Adoption of product market competition on the relationship between environmental accounting information disclosure and financing constraints

Adoção da concorrência de mercado de produtos na relação entre a divulgação de informações contábeis ambientais e as restrições de financiamento

Adopción de competencia en el mercado de productos sobre la relación entre la divulgación de información contable ambiental y las restricciones de financiamiento

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Abstract

In the context of growing global environmental concerns, investors and financial institutions are emphasizing environmental responsibility and sustainability. Financing constraints represent barriers that companies may encounter when seeking funding, which can have a significant impact on their investment decisions and expansion plans. Through enhanced environmental accounting information disclosure (EAID), companies can communicate their financial constraints to the outside world while still showing their commitment to being environmentally responsible. This approach not only enhances their corporate image, but may also help alleviate financing constraints and promote their sustainable development. Product market competition, as an external governance discipline mechanism, has the potential to drive innovation and productivity within companies. However, there is a complex relationship between product market competition and financing constraints. The enhancement of product market competitiveness can enhance investor confidence, reduce investors' requirements for risk premium, and thus reduce external financing costs. This study examined the influence of EAID on financing constraints through the lens of information asymmetry theory and resource dependence theory, while also investigating the heterogeneity of product market competition in the relationship between EAID and financing constraints, considering the nature of property rights. It was found that EAID can significantly alleviate financing constraints, that product market competition is negatively related to financing constraints, and that product market competition weakens the mitigating effect of EAID on financing constraints. These findings provide valuable insights for policymakers, investors, and managers seeking to balance environmental responsibility while fostering financial development under competitive market pressures.

Keywords: Environmental Accounting Information Disclosure; Financing Constraints; Product Market Competition; Environmental Responsibility

Resumo

No contexto das crescentes preocupações ambientais globais, investidores e instituições financeiras estão enfatizando a responsabilidade ambiental e a sustentabilidade. Restrições de financiamento representam barreiras que as empresas podem encontrar ao buscar financiamento, o que pode ter um impacto significativo em suas decisões de investimento e planos de expansão. Por meio da divulgação aprimorada de informações contábeis ambientais (EAID), as empresas podem comunicar suas restrições financeiras ao mundo externo e, ao mesmo tempo, mostrar seu comprometimento em serem ambientalmente responsáveis. Essa abordagem não apenas melhora sua imagem corporativa, mas também pode ajudar a aliviar as restrições de financiamento e promover seu desenvolvimento sustentável. A competição no mercado de produtos, como um mecanismo de disciplina de governança externa, tem o potencial de impulsionar a inovação e a produtividade dentro das empresas. No entanto, há uma relação complexa entre a competição no mercado de produtos e as restrições de financiamento. O aprimoramento da competitividade no mercado de produtos pode aumentar a confiança do

investidor, reduzir os requisitos dos investidores para prêmio de risco e, assim, reduzir os custos de financiamento externo. Este estudo examinou a influência do EAID nas restrições de financiamento através das lentes da teoria da assimetria de informação e da teoria da dependência de recursos, enquanto também investigava a heterogeneidade da competição do mercado de produtos na relação entre o EAID e as restrições de financiamento, considerando a natureza dos direitos de propriedade. Foi descoberto que o EAID pode aliviar significativamente as restrições de financiamento, que a competição do mercado de produtos está negativamente relacionada às restrições de financiamento e que a competição do mercado de produtos enfraquece o efeito mitigador do EAID nas restrições de financiamento. Essas descobertas fornecem insights valiosos para formuladores de políticas, investidores e gerentes que buscam equilibrar a responsabilidade ambiental enquanto promovem o desenvolvimento financeiro sob pressões competitivas de mercado.

Palavras-chaves: Divulgação de informações contábeis ambientais; Restrições de financiamento; Concorrência de mercado de produtos; Responsabilidade ambiental

Resumen

En el contexto de las crecientes preocupaciones ambientales globales, los inversores e instituciones financieras están enfatizando la responsabilidad ambiental y la sustentabilidad. Las restricciones de financiación representan barreras que las empresas pueden encontrar para buscar financiación, o que pueden tener un impacto significativo en sus decisiones de inversión y planes de expansión. Por meio da divulgação aprimorada de informações contábeis ambientais (EAID), as empresas podem comunicar sus restricciones financieras al mundo externo y, ao mesmo tempo, mostrar su compromiso em serem ambientalmente responsable. Este enfoque no es sólo mejorar su imagen corporativa, pero también puede ayudar a aliviar las restricciones financieras y promover su desarrollo sostenible. La competencia en el mercado de productos, como un mecanismo de disciplina de gobernanza externa, tiene el potencial de impulsar la innovación y la productividad dentro de las empresas. Sin embargo, hay una relación compleja entre la competencia en el mercado de productos y restricciones de financiación. El aprimoramento de la competitividad en el mercado de productos puede aumentar la confianza del inversor, reducir los requisitos de los inversores para obtener un benefício de riesgo y, así, reducir los custodios de financiamiento externo. Este estudio examina la influéncia de EAID en las restricciones de financiación a través de las lentes de la teoría de la assimetría de la información y la teoría de la dependencia de recursos, mientras que también investiga la heterogeneidad de la competencia del mercado de productos en la relación entre EAID y las restricciones de financiación. considerando la naturaleza de los derechos de propiedad. Si descubrimos que EAID podría aliviar significativamente las restricciones de financiación, que la competencia del mercado de productos está negativamente relacionada con las restricciones de financiación y que la competencia del mercado de productos enmarca el efecto mitigador de EAID en las restricciones de

financiación. Essas descobertas fornecem insights valiosos para formuladores de políticas, inversores e gerentes que buscan equilibrar la responsabilidad ambiental en cuanto a promoción o desarrollo financiero bajo presiones competitivas de mercado.

Palavras-chave: Divulgação de informações contábeis ambientais; Restricciones de financiación; Concorrência de mercado de productos; Responsabilidad ambiental

1 Introduction

The globe is currently dealing with a growing number of environmental issues, including extreme weather occurrences, crucial ecological changes, and biodiversity loss. These issues have implications for corporate finance, as investors and financial institutions place greater emphasis on corporate sustainability and environmental responsibility (Zhai et al., 2022; Sandberg et al., 2023). Instances of environmental malpractice, such as the Volkswagen emissions scandal and Mitsubishi Motors' extended history of cheating on fuel tests, highlights the substantial impact of environmental issues on corporate reputation and financing capacity. Similarly, intensifying product market competition may drive companies to neglect their environmental responsibilities in the fierce market competition, which further affecting their market position and financing ability (Tan and Zhu, 2022). Thus, environmental issues not only challenge the social responsibility of companies, but also profoundly influence their financial health and market competitiveness.

Research on environmental accounting information disclosure (EAID) has shown its beneficial impact on various aspects of corporate performance, including the value of cash holdings and stock market liquidity (Krishnamurti and Velayutham, 2018), cost of debt (Arora and Sharma, 2022; Yang et al., 2024), corporate innovation (Bai and Lyu, 2023; Chen et al., 2023), corporate reputation (Maaloul et al., 2023), and firm value (Hassan, 2018; Emmanuel et al., 2019). Li et al. (2021) proposed that cities with stronger economic development, superior business performance, higher environmental performance, and better regulatory status tend to disclose more environmental information. Moreover, local governments in more economically advanced regions may possess the financial and non-financial resources to exceed these targets, setting higher environmental disclosure baselines for local companies (Qian et al., 2022).

The use of EAID to gain social legitimacy and recognition has become the key to the survival and development of companies (Parsa et al., 2021). While China, as the largest developing country (Nguyen et al., 2021), has made some strides in environmental accounting information disclosure, it continues to face many challenges. At present, China's standards and guiding documents for EAID are relatively outdated, and lack of consistent norms and regulation, resulting in greater difficulty and uncertainty for companies in the disclosure process (Qi et al., 2021; Shang and Chi, 2023). In addition, the relationship between product market competition and EAID is intricate. In a competitive market, companies may improve EAID to gain a 'green competitive advantage'. However, when the level of competition exceeds a certain limit, companies may compromise the quality of EAID due to the pressure of competing costs (Tan et al., 2022). EAID is also significantly affected by industry differences and pressure from external environmental regulatory mechanisms (Liu and Guo, 2023). Significant differences exist in the level of EAID between heavy polluting and non-heavy polluting industries.

Financing constraints (FC) are barriers that companies may encounter when seeking funding, significantly impacting their investment decisions and expansion plans. Improving EAID allows companies to demonstrate their commitment to environmental responsibility, which not only enhances their corporate image, but may also ease financing constraints and promote sustainable development (Yao et al., 2019; Zhou et al., 2022). Additionally, financing constraints have been argued to negatively affect consumer and investor confidence in companies' social responsibility activities and green products (Leong and Yang, 2021; Sun et al., 2022). Consequently, it is imperative to comprehend the factors influencing corporate financing constraints.

Product market competition (PMC) as an important external governance constraint mechanism, it drives business innovation, improves productivity and reduces costs (Luo et al., 2022). In a competitive market, companies must constantly improve their products and services in order to maintain a competitive edge, thus increasing economic activity and efficiency. However, the relationship between product market competition and financing constraints is complex. On the one hand, fierce market competition may increase companies' uncertainty and

raise their financing costs, thus exacerbating financing constraints (Bernini and Montagnoli, 2017; Zhang and Zhou, 2022; Chaturvedi and Singh, 2024). On the other hand, market competition may also help to alleviate financing constraints by increasing company transparency and reputation of companies and reducing information asymmetry (Babar and Habib, 2021). Thus, product market competition not only affects companies' market performance, but also influences their development and investment decisions by affecting their financing constraints.

Notwithstanding governmental, public, and media scrutiny, managers hide environmental data due to economic constraints. Company managers often resort to 'greenwashing,' a practice of environmental defrauding, to legitimize their activities (Chen et al., 2022). Theoretically, the potential link between EAID and PMC is ambiguous. There is a possibility that, on the one hand, highly competitive pressures may lead to the spread of reprehensible behaviors such as greenwashing (Arouri et al., 2021). In fact, positive environmental disclosures by competitors can improve a company's image and reduce its cost of capital. Conversely, PMC can serve as a disciplinary device to mitigate managers' propensity for excessive EAID. The expense increases when a greater number of customers and investors are inclined to pay for ethical conduct through private decisions, such as abstaining from the products and assets of heavily polluting companies (Liu et al., 2022). In addition, the disciplining effect of PMC on heavy polluting companies should be more apparent because these companies need to be more oriented towards EAID in the first place. However, there is no research regarding the potential impact of product market competition on the alleviating effect of EAID on financing constraints.

This paper analyzed the relationship between EAID and financing constraints, including the institutional weaknesses of EAID and the regulatory influence of PMC within the context of product market competition. We examined the influence of EAID on financing constraints via the lenses of information asymmetry theory and resource dependence theory. The study ultimately investigated the heterogeneity of product market competition in the connection between EAID and financing constraints, focusing on the nature of company property rights.

The results offer a theoretical foundation and empirical support for the further standardization of the EAID system and the acceleration of financial development.

This paper is organized as follows: the initial section is the “Introduction”; the subsequent section examines pertinent literature on EAID, FC, and PMC, and articulates theoretical analysis and research hypotheses; the third section delineates the research design and relevant models; the fourth section showcases the findings, offering empirical findings, robustness assessments, and avenues for future studies; the fifth and sixth sections encompass the discussion and conclusion, respectively, proffering recommendations.

2 Literature review and hypothesis development

2.1 Environmental accounting information disclosure and financing constraints

Environmental accounting information disclosure, as an important aspect of corporate transparency, helps reduce information asymmetry between companies and investors. Research has shown that high-quality EAID serves as a signal of strong operating performance, enhancing investor confidence, and reducing the cost of capital (Liu and Bai, 2022). In addition, environmental disclosure is seen as an important indicator of a company’s attitude towards social responsibility and its level of environmental governance.

Theory of information asymmetry posits that extensive environmental information disclosure lessens the costs for external investors in acquiring necessary information, hence enhancing investment efficiency and mitigating financing constraints (Zhou et al., 2022; Xu and Noriza, 2024). Current research suggests that there is a significant relationship between EAID and financing constraints. On one hand, disclosure of environmental information signals good environmental performance, reducing investors’ uncertainty about a company’s future cash flows and reducing financing costs (Meng et al., 2022; Yang et al., 2024). On the other hand, EAID may expose environmental risks and compliance costs that companies face, potentially increasing financing constraints (Fard et al., 2020). Research suggests that companies tend to disclose more information when their environmental performance is better,

while those with poorer performance may withhold or selectively disclose to avoid negative market reactions (Lin et al., 2021). Furthermore, the quality of EAID has been identified as an important factor affecting corporate financing constraints.

