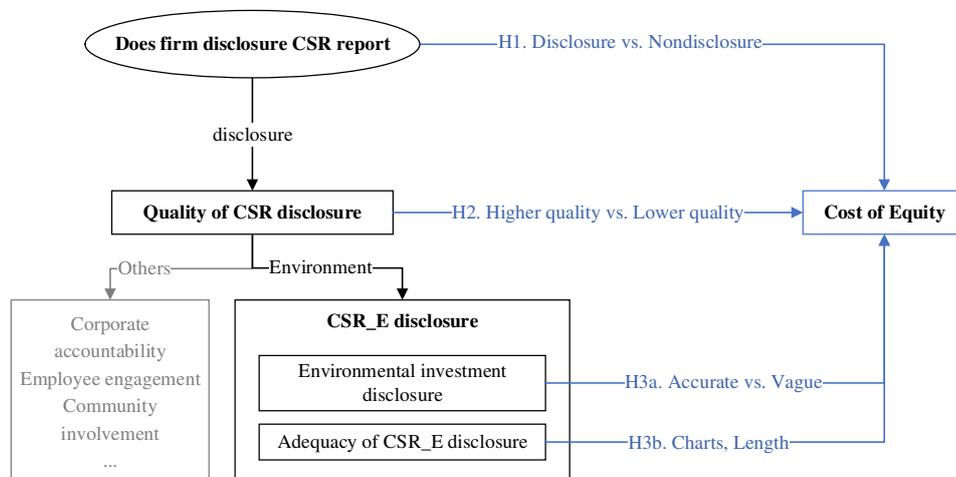
285 Such information is the effective information for investors' decision-making for its relieving the

286 difficulty of information interpretation (Blankespoor et al., 2020), that is to say the cost of
 287 information integration could be reduced. So far, enterprises can obtain additional discounts on CE
 288 given by investors by means of improving the effectiveness and utilization of disclosed information.
 289 This leads to our third hypothesis:

290 **Hypothesis 3a.** The higher level of environmental investment disclosure in the CSR_E, the lower
 291 FC EHPIs will acquire.

292 The multiple styles of CSR_E disclosure further affect the pricing level of equity financing provided
 293 by investors for enterprises (Kalkanci and Plambeck, 2020). Since normative documents of China's
 294 CSR report disclosure are more of a principled requirement on the content and scope of disclosure,
 295 such as (the “Notice on Strengthening the Social Responsibility Commitment of Listed Companies”
 296 and the “Guideline of Environmental Information Disclosure for Listed Companies” submitted by
 297 Shanghai Stock Exchange (2008), this provides enterprises greater flexibility and independent space
 298 for the CSR_E disclosure. And the emphases on the strict environmental regulations and penalties
 299 for EHPIs in China have made enterprises more cautious in the disclosure of environmental
 300 information. Therefore, a company with better environmental governance is willing to add different
 301 styles of information disclosure, such as charts, to increase its publicity and expression (Du and Yu,
 302 2021), and directly to convey the signal to investors that the operation situation is further improving
 303 and gains its momentum by expanding the length of disclosure (Haffar and Searcy, 2018).
 304 Although environmental information has been disclosed in their mandatorily documents for EHPIs,
 305 most of this information are text and data. The differences of the disclosure manners, including
 306 length of texts and charts, in CSR_E will further affect investors' attention and consideration. Based
 307 on reputation theory, the better performance of environmental responsibility thought to be the good
 308 reputation can satisfy investors' psychological needs for confidence in the company, attract more
 309 investors' attention, and increase trust and faith in the company. It not only obtains more high-
 310 quality investment opportunities for enterprises, but also reduces the cost of uncertain risks for
 311 investors to bear, reducing the uncertainty of investment ultimately, and enterprises can fight for a
 312 lower CE for themselves in the meantime. Hence, the fourth hypothesis is formulated as follows:

313 **Hypothesis 3b.** The richer the CSR_E disclosure manners, that is length of contents and charts, the
 314 lower the CE that EHPIs will capture.



315

316

Fig.1 Hypotheses framework

317 Data and methods

318 Sample selection and data

319 All the enterprises that belong to the heavy pollution industries listed in the Shanghai and Shenzhen
320 Stock Exchanges are chose as our research samples, and the sample period is decided based: (1)
321 Since 2010, the Ministry of Ecology and Environment of the People’s Republic of China (MEE)
322 has mandated the listed enterprises in 16 heavy polluting industries like thermal power, steel, cement,
323 electrolytic aluminum to announce the environmental annual report to disclose the pollutant
324 emissions, environmental compliance, environmental management and so on (the "*Guidelines for*
325 *Environmental Information Disclosure of Listed Enterprises*" issued by the MEE, 2010); (2) In 2008,
326 the MEE issued specific opinions on the environmental information disclosure of listed enterprises
327 of heavy pollution industries that will apply for IPO or re-financing in accordance with the
328 requirements of 2007 for the listing and financing of heavy pollution industries, which will bring
329 about major changes in the environmental management and equity financing behavior of EHPIs (the
330 "*Notice on the further specification of environmental inspection to the application for EHPIs’ IPO*
331 *and re-financing*" was issued by the MEE, 2008); (3) within the promulgation of Environmental
332 Protection Tax Law in China which went into effect since 2018, the pollution treatment was changed
333 that enterprises have been imposed the pollutant emission charge substituting the environmental tax,
334 and the environmental strategy and disclosure project of EHPIs are both influenced since then
335 substantially (the "*Environmental Protection Tax Law of the People’s Republic of China*" was
336 passed by the Twenty-fifth session of the Standing Committee of the twelfth National People's
337 Congress, 2016; the "*Implementation Regulations of Environmental Protection Tax Law of the*
338 *People’s Republic of China*" was jointly issued by the Ministry of Finance, State Administration of
339 Taxation and Ministry of Ecology and Environment, 2017). In summary, the research sample period
340 from 2010 to 2017.

341 Combining with the research samples, we collect various data required for the calculation of the CE
342 and the original text of the EHPIs’ CSR report from the Wind database, and then, based on the
343 Python text analysis technology, gather the number of charts and pages of CSR_E and
344 environmental investment information that is further identified with the disclosure degree and
345 divided into three types: whether to disclose, accurate disclosure or vague disclosure. Moreover, the
346 quality of CSR disclosure is measured by the rating information of China’s third-party authoritative
347 evaluation agency (www.hexun.com), and other remaining data required for the study comes from
348 Wind and CSMAR database.

349 Besides, consideration the extreme value influence, ST enterprises and the samples of enterprises
350 that have been delisted from the 2010-2017 period is excluded, as well as the samples with missing
351 data. Therefore, the final sample size is 4390 listed enterprises incorporated.

352 Variable measures

353 We discuss the construction of the main variables of interest in detail below, and in the Table 1 we
354 provide a detailed description (and operationalization, when applicable) of all variables used in the
355 empirical analysis, including the associated items we used to construct them.

356 **Dependent variables:**

357 Regarding the measurement model of the CE, the implicit cost of capital model based on expected
358 returns is considered to be better than the risk compensation model based on realized returns, that
359 is, PEG, MPEG and OJM models have better measurement results. Among them, the PEG model is
360 more appropriate to grasp the various risk factors that affect the cost of equity capital, so the
361 calculation results are more reliable and accurate, and it is especially suitable for the Chinese capital
362 market (Lim, 2016). Therefore, we use the PEG model proposed by Easton [25] to calculate the CE
363 required for research, and the model is as shown in formula (1):

$$364 \quad R_{PEG(i,t)} = \sqrt{(EPS_{i,t+1} - EPS_{i,t}) / P_{0(i,t)}} \quad (1)$$

365 where for firm i in year t , $R_{PEG(i,t)}$ is a continuous variable that reflects the CE of EHPIs; $EPS_{i,t+1}$
366 is the estimated earnings per share for the period of $t+1$; $EPS_{i,t}$ is the estimated earnings per share
367 for the period of t ; $P_{0(i,t)}$ represents the stock price per share.

368 **Independent variables:**

369 **CSR disclosure** The CSR disclosure (CSR_d) is the binary variable, in the form of “yes/no” disclosure,
370 indicating whether EHPIs separately disclose CSR reports. We code 1 if the company discloses a
371 CSR report, otherwise it is 0.

372 **CSR disclosure quality (CSR_q)** We use an official rating data from *Hexun* to capture the score of CSR
373 disclosure to evaluate its quality with the hundred-mark system. Its social responsibility professional
374 evaluation system examines five aspects: shareholder responsibility, employee responsibility,
375 supplier, customer and consumer rights and interests, environmental responsibility and social
376 responsibility, and each has been set up secondary and tertiary indicators. Each items score is
377 summed to conduct a comprehensive evaluation of social responsibility (Chen et al., 2018). The
378 quality of corporate CSR disclosure is quantified based on the total points obtained from the
379 evaluation. The higher the score, the better the quality of CSR disclosure.

380 **Degree of environmental investment disclosure (CSR_E1)** Python text analysis technology is taken to identify
381 and collect the environmental investment disclosure types, and we measure environmental
382 investment disclosure degree with points approach. The sample enterprises that disclose CSR
383 reports are divided into enterprises that disclose and undisclosed environmental investment
384 information, and then the enterprises that disclose environmental investment information are further
385 divided into accurate disclosure of environmental investment amount and vague disclosure (or
386 partial disclosure) of environmental investment amount Then the positive value of environmental
387 investment disclosure degree indicates a discrepancy among accurate disclosed, vague disclosed
388 and undisclosed of environmental investment amount successively by variable assignment. This is
389 the method to investigate the characteristics of corporate information disclosure from the
390 perspective of text maneuverability (Naughton et al., 2019).

391 **Richness of CSR_E disclosure (CSR_E2)** CSR_E disclosure richness is measured by the textural analysis with
392 Python by counting the number of charts and pages (Cong L W 2019). On the one hand, chart is one
393 of the principal features which distinguish the environmental information from CSR reports mainly
394 adopted text and charts and other reports in which enterprises mandatorily disclose their
395 environmental information mainly adopted text and data tables, we then calculate the number of
396 charts appeared in the part of CSR_E to examine the effectiveness of CSR_E that environmental

397 information does not possess in financial reports or others. On the other hand, the length of CSR_E
 398 indirectly signifies the enthusiasm of voluntary disclosure (Basu and Palazzo, 2008), so we take
 399 follow way of pages to compute the length. The length of CSR_E is calculated as half a page if the
 400 number of pages is less than half a page, and calculated as one page if there are more than half but
 401 less than one page, subtracting the pages that charts occupied to get the total pages amount, and we
 402 get the length of CSR_E within the natural logarithm calculated based on the final number of
 403 statistical pages plus one. Both of above methods measure the richness of the form and content for
 404 CSR_E disclosure.

405 **Control variables:**

406 In all the empirical models, time-invariant firm level effects that may drive firms' cost of equity are
 407 controlled by including firm fixed effects, such as year and industry. Other time-varying factors
 408 influenced firms' cost of equity are incorporated at the level of external and internal of enterprises
 409 (Table 1).

410 **Model design**

411 **Research design for H1** Based on H1, there is only one situation between disclosure and non-disclosure
 412 of the company's disclosure of CSR. If a company discloses a CSR report, it will not be able to
 413 learn the characteristics of its non-disclosure of the CSR. In consideration of the impossible to
 414 observe the disclosure and non-disclosure of CSR simultaneously, the two reported situations are
 415 likely to cause the sample selection bias or self-selection, for which the Propensity matching score
 416 (PSM) method is taken to construct the regression model of H1.

417 First of all, it is divided into the experimental group (disclosed CSR report sample) and control
 418 group (undisclosed CSR report sample) according to the research sample. Secondly, propensity
 419 score matching performed based on the following three steps:

420 **Table 1** Variable definitions

Variables	Definition
Dependent Variable	
<i>CE</i>	Cost of equity, calculated with PEG model, MPEG model (Easton, 2004), OJM model (Ohlson et al., 2005)
Test Variables	
<i>CSR_d</i>	Is a dummy variable taking the value of 1 if the enterprise discloses the CSR report, and 0 otherwise
<i>CSR_q</i>	Quality of CSR report, is computed as the sum of net CSR indices for five "stakeholder-oriented" categories within scores from 0 and 100
<i>CSR_Einv</i>	The degree of environmental investment disclosure: Is a dummy variable taking the value of 2 if the enterprise discloses the precise number of environmental investments, the value of 1 if the enterprise discloses the vague (or partial) number of environmental investments, and 0 otherwise (Loftus and Tanlu, 2018)
<i>CSR_Eric</i>	Natural logarithm of the number of charts appeared in the part of CSR_E(<i>CSR_Eric1</i>);

natural logarithm of the number of CSR_E pages (*CSR_Eric2*);
 natural logarithm of the number of CSR_E words (*CSR_Eric3*)

Control Variables

<i>INST</i>	The proportion of shares held by institutions: shares held by institutions scaled by total shares outstanding.
<i>BIG4</i>	Is a dummy variable taking the value of 1 if the enterprise is audited by a Big 4 auditor, and 0 otherwise
<i>LEV</i>	The book value of financial debts scaled by lagged total assets
<i>DFL</i>	Financial risk: the book value of long-term liabilities scaled by net assets
<i>Cash</i>	Cash flow from operation activities scaled by total assets
<i>OR</i>	Operation risk: fix assets scaled by total assets
<i>Size</i>	Firm size: natural logarithm of total assets
<i>Sharecon</i>	Ownership concentration: the sum of square of top 5 shareholders proportion
<i>Liquidity</i>	The percentage of the firm's shares traded (shares traded/shares outstanding) during the current year by total shares submitted
<i>Zindex</i>	The percentage of shares held by top 1 shareholder scaled by that second shareholder
<i>CEOcom</i>	Natural logarithm of top 3 managers compensation
<i>Year FE</i>	Indicator variables for fiscal years
<i>Industry FE</i>	Indicator variables for each industry following the China Securities Regulatory Commission

421

422 The first step is to calculate the propensity score (PS) of the experimental group and the control
 423 group within logistic and probit regression, and obtain the PS of the two groups of observations:

$$424 \quad P(x_i) = P(D_i = 1|x = x_i) \quad (3)$$

425 Where x_i is the variable that affects the disclosure of the CSR report, D_i is a dichotomous variable,
 426 if the CSR report is disclosed, D_i equals 1, and 0 otherwise.

427 The second step is to match the experimental group (=1) and the control group (=0) according to
 428 the PS. Due to the various matching methods, such as the nearest neighbor matching of the direct
 429 method, the weighted average radius matching, and the kernel matching with a wide coverage,
 430 drawing on the existing research, the kernel matching method is selected (Luo et al., 2019).

431 The third step is to estimate the average treatment effect (ATT) of enterprises that choose to disclose
 432 CSR reports:

$$433 \quad ATT = E(EquityCost_1|D = 1, P(x)) - (EquityCost_0|D = 0, P(x)) \quad (4)$$

434 Where $EquityCost_1$ and $EquityCost_0$ respectively represent the CE of the experimental group
 435 (=1) and different control groups (=0), so as to compare the effect of the CE under different
 436 disclosure behavior choices.

437 Finally, a regression model (Model 1) is built combined with the testing needs of H1,

438 **Model 1:**

$$439 \quad CE_{i,t+1} = \alpha_0 + \alpha_1 CSR_d_{i,t} + \alpha_2 INST_{i,t} + \alpha_3 BIG4_{i,t} + \alpha_4 LEV_{i,t} + \alpha_5 DFL_{i,t} + \alpha_6 Cash_{i,t} + \\ 440 \quad \alpha_7 OR_{i,t} + \alpha_8 Size_{i,t} + \alpha_9 Sharecon_{i,t} + \alpha_{10} Liquidity_{i,t} + \alpha_{11} Zindex_{i,t} + \alpha_{12} CEOcom_{i,t} + \\ 441 \quad \sum \alpha_j Year_{i,t} + \sum \alpha_j Industry_{i,t} + \varepsilon_{i,t} \quad (5)$$

442 Where, $CSR_d_{i,t}$ is the main research variable, the coefficient of this variable α_1 indicates the
443 impact of choosing to disclose the CSR on the CE. According to the above analysis, the forecast is
444 negative.

445 Research design for H2 Aiming at H2, the regression model (Model 2) is constructed in this paper:

446 **Model 2:**

$$447 \quad CE_{i,t+1} = \beta_0 + \beta_1 CSR_q_{i,t} + \beta_2 INST_{i,t} + \beta_3 BIG4_{i,t} + \beta_4 LEV_{i,t} + \beta_5 DFL_{i,t} + \beta_6 Cash_{i,t} + \\ 448 \quad \beta_7 OR_{i,t} + \beta_8 Size_{i,t} + \beta_9 Sharecon_{i,t} + \beta_{10} Liquidity_{i,t} + \beta_{11} Zindex_{i,t} + \beta_{12} CEOcom_{i,t} + \\ 449 \quad \sum \beta_j Year_{i,t} + \sum \beta_j Industry_{i,t} + \varepsilon_{i,t} \quad (6)$$

450 Where, $CSR_q_{i,t}$ is a research variable, and the coefficient of this variable β_1 represents the
451 impact of CSR report disclosure quality on the CE. According to the above analysis, the forecast is
452 negative.

453 Research design for H3a and H3b Aiming at H3a, 3b, we construct regression model (3-1) and model (3-
454 2):

455 **Model 3-1:**

$$456 \quad CE_{i,t+1} = \gamma_0 + \gamma_1 CSR_Einv_{i,t} + \gamma_2 INST_{i,t} + \gamma_3 BIG4_{i,t} + \gamma_4 LEV_{i,t} + \gamma_5 DFL_{i,t} + \\ 457 \quad \gamma_6 Cash_{i,t} + \gamma_7 OR_{i,t} + \gamma_8 Size_{i,t} + \gamma_9 Sharecon_{i,t} + \gamma_{10} Liquidity_{i,t} + \gamma_{11} Zindex_{i,t} + \\ 458 \quad \gamma_{12} CEOcom_{i,t} + \sum \gamma_j Year_{i,t} + \sum \gamma_j Industry_{i,t} + \varepsilon_{i,t} \quad (7)$$

459 Where, $CSR_Einv_{i,t}$ is the research variable, and the coefficient of this variable γ_1 indicates the
460 impact of the degree of environmental investment disclosure on the CE. According to the above
461 analysis, the forecast is negative.

462 **Model 3-2:**

$$463 \quad CE_{i,t+1} = \delta_0 + \delta_1 CSR_Eric_{i,t} + \delta_2 INST_{i,t} + \delta_3 BIG4_{i,t} + \delta_4 LEV_{i,t} + \delta_5 DFL_{i,t} + \\ 464 \quad \delta_6 Cash_{i,t} + \delta_7 OR_{i,t} + \delta_8 Size_{i,t} + \delta_9 Sharecon_{i,t} + \delta_{10} Liquidity_{i,t} + \delta_{11} Zindex_{i,t} + \\ 465 \quad \delta_{12} CEOcom_{i,t} + \sum \delta_j Year_{i,t} + \sum \delta_j Industry_{i,t} + \varepsilon_{i,t} \quad (8)$$

466 Where, $CSR_Eric_{i,t}$ is the research variable, the coefficient of this variable δ_1 indicates the
467 impact of CSR_E disclosure richness on the CE. According to the above analysis, the forecast is
468 negative.

469 Results analysis

470 Descriptive statistical analysis

471 The descriptive statistical analysis of the research samples is shown in Table 2. Firstly, it is
472 concluded that the average CE of EHPIs is close to the existing results. According to the sample,

473 the average value of CE is about 10%, and the standard deviation is 0.0313, it indicates that
 474 individual differences of the CE are relatively lithe, reflecting to a certain extent the correlation
 475 between the CE and the attributes of heavy pollution industries. Second, the average *CSR_d* of the
 476 whole sample is 0.3651, showing that less than half of the EHPIs choose to disclose CSR. Although
 477 the proportion of enterprises that choose to disclose CSR after 2017 has increased, the CSR
 478 disclosure scales of EHPIs are still need to be improved, and among which there are discrepancies
 479 for each enterprise that disclosed CSR (Std. Dev. (*CSR_q*): 12.8856).

480 Furthermore, for the situation of the additional environmental information disclosure in the CSR
 481 report apart from the mandatory disclosure requirement of environmental information in other
 482 reports, on the one hand, the number of enterprises that disclose environmental investment is
 483 minority and the majority of which are simply settle for the vague disclosures (Mean (*CSR_Einv*):
 484 0.5469), this means enterprises are fractionally motivated to disclose or accurately disclose in
 485 particular environmental investment. then, voluntary disclosure of CSR and the circumvention of
 486 environmental penalties are extrapolated for this phenomenon. On the other hand, despite the unity
 487 of environmental information disclosure styles in their annual reports have been stripped out for
 488 EHPIs and the chart disclosure approach in the *CSR_E* is actively adopted, there is also a big
 489 diversity for the degree of chart employment (Std. Dev. (*CSR_Eric1*): 3.5915). The number of
 490 enterprises with the largest use of charts has reached 33 stupendously. while there are less than 2
 491 charts on average utilized for *CSR_E* disclosure (Mean (*CSR_Eric1*): 1.5091). The difference in
 492 length of *CSR_E* disclosure (number of pages), by contrast, is relatively smaller (Std. Dev.
 493 (*CSR_Eric2*): 0.5685). Furthermore, it can be clearly found that enterprises that use more charts are
 494 also willing to cooperate with more textual expressions from the statistical analysis results of
 495 $CSR_Eric1 \times CSR_Eric2$, which leads to the individual difference increased (Std. Dev.
 496 ($CSR_Eric1 \times CSR_Eric2$): 8.173).

497 In short, the level of voluntary CSR disclosure by EHPIs is not commonplace enough, as well as its
 498 quality difference is distinctive, enterprises with higher quality of CSR disclosure tend to use more
 499 charts and texts in *CSR_E*. In other words, enterprises with a strong willingness to chart are also
 500 willing to cooperate with more textual *CSR_E* information to convey the enthusiasm of
 501 environmental responsibility.

502
 503

Table 2 Descriptive statistics

Variables	No. Obs.	Mean	Std. Dev.	Min.	P25	Median	P75	Max.
CE	4390	0.1047	0.0313	0.0501	0.0827	0.1030	0.1253	0.1690
CSR_d	4390	0.3651	0.4815	0.0000	0.0000	0.0000	1.0000	1.0000
CSR_q	1460	39.6836	12.8856	13.0000	31.0000	37.0000	46.0000	88.0000
CSR_Einv	4390	0.5469	0.8530	0.0000	0.0000	0.0000	1.0000	3.0000
CSR_Eric1	1369	1.5091	3.5915	0.0000	0.0000	0.0000	1.0000	33.0000
CSR_Eric2	1369	1.1506	0.5685	0.0000	0.6931	1.0986	1.5041	3.2581
CSR_Eric 1×2	1369	3.0328	8.1730	0.0000	0.0000	0.0000	1.3863	80.9670
INST	4390	0.4250	0.2481	0.0000	0.2129	0.4432	0.6249	1.8697
BIG4	4390	0.0843	0.2778	0.0000	0.0000	0.0000	0.0000	1.0000
LEV	4390	0.4137	0.2042	0.0127	0.2497	0.4102	0.5713	1.1123
DFL	4390	0.2289	0.2913	0.0026	0.0191	0.0970	0.3354	1.0405
Cash	4390	0.6168	0.6649	-0.4387	0.1715	0.4879	0.9557	2.2189

OR	4390	0.3087	0.1661	0.0019	0.1777	0.2797	0.4218	0.9480
Size	4390	22.4197	1.3615	19.5108	21.4377	22.1891	23.2519	28.5087
Sharecon	4390	0.1893	0.1302	0.0030	0.0928	0.1644	0.2566	0.7938
Liquidity	4390	3.2100	2.0975	0.5909	1.5547	2.7220	4.3356	8.1414
Zindex	4390	9.9968	12.6184	1.1053	2.0000	4.2872	11.8623	47.1203
CEOcom	4390	14.2208	0.7160	10.3090	13.7787	14.2236	14.6573	17.3525

Table 2 presents descriptive statistics of the variables used in the regression analysis, $CSR_Eric\ 1 \times 2$ is the multiplicative interaction item between CSR_Eric1 and CSR_Eric2 .

504

505 **Correlation analysis**

506 Correlation analysis of the research variables (Table 3) is conducted to provide greater insight into
507 the CSR, especially CSR_E disclosure texture characteristics for EHPIs based on the descriptive
508 statistical analysis and research designed models. Firstly, as well as generally, the possibility of
509 multicollinearity in the models built in this paper is eliminated in the light of the absolute value of
510 the Pearson correlation coefficient between research variables less than 0.7 combined with the VIF
511 tests. Secondly and concretely, the Pearson correlation coefficient between CSR disclosure and CE
512 is 0.0355 at a significant level of 5% (Panel A), from which the significant positive correlation
513 between these two variables is concluded intuitively, however, the positive correlation results
514 obtained in this part cannot directly prove that CSR disclosure of corresponds to higher CE
515 considering that CSR_d is a dummy variable while its' median and he lower quartile is 0 and 1
516 respectively shown in Table 2. The similarity also includes the correlation coefficient between
517 environmental investment disclosure in CSR_E (CSR_Einv) and CE, the positive correlation,
518 although a significant correlation exists, that found in the results (Panel C) cannot be used as the
519 final conclusion (the Pearson correlation coefficient is 0.0267 with 1% significant level). Among
520 the remaining research variables, the quality of CSR disclosure (the Pearson correlation coefficient
521 is -0.0913 with 1% significant level), the length of CSR_E disclosure (the Pearson correlation is -
522 0.04 with 10% significant level), and the amount of chart usage (the Pearson correlation coefficient
523 is -0.0511 with 10% significant level) and CE presents an obvious negative correlation, it is initially
524 verified the significant correlation among the CSR disclosure of EHPIs, the degree of CSR_E
525 disclosure richness and the cost of equity in the light of the results of the above-mentioned
526 correlation analysis.

527 **Regression analysis**

528 Combined with the built regression models, this study the hypothesis that proposed in the research
529 are further tested after conducting statistical description analysis and correlation analysis.

530 **Test for H1: CSR disclosure of EHPIs** The column (1) in Panel A of Table 4 shows the regression
531 result of the test for H1. The regression coefficient of the CSR disclosure (CSR_d) to the CE is
532 significantly negative at the 1% level ($\alpha=-0.0035$), and it means EHPIs that disclose CSR reports
533 are more likely to obtain lower CE compared with the companies undisclosed CSR. The regression
534 coefficient is -0.0035, indicating that a company can reduce 0.35% CE by disclosing CSR reports.
535 This regression result support the prediction of H1 and suggest that, on the one hand, companies'
536 voluntary disclosure of CSR reports could make for the investor uncertainty reduction via receding
537 information asymmetry in the capital market, and therefore indirectly increasing stock liquidity, for
538 which ultimately investors acquire venture deals at a lower price while they are willing to provide

539 corporate with discount on the CE. Further notice, the regression result of liquidity on CE ($\alpha=-$
540 0.0002, $p<0.05$) confirmed above inference of H1, which means the increase in liquidity can help
541 reduce CE. On the other hand, besides for that EHPs disclose environmental information related to
542 their industries and primary business in the financial report and other reports accordance with
543 mandatory disclosure requirements, enterprises' willingness to disclose extra CSR reports separately
544 indicates that a majority of companies prefer to disclose CSR to a certain extent to provide investors
545 with supplementary expansion of other reports information. Text materials for further
546 supplementation and verification of environmental information are sufficient to convey positive
547 signals of corporate operation and social responsibility (especially environmental responsibility) to
548 investors in the annual report, which in turn helps to lower investors' requirements for the minimum
549 expected return. In this regard, the enterprise can reduce the cost during equity financing. In addition
550 to the compulsory disclosure of environmental information, active disclosure of CSR reports can
551 also help EHPs themselves win the support of responsible investors and obtain additional equity
552 financing compensation from responsible investors.

553 **Test for H2: CSR disclosure quality of EHPs** For EHPs that disclose CSR reports, the quality
554 of disclosure has further become the classification standard in the capital market. In order to further
555 examine the impact of the quality of CSR disclosure by EHPs on the CE, Table 4 resents the result
556 associated with model 2 to test H2 (the column (2) of Table 4). The regression coefficient of CSR
557 disclosure quality to the CE is significantly negative at the level of 5% ($\beta=-0.0002$), indicating that
558 higher-quality CSR disclosure companies can reduce investors' trade friction to a certain extent, and
559 the transaction costs are controlled efficiently achieving the lower CE. Meanwhile, the regression
560 coefficient of operating risk (*OR*) to CE is significantly positive ($\beta=0.0095$, $p<0.01$), based on which
561 it is partially inferred that high-quality CSR disclosure helps companies to promote publicity of
562 harmonious social ties with their stakeholders to investors and maintain mutually beneficial
563 relationships. Facing the future uncertainty risk, companies can better play the role of common
564 governance and reflect stronger risk response capabilities. Moreover, the consequent risk decreasing
565 for investors can ensure enterprises a greater equity financing discount, hereby the CE will be also
566 lowered, which verifies H2.

567 **Test for H3a: environmental investment disclosure of CSR_E** In response to the mandatory
568 requirements for EHPs to disclose environmental information in annual reports, we then focus on
569 the impact of major component for companies' voluntary disclosure of CSR_E, environmental
570 investment disclosure, on the CE (the columns (3) of Table 4). According to the regression results,
571 the impact of environmental investment disclosure degree on CE is significantly negative at the 1%
572 level ($\gamma=-0.0017$, $p<0.01$). suggesting that companies voluntarily disclosed environmental
573 investment have a lower CE than companies that do not disclose. Besides, companies that disclose
574 precise data of environmental investments enjoy lower CE compared with the companies that make
575 vague disclosures, thus supported H3a. It correspondingly facilitates us to figure out that companies'
576 disclosure of accurate quantification of CSR_E can bring greater information value realizing value
577 appreciation following to the compulsory disclosure requirement of environmental information for
578 EHPs. Correspondingly, the precise quantitative information obtained by capital market investors
579 is beneficial to reduce the information processing costs of trade decisions and increase investors'
580 willingness to invest.

581 **Test for H3b: the richness of CSR_E disclosure** In addition to the quantitative information for

582 disclosure, the CSR_E that EHPIs voluntary disclosure includes the use of charts and length of text,
583 the column (4)-(6) in Panel B of Table 4 are the regression results of the richness of CSR_E
584 disclosure on the CE.

585 Firstly, the regression result of the graph exploit on the CE in column (4) is distinctly negative ($\delta =$
586 -0.0004 , $p < 0.1$), indicating that positive effects for enterprises to reduce CE is created by the using
587 of graphs in CSR_E of EHPIs. Specifically, against the context of mandatory disclosure of
588 environmental information in annual reports, EHPIs actively adopt charts to further disclose
589 environmental responsibility information in CSR report, showing that companies are actively
590 performing environmental responsibilities and attempt to deliver with diversified announcement
591 forms which are recognized by investors. Then, the recognition of investors, including better
592 positive reviews on operation, especially the long-term evaluation of corporate sustainable
593 development, can better explain the reasons why companies obtain lower-cost equity financing from
594 capital market. In addition, the results also indirectly manifest that the chart is a better way for
595 companies to disclose external information.

Table 3 Correlation Matrix

Panel A

	1	2	3	4	5	6	7	8	9	10	11	12	13
1 CE	1												
2 CSR_d	0.0355**	1											
3 INST	0.0193	0.3166***	1										
4 BIG4	0.0274*	0.2621***	0.1815***	1									
5 LEV	0.1914***	0.2066***	0.2761***	0.1069***	1								
6 DFL	0.0520***	0.0355**	0.0420***	0.0325**	0.1477***	1							
7 Cash	-0.0062	0.1092***	0.2430***	0.1368***	0.0635***	0.0447***	1						
8 OR	0.0896***	0.1599***	0.1838***	0.1118***	0.4517***	0.0808***	0.1839***	1					
9 Size	0.1238***	0.4389***	0.4723***	0.4033***	0.5581***	0.1115***	0.2846***	0.3630***	1				
10 Sharecon	-0.0391***	0.1547***	0.3557***	0.1852***	0.1282***	0.0251*	0.1574***	0.1305***	0.3926***	1			
11 Liquidity	-0.1469***	-0.1020***	-0.2249***	-0.1794***	0.0568***	0.0005	-0.1104***	0.0556***	-0.2681***	-0.3493***	1		
12 Zindex	0.0074	0.0746***	0.1335***	-0.0046	0.1843***	0.0280*	0.0309**	0.1162***	0.1683***	0.4138***	-0.0113	1	
13 CEOcom	0.0142	0.2387***	0.1990***	0.2760***	-0.0087	0.0149	0.1902***	-0.0276*	0.3185***	0.0285*	-0.2042***	-0.0673***	1

Panel B

	1	2	3	4	5	6	7	8	9	10	11	12	13
1 CE	1												
2 CSR_q	-0.0913***	1											
3 INST	-0.0735***	0.2453***	1										
4 BIG4	0.0097	0.2343***	0.2104***	1									
5 LEV	0.2202***	0.0872***	0.1313***	0.0664**	1								
6 DFL	0.0567**	0.0332	0.012	0.0199	0.0678***	1							
7 Cash	-0.0101	0.1598***	0.2693***	0.1925***	0.0534**	0.0570**	1						
8 OR	0.0638**	0.0338	0.0589**	0.0787***	0.3940***	0.0109	0.2506***	1					
9 Size	0.1083***	0.4281***	0.4174***	0.4643***	0.4735***	0.0594**	0.3008***	0.2990***	1				
10 Sharecon	-0.1004***	0.2794***	0.5057***	0.2610***	0.0683***	0.0111	0.1748***	0.1106***	0.4768***	1			
11 Liquidity	-0.1549***	-0.2004***	-0.3625***	-0.2966***	-0.0175	0.0076	-0.1940***	-0.0565**	-0.3978***	-0.4216***	1		
12 Zindex	0.0036	0.0222	0.0948***	-0.0466*	0.1088***	0.0123	-0.0165	0.0780***	0.0589**	0.3508***	-0.0161	1	
13 CEOcom	0.0614**	0.2776***	0.1545***	0.3443***	-0.0328	0.0226	0.1930***	-0.1012***	0.2640***	-0.0311	-0.2035***	-0.1089***	1

Panel C

	1	2	3	4	5	6	7	8	9	10	11	12	13
1 CE	1												
2 CSR_Einv	0.0267*	1											
3 INST	0.0193	0.2881***	1										
4 BIG4	0.0274*	0.2381***	0.1815***	1									
5 LEV	0.1914***	0.1940***	0.2761***	0.1069***	1								
6 DFL	0.0520***	0.0389**	0.0420***	0.0325**	0.1477***	1							
7 Cash	-0.0062	0.1113***	0.2430***	0.1368***	0.0635***	0.0447***	1						
8 OR	0.0896***	0.1424***	0.1838***	0.1118***	0.4517***	0.0808***	0.1839***	1					
9 Size	0.1238***	0.4148***	0.4723***	0.4033***	0.5581***	0.1115***	0.2846***	0.3630***	1				
10 Sharecon	-0.0391***	0.1649***	0.3557***	0.1852***	0.1282***	0.0251*	0.1574***	0.1305***	0.3926***	1			
11 Liquidity	-0.1469***	-0.1034***	-0.2249***	-0.1794***	0.0568***	0.0005	-0.1104***	0.0556***	-0.2681***	-0.3493***	1		
12 Zindex	0.0074	0.0953***	0.1335***	-0.0046	0.1843***	0.0280*	0.0309**	0.1162***	0.1683***	0.4138***	-0.0113	1	
13 CEOcom	0.0142	0.2251***	0.1990***	0.2760***	-0.0087	0.0149	0.1902***	-0.0276*	0.3185***	0.0285*	-0.2042***	-0.0673***	1

Panel D

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1 CE	1													
2 CSR_Eric1	-0.0511*	1												
3 CSR_Eric2	-0.04*	0.6353***	1											
4 INST	-0.0640**	0.1556***	0.1565***	1										
5 BIG4	0.0088	0.1730***	0.2182***	0.1475***	1									
6 LEV	0.2188***	0.0527*	0.1552***	0.1593***	0.0706***	1								
7 DFL	0.0595**	0.0192	0.0234	0.0105	0.0259	0.0608**	1							
8 Cash	-0.0002	0.1453***	0.1714***	0.2422***	0.1441***	0.0670**	0.0596**	1						
9 OR	0.0540**	0.0249	0.1149***	0.0725***	0.0635**	0.3967***	0.0055	0.2633***	1					
10 Size	0.1175***	0.3090***	0.4585***	0.3615***	0.3999***	0.5411***	0.0632**	0.2698***	0.3233***	1				
11 Sharecon	-0.0957***	0.1683***	0.2283***	0.4405***	0.1766***	0.0918***	0.0108	0.1345***	0.1127***	0.3621***	1			
12 Liquidity	-0.1727***	-0.1412***	-0.1695***	-0.3041***	-0.2597***	-0.0148	0.0092	-0.1617***	-0.0514*	-0.3329***	-0.3969***	1		
13 Zindex	0.0093	0.0002	0.0369	0.1038***	-0.0701***	0.1289***	0.0154	-0.0114	0.0710***	0.0687**	0.3693***	-0.0215	1	
14 CEOcom	0.0351	0.1755***	0.2452***	0.1262***	0.3103***	-0.0366	0.0239	0.1700***	-0.1061***	0.2512***	-0.0746***	-0.1724***	-0.1290***	1

***, **, * indicate statistical significance at the 1 percent, 5 percent and 10 percent levels, respectively.

Table 3 displays the Pearson correlation analysis results based on the H1, H2, H3a and H3b successively.

596 Secondly, in the column (5) of Table 4, the regression of the length of CSR_E disclosure on the CE
597 yielded results similar to the graph above, showing a brightly negative impact ($\delta = -0.0037$, $p < 0.05$).
598 In other words, the greater number of pages of CSR_E disclosure, the lower CE company
599 accomplished. H3b is proved. It also follows that, if EHPIs are willing to invest more energy and
600 cost to disclose CSR_E information related to its operation, the company will earnestly fulfill its
601 environmental responsibilities and convey a positive signal for operation. From this perspective, the
602 cost of company information disclosure can be compensated by saving CE. So, in other words,
603 enterprises would like to obtain lower-cost of equity financing through a higher degree of CSR_E
604 disclosure. For another, investors prefer EHPIs to disclose more environmental information in their
605 CSR reports. That means, it is better for companies to disclose the abundant environmental
606 information. Compared with the standpoint that companies talk more and cause investors to find
607 more problems, the more CSR_E disclosure will gain higher positive evaluation from investors.

608 Ulteriorly, the disclosure of CSR_E does not exist alone in the form of charts, the use of charts is
609 more embedded in the text information. Then, the interaction impact of the chart and pages of
610 CSR_E on the CE is further examined. The results show that (column (6) of in Table 4) the
611 regression coefficient of the interaction item is significantly negative ($\delta = -0.0002$, $p < 0.05$). By
612 simultaneously using charts and larger pages to disclose CSR_E, the savings in CE can be brought
613 to a total of 0.43%. This result further validates the inference of H3b. That is to say, the higher
614 richness of CSR_E disclosure of EHPIs, including the amount of space and charts, the lower the CE
615 get for enterprises.

616 To sum up, the impact of CSR_E disclosure, environmental investment disclosure, charts and length
617 of CSR_E on CE reduction attains 0.58% in total, the effect of which is 30 times that of CSR
618 disclosure. Besides, the results show that the decreasing effectiveness of CE is largely from CSR_E
619 disclosure as well as its' textual features instead of CSR disclosure.

620 Robust test

621 In this section, we conduct four robust tests to corroborate our arguments. the first test examines
622 whether CSR as well as CSR_E disclosure of EHPIs indeed have overly positive effect on reduction
623 of CE after measurement substitution of CE, the second test verifies the consistent effect of degree
624 of environmental investment disclosure on CE by reclassifying environmental investment disclosure,
625 the third test supports that the richness of CSR_E disclosure characterizing with interaction of total
626 words and charts instead of the length and charts causes the negative effect on the CE companies
627 undertook, the last test is to confirm the vigorous effect of CSR, CSR_E disclosure on CE decline
628 via period extension.

629 CE evaluation with different models

630 Previous studies have used the PEG model to calculate the CE for empirical testing. In order to
631 avoid the bias results for the measurement model selection, we further examine and confirm the
632 empirical results by related with the MPEG model (Easton, 2004) and the OJM model to measure
633 CE. And the PSM method is used again to get the regression results shown in Table 5. CSR
634 disclosure, quality of CSR disclosure and CSR_E disclosure (including environmental investment
635 disclosure and richness of CSR_E disclosure) all have a prominently negative impact on the CE
636 (MPEG model: $CSR_d \beta = -0.0031$, $CSR_q \beta = -0.0002$, $CSR_Einv \beta = -0.0017$, $CSR_Eric1 \beta = -$

637 0.0005, CSR_Eric2 $\beta=-0.0042$, $CSR_Eric1 \times 2$ $\beta=-0.0003$; OJM model: CSR_d $\beta=-0.0031$, CSR_q
638 $\beta=-0.0001$, CSR_Einv $\beta=-0.0016$, CSR_Eric1 $\beta=-0.0004$, CSR_Eric2 $\beta=-0.0039$, $CSR_Eric1 \times 2$
639 $\beta=-0.0002$). Consistent with the results of the regression test above, and the H1, H2, H3a and H3b
640 are supported again.

641 **Table 4** Tests of Hypotheses: Year and industry fixed effects regression analyses

	Dependent variable=CE					
	(1)	(2)	(3)	(4)	(5)	(6)
CSR_d	-0.0035*** (-3.57)					
CSR_q		-0.0002** (-2.55)				
CSR_Einv			-0.0017*** (-3.23)			
CSR_Eric1				-0.0004* (-1.86)		
CSR_Eric2					-0.0037** (-2.47)	
CSR_Eric 1×2						-0.0002** (-2.16)
INST	-0.0045** (-2.28)	-0.0107*** (-2.72)	-0.0048** (-2.45)	-0.0104*** (-2.65)	-0.0111*** (-2.82)	-0.0104*** (-2.65)
BIG4	-0.0033* (-1.93)	-0.0043** (-2.01)	-0.0038** (-2.29)	-0.0039* (-1.65)	-0.0039* (-1.66)	-0.0038 (-1.61)
LEV	0.0180*** (6.31)	0.0239*** (5.02)	0.0188*** (6.75)	0.0258*** (5.08)	0.0259*** (5.10)	0.0257*** (5.06)
DFL	0.0005* (1.92)	0.0006** (2.14)	0.0005** (1.97)	0.0006** (2.02)	0.0006** (2.02)	0.0006** (2.03)
Cash	-0.0006 (-1.53)	-0.0006 (-0.76)	-0.0006 (-1.63)	-0.0004 (-0.44)	-0.0004 (-0.43)	-0.0003 (-0.40)
OR	0.0111*** (3.68)	0.0095* (1.92)	0.0118*** (3.98)	0.0063 (1.20)	0.007 (1.33)	0.0062 (1.18)
Size	0.0048*** (8.69)	0.0047*** (5.74)	0.0045*** (8.64)	0.0042*** (4.76)	0.0046*** (5.00)	0.0043*** (4.82)
Sharecon	-0.0298*** (-7.12)	-0.0383*** (-5.01)	-0.0304*** (-7.43)	-0.0468*** (-5.79)	-0.0454*** (-5.60)	-0.0466*** (-5.77)
Liquidity	-0.0005** (-2.13)	-0.0013*** (-2.89)	-0.0005** (-2.49)	-0.0015*** (-3.15)	-0.0014*** (-3.11)	-0.0015*** (-3.13)
Zindex	0.0000 (0.03)	0.0000 (1.40)	0.0000 (0.35)	0.0000** (1.97)	0.0000** (2.00)	0.0000* (1.96)
CEOcom	0.0016** (2.36)	0.0024** (2.05)	0.0016** (2.36)	0.002 (1.62)	0.0022* (1.79)	0.0020* (1.66)
Iintercept	-0.0371*** (-2.70)	-0.0422* (-1.87)	-0.0288** (-2.19)	-0.0223 (-0.91)	-0.0293 (-1.18)	-0.0243 (-0.99)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
R ² -adj	0.2688	0.152	0.0741	0.1314	0.1346	0.1323
Wald chi2/F-values	1570.83	29.93	121.08	17.21	17.43	17.31

***, **, * indicate statistical significance at the 1 percent, 5 percent and 10 percent levels, respectively, t-statistics are reported in parentheses below the coefficient estimates. Year and industry fixed effects are added to the model. All continuous variables are winsorized at the 1 percent level.

Table 4 displays the test results of the relation between CSR disclosure, quality of CSR report, environmental investment disclosure, richness of CSR_E disclosure and cost of equity respectively from column (1) to column (6). The propensity matching score (PSM) is adopted to test the relation between CSR disclosure and cost of equity to avoid self-selection. CSR_Eric 1×2 is the multiplicative interaction item between CSR_Eric1 and CSR_Eric2.

642

643

Table 5 CSR disclosure, quality of CSR report, environmental investment disclosure, richness of CSR_E disclosure and cost of equity measured by MPEG model and OJM model

644

645

Panel A

Dependent variable=CE	(1)		(2)		(3)	
	MPEG model	OJM model	MPEG model	OJM model	MPEG model	OJM model
CSR_d	-0.0031*** (-3.08)	-0.0031*** (-2.98)				
CSR_q			-0.0002*** (-2.81)	-0.0001** (-2.06)		
CSR_Einv					-0.0017*** (-2.99)	-0.0016*** (-2.76)
INST	-0.0035* (-1.67)	-0.0026 (-1.25)	-0.0100** (-2.42)	-0.0088** (-2.05)	-0.0036* (-1.78)	-0.0029 (-1.40)
BIG4	-0.0033* (-1.84)	-0.0028 (-1.52)	-0.0044* (-1.94)	-0.0046* (-1.92)	-0.0033* (-1.91)	-0.0034* (-1.87)
LEV	0.0135*** (4.50)	0.0162*** (5.29)	0.0154*** (3.06)	0.0208*** (3.97)	0.0137*** (4.70)	0.0174*** (5.84)
DFL	0.0005* (1.91)	0.0005* (1.83)	0.0006** (2.05)	0.0006* (1.95)	0.0005* (1.93)	0.0005* (1.88)
Cash	-0.0002 (-0.50)	-0.0011** (-2.57)	0.0003 (-0.32)	-0.0015* (-1.69)	-0.0002 (-0.58)	-0.0011*** (-2.71)
OR	0.0132*** (4.19)	0.0116*** (3.60)	0.0129** (2.47)	0.0112** (2.05)	0.0141*** (4.53)	0.0124*** (3.88)
Size	0.0062*** (10.73)	0.0051*** (8.63)	0.0065*** (7.52)	0.0055*** (6.06)	0.0060*** (11.05)	0.0047*** (8.43)
Sharecon	-0.0305*** (-6.94)	-0.0306*** (-6.84)	-0.0398*** (-4.93)	-0.0408*** (-4.88)	-0.0310*** (-7.25)	-0.0313*** (-7.16)
Liquidity	-0.0004* (-1.83)	-0.0004 (-1.62)	-0.0011** (-2.45)	-0.0012** (-2.47)	-0.0005** (-2.13)	-0.0005** (-2.00)
Zindex	-0.0001 (-0.41)	0.0000 (0.29)	0.0000 (1.36)	0.0000 (1.30)	-0.0000 (-0.04)	0.0001 (0.66)
CEOcom	0.0027*** (3.80)	0.0015** (2.09)	0.0039*** (3.16)	0.0021 (1.60)	0.0026*** (3.78)	0.0015** (2.15)
Intercept	-0.0792*** (-5.51)	-0.0231 (-1.57)	-0.0908*** (-3.81)	-0.0298 (-1.20)	-0.0734*** (-5.32)	-0.0143 (-1.01)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
R2-adj	0.2800	0.2450	0.1466	0.1283	0.0776	0.0658
Wald chi2/F-values	1662.81	1361.65	32.43	26.26	129.20	106.64

646

Panel B

Dependent variable=CE	(4)		(5)		(6)	
	MPEG model	OJM model	MPEG model	OJM model	MPEG model	OJM model
CSR_Eric1	-0.0005** (-2.16)	-0.0004* (-1.74)				
CSR_Eric2			-0.0042*** (-2.65)	-0.0039** (-2.40)		
CSR_Eric 1×2					-0.0003** (-2.44)	-0.0002** (-2.12)
INST	-0.0092** (-2.26)	-0.0071* (-1.70)	-0.0100** (-2.44)	-0.0078* (-1.86)	-0.0093** (-2.26)	-0.0072* (-1.71)
BIG4	-0.0034 (-1.38)	-0.0039 (-1.54)	-0.0034 (-1.39)	-0.0040 (-1.56)	-0.0033 (-1.33)	-0.0038 (-1.50)
LEV	0.0183*** (3.44)	0.0247*** (4.50)	0.0184*** (3.47)	0.0247*** (4.49)	0.0182*** (3.43)	0.0246*** (4.48)
DFL	0.0006* (1.96)	0.0006* (1.87)	0.0006* (1.96)	0.0006* (1.87)	0.0006** (1.97)	0.0006* (1.88)
Cash	0.0004 (0.48)	-0.0011 (-1.27)	0.0004 (0.47)	-0.0011 (-1.26)	0.0004 (0.52)	-0.0011 (-1.24)
OR	0.0102* (1.87)	0.0072 (1.27)	0.0110** (2.01)	0.0079 (1.39)	0.0101* (1.84)	0.007 (1.24)
Size	0.0058*** (6.22)	0.0047*** (4.85)	0.0061*** (6.43)	0.0050*** (5.10)	0.0059*** (6.29)	0.0048*** (4.93)
Sharecon	-0.0488*** (-5.80)	-0.0489*** (-5.63)	-0.0473*** (-5.60)	-0.0474*** (-5.43)	-0.0486*** (-5.77)	-0.0486*** (-5.60)
Liquidity	-0.0014*** (-2.95)	-0.0014*** (-2.87)	-0.0014*** (-2.91)	-0.0014*** (-2.84)	-0.0014*** (-2.93)	-0.0014*** (-2.86)
Zindex	0.0000* (1.70)	0.0000 (1.51)	0.0000* (1.73)	0.0000 (1.53)	0.0000* (1.69)	0.0000 (1.50)
CEOcom	0.0035*** (2.76)	0.0019 (1.43)	0.0038*** (2.92)	0.0021 (1.59)	0.0036*** (2.80)	0.002 (1.48)
Intercept	-0.0738*** (-2.89)	-0.0125 (-0.47)	-0.0807*** (-3.12)	-0.0202 (-0.75)	-0.0758*** (-2.97)	-0.015 (-0.57)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
R ² -adj	0.1290	0.1159	0.1317	0.1197	0.1299	0.1169
Wald chi2/F-values	18.01	14.86	18.20	15.08	18.11	14.98

647 ***, **, * indicate statistical significance at the 1 percent, 5 percent and 10 percent levels, respectively.
648 All continuous variables are winsorized at 1 percent level. t-statistics are reported in parentheses below
649 the coefficients estimates. Year and industry fixed effects are added to the model
650 Table 5 displays the robust test results of the relation between CSR disclosure, quality of CSR report,
651 environmental investment disclosure, richness of CSR_E disclosure and cost of equity respectively from
652 column (1) to column (6) by changing measurement of cost of equity from PEG model to MPEG model
653 and OJM model. The propensity matching score (PSM) is adopted to test the relation between CSR
654 disclosure and cost of equity to avoid self-selection. CSR_Eric 1×2 is the multiplicative interaction item
655 between CSR_Eric1 and CSR_Eric2.

656 Reclassification of environmental investment disclosure

657 By reclassified the environmental investment disclosure into two categories, the robustness of the
658 regression results above is tested again. Integrating the precise disclosure and fuzzy disclosure of
659 environmental investment amount into the environmental investment disclosure which is assigned

660 1 while 0 for companies that do not disclose environmental investment amount. Then, the disclosure
661 of environmental investment of EHPIs (Total2) was re-measured. Based on the CE obtained by
662 using the PEG model in the earlier, the MPEG and OJM models are also included, and regression
663 analysis is performed respectively. The results are shown in Table 6. The disclosure of
664 environmental investment is sharply negative to CE by the three models (PEG model: $\beta=-0.0021$,
665 $p<0.01$; MPEG model: $\beta=-0.0020$, $p<0.01$; OJM model: $\beta=-0.0019$, $p<0.01$). It is
666 facile for us to draw the conclusion that, companies have access to the lower CE if they disclose
667 environmental investment information in CSR_E whether accurate or hazy quantitative information
668 compared with such information undisclosed, and the stability of the regression results is not
669 affected by the different measurement of the environmental investment disclosure corresponding to
670 the CE measured within different models. So, the H3a is proved again.

671 Richness of CSR_E disclosure measured with number of words

672 In the test of H3b, the abundance of CSR_E disclosure was measured by the number of pages and
673 graphs, Considering the difference in length of CSR_E caused by the font size of each CSR report,
674 we further employ the number of characters of CSR_E counted with Python, substituting textual
675 length, to repeat the previous regression analysis. From the results in Table 7, the number of
676 characters and graphs in CSR_E of EHPIs has a significant negative impact on the CE ($\beta=-0.0001$,
677 $p<0.05$). To summarize, the more characters and graphs used in CSR_E, the lower the CE a company
678 undertake. Therefore, H3b is proved to ensure the robust of the results.

679 Extending the research period

680 In order to further verify the reliability of the CSR disclosure, quality of CSR disclosure and the
681 richness of CSR_E disclosure in the negative impact of CE for different periods, investigating
682 whether heterogeneity of each subsample exists, we extend the sample period from 2010-2017 to
683 2010-2018. The regression results (Table 8) are shown (CSR_d $\beta=-0.0047$, CSR_q $\beta=-0.0001$,
684 CSR_{Eric1} $\beta=-0.0006$, CSR_{Eric2} $\beta=-0.0042$, $CSR_{Eric1} \times 2$ $\beta=-0.0003$) that even if the sample
685 period of the empirical test is changed, the result is steady. In yet other words, the CSR disclosure,
686 quality of CSR disclosure and the richness of CSR_E disclosure of EHPIs all make significant
687 negative impacts on the CE. As a result, H1, H2, and H3b have been verified again.

688

689 **Table 6** Environmental investment disclosure reclassified and cost of equity

Dependent variable=CE	(1)	(2)	(3)
	PEG model	MPEG model	OJN model
CSR_Einv'	-0.0021*** (-3.25)	-0.0020*** (-2.86)	-0.0019*** (-2.64)
INST	-0.0047** (-2.39)	-0.0036* (-1.74)	-0.0028 (-1.36)
BIG4	-0.0037** (-2.24)	-0.0033* (-1.88)	-0.0033* (-1.84)
LEV	0.0187*** (6.72)	0.0137*** (4.69)	0.0174*** (5.82)
DFL	0.0005* (1.96)	0.0005* (1.92)	0.0005* (1.87)
Cash	-0.0007* (-1.96)	-0.0002 (-0.58)	-0.0011*** (-3.01)

	(-1.66)	(-0.59)	(-2.72)
OR	0.0119***	0.0141***	0.0124***
	(3.98)	(4.52)	(3.88)
Size	0.0045***	0.0060***	0.0047***
	(8.66)	(11.03)	(8.42)
Sharecon	-0.0304***	-0.0311***	-0.0313***
	(-7.45)	(-7.26)	(-7.17)
Liquidity	-0.0005**	-0.0005**	-0.0005**
	(-2.46)	(-2.10)	(-1.97)
Zindex	0.0000	0.0000	0.0000
	(0.30)	(-0.09)	(0.61)
CEOcom	0.0016**	0.0027***	0.0015**
	(2.39)	(3.79)	(2.16)
Intercept	-0.0320**	-0.0738***	-0.0147
	(-2.43)	(-5.31)	(-1.03)
Year FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
R ² -adj	0.0733	0.0769	0.0651
Wald chi2/F-values	121.17	129.08	106.54

***, **, * indicate statistical significance at the 1 percent, 5 percent and 10 percent levels, respectively. All continuous variables are winsorized at 1 percent level. t-statistics are reported in parentheses below the coefficients estimates. Year and industry fixed effects are added to the model

Table 6 displays the robust test results of the relation between environmental investment disclosure within reclassification and cost of equity measured by PEG model, MPEG model and OJM model respectively from column (1) to column (3). CSR_Einv' is the environmental investment disclosure reclassified.

690

Table 7 The number of words of CSR_E and cost of equity

	Dependent variable=CE
CSR_Eric 1×3	-0.0001** (-2.01)
INST	-0.0104*** (-2.65)
BIG4	-0.0038 (-1.62)
LEV	0.0258*** (5.07)
DFL	0.0006** (2.02)
Cash	-0.0003 (-0.42)
OR	0.0063 (1.19)
Size	0.0043*** (4.78)
Sharecon	-0.0466*** (-5.77)
Liquidity	-0.0015*** (-3.14)
Zindex	0.0000** (1.98)

CEOcom	0.002 (1.64)
Intercept	-0.0232 (-0.95)
Year FE	Yes
Industry FE	Yes
R ² -adj	0.1318
Wald chi2/F-values	17.26

***, **, * indicate statistical significance at the 1 percent, 5 percent and 10 percent levels, respectively. All continuous variables are winsorized at 1 percent level. t-statistics are reported in parentheses below the coefficients estimates. Year and industry fixed effects are added to the model

Table 7 displays the robust test results of the relation between number of words of CSR_E and cost of equity measured by PEG model. CSR_Eric 1×3 is the multiplicative interaction item between CSR_Eric1 and CSR_Eric3.

691

692 **Table 8** CSR disclosure, quality of CSR report, richness of CSR_E disclosure and cost of equity
693 during 2010-2018

Dependent variable=CE	(1)	(2)	(3)	(4)	(5)
CSR_d	-0.0047*** (-5.11)				
CSR_q		-0.0001** (-2.44)			
CSR_Eric1			-0.0006** (-2.48)		
CSR_Eric2				-0.0042*** (-2.86)	
CSR_Eric1×2					-0.0003*** (-2.78)
INST	-0.0003*** (-6.43)	-0.0003*** (-4.80)	-0.0004*** (-3.41)	-0.0004*** (-3.36)	-0.0004*** (-3.42)
BIG4	-0.0038** (-2.27)	-0.0051*** (-2.67)	-0.0049** (-2.17)	-0.0049** (-2.16)	-0.0048** (-2.12)
LEV	0.0002*** (3.04)	0.0003*** (3.39)	0.0003** (2.26)	0.0003** (2.35)	0.0003** (2.28)
DFL	0.0034*** (3.27)	0.0006** (2.30)	0.0006** (2.05)	0.0006** (2.04)	0.0006** (2.06)
Cash	-0.0011*** (-3.02)	-0.0004* (-1.65)	-0.0012 (-1.62)	-0.0012* (-1.65)	-0.0012 (-1.58)
OR	0.0122*** (4.27)	0.0143*** (3.38)	0.0102** (2.07)	0.0112** (2.27)	0.0101** (2.04)
Size	0.0061*** (13.06)	0.0064*** (10.13)	0.0063*** (8.72)	0.0066*** (8.87)	0.0063*** (8.78)
Sharecon	-0.0325*** (-8.13)	-0.0499*** (-7.75)	-0.0529*** (-7.04)	-0.0520*** (-6.90)	-0.0527*** (-7.01)
Liquidity	-0.0001 (-0.51)	-0.0003 (-0.64)	-0.0007 (-1.63)	-0.0007 (-1.53)	-0.0007 (-1.62)
Zindex	0.0000 (0.80)	0.0000** (2.26)	0.0001*** (2.66)	0.0001*** (2.70)	0.0001*** (2.65)
CEOcom	0.0014** (2.11)	0.0022** (2.22)	0.0020* (1.71)	0.0022* (1.84)	0.0021* (1.75)

Intercept	-0.0593*** (-4.65)	-0.0552** (-2.42)	-0.0640*** (-2.89)	-0.0701*** (-3.11)	-0.0659*** (-2.97)
Year FE	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
R2-adj	0.2768	0.1643	0.0898	0.0918	0.0910
Wald chi2/F-values	1813.27	32.40	33.86	33.59	33.85

***, **, * indicate statistical significance at the 1 percent, 5 percent and 10 percent levels, respectively, t-statistics are reported in parentheses below the coefficient estimates. Year and industry fixed effects are added to the model. All continuous variables are winsorized at the 1 percent level.

Table 8 displays the robust test results of the relation between CSR disclosure, quality of CSR report, richness of CSR_E disclosure and cost of equity respectively from column (1) to column (5) by extending periods from 2017 to 2018. The propensity matching score (PSM) is adopted to test the relation between CSR disclosure and cost of equity to avoid self-selection. $CSR_Eric1 \times 2$ is the multiplicative interaction item between CSR_Eric1 and CSR_Eric2 .

694 Additional analysis

695 It is proved above that the CSR disclosure of EHPIs, especially the CSR_E disclosure, make
696 dramatical inhibiting effect on the CE. Thus, we further examine whether the same effect of this
697 type of information disclosure exists on the cost of debt for EHPIs. On these grounds, the cost of
698 debt financing ($DebtCost1$ and $DebtCost2$) is calculated in terms of two approaches (Ahmed et al.,
699 2002; Zhou et al., 2016), the regression analysis based on the hypotheses put forward above is in
700 Table 9. It is found that the higher the quality of CSR disclosure and abundance of CSR_E disclosure,
701 the easier it is for companies to obtain lower cost of debt ($DebtCost1$: $CSR_d \beta = -0.0149$, CSR_q
702 $\beta = -0.0012$, $CSR_Einv \beta = -0.0082$, $CSR_Eric1 \beta = -0.0098$, $CSR_Eric2 \beta = -0.0887$, $CSR_Eric1 \times 2 \beta =$
703 0.0043 ; $DebtCost2$: $CSR_d \beta = -0.0163$, $CSR_q \beta = -0.0017$, $CSR_Einv \beta = -0.0090$, $CSR_Eric1 \beta =$
704 0.0026 , $CSR_Eric2 \beta = -0.0156$, $CSR_Eric1 \times 2 = -0.0012$). This effect is consistent with the results
705 of CE. CSR as well as CSR_E disclosure have a greater degree of impact on cost of debt financing
706 compared to the degree of impact that on CE, and the positive effect of the cost reduction of debt
707 financing from CSR disclosure and the CSR_E disclosure, are 0.1 percent and 2.16 percent greater
708 obvious than that of the CE respectively. The results indirectly indicate that the CSR disclosure of
709 EHPIs and the CSR_E therein will not decrease one type of financing cost at the expense of another
710 type of the cost increasing. In other words, the voluntary disclosure of this type of information and
711 its' disclosure characteristic has purely positive effects on the financing cost decreasing (equity
712 financing and debt financing) while no substitution or hedging between different financing markets
713 been found.

714 **Table 9** CSR disclosure, quality of CSR report, environmental investment disclosure and cost of
715 debt

716 Panel A

Dependent variable=cost of debt	(1)		(2)		(3)	
	$DebtCost1$	$DebtCost2$	$DebtCost1$	$DebtCost2$	$DebtCost1$	$DebtCost2$
CSR_d	-0.0149*** (-4.62)	-0.0163*** (-4.93)				
CSR_q			-0.0012*** (-4.87)	-0.0017*** (-6.27)		

CSR_Einv					-0.0082***	-0.0090***
					(-4.38)	(-4.71)
INST	-0.0393***	-0.0519***	0.0048	-0.0206	-0.0371***	-0.0493***
	(-6.04)	(-7.74)	-0.33	(-1.32)	(-5.61)	(-7.25)
BIG4	-0.0176***	0.0055	-0.0266***	0.0084	-0.0339***	-0.0114*
	(-2.86)	-0.87	(-3.18)	-0.94	(-5.53)	(-1.82)
LEV	0.4117***	0.3847***	0.4506***	0.4472***	0.3437***	0.3301***
	(49.09)	(44.59)	(27.08)	(25.12)	(47.96)	(44.27)
DFL	0.0013**	0.0027***	0.0019**	0.0020**	0.0006*	0.0009***
	(2.08)	(4.05)	(2.12)	(2.10)	(1.79)	(2.66)
Cash	-0.0112***	-0.0135***	-0.0098***	-0.0103***	-0.0121***	-0.0140***
	(-7.82)	(-9.20)	(-3.26)	(-3.18)	(-8.27)	(-9.33)
OR	0.1670***	0.1233***	0.1466***	0.0884***	0.1839***	0.1383***
	(17.83)	(12.76)	(8.14)	(4.56)	(19.40)	(14.16)
Size	0.0355***	0.0449***	0.0395***	0.0497***	0.0406***	0.0481***
	(21.21)	(26.12)	(13.63)	(16.04)	(25.81)	(29.66)
Sharecon	-0.0317**	-0.002	-0.0982***	-0.0908***	-0.0526***	-0.0329**
	(-2.33)	(-0.14)	(-3.55)	(-3.07)	(-3.85)	(-2.34)
Liquidity	0.0014**	0.0015**	0.0023	0.0015	0.0023***	0.0021***
	(2.15)	(2.29)	(1.56)	(0.95)	(3.56)	(3.10)
Zindex	-0.0001	-0.0001**	0.0000	0.0000	0.0000	-0.0000
	(-1.06)	(-2.19)	(0.56)	(0.21)	(0.08)	(-0.33)
CEOcom	-0.0266***	-0.0341***	-0.0454***	-0.0545***	-0.0272***	-0.0343***
	(-12.04)	(-14.98)	(-10.53)	(-11.75)	(-12.17)	(-14.88)
Intercept	-0.4818***	-0.5293***	-0.2930***	-0.3081***	-0.5591***	-0.5667***
	(-11.40)	(-12.15)	(-3.65)	(-3.59)	(-13.68)	(-13.47)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
R2-adj	0.6543	0.6526	0.6797	0.6738	0.6272	0.624
Wald chi2/F-values	11604.04	11158.51	258.14	244.04	527.65	503.13

717

718

Panel B

	(4)		(5)		(6)	
	DebtCost1	DebtCost2	DebtCost1	DebtCost2	DebtCost1	DebtCost2
CSR_Eric1	-0.0098**	-0.0026***				
	(-2.39)	(-2.93)				
CSR_Eric2			-0.0867***	-0.0156***		
			(-3.32)	(-2.73)		
CSR_Eric1×2					-0.0043**	-0.0012***
					(-2.39)	(-2.99)
INST	0.0694	-0.0348**	0.0562	-0.0370**	0.0692	-0.0349**
	(1.01)	(-2.34)	(0.82)	(-2.48)	(1.00)	(-2.35)
BIG4	-0.0973**	0.0138	-0.0955**	0.0137	-0.0946**	0.0144

	(-2.31)	(1.49)	(-2.27)	(1.48)	(-2.25)	(1.55)
LEV	-0.2233***	0.4252***	-0.2216***	0.4272***	-0.2250***	0.4247***
	(-2.61)	(23.46)	(-2.60)	(23.60)	(-2.63)	(23.43)
DFL	-0.0038	0.0026**	-0.0039	0.0026**	-0.0038	0.0026**
	(-0.77)	(2.37)	(-0.79)	(2.36)	(-0.77)	(2.37)
Cash	0.0300**	-0.0096***	0.0308**	-0.0097***	0.0302**	-0.0096***
	(2.10)	(-3.03)	(2.16)	(-3.03)	(2.11)	(-3.00)
OR	-0.3088***	0.0712***	-0.2939***	0.0735***	-0.3122***	0.0701***
	(-3.39)	(3.62)	(-3.23)	(3.73)	(-3.42)	(3.56)
Size	-0.0381***	0.0516***	-0.0312**	0.0523***	-0.0380***	0.0517***
	(-2.60)	(16.21)	(-2.10)	(16.10)	(-2.60)	(16.24)
Sharecon	0.3498**	-0.0355	0.3786***	-0.0324	0.3512**	-0.0352
	(2.54)	(-1.19)	(2.74)	(-1.08)	(2.55)	(-1.18)
Liquidity	-0.0002	0.0035**	0.0001	0.0036**	0.0003	0.0036**
	(-0.02)	(2.18)	(0.02)	(2.23)	(0.03)	(2.24)
Zindex	-0.0005	-0.0001	-0.0005	-0.0001	-0.0005	-0.0001
	(-1.32)	(-1.18)	(-1.23)	(-1.08)	(-1.32)	(-1.18)
CEOcom	0.0584***	-0.0548***	0.0626***	-0.0543***	0.0584***	-0.0547***
	(2.70)	(-11.75)	(2.89)	(-11.61)	(2.70)	(-11.74)
Intercept	0.2958	-0.3939***	0.1558	-0.4039***	0.2916	-0.3966***
	(0.72)	(-4.47)	(0.38)	(-4.53)	(0.71)	(-4.50)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Included	Yes	Yes	Yes	Yes	Yes
R ² -adj	0.0952	0.6900	0.0984	0.6898	0.0952	0.6902
Wald chi2/F-values	11.39	259.48	11.80	259.28	11.38	259.62

719 ***, **, * indicate statistical significance at the 1 percent, 5 percent and 10 percent levels,
720 respectively, t-statistics are reported in parentheses below the coefficient estimates. Year and
721 industry fixed effects are added to the model. All continuous variables are winsorized at the 1 percent
722 level.

723 Table 8 displays the additional test results of the relation between CSR disclosure, quality of CSR
724 report, environmental investment disclosure, richness of CSR_E disclosure and cost of debt with
725 two measurements respectively from column (1) to column (6). The propensity matching score
726 (PSM) is adopted to test the relation between CSR disclosure and cost of equity to avoid self-
727 selection. CSR_Eric 1 × 2 is the multiplicative interaction item between CSR_Eric1 and CSR_Eric2.

728 Discussion

729 It is trapped in the strongly connection between the main operation of EHPIs and environment
730 deterioration, companies in these types of industries have been required to disclose environmental
731 information in different reports since 2010. However, these companies have also carried out
732 voluntary disclosure of CSR reports, especially CSR_E disclosed in the report is more plentitude
733 and abundant. We exploit the motivation for voluntary disclosure of CSR and CSR_E by EHPIs
734 from the perspective of equity financing. That is, in addition to disclosing mandatory environmental
735 information in annual reports, companies also disclose CSR and improve its disclosure quality,
736 provide more quantitative information and increase the length of CSR_E disclosure by combining
737 more charts to obtain lower-cost equity financing. Specifically:

738 (1) Under the condition of the mandatory disclosure of environmental information, companies'
739 voluntary disclosure of CSR delivers more positive signals, enterprises can obtain lower-cost equity
740 financing by reducing information friction and improving co-governance.

741 For EHPs, the quality of CSR disclosures depends largely on the CSR_E disclosures. Compared
742 with fully voluntary disclosure, on the basis of mandatory disclosure of environmental information
743 in annual reports, companies further voluntarily disclose CSR, especially the CSR_E disclosure,
744 indicating that companies actively communicate the better prospects of corporate responsibility
745 performance and business operations management. In addition to reducing the information
746 asymmetry and reducing information processing costs by eliminating investors' trade friction,
747 higher-quality CSR disclosure also means that companies have a more stable stakeholder network
748 to better play the role of co-governance. When confronted with future uncertainties, it is of better
749 risk resistance capacity for EHPs, in the meanwhile, the corresponding investment risk and
750 uncertainty is remitted, indirectly improving stock liquidity. Therefore, the quality of CSR
751 disclosure is higher, and it is easier for investors to provide corporate equity financing discounts.

752 (2) It is better for CSR_E disclosure that should strive to be as plenitude as possible. Noticeably, the
753 positive effects for CE cuts that the charts in CSR_E enjoyed is the absence of texture, and the more
754 accurate the quantitative environmental information with substantial actions, the more value it
755 creates for the enterprise.

756 As the essential component of CSR report, environmental information is directly concerned with
757 the main business of EHPs. Compared with occasional information on social welfare activities that
758 irrelevant to the core business, such as donations, the accumulative characteristics of environmental
759 information directly reflect the future development direction of business operations and the level of
760 technological upgrading to a great extent (Zhang et al., 2021).

761 On one hand, compared to the mere text disclosure of environmental information in the annual report,
762 the CSR_E can be visualized through graphic information, which can reduce the information
763 processing cost for investors. Meanwhile, the use of charts as much as possible is also an indirect
764 expression of positive environmental governance and improving business operations. When
765 companies show greater development potential or are the leading enterprise of the industry, they
766 will have the motivation to put their efforts and invest more costs to compile and deliver more
767 information in the form of charts. This also reveals that the disclosure method of charts can produce
768 positive effects that texts cannot. Meanwhile, although the mandatory disclosure of environmental
769 information in different report has already provided some quantitative information, companies still
770 choose to disclose quantitative environmental information such as the amount of environmental
771 investment in the voluntary disclosure of CSR_E facing increasingly stringent environmental
772 regulations, and investors are conveyed the company's positive behavior in environmental
773 governance and main business. Compared with the qualitative information of social responsibility
774 ideology (Rustam et al., 2020), the voluntary disclosure of quantitative information, in addition to
775 clearly conveying the information that has been put into practice to investors, and gaining conviction
776 for the authenticity of the practice, accurate quantitative information expresses the more company's
777 initiative actions. The attitude of the company indirectly indicates that it is willing to accept the
778 information traceability of environmental regulations for its disclosed information; and the vague
779 quantitative information disclosure is more considered to avoid punishment of environmental

780 regulations, and deliberately concealing the unfavorable information of the company that doubts
781 about reliability from investors still exists. However, vague quantitative information disclosure can
782 still be favored by investors in decision-making compared to the non-disclosure of quantitative
783 information such as environmental investment. Generally, quantitative information is more valuable
784 than qualitative information, accurate quantitative environmental information disclosure can bring
785 more value to enterprises, including CE saving. Furthermore, the company's choice of quantitative
786 environmental information disclosure above has already reflected the text manipulation in its
787 information disclosure, by which it may be pursued for specific interests to adjust the expression of
788 information disclosure, choosing to disclose or not, to disclose precise or ambiguous information.
789 The vague quantitative information on the environment also partially supports the existence of CSR
790 greenwashing (Marquis and Qian, 2014).

791 On the other hand, the more CSR_E disclosed, the more that the further supplementation and
792 comparison information, especially environmental information in the annual report is provided to
793 investors. And investors have been announced more positive signals of corporate operation and
794 better social responsibility performance (especially environmental responsibility), which will help
795 reduce investors' requirements for a minimum return on investment and provide companies' lower
796 CE for EHPIs. As for investors, the environmental information disclosure of EHPIs is not the
797 viewpoint in existing studies that the more words will lead to more erroneousness. It is better to
798 speak than to keep silence to a greater extent, and the more adequate environmental disclosure from
799 different channels, like financial report and CSR report here, the more positive evaluation the
800 investors will make.

801 (3) Although the CE reduction degree from CSR and CSR_E disclosure is less than that from cost
802 of debt, debt financing constraints of EHPIs have limited this reduction effect. And the length of
803 CSR_E, graphs utilization and quantitative information have become the critical decision-making
804 elements for responsible investments in heavily polluting industries.

805 The release of CSR, CSR disclosure quality, CSR_E disclosure, including the length of CSR_E,
806 charts number and environmental investment disclosure, all make a greater impact on debt financing
807 costs than CE. The fantastic discount of debt financing costs from CSR especially CSR_E disclosure
808 indicates that CSR particularly CSR_E information receives vast attention from debt financing
809 institutions, such as banks, and become the pivotal grounds of loan pricing. Besides, it is shown that
810 the CSR_E contents affect the credit qualification evaluation when applying green credit. It is further
811 shown that the corporate "green talk" is more attractive in credit markets and get in return the
812 compensation of debt cost while sectional "green talk" is identified by the investors in equity
813 markets and obtain less discount of CE accordingly (Zhou et al., 2016). However, the debt financing
814 constraints of EHPIs multiplied along with the increasing environmental deterioration. Meanwhile,
815 compared with the scale of equity financing, the scale of debt financing is limited, and enterprises
816 need to face the financial pressure of periodic repayment, and equity financing channels is preferred.
817 Therefore, the disclosure of this type of information is limited in its effectiveness of debt financing
818 costs reducing.

819 In addition, the long-term sustainability of equity financing is also the core of responsible
820 investment focus on, and the environmental responsibility of EHPIs is the key area of responsible
821 investment. Thus, research results also show that the CSR_E disclosure of EHPIs can be used as an

822 important basis for investors' responsible investment decision-making. In the responsible investment,
823 charts and quantitative information, especially accurate quantitative information, become a crucial
824 foundation for investment decision-making. For companies, charts and precise quantitative
825 information are better approaches to convey their positive signals of environmental responsibility,
826 as researchers said that a picture is worth a thousand words, and precise quantitative information is
827 also proved of this worth here (Obaid and Pukthuanthong, 2021).

828 Conclusion

829 In view of the mandatory disclosure of environmental information in different reports for EHPIs,
830 this study aims to exploit the impact of companies' voluntary disclosure of CSR reports on their CE.
831 Taking the 2010-2018 Shanghai and Shenzhen A-share listed companies in the heavy pollution
832 industry as a sample, based on theoretical hypotheses, empirical tests within texture analysis have
833 shown the disclosure of the CSR reports, the quality of CSR disclosure, the environmental
834 investment disclosure in CSR_E, the richness of CSR_E disclosure have a significant negative
835 impact on CE. The robust test was carried out by means of alternative CE measurement, the
836 disclosure of environmental investment, the richness of CSR_E disclosure, and the extension of
837 sample period. We further confirm that the higher the quality of CSR disclosure by EHPIs, especially
838 the higher the degree of CSR_E disclosure (including environmental investment disclosure and the
839 abundance of CSR_E), the easier it is for companies in the heavy pollution industry to obtain lower
840 cost of equity. Specifically, the more precise disclosure of environmental protection investment
841 amount, the more the number of charts used, and the more the environmental information disclosure
842 of the CSR report, the more facile for companies to strive for discounts on CE. In further analysis,
843 similar results were obtained for the impact on the cost of debt financing, and the CSR report,
844 especially the CSR_E disclosure, had a greater impact on the cost of debt financing than the CE.

845 Based on the above discussion, the practical suggestions of this research are summarized as follows:
846 (1) Companies should be encouraged to make full use of voluntary information disclosure of
847 different pathways, pay attention to the psychology of market investors, and enhance the
848 effectiveness of information in terms of the content and method of disclosure, so as to create value
849 for the company, reduce investors' over-underestimation and lack of confidence of high-quality
850 enterprises, which is also the breakthroughs for the sustainable development of EHPIs. (2) For the
851 designing of information disclosure, environmental regulation and other policies, market regulatory
852 agencies should pay more attention to industry differences and use the combination of mandatory
853 and voluntary disclosure to give full play to the market's independent supervision effect on
854 information screening; (3) The use of CSR reports and environmental information disclosures of
855 EHPIs provides valuable reference for the building of an evaluation system for responsible
856 investment governance in the capital market. In addition to traditional data and information, more
857 attention should be paid to texture features and its analysis to comply with the development
858 characteristics of big data. In this way, the rights and interests of investors can be guaranteed with
859 the promotion of responsible investment.

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