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The nature of corporate social responsibility disclosure and investment efficiency: Evidence from China

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Corporate social responsibility (CSR) disclosure has gained more attention from both practitioners and scholars. Company executives are starting to seek competitive differentiation from their sustainability strategies (McKinsey & Company, 2020). This study explores the link between CSR disclosure and investment efficiency using a sample of Chinese-listed firms from 2010 to 2019. The findings suggest that CSR disclosure improves investment efficiency through reducing information asymmetry and agency cost. Also, mandatory CSR disclosure has a more significant effect on investment efficiency than voluntary CSR disclosure. In addition, this study finds that the nature of ownership (state-owned vs. non-state-owned), CSR performance, institutional ownership, and the level of industry competition all affect this relationship. The study provides meaningful implications for future CSR disclosure policy development.

KEYWORDS

corporate social responsibility, investment efficiency, information asymmetry, agency problems, mandatory disclosure VS. voluntary disclosure

1 Introduction

Growing global concern about economic and environmental sustainability has sparked a trend toward requiring companies to disclose their corporate social responsibility (CSR) activities. Companies start to benefit from moving CSR from the sidelines into mainstream value creation. And CSR related investment strategies increased approximately 150% in 2019 according to the 2021 CSR white paper.

CSR disclosure may be defined as information that a firm makes public, typically within a stand-alone report, that relates to its performance, standards, or activities under the CSR umbrella (Brooks and Oikonomou, 2018). CSR disclosure may be mandatory—firms are legally required to deliver CSR information—or voluntary, where the extent of reporting may vary substantially among firms. CSR disclosure guidelines issued by different countries show considerable variance regarding information required to be disclosed in CSR reports (Brooks and Oikonomou, 2018). The China Securities Regulatory Commission (CSRC) began mandating certain firms to issue stand-alone CSR reports in response to emerging environmental and social issues while encouraging other firms to publish CSR reports voluntarily at the same time (Brooks and Oikonomou, 2018; Makosa et al., 2020; Liu and Tian, 2021; Zhang, 2022). For example, the Shanghai Stock Exchange announced on 30 December 2008 that firms listed in the "Corporate Governance Sector", firms with shares listed overseas, and firms in the financial industry were henceforth required to issue a CSR report with their annual report beginning with the 2008 report. The Shenzhen Stock Exchange released a similar announcement pertaining to all firms on its "Shenzhen 100 Index".

From 2001 to 2019, the number of firms disclosing CSR reports increased dramatically (for both mandatory and voluntary disclosures).

The economic consequences of CSR disclosure have aroused much attention in academia in recent years (Krüger, 2015; Chen et al., 2018; Pham and Tran, 2020; Bae et al., 2021; Qin and Yang, 2022). Many scholars have investigated the role of CSR disclosure in decreasing profitability (Chen et al., 2018), lowering financing costs (Ni and Zhang, 2019), adding value to firms (Xu et al., 2020), improving consumer loyalty (Contini et al., 2020), improving firm performance (Pham and Tran, 2020), curtailing excessive payouts (Liu and Tian, 2021), and lowering the idiosyncratic risk (He et al., 2022).

More importantly, previous research has shown that a company's CSR disclosure impacts its investment behavior. However, previous studies in this field all contain various imperfections. For example, Liu and Tian (2021), Makosa et al. (2020) study the impact of CSR disclosure on investment efficiency, but their sample is limited to the year 2008 and could not reflect the long-term effects of the policy changes. Cao et al. (2012) use Rankins CSR ratings (RKS) as a proxy for CSR disclosure quality and analyze the relationship between CSR disclosure and investment efficiency. It is worth noting that RKS only covers listed firms that publish CSR reports. In other words, their study is limited to all listed firms who disclosed CSR information but does not show the difference between disclosed and undisclosed firms. The most relevant study is Zhong and Gao (2017), which studies whether Chinese firms that issue CSR reports exhibit a higher level of investment efficiency than firms that do not issue CSR reports. However, Zhong and Gao's study mainly focuses on the role of CSR disclosure in reducing information asymmetry, neglecting other potential mechanisms.

The study makes the following contributions. First, the study differs from previous studies in that it focuses on the long-term economic benefits generated by CSR disclosure rather than the short-term impact of the mandatory CSR disclosure policy implemented in December of 2008. The empirical findings in this study provide new insights to the long-term impact of CSR disclosure on economic implications using ten-year data from 2010 to 2019. This research shows that CSR disclosure has a favorable influence on investment efficiency by reducing underinvestment, not overinvestment.