While the existing literature provides valuable insights into the relationship between EAID and financing constraints, there are still some research gaps and criticisms. Numerous studies neglect the impact of EAID's quality and depth on financing constraints. Although companies may disclose a large amount of information, its relevance and comparability may be lacking, diminishing its effectiveness in financing decisions. In addition, the relationship between EAID and financing constraints is likely influences by factors such as market features, company size, and ownership structure, which are often inadequately taken into account in existing studies. Considering the above, we proposed Hypothesis 1.

Hypothesis 1: Environmental accounting information disclosure alleviates financing constraints.

2.2 Product market competition and financing constraints

In fiercely competitive markets, companies need to continuously optimize their products and services in order to maintain or increase their market share, a process that often requires significant financial support. Competition in product markets can act as an effective external mechanism, forcing managers to make cash payments to shareholders (Pan, 2020). Moreover, the degree of competition in the market affects a company's financing cost and access to financing, as investors and lending institutions assess risk based on the company's market position and competitiveness (Babar and Habib, 2021). The resource dependence theory proposed that there is a resource dependence relationship between a company and its external environment (Guluma, 2021) and that competition in the product market as one of the important external environments of a company (Boubaker et al., 2018). This significantly shapes a company's financing decisions. Accordingly, in a competitive market, a company may need more capital to cope with competitive pressures, which can, in turn, exacerbate financing constraints.

The relationship between product market competition and financing constraints remains underexplored in the existing literature. Research suggests that increased market competition may exacerbate companies' financing constraints, as an intensely competitive environment may lead to a decline in companies' profits, impairing their ability to raise finance (Zhang and Zhou, 2022). In addition, market competition may compel companies to invest in R&D and innovation activities, further increasing their need for financial support. However, market competition may also indirectly reduce financing costs by increasing companies' visibility and market position. In this context, financially unconstrained companies are more likely to engage in debt-financed share buybacks when faced with intense product market competition.

While existing studies provide valuable insights, there are still research gaps. The specific mechanisms of how product market competition affects financing constraints have yet to be fully explored. In particular, the effects of different property rights and market structures in shaping the relationship between product market competition and financing constraints require further investigation. These gaps limit our full understanding of the impact of product market competition, notably how companies adjust their strategies to navigate competitive pressures in varying market environments. To address these gaps and provide more specific guidance for companies' financing strategies, we proposed Hypothesis 2.

Hypothesis 2: Product market competition is negatively associated with financing constraints.

2.3 Environmental accounting information disclosure, product market competition, and financing constraints

Building on the literature reviewed in Sections 2.1 and 2.2, this section explores the combined effects of environmental accounting information disclosure (EAID) and product market competition (PMC) on financing constraints. The interaction between these two factors is crucial as it offers a more nuanced understanding of how companies navigate the complexities of environmental reporting and competitive pressures. Companies operating in intensely competitive product markets tend to be more reluctant to voluntarily disclose carbon emissions information compared to those with less competitive product markets. The impact of market

competition on overall carbon reporting is more apparent in companies that face less pressure to make profits or greater pressure to maintain environmental legitimacy (Luo et al., 2022).

The relationship between EAID and financing constraints varies according to the competition in the product market. The combination of product market competition and EAID leads to differences in companies' environmental performance. High market competition leads to low environmental performance, as intense industry competition often results in low industry average profitability (Wu et al., 2021). In competitive environments, companies motivated by the need for innovation and financial support often disclose more environmental information to attract investment and reduce financing costs. In contrast, those companies in weaker competitive environments may be less inclined to disclose such information, which may increase financing constraints due to reduced transparency and investor confidence. The extent of market competition can either expand or reduce the impact of EAID on financing constraints, with disclosure serving as a key tool for distinction and signaling in highly competitive environments.

This study aimed to fill the research gap by examining the moderating role of product market competition in the relationship between EAID and financing constraints. We proposed that product market competition weaken the alleviating effect of EAID on financing constraints. This hypothesis was grounded in the premise that competitive pressures can motivate companies to enhance their environmental transparency, thereby reducing the information gap and lowering the cost of capital.

Hypothesis 3: Product market competition helps to weaken the alleviate effect of the EAID on financing constraints.

Table 1 encapsulates prior study endeavors, predominantly examining several facets associated with EAID, FC, and PMC-related studies. The novelty of this study lies in its integrated approach to understanding the complex dynamic relationship between EAID, product market competition, and financing constraints. By considering the moderating role of product market competition, this study offers a more thorough picture of how environmental

disclosure can mitigate financing constraints under different competitive conditions. This insight is particularly valuable for policymakers, investors, and company managers who need to develop strategies to balance environmental responsibility with financial performance amidst competitive market pressures.

Table 1
Systematic review of previous studies

Authors	Objectives	Context	Results
Panel A: EAID-to-FC studies			
Yao et al. (2019)	Investigating the relationship between EAID and FC after the implementation of the Measures on Environmental Information Disclosure (MDEI) in China.	China	FC after the implementation of MDEI and decreases as the EAID score increases. Moreover, the negative relationship between EAID and FC is more significant for highly polluting companies and companies with effective internal controls.
Arora and Sharma (2022)	Assessing the impact of environmental, social and governance (ESG) ratings on the cost of debt.	India	Higher ESG scores are associated with a reduction in the cost of debt. In addition, when cost of debt increases, its total ESG score and governance score are significantly lower.
Meng et al. (2022)	Empirical study on the impact of EAID on FC, and the moderating effect of internal control.	China	Improving EAID can significantly alleviate FC, and the alleviation effect is more significant for non-state-owned companies. Internal control helps to strengthen the alleviating effect of EAID on FC.
Maaloul et al. (2023)	Examining the mediating role of corporate reputation between ESG and debt costs.	America	Companies that manage and disclose ESG information have better reputations, which in turn reduces their debt financing costs.
Yang et al. (2024)	Exploring the impact of EAID on the cost of debt.	China	EAID can reduce cost of debt, an effect that is realized through enhanced corporate reputation and improved information transparency.
Panel B: PMC-to-FC studies			
Povel and Raith (2004)	Analyzing the interaction between financing and output market decisions, particularly in situations where a firm faces financing constraints.	-	Companies facing financing constraints produce less and their unconstrained competitors produce more, both at higher prices, compared to the case without financing constraints.
Boubaker et al. (2018)	Examining how competitive pressures in product markets affect companies' choices between bank debt and public debt.	America	Product market competition is associated with long-term debt maturity, indicating that companies prefer long-term debt in competitive markets.
Zhang and Zhou (2022)	Investigating the impact of market competition on corporate cash holdings.	China	Market competition has a negative impact on companies' cash holdings. Companies tend to hold less cash in a more competitive market environment.
Panel C: Studies on PMC			

Javeed et al. (2020)	Discussing the relationship between environmental regulations (ER) and firm performance (FP)	Pakistan	ER have a positive impact on FP, and this impact is moderated by PMC. In highly competitive markets, ER may improve FP by promoting innovation and efficiency.
Chaturvedi and Singh (2024)	Exploring the impact of the interactive effect of PMC and rollover risk on corporate default risk.	India	The role of PMC in increasing rollover risk and default risk was emphasized, especially as financing constraints exacerbated in a competitive environment.

3 Research methodology

3.1 Sample selection and data sources

In this study, 3776 observations of Chinese listed companies that disclose environmental information from 2019 to 2023 were selected from an unbalanced panel data set. The choice of 2019 as the starting year for the study was based on the following rationale: in 2018, Circular No. 23 of the Ministry of Finance regulated the investment and financing behaviors of financial companies with local governments and state-owned enterprises (SOEs), aiming to prevent the risks associated with local government debt and promote the stable and healthy development of the financial market and the financing environment for companies. These actions reflect the Chinese government's efforts to optimize the finance environment. In the present study, the EAID data were sourced from the annual reports, social responsibility reports, environmental reports, and sustainability reports of publicly listed China companies. Other data used in this study were obtained from the China Stock Market Accounting Research (CSMAR) database. Furthermore, all continuous variables were winsorized to 1% and 99%. This study eliminated the following from the first sample screening: (1) listed companies not classified as heavy polluting company, (2) ST and *ST listed companies, and (3) listed companies with incomplete data.

3.2 variable design

3.2.1 Dependent variables

The dependent variable in this study was the KZ index, which reflects the extent of financing constraints faced by a company. There are several ways to measure financial constraints, with most existing research relying on composite indicators such as the SA index

(Hadlock and Pierce, 2010), WW index (Whited and Wu, 2006), and KZ index. In this study, we constructed a KZ indicator to measure the degree of financial constraint using the accounting information of Chinese listed companies, following the methodology proposed by Kaplan and Zingales (1997), Wei (2014), and Akbar et al. (2021). A higher KZ index indicates a greater extent of financing constraints faced by listed companies. The KZ index is calculated as shown in Model (1).

$$KZ_{i,t} = \alpha_1 \frac{CF_{it}}{ASSET_{it-1}} + \alpha_2 LEV_{it} + \alpha_3 \frac{DIV_{it}}{ASSET_{it-1}} + \alpha_4 \frac{CASH_{it}}{ASSET_{it-1}} + \alpha_5 Q_{it} \quad (1)$$

In this model, i denotes the company and t represents the year. CF represents operating net cash flow, $ASSET_{it-1}$ represents total assets at the beginning of the year, LEV represents asset-liability ratio, DIV represents cash dividends, CASH represents cash holdings, and Q represents Tobin's Q.

3.2.2 Independent variables

The EAID index consisted of five categories of items: environmental management, environmental regulation and certification, environmental performance and governance, environmental liabilities, and environmental vehicles (see Table 2). Unlike the studies of Meng et al. (2022) and Wu et al. (2021), which focused on the quality or level of environmental disclosure, this study analyzed the EAID in a combined context. Therefore, in order to examine the overall reporting in this study, the scoring rule for environmental management, environmental regulation, and certification was divided into two levels: the company discloses a certain information, which is recorded as 1, and an item is not disclosed, which is recorded as 0. For environmental performance and governance, environmental liabilities the rating scale is divided into three categories: no description is recorded as 0; qualitative description is recorded as 1; and quantitative description (i.e., the disclosure includes a description of the type of monetary or numerical data) is recorded as 2. For environmental vectors, the fact that the report contains environmental information is marked as 1, and the absence of such information is marked as 0. Thus, the maximum score for complete and full disclosure of all five categories

of items was 44. The scores of all items were summed to give each company a total score reflecting its overall EAID.

Table 2
Environmental Accounting Information Disclosure Evaluation System

Indicators		Scoring rules
Environmental Management	Environmental protection concept Environmental goal Environmental Protection Management System Environmental education and training Environmental protection special action Environmental incident emergency response mechanism Environmental honor or reward Three simultaneities	The company discloses the information by assigning a value of 1, otherwise it is 0.
Environmental Regulation and Certification	Key pollution monitoring unit Pollutant emission standard Sudden environmental accident Environmental violation Environmental petition case Pass ISO14001 Pass ISO9001	
Environmental Performance and Governance	Waste gas emission reduction Waste water emission reduction Dust and smoke reduction Solid waste utilization and disposal Noise, light pollution and radiation governance Cleaner production implementation	0 = no description; 1 = qualitative description; 2 = quantitative description (monetary/numerical type description)
Environmental Liabilities	Waste water emission COD emission SO2 emission CO2 emission Smoke and dust emission Industrial solid waste emission	
Disclosure Vehicle	Annual report	1=Yes; 0=No; Whether listed companies disclose environment-related information in the annual reports
	Social responsibility report	1=Yes; 0=No; Whether listed companies disclose environment-related information in the social responsibility report

Environmental report	1=Yes; 0=No; Whether listed companies disclose environmental report

3.2.3 Moderator variables

Previous studies have measured PMC through different methods such as product substitution, market concentration and market size. Based on previous studies in both developed and emerging markets (Babar and Habib, 2021; Zhang and Zhou, 2022), this study used a proxy variable for market concentration, namely the Herfindahl-Hirschman Index (HHI). Each company's market share was calculated by dividing the company's main business revenue by the total main business revenue of the industry. The index measures the degree of concentration within each industry, with a higher HHI indicating a more concentrated industry and lower market competition. Therefore, this study used the reciprocal number of the HHI to measure PMC.

3.2.3 Control variables

According to the relevant empirical studies (Meng et al., 2022; Mertzanis et al., 2024), the selected control variables reflect the company's financial status, profitability, growth capacity, and corporate governance. The specific variables were defined as shown in Table 3.

Table 3
The operational definitions of research variables

Variable type	Variable name	Abbreviations	Operational definition
Dependent variable	Financing constraints	KZ	KZ index in absolute terms
Independent variable	Environmental accounting information disclosure	EAID	LN (Environmental accounting information disclosure score)
Moderator variable	Product market competition	PMC	The reciprocal number of Herfindahl-Hirschman index
Control variables	Firm size	Fsize	The natural log of total assets
	Return on assets	ROA	Net income divided by total assets
	Investment opportunity	Growth	Current year's total assets / previous year's total assets) - 1
	Ownership nature	SOE	1 for state-owned companies, 0 for non-state-owned companies
	CEO-duality	Duality	Dummy variable equals 2 if the same person holds CEO and the chairman positions, otherwise 1

	Ownership concentration	Owncon	The shareholding ratio of the largest shareholder
	Board size	Bsize	Total number of directors on the board

3.3 Model specification

This study aimed to examine EAID influence on the financing constraints of listed companies in China, as well as the moderating role of product market competition on the link between EAID and financing constraints. This study employed a quantitative methodology to experimentally evaluate the provided hypotheses, given that financing constraints were influenced by many factors, including EAID and product market competition. In order to achieve the research objectives, the following multiple linear regression analysis model was established in this study:

$$KZ_{i,t} = \alpha_0 + \alpha_1 EAID_{i,t} + \alpha_2 Control_{i,t} + \sum Year + \varepsilon_{it} \quad (2)$$

$$KZ_{i,t} = \alpha_0 + \alpha_1 PMC_{i,t} + \alpha_2 Control_{i,t} + \sum Year + \varepsilon_{it} \quad (3)$$

$$KZ_{i,t} = \alpha_0 + \alpha_1 EAID_{i,t} + \alpha_2 PMC_{i,t} + \alpha_3 EAID_{i,t} * PMC_{i,t} + \alpha_4 Control_{i,t} + \sum Year + \varepsilon_{it} \quad (4)$$

In the models, i signifies the company and t specifies the year. Model (2) analyzed the relationship between EAID and financing constraints, Model (3) investigated the impact of product market competition on financing constraints, and Model (4) incorporated EAID items and product market competition into Model (2) to assess the moderating effect of product market competition.

4. Results

4.1 Descriptive statistics

Table 4 illustrates the descriptive statistics of the variables used in this investigation. The companies in the sample generally face some degree of financing constraints (KZ), as indicated by the mean value of 0.847. The KZ index ranged from a minimum of -6.024 to a maximum of 6.486, with a standard deviation of 2.429. The level of environmental accounting

information disclosure (EAID) was average, with a mean value of 0.377. The EAID ranged from a minimum value of 0.0700 to a maximum value of 0.800, and the standard deviation was 0.185. This suggests that while the degree of disclosure varies widely, the distribution of the degree of disclosure is relatively concentrated. The degree of product market competition (PMC), as measured by the HHI, was lower on average, with a mean value of 48.45. The HHI ranged from a minimum value of 3.222 to a maximum value of 82.29, with a standard deviation of 22.12. This indicates significant variation in market competition, and the distribution of product market competition is relatively decentralized.

Regarding the control variables, firm size (Fsize) was predominantly medium, with a mean value of 22.60. Return on assets (ROA) was low, with a mean value of 0.0397, and exhibited a more dispersed distribution. Investment opportunity (Growth) was average, with a mean value of 0.103, but showed highly variability. State-owned enterprises (SOE) accounted for about 35.2% of the total sample, indicating a significant presence of state ownership. Additionally, it is common for the CEO to also serve as the chairman of the board (Duality). Ownership concentration (Owncon) was high, with a mean value of 0.575. Board size (Bsize) was moderate, with a mean of 10.28, but exhibited high variability. These statistics provided a preliminary understanding of financing constraints, EAID, and market characteristics, highlighting the diversity and complexities within the sample.

Table 4
Descriptive statistics

Variable	N	Mean	Max	P50	Min	Std
KZ	3776	0.847	6.486	1.062	-6.024	2.429
EAID	3776	0.377	0.800	0.370	0.0700	0.185
HHI	3776	48.45	82.29	54.07	3.222	22.12
Fsize	3776	22.60	26.57	22.35	20.13	1.391
ROA	3776	0.0397	0.213	0.0392	-0.217	0.0634
Growth	3776	0.103	2.500	0.0460	-0.668	0.393
SOE	3776	0.352	1	0	0	0.478
Duality	3776	1.719	2	2	1	0.450
Owncon	3776	0.575	0.914	0.575	0.240	0.153
Bsize	3776	10.28	19	10	5	2.750

4.2 Correlation analysis

Table 5 displays the Pearson and Spearman correlations among EAID, PMC, FC, and all control variables. Spearman correlations were reported above the main diagonal, while Pearson correlations were reported below the diagonal.

As shown in Table 5, the Pearson correlation coefficient indicates a significant negative relationship between EAID (coefficient = -0.030), PMC (coefficient = -102), ROA (coefficient = -0.630), and ownership concentration (coefficient = -0.211) with financing constraints. A similar pattern was observed in the Spearman correlation coefficients. Furthermore, while the Pearson correlation coefficient indicates no significant relationship between Growth and financing constraints, the Spearman correlation coefficient indicates a significant negative relationship between Growth (coefficient = -0.060) and financing constraints.

In the correlation analysis, all correlation values were between -0.5 and 0.5, except for the relationship between ROA and KZ (-0.630). However, since ROA was included as a control variable in the regression model, this relationship did not affect the results. Overall, this result indicates that the Pearson and Spearman correlation coefficients yielded highly similar results, and there was also a significant correlation between most of the control variables and financing constraints. Furthermore, the average value of the variance inflation factor (VIF) was 1.21, suggesting that multicollinearity among the variables is not a serious issue.

Table 5
Correlation Matrix Results

	KZ	EAID	PMC	Fsize	ROA	Growth	SOE	Duality	Owncon	Bsize
KZ	1	-0.027*	-0.117***	0.119***	-0.643***	-0.060***	0.147***	0.033**	-0.208***	0.116***
EAID	-0.030*	1	-0.091***	0.379***	0.079***	-0.110***	0.142***	0.052***	0.103***	0.099***
PMC	-0.102***	-0.107***	1	-0.295***	0.107***	0.015	-0.262***	-0.122***	-0.086***	-0.140***
Fsize	0.095***	0.392***	-0.333***	1	0.019	-0.109***	0.414***	0.218***	0.129***	0.274***
ROA	-0.630***	0.100***	0.055***	0.080***	1	0.067***	-0.120***	-0.021	0.194***	-0.083***
Growth	-0.019	-0.097***	-0.018	-0.095***	0.023	1	-0.039**	-0.039**	0.042**	-0.041**
SOE	0.147***	0.150***	-0.280***	0.428***	-0.067***	-0.004	1	0.307***	0.050***	0.334***
Duality	0.042**	0.047***	-0.130***	0.210***	-0.004	-0.024	0.307***	1	-0.035**	0.151***

Owncon	-0.211***	0.110***	-0.101***	0.219***	0.195***	0.029*	0.068***	-0.025	1	0.010
Bsize	0.108***	0.089***	-0.173***	0.307***	-0.063***	-0.022	0.346***	0.158***	0.042***	1

Notes: ***, ** and * denote the significance at the 1%, 5% and 10% respectively.

4.3 Regression analysis

Table 6 presents the regression analyses results for the control variables only (financing constraints) and the baseline model, which includes both control and independent variables. These analyses were based on Equation (2). The objective of doing analyses with and without independent variables was threefold: first, to compare the coefficients of the control variables following the incorporation of the independent variable (EAID) into the model. Secondly, to compare the results of the F-test, Breusch-Pagan LM test, and Hausman test. Lastly, to test the sign, significance, and magnitude of the independent variables in OLS, FEM, and REM in each table.

As noted in the descriptive statistics, this study included 3776 observations. The comparison in Table 6 shows that the coefficients of the control variables changed after the introduction of EAID into the model. These changes imply that EAID may have an impact on financing constraints. To select the most appropriate estimator for regression analysis, the study conducted the F-test for FEM, the Breusch-Pagan LM test for REM, and the Hausman test. The test results in Table 6 indicate the presence of heteroskedasticity in the data, indicating that OLS estimation might not be valid. The significance of the three tests (as shown by the p-values in Table 6) suggests rejecting the null hypotheses of the F-test, Breusch-Pagan LM-test, and Hausman test. It is concluded that FEM was the preferred estimation method in this study. The fixed effects model findings in Table 6 exhibited that the effect of EAID on financing constraints was notably negative at the 10% level. Hypothesis 1 was verified.

Table 6
Regression results for Environmental Accounting Information Disclosure on Financing Constraints

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	OLS		FEM		REM	
EAID		-0.310*		-0.415*		-0.571***
		(-1.76)		(-1.79)		(-2.89)
Fsize	0.265***	0.281***	-0.0440	-0.0276	0.224***	0.251***
	(10.63)	(10.59)	(-0.44)	(-0.28)	(5.88)	(6.41)
ROA	-23.50***	-23.44***	-15.18***	-15.18***	-18.25***	-18.21***
	(-48.66)	(-48.42)	(-28.58)	(-28.59)	(-38.65)	(-38.58)
Growth	0.0848	0.0756	0.166**	0.162**	0.158**	0.151**
	(1.11)	(0.99)	(2.19)	(2.14)	(2.27)	(2.17)
SOE	0.248***	0.249***	0.122	0.136	0.371***	0.376***
	(3.38)	(3.38)	(0.50)	(0.56)	(3.36)	(3.41)
Duality	-0.0676	-0.0717	0.00285	0.00408	0.0322	0.0312
	(-0.97)	(-1.02)	(0.03)	(0.04)	(0.40)	(0.39)
Owncon	-2.057***	-2.052***	0.0188	0.0328	-1.973***	-1.943***
	(-10.13)	(-10.11)	(0.04)	(0.07)	(-6.96)	(-6.86)
Bsize	0.0110	0.0105	-0.00673	-0.00599	0.000121	-0.000349
	(0.93)	(0.89)	(-0.57)	(-0.52)	(0.01)	(-0.03)
Constant	-3.129***	-3.368***	1.987	1.740	-2.845***	-3.271***
	(-5.85)	(-6.10)	(0.90)	(0.79)	(-3.45)	(-3.91)
YEAR	NO	NO	YES	YES	YES	YES
N	3776	3776	3776	3776	3776	3776
F	415***	364***	119***	109***		
r2	0.436	0.436	0.315	0.316		
F-test			6.33	6.31		
			[0.0000]	[0.0000]		
Breusch–Pagan LM test					1564.48	1568.36
					[0.0000]	[0.0000]
Hausman test			157.74	154.92		
			[0.0000]	[0.0000]		

Notes: Figures in [ ] are the p-value; ***, ** and * denote the significance at the 1%, 5% and 10% respectively.

Based on the above analysis, the fixed effects model was used to test the effect of product market competition and the interaction term (EAID*PMC) on financing constraints, as shown in Table 7. Model (2) in Table 7 indicates that the coefficient of PMC was -0.00975, demonstrating a considerably beneficial influence of PMC on financing constraints at the 1% level. This finding suggests that an increase in product market competition may reduce financing constraints, thereby supporting Hypothesis 2. The fixed effects findings in Table 7 indicate that the interaction term EAID*PMC has a considerably positive impact on financing constraints in Model (3) at the 5% level. This outcome indicates that the PMC exerts a more significant moderating influence on financing constraints, hence validating Hypothesis 3.

Table 7
Regression Results on the Moderating Effect of Product Market Competition on Environmental Accounting Information Disclosure and Financing Constraints

	(1)	(2)	(3)
Variables	H1	H2	H3
EAID	-0.415*		-0.378
	(-1.79)		(-1.63)
PMC		-0.00975***	-0.00733**
		(-2.89)	(-2.06)
EAID*PMC			0.0205**
			(2.22)
Fsize	-0.0276	-0.0795	-0.0607
	(-0.28)	(-0.79)	(-0.60)
ROA	-15.18***	-15.15***	-15.13***
	(-28.59)	(-28.55)	(-28.53)
Growth	0.162**	0.168**	0.164**
	(2.14)	(2.23)	(2.17)
SOE	0.136	0.122	0.129
	(0.56)	(0.50)	(0.53)
Duality	0.00408	0.00369	0.00831
	(0.04)	(0.04)	(0.08)
Owncon	0.0328	0.244	0.294
	(0.07)	(0.49)	(0.59)
Bsize	-0.00599	-0.00547	-0.00671
	(-0.52)	(-0.48)	(-0.59)
Constant	1.740	3.154	2.718
	(0.79)	(1.41)	(1.21)
YEAR	YES	YES	YES
N	3776	3776	3776
F	109***	110***	95***
r2	0.316	0.317	0.319

Notes: ***, ** and * denote the significance at the 1%, 5% and 10% respectively.

4.4 Robustness tests and further analysis

This study tested the robustness of the above empirical regression findings for both the endogeneity problem and the substitution variable.

4.4.1 Solving endogenous problems

Considering the potential issue of heteroskedasticity, we employed the two-step system generalized method of moment (GMM) for regression analysis. The substantial values of the estimated coefficients in Table 8 were comparable to those of the FEM coefficients, suggesting that the regression outcomes of the model retain their robustness after addressing the issue of heteroskedasticity. All AR1 were less than 0.05, indicating statistical significance. Conversely, all AR2 values exceeded 0.05 and were non-significant. Additionally, the p-value of Hansen's test was greater than 0.05, confirming that the selected instrumental variables were exogenous and not over-identified.

Model (1) in Table 8 indicates that EAID had a substantial negative correlation with financing constraints at the 1% significance level, whereas Model (2) demonstrates that PMC had a significant negative correlation with financing constraints at the 1% significance level. Model (3) show that the interaction term EAID*PMC was positively significant, this implies that stronger product market competition weakens the mitigation of EAID on financing constraints. Interestingly, positive findings were obtained from all the model evaluations. The GMM estimation method was proven to be robust. Consequently, research hypotheses one, two, and three remained valid after accounting for endogeneity.

Table 8
GMM Results for Robustness Test

	(1)	(2)	(3)
Variables	H1	H2	H3
L_KZ	0.387***	0.511**	0.411**
	(0.042)	(0.252)	(0.208)
EAID	-1.460***		3.613**
	(0.393)		(1.513)
PMC		-0.062***	-0.017*
		(0.018)	(0.009)
EAID*PMC			0.050***
			(0.018)
Fsize	0.268***	0.625***	0.288**
	(0.077)	(0.182)	(0.145)
ROA	-15.690***	7.363	-6.556
	(1.243)	(10.423)	(8.791)
Growth	1.021	-0.064	0.950
	(0.755)	(0.175)	(1.782)
SOE	-0.110	0.325	0.061
	(0.257)	(0.415)	(0.153)
Duality	-1.716***	-0.938**	-1.103**
	(0.302)	(0.387)	(0.524)
Owncon	-5.691***	-5.548***	-5.170**
	(0.931)	(1.746)	(2.022)
Bsize	0.203	-0.595***	-0.127*
	(0.167)	(0.218)	(0.073)
Constant	-	-	-
Observations	2,787	2,787	2,787
AR1	0.000	0.000	0.001
AR2	0.480	0.079	0.927
Hansen-J P value	0.505	0.532	0.401

Notes: ***, ** and * denote the significance at the 1%, 5% and 10% respectively.

4.4.2 Substitute the Moderator Variable

Table 9 replicates the analysis previously reported in Table 8, utilizing an additional indicator of product market competition. This paper examined the sensitivity of the HHI by regressing CR_4, the concentration rate of the four largest companies in the industry, which served as a proxy variable for the PMC, a metric of market concentration that indicates the market share held by these four companies. The explanatory variables were also lagged by one period, denoted as L_KZ.

The results of Models (1) - (3) in Table 9 shows that L_KZ had a significant positive effect on current financing constraints, indicating that financing constraints exhibited persistence. At a 1% significant level, EAID demonstrated an alleviating effect on financing constraints, while 1/CR_4 reduced financing constraints. Furthermore, the interaction term EAID*1/CR_4 was positively significant, this implies that stronger product market competition weakens the mitigation of EAID on financing constraints. The first, second, and third hypotheses remained valid, signifying that the results of this study are robust.

Table 9
GMM Results for Substitute the Moderator Variables

	(1)	(2)	(3)
Variables	H1	H2	H3
L_KZ	0.360***	0.532***	0.348**
	(0.041)	(0.171)	(0.154)
EAID	-1.372***		-0.698
	(0.380)		(0.465)
1/CR_4		-0.551***	-0.266***
		(0.127)	(0.084)
EAID*1/CR_4			0.457*
			(0.252)
Fsize	0.296***	0.367***	0.552***
	(0.074)	(0.115)	(0.158)
ROA	-16.571***	-2.062	-7.461
	(1.243)	(6.839)	(4.802)
Growth	1.223	-0.042	-0.238
	(0.784)	(0.133)	(1.105)
SOE	-0.019	0.088	0.075
	(0.277)	(0.310)	(0.881)
Duality	-1.700***	-0.426	-4.514**
	(0.309)	(0.293)	(2.292)
Owncon	-5.909***	-2.612**	-2.004**
	(0.945)	(1.152)	(0.903)
Bsize	0.147	-0.290**	-0.118
	(0.176)	(0.142)	(0.239)
Constant	-	-	-
Observations	2,691	2,691	2,691
AR1	0.000	0.000	0.000
AR2	0.667	0.307	0.918
Hansen-J P value	0.728	0.247	0.233

Notes: ***, ** and * denote the significance at the 1%, 5% and 10% respectively.

4.4.3 Further analysis

Listed companies in China can be classified by ownership into state-owned enterprises (SOE) and non-state-owned enterprises (non-SOE). These two categories of companies significantly differ in their operating aims, organizational frameworks, and management strategies. Based on the above considerations, we separated the sample companies by ownership to examine whether heterogeneity exists in the moderating effects of EAID on reducing financing constraints and product market competition across different categories of listed companies. In addition, the absence of imperfect political connections among non-state-owned companies makes these companies more motivated to disclose environmental information as a means to alleviate financing constraints.

The two groups of companies (state-owned and non-state-owned) were tested using Equations (2), (3), and (4). The results, presented in Table 10, indicate that the financing constraints of non-state-owned companies were more significantly reduced. State-owned companies have governmental backing and have distinct advantages over non-state-owned companies regarding policy loans and subsidies, local government assistance, and bank fundings, resulting in reduced financing constraints.

Nonetheless, non-state-owned companies depend on their own credit for funding and have more financing constraints as a result of information asymmetry between creditors and borrowers. EAID requires the disclosure of more detailed company information, resulting in a greater impact of EAID on financing constraints for non-state-owned companies. Interestingly, similar patterns are observed with product market competition and the interaction term EAID*PMC. Specifically, higher product market competition corresponded to decreased financing constraints for non-state companies. Furthermore, the moderating effect of product market competition demonstrated a stronger alleviating effect on financing constraints in the context of non-state-owned companies.

Table 10
Analysis of heterogeneity

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	SOE-0	SOE-1	SOE-0	SOE-1	SOE-0	SOE-1
L_KZ	0.374***	0.355***	1.017***	0.298***	0.670***	0.340***
	(0.069)	(0.084)	(0.184)	(0.079)	(0.119)	(0.072)
EAID	-2.895***	-0.506			-4.004	-0.157
	(0.936)	(0.899)			(2.558)	(0.914)
PMC			-0.018**	-0.038	0.088***	0.004
			(0.008)	(0.072)	(0.022)	(0.009)
EAID*PMC					0.203***	0.009
					(0.068)	(0.024)
Fsize	0.320**	0.258	-0.520**	0.397	2.385**	0.591
	(0.156)	(0.420)	(0.205)	(0.310)	(1.133)	(0.488)
ROA	-12.999***	-17.885***	24.086**	-19.150***	-17.644***	-18.747***
	(1.589)	(2.256)	(11.973)	(3.336)	(2.047)	(2.272)
Growth	2.620**	-2.294**	-4.616***	0.301	0.145	0.342*
	(1.299)	(1.136)	(1.654)	(1.659)	(0.186)	(0.190)
SOE	1.582	-1.600	1.399	-1.307	-0.557	-0.716**
	(1.720)	(7.716)	(2.022)	(3.398)	(1.279)	(0.345)
Duality	-2.460***	-0.225	-0.189	-0.404	-0.267	1.511
	(0.620)	(0.365)	(0.193)	(0.590)	(0.234)	(1.305)
Owncon	-9.836***	-1.350	-0.663	-3.131	1.426	-2.600
	(2.307)	(2.207)	(0.919)	(3.541)	(1.350)	(1.836)
Bsize	0.478	-0.106	0.187	-0.189	0.252	-0.087
	(0.341)	(0.193)	(0.362)	(0.428)	(0.341)	(0.081)
Constant	-	-	11.233***	-	-57.586**	-12.001
	-	-	(4.007)	-	(27.366)	(8.489)
Observations	1,800	987	1,800	987	1,800	987
AR1	0.000	0.001	0.000	0.018	0.000	0.000
AR2	0.563	0.974	0.454	0.415	0.322	0.142
Hansen-J P value	0.108	0.229	0.851	0.119	0.240	0.060

Notes: ***, ** and * denote the significance at the 1%, 5% and 10% respectively.

5. Discussion

Firstly, this study supported that environmental accounting information disclosure (EAID) can significantly alleviate financing constraints. This finding is consistent with previous research, suggesting that high-quality EAID serves as a signal of a company's good operational performance, boosting investor confidence, and consequently reducing the cost of capital (Meng et al., 2022; Yang et al., 2024). In contexts like China, where environmental regulations and EAID standards are still imperfect, improving EAID serves as an effective mechanism to ease financing constraints and promote sustainable development. By improving EAID, companies can better communicate their commitment to environmental responsibility.

This study further demonstrated a significant negative relationship between product market competition and financing constraints. Product market competitiveness is the result of the joint action of enterprises, markets and competition, the lower the intensity of competition in the industry, the greater the space for companies to improve competitiveness. The enhancement of product market competition can improve the profitability of companies. On the one hand, it can increase the accumulation of the company's own funds and improve the ability of endogenous financing, on the other hand, it can enhance the confidence of investors and reduce the demand for risk premium, thus reducing the cost of external financing and narrowing the difference between internal and external financing costs.

Most importantly, this study revealed the moderating role of product market competition in the relationship between EAID and financing constraints, showing that the alleviating effect of EAID on financing constraints is more significant in less competitive markets. This may result from the tendency of companies in a competitive environment to improve the quality of environmental information disclosure to secure a 'green competitive advantage', thus attracting investment and lowering financing expenses. This finding provided a fresh perspective for understanding the role of EAID in different market environments and offers a new strategy for companies to seek advantages in competition.

In addition, this study examined the heterogeneity in the effects of EAID and product market competition on financing constraints among listed companies with different ownership

nature. A comparative analysis between state-owned enterprises (SOEs) and non-state-owned enterprises (non-SOEs) revealed that non-SOEs' experienced a greater influence of EAID on their financing constraints. Given that SOEs have government backing, they encounter comparatively fewer financing constraints, aligning with the conclusions of most researchers (Meng et al., 2022; Liang and Chen, 2023). In contrast, non-state companies have more significant financing constraints as they depend predominantly on their own credit for funding, exacerbated by information asymmetry between creditors and debtors. Therefore, EAID has a more significant alleviating effect on financing constraints for non-state-owned companies. In addition, product market competition and the interaction term EAID*PMC showed similar results, indicating that higher product market competition correlates with less financing constraints for non-state companies. Moreover, the moderating effect of product market competition showed a stronger alleviating effect on the financing constraints of non-state-owned companies. This finding further emphasized the importance of EAID in enhancing the financing capacity of companies, especially non-state-owned companies.

6. Conclusion

This study investigated the impact of environmental accounting information disclosure (EAID) on companies' financing constraints and explored the moderating role of product market competition through empirical analyses. Above all, the findings indicated that environmental accounting information disclosure can effectively alleviate companies' financing constraints. This finding aligned with information asymmetry theory, which posits that high-quality EAID reduces the information gap between companies and investors, thus reducing financing costs for companies.

Furthermore, the study identified a significant negative relationship between product market competition and companies' financing constraints. Competition in product markets can reduce the cost of external financing by affecting the profitability, debt servicing and going concern of companies, increasing investor confidence, alleviating information asymmetries with companies and reducing the cost of external financing These findings suggest the need for

companies to pay more attention to financial management and strategic adjustments to cope with possible financing challenges arising from market competition.

Foremost, this study shed light on the moderating role of product market competition in the relationship between EAID and financing constraints. Increased competition in product markets may have weakened the alleviating effect of EAID on financing constraints. When product market competition increases, the negative impact of EAID on financing constraints is weakened. This may be because in highly competitive markets, investors and creditors may pay more attention to the financial performance and market position of companies rather than environmental information disclosure. In addition, this study revealed that non-state-owned companies face greater financing constraints due to the lack of government support. Thus, the alleviating effect of EAID on financing constraints was more significant for non-state-owned companies. This finding suggests the importance for non-state companies to adopt a proactive approach to information disclosure as a strategy to mitigate financing challenges arising from information asymmetry.

For policy makers, the results of the study highlighted the importance of improving environmental information disclosure standards and strengthening market regulation. For company managers, the study provided actionable strategies to reduce financing constraints by improving EAID in competitive markets. Managers should invest in environmentally responsible projects and ensure information is adequately disclosed to attract investors. For investors, the study emphasized the importance of considering the effects of EAID and product market competition when assessing a company's financial risk. Companies with robust EAID practices often face lower financing constraints and exhibit greater financial stability. Investors should factor these elements into their decision-making process to make more informed and strategic investment choices.

Future research could expand the role of EAID across different cultural and institutional contexts, as well as the impact of EAID on other financial metrics of a company, in order to provide more comprehensive financial management advice to companies. As global focus on sustainable development and companies' social responsibility intensifies, the importance of EAID will undoubtedly continue to grow. Consequently, studies investigating the relationship

between EAID and financing constraints will remain valuable, offering both theoretical contributions and practical guidance.

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