Also, this article investigates the different effects of *mandatory vs. voluntary* CSR disclosure on investment efficiency. Previous studies show voluntary CSR disclosure increases firm investment (Bouquet and Deutsch, 2008; Tan et al., 2020), but do not shed light on its effect on investment efficiency. Makosa et al. (2020) find mandatory CSR disclosure decreases firm investment but enhances investment efficiency using difference-in-difference design around 2008 when China mandated certain firms to disclose CSR information. This paper analyzes the different effects of mandatory versus voluntary CSR disclosure on investment efficiency in China using a longer sample period.

Second, this study complements and extends previous research by demonstrating that CSR disclosure improves investment efficiency, and more importantly, by investigating the underlying mechanisms. Accounting studies show that a decrease in information asymmetry and agency cost could increase investment efficiency (Jensen, 1986; Biddle and Hilary, 2006; Chen F. et al., 2011). This article adds to this line of research by providing direct empirical evidence that CSR disclosure improves investment efficiency by reducing both information asymmetry and agency cost.

Third, this paper examines the effects of CSR disclosure on investment efficiency across multiple dimensions and explores related policy implications. The study analyzes the impact of state ownership, CSR performance, institutional ownership, and industry competition on the relationship between CSR disclosure and investment efficiency. With such multi-dimensional analysis, this study tries to explain why companies' CSR disclosure could benefit their corporate governance. The findings help enhance companies' understanding of the two-fold mechanisms and encourage companies to implement CSR disclosure strategies to improve their long-term business performance. At the same time, the discussion of the economic consequences of mandatory vs voluntary CSR disclosure will also help policymakers develop and promote the implementation of CSR disclosure related policies.

In summary, many studies use the DID model to investigate the positive governance effects of CSR disclosure on corporate investment efficiency, but the specific mechanisms by which CSR disclosure affects investment efficiency remain unknown. Also, most CSR studies focus on the impact of policy shocks in 2008, ignoring the long-term effects of CSR disclosure on companies. Very little research has been conducted on the impact of mandatory vs. voluntary CSR disclosure on investment efficiency. In China's long-standing, fast-growing economy, the impact of different industry contexts and companies' characters on CSR disclosure has not been sufficiently researched and explored. The study intends to complement and extend the line of literature from above mentioned aspects.

The rest of the paper is organized as follows. Section 2 reviews related literature. Section 3 presents the development of the hypotheses. Section 4 describes the data, variables definition, and empirical models. Section 5 presents the empirical results and Section 6 is the robustness check. Section 7 reports the additional analysis and Section 8 presents the main conclusions of the paper.

2 Literature review

CSR disclosure has been shown to affect various firms' economic outcomes, such as decreasing profitability (Chen et al., 2018), lowering financing costs (Ni and Zhang, 2019), improving consumer loyalty (Contini et al., 2020), improving firm performance (Pham and Tran, 2020), adding value to firms (Xu et al., 2020), curtailing excessive payouts (Liu and Tian, 2021), promoting long-term growth and substantial innovation (Zhang, 2022), and lowering the idiosyncratic risk (Wang et al., 2018; He et al., 2022), *etc.* These studies all demonstrate the important roles CSR disclosure plays in corporate governance and keep inspiring more related studies.

A key question in corporate finance is: What motivates a firm's investment? In an ideal world, a firm's investment efficiency should be determined only by its investment opportunities (Stein, 2003; Cheng et al., 2014). Numerous studies have conclusively established that information asymmetry and agency issues impact the efficiency of business investment (Biddle et al., 2009; Chen F. et al., 2011; Shahzad et al., 2018; Wu et al., 2022). But only a few studies shed light on the relationship between CSR disclosure and investment efficiency. Cao et al. (2012) uses Rankins ESG Ratings from RKS to proxy for CSR disclosure quality and studies its impact on investment efficiency with a sample of listed companies in China. The problem with their study is that it only covers listed firms who publish CSR reports and does not differentiate between mandatory and voluntary disclosures. Zhong

and Gao (2017) also use RKS's ranking as a proxy for CSR disclosure quality and analyze its influence on investment efficiency. But their study mainly focuses on CSR disclosure's role in reducing information asymmetry and ignores the role CSR disclosure plays in reducing agency cost. Liu and Tian (2021), Makosa et al. (2020) and Zhang (2022) all study the impact of CSR disclosure on investment efficiency, but they only focus on the milestone year 2008 when China mandates CSR disclosure among certain companies. These studies do not examine the long-term effect of the CSR disclosure mandate or consider the more recent changes. The aim of this study is to complement and extend this line of research by examining the impact of CSR disclosure on investment efficiency within a longer time period and analyze the two-fold underlying mechanisms: information asymmetry and the agency problem.

Jensen and Meckling (1976) and Myers and Majluf (1984) propose a paradigm to explain the role of information asymmetry in investment decisions, which includes adverse selection and moral hazard. According to Mikkelson and Partch (1986), non-public information from management may cause investors to conclude that the capital market is overvalued, raising firms' cost of capital, and excluding otherwise suitable investment prospects. On the other hand, companies with high-quality financial information have fewer opportunities to depart from optimal investment levels (Biddle et al., 2009; Chen S. et al., 2011; Gomariz and Ballesta, 2014). By releasing environmental and other certain internal information, CSR disclosure should act as a bridge between stakeholders and company management, mitigating information asymmetry. As a result, CSR disclosure should enable managers to make more informed investment decisions and facilitates more efficient resource allocation.

Agency problems arise when managers or controlling shareholders use corporate resources for personal benefit at the expense of minority shareholders (Jensen and Meckling, 1976; Denis et al., 1997; Djankov et al., 2008). It has been argued that agency conflicts between management and shareholders, as well as between controlling and minority shareholders, significantly impact the company's investment decisions (Jensen, 1986; Fazzari et al., 1988; Jiang et al., 2010; Luo et al., 2015). Since investments are cash-flow sensitive and thus often suffer from agency problems (Pawlina and Renneboog, 2005), companies with more severe agency problems tend to spend the free cash flow on negative net present value projects rather than distribute dividends to shareholders (Jiang et al., 2010; Andrén and Jankensgård, 2015; Luo et al., 2015). For example, if stakeholders are not aware of the financial and non-financial information of the company, there would be a lack of effective communication between shareholders and managers and thus a lack of effective monitoring of managers' behavior. In such cases, management, driven by their self-interest, tends to manipulate information, such as mislead investors by reducing the readability of reports (Lo et al., 2017), make investment decisions which benefit their personal interest rather than shareholders' interest, and finally result in firms' inefficient investment (Jensen and Meckling, 1976).

The empirical evidence in this area seems to be mixed. Using a sample of US firms, Lopatta et al. (2016) discover that better corporate CSR performance reduces insider trading, mitigates information asymmetry, and mitigates agency problems. But they focus on firm CSR performance rather than CSR disclosure. Lu et al. (2017) study the effect of CSR reports on the value of cash holding and find that the voluntary issuance of a standalone CSR report substantially increases the value of cash holdings by providing incremental information. Their findings suggest that CSR disclosure reduces information asymmetry related to managerial investment decisions, which may reduce managers' opportunistic behavior when investing in excess cash holdings. On the contrary, Guo et al. (2022) find that stock price informativeness decreases after China's 2008 CSR disclosure mandate and information asymmetry between investors and managers increased significantly. They also point out that the reduction applies mainly to firms under a mandatory CSR program rather than firms that voluntarily disclosed CSR before 2008. The mixed evidence calls for more empirical studies in this field.

More importantly, existing studies do not compare the different impact of mandatory CSR disclosure versus voluntary CSR disclosure on investment efficiency. This addresses the importance of this study which intends to fill this vacuum in the literature. Previous studies on mandatory CSR disclosure have only examined its economic consequences using a natural or quasi-natural experiment and the DID model around 2008. For example, Liu and Tian (2021) find that firms subject to the mandatory CSR regulation have lower investment inefficiency using a natural experiment. Zhang (2022) discovers that mandatory CSR disclosure increases corporate innovation using quasi-natural experimentation.

On the other hand, studies show voluntary CSR disclosure also has significant economic consequences but might suffer from credibility concerns. For example, Cho et al. (2013) argue that voluntary CSR disclosure mitigates the impact of poor environmental performance on firms' reputation, but stakeholders must use filters to assess the credibility of voluntarily disclosed CSR information. Sethi et al. (2017) find that voluntary CSR disclosure has made it challenging to implement robust measures to evaluate the quality and accuracy of the reports. Nekhili et al. (2017) point out that the voluntary nature of CSR disclosure has resulted in several irregularities in reporting formats which largely affect the information value added by voluntary CSR disclosure. These studies further show the importance of research into the economic consequences of voluntary disclosure. This study analyzes how mandatory and voluntary CSR disclosure affect information asymmetry separately and differently during a ten-year period after the milestone year 2008 when China mandated certain companies to disclose CSR information.

3 Hypotheses development

3.1 CSR disclosure and investment efficiency

The goal of an enterprise is to create value and to pursue all projects with positive net present value (Luo et al., 2015). An enterprise must make investments to maximize value until its income and expenditure reaches an equilibrium (Harjoto and Jo, 2011). The volatility of the capital market as well as other pitfalls may prevent managers from accepting all profitable projects, resulting in deviations from an optimal investment level. As a result, firms with more severe capital constraints may suffer from more severe investment inefficiencies (Hubbard, 1990; Campello et al., 2010). Since managers are better informed than external investors, they are more incentivized to issue capital when companies are overvalued. Rational investors who can anticipate such managerial behavior tend to retain their capital or raise interest rates they charge, resulting in firms' higher financial constraints and underinvestment

(Stiglitz and Weiss, 1981; Biddle et al., 2009). CSR disclosure often contains vital important information and could mitigate firms' financial constraints and improve corporate investment efficiency by reducing information asymmetries. Dhaliwal et al. (2011) find that companies which initiate voluntary CSR disclosure not only benefit from a lower cost of equity capital but also appear more appealing to private investment firms and financial analysts. Similarly, Nandy and Lodh (2012) reveal that eco-friendly firms with higher environmental CSR disclosure scores can obtain more favorable and suitable loan deals than their non-eco-friendly counterparts. Furthermore, Samet and Jarboui, (2017) provide confirmatory evidence of CSR disclosure's positive impact on firm investment efficiency.

According to Freeman (1984) stakeholder theory, employees, consumers, suppliers, and investors who control resources, can affect the implementation of corporate decisions. Paying attention to stakeholders' concerns and expectations could help firms prevent stakeholders from undermining or thwarting firm's goals (Wang et al., 2016). CSR disclosure can be viewed as a response of management to shareholders' information inquiries and regulatory needs. Increasing CSR disclosure may increase the amount of information available to stakeholders and allow external stakeholders to observe and monitor firm behavior (Yusoff et al., 2013; Zhang, 2022), which further encourages companies to improve their corporate governance and investment efficiency. CSR disclosure enhances the mutual trust between managers and other stakeholders by providing more information (Cheng et al., 2014). With less short-term performance pressure, managers may pay more attention to the company's long-term interests, do more rational resource allocation, and improve investment efficiency. As a result, the first hypothesis is stated as follows.

H1: CSR disclosure improves investment efficiency.

3.2 CSR disclosure, information asymmetry, and investment efficiency

As introduced in the literature review session, information asymmetry and agency cost are the two well-established reasons behind inefficient investments. CSR disclosure could reveal information managers attempt to conceal and helps to eliminate information asymmetry (Cho et al., 2013; Lopatta et al., 2016; Cui et al., 2018). The additional information in CSR disclosure shows a more complete picture of the company's operations (Lopatta et al., 2016).

CSR disclosure could reduce the level of information asymmetry by assisting external investors to better understand the company's strategies, enhancing the efficiency of information transmission. Previous studies show that CSR disclosure could provide investors with an information edge and allows them to make better investment decisions (Cho et al., 2013), lower insider trading, and lessen information asymmetry (Lopattaet al., 2016). Capital markets are shown to be extremely sensitive to company-released CSR information, and stock markets even react directly to the positive and poor performance of CSR events (Krüger, 2015; Kölbel et al., 2017). Attig et al. (2014) show that CSR disclosure conveys critical environmental information and could potentially lower the financial cost. The most related study to ours is (Samet and Jarboui, 2017) which show the mediation function of information asymmetry between CSR activities and investment efficiency with a sample of firms listed on the Tehran Stock Exchange during 2012–2017 using content analysis. They focus on the mediating role of information efficiency in the relationship between CSR disclosure and underinvestment but not between CSR disclosure and overinvestment or the overall investment efficiency. Based on above discussion, this article states the second hypothesis as follows.

H2: Information asymmetry plays a mediating role in the relationship between CSR disclosure and overall investment efficiency.

3.3 CSR disclosure, agency cost, and investment efficiency

Agency problems have been shown to cause inefficient investment (Jensen, 1986; Biddle and Hilary, 2006). CSR disclosure could mitigate the conflicts of interest among various stakeholders and maximize shareholders' wealth (Calton and Payne, 2003; Jensen, 2010). CSR disclosure helps stakeholders perform better monitoring and governance functions, discourages opportunistic management behavior, urges managers to choose projects that are in the companies' long-term interests, and ultimately reduces inefficient investments. Harjoto and Jo (2011) find that CSR involvement reduces conflicts of interest between managers and non-investing stakeholders and increases firm value. Eccles et al. (2014) study the effect of firms' integrating social and environmental issues into corporate strategy and reveal that highly sustainable firms are more likely to have established processes for shareholders engagement, which limits short-term opportunistic behavior.

CSR disclosure could also send positive signals to market participants and enhance firm reputation, form stronger mutual trust between managers and other stakeholders within the company, and stabilize contractual relationships in the long run (Cheng et al., 2014). This enhanced stakeholder engagement will further reduce supervision costs, alleviate agency problems, and ultimately discourage inefficient investment. For example, Jo and Harjoto (2011) find that CSR is positively associated with internal and external monitoring mechanisms. CSR disclosure brings rising risks to managers by strengthening external supervision and monitoring mechanisms and impedes managers from making investments out of self-interest (Lu et al., 2017). Samet and Jarboui, (2017) also study the mediating role of agency problems in the relationship between CSR disclosure and investment efficiency, but again their study is limited to overinvestment, rather than overall investment efficiency. And their sample is from the Tehran Stock Exchange while ours is from the Chinese stock exchanges. This study proposes the following hypothesis.

H3: Reduced agency problems play a mediating role in the relationship between CSR disclosure and investment efficiency.

3.4 Mandatory vs. voluntary: The impact of CSR disclosure on investment efficiency

The Shenzhen Stock Exchange and the Shanghai Stock Exchange mandate certain listed firms to issue CSR reports at the end of

2008 while encouraging other listed companies to do so voluntarily. Previous studies show differences in the economic impact of mandatory and voluntary CSR disclosures (Dong and Xu, 2016; Chen et al., 2018). Voluntary CSR disclosure may differ largely in their focus and scope, which are mainly determined by firms' willingness to disclose. In contrast, mandatory disclosure is more standard about format, disclosing scope, and elements following the directive document issued by the government. As a result, mandatory and voluntary CSR disclosure should have different economic implications for investment efficiency. Corporations under the CSR disclosure mandate are subject to more stringent government control and, as a result, less likely to engage in irresponsible investment activities (Christensen et al., 2017). On the other hand, companies mandated to provide CSR reports are backed by the government's credibility and possess a more solid financial position. Accordingly, they should take less unproductive investments.

This study proposes the following hypothesis based on above discussion.

H4: Mandatory CSR disclosures are more effective in improving corporate investment than voluntary CSR disclosures.

4 Research design

4.1 Sample and data collection

Since 2009 was the first year the mandatory CSR disclosure policy became effective in China, the initial sample consists of all Chinese A-shares firms listed on the Shanghai and Shenzhen stock exchanges from 2010 to 2019 with 21,085 observations. This research obtains financial data from the China Stock Market and Accounting Research (CSMAR) database, and the CSR disclosure data from the RKS database (Rankins ESG Ratings database[1]). Then, the study cleans the sample according to the following procedures: First, this research excludes firms in the financial industry based on the CSRC classification criteria. The research also excludes ST/PT firms (ST: Special treatment[2]; PT: Particular Transfer[3]) This step leaves the research 19,702 observations. Second, the study winsorizes continuous variables at the top and bottom one percent to avoid the impact of outliers and get 18,714 observations. The final sample contains 18,431 observations with no missing dependent or control variables.

Table 1 shows the sample distribution by year and industry (please refer to Appendix 1 for the industry classification code). The sample distribution by year from 2010 to 2019 shows that CSR disclosures among Chinese listed companies increased over time, with mandated disclosure outnumbering voluntary disclosure until 2018. The sample distribution by industry shows that the manufacturing industry (Industry Code "C") dominates other industries with 11,724 observations which account for 63.61% of the whole sample. Other industries, such as retail and information transmission, software, and information technology services, also have a considerable number of observations.

4.2 Variable measures

4.2.1 Dependent variable: Investment efficiency

This article defines investment efficiency $Inv_{i,t}$ as the number of new investments made by the company divided by the total assets at the beginning of the year. New investment equals expenditure on the acquisition of fixed assets, intangible assets, and other long-term assets, plus net cash paid for the acquisition of subsidiaries and other business units, minus net cash recovered from the disposal of fixed assets, intangible assets, and other long-term assets minus depreciation. *TobinQ* measures the company's growth opportunities, defined as the sum of the market value of tradable shares, the book value of non-tradable shares, and liabilities divided by total assets. *Lev* is the gearing ratio. *Cash* is the ratio of cash and cash equivalents to total assets. *Age* is the number of years the company has been listed. *Size* is the size of assets. *Return* is the annual return on individual shares, considering the reinvestment of cash dividends. All control variables are lagged by 1 year. The model also controls for industry and year fixed effects.

$$\begin{aligned} Inv_{i,t} = {} & \alpha_0 + \alpha_1 Inv_{i,t-1} + \alpha_2 TobinQ_{i,t-1} + \alpha_3 Lev_{i,t-1} + \alpha_4 Cash_{i,t-1} \\ & + \alpha_5 Age_{i,t-1} + \alpha_6 Size_{i,t-1} + \alpha_7 Return_{i,t-1} + \varepsilon_{i,t} \end{aligned} \quad (1)$$

4.2.2 Independent variable: CSR disclosure

Following prior CSR studies (e.g., Michelon et al., 2013; Zhong and Gao, 2017; Liu and Tian, 2021), the research uses the disclosure of stand-alone CSR reports in period t-1 as a dummy variable (*CSR_Disclosure*) which equals to 1 if there is disclosure and 0 otherwise.

4.2.3 Mediating variables: Information asymmetry and agency problems

Following Dechow et al. (1995) and Hu (2021), this study applies the modified Jones model to calculate firms' information asymmetry. The modified Jones model (Dechow et al., 1995; Hu, 2021) is estimated by industry and year, and then the γ estimated in Eq. 2 are substituted into Eq. 3 to calculate the discretionary accruals (*DA*). This study uses the absolute value of *DA* to get *Opaque* which measures the information asymmetry. The larger *Opaque*, the lower the information transparency and higher information asymmetry; *TA* stands for total accruals, which is equal to operating profit minus net cash flow from operating activities; *Asset* is total assets; *PPE* is the value of fixed assets at the end of the period; ΔREV is the difference between the company's operating income in the current period and the previous period; and ΔREC is the increase in accounts receivable in the current period from last period.

$$\frac{TA_{i,t}}{As\ set_{i,t-1}} = \gamma_0 \frac{1}{Asset_{i,t-1}} + \gamma_1 \frac{PPE_{i,t}}{Asset_{i,t-1}} + \gamma_2 \frac{\Delta REV_{i,t} - \Delta REC_{i,t}}{Asset_{i,t-1}} + \varepsilon_{i,t} \quad (2)$$

1 RKS is a third-party rating agency of public interest and the authority for CSR in China. It was established in 2007 and independently developed the first rating system for social responsibility reports of listed companies in China. This database has been widely used in academic research.

2 Firms that received delisting risk warnings for two consecutive years of operating losses.

3 Firms with three consecutive years of losses and suspended from trading.

TABLE 1 Sample breakdown by year and industry.

Year	N	%	CSR_disclosure	Mandatory	Voluntary
2010	1,081	5.87	360	280	80
2011	1,186	6.43	411	300	111
2012	1,553	8.43	483	311	172
2013	1799	9.76	529	321	208
2014	1842	9.99	555	336	219
2015	1770	9.60	539	319	220
2016	1841	9.99	557	306	251
2017	2082	11.30	591	302	289
2018	2,383	12.93	674	303	371
2019	2,894	15.70	765	285	480
Total	18,431	100	5,464	3,063	2,401
Industry Code	**N**	**%**	**CSR_disclosure**	**Mandatory**	**Voluntary**
A	267	1.45	60	30	30
B	490	2.66	263	188	75
C	11,724	63.61	3,065	1,590	1,475
D	711	3.86	333	215	118
E	535	2.90	199	127	72
F	1,082	5.87	308	128	180
G	625	3.39	328	265	63
H	31	0.17	4	4	0
I	1,084	5.88	248	125	123
K	940	5.10	371	239	132
L	210	1.14	55	27	28
M	121	0.66	21	8	13
N	217	1.18	47	25	22
R	218	1.18	95	48	47
S	176	0.95	67	44	23
Total	18,431	100	5,464	3,063	2,401

Note: This table presents the year and industry (according to the industrial classification of China's national economy) distributions for the 18,431 industry-year observations between 2010 and 2019.

$$DA_{i,t} = \frac{TA_{i,t}}{Asset_{i,t-1}} - \left(\hat{\gamma}_0 \frac{1}{Asset_{i,t-1}} + \hat{\gamma}_1 \frac{PPE_{i,t}}{Asset_{i,t-1}} + \hat{\gamma}_2 \frac{\Delta REV_{i,t} - \Delta REC_{i,t}}{Asset_{i,t-1}}\right) \quad (3)$$

The study uses the difference between the actual and expected expenditures of a firm's executives to measure agency costs (Luo et al., 2011). The larger the difference, the more severe the agency problem. This is measured by the abnormal executive on-the-job consumption, expressed as the difference between management on-the-job consumption and the expected normal on-the-job consumption of executives as determined by economic factors (Luo et al., 2011). The following model measures the expected normal level of executive on-the-job consumption:

$$\frac{Perks_{i,t}}{Asset_{i,t-1}} = \delta_0 + \theta_1 \frac{1}{Asset_{i,t-1}} + \theta_2 \frac{\Delta sale_{i,t}}{Asset_{i,t-1}} + \theta_3 \frac{PPE_{i,t}}{Asset_{i,t-1}} \theta_4 \frac{Inventory_{i,t}}{Asset_{i,t-1}} + \theta_5 LnEmployee_{i,t} + \varepsilon_{i,t} \quad (4)$$

Perks is the amount of in-service consumption of executives, which is derived from administrative expenses after deducting the remuneration of directors, officers, and supervisory board members, provision for bad debts, provision for the decline in value of inventories1, and amortization of intangible assets for the year,

TABLE 2 Definition of variables.

Variable	Definition
Ineff	The absolute value of the residuals was calculated from the regression fit of Richardson's model, with larger values indicating higher levels of inefficient investment and lower firm investment efficiency
CSR_Disclosure	Equals 1 if a company releases a CSR report in period t-1, 0 otherwise
CSR_Type	*CSR_type* = 1 if the firm does not disclose the CSR report; *CSR_type* = 2 if the disclosure is voluntary; and *CSR_type* = 3 if the disclosure is mandatory
SOE	Nature of ownership, with the value of 1 if the firm is a state-owned enterprise, 0 otherwise
Opaque	Information asymmetry. The study uses the modified Jones model to calculate the absolute value
Agcost	Agency problems. It is measured by the non-monetary income of the executives
Staff	Natural logarithm of the number of employees of a company
ROA	The ratio of net profit to the average balance of total assets
Cashflow	Net cash flow from operating activities divided by total assets
Salary	Natural logarithm of the executives' remunerations
Dual	Equals 1 if the chairman of the board of directors is also the CEO; otherwise, 0
Balance	Shares held by the second to fifth largest shareholders are divided by the shares held by the first largest shareholder
Occupy	Other receivables are divided by total assets
Board	Natural logarithm of the number of board members
Top1	The ratio of the number of shares held by the first largest shareholder to the total number of shares
Inst	The ratio of the shares held by institutional investors to all tradable shares
ListAge	Natural logarithm of the number of years after the company's being listed

which is clearly not in-service consumption; *Asset* is the total assets at the end of the previous period; *Δsale* is the change in revenue from primary business for the period; *PPE* is the net value of fixed assets such as plant, property, and equipment for the period; $Inventory_{it}$ is total inventory for the period, and *LnEmployee* is the natural logarithm of the total number of employees in the business. The predicted value of the dependent variable obtained from the model is the normal on-the-job consumption, and the difference between the actual on-the-job consumption and the normal on-the-job consumption is the abnormal on-the-job consumption, represented by the variable *Agcost*. The higher the *Agcost*, the more serious the agency problem.

4.3 Model specification

To investigate the effects of CSR disclosure on investment efficiency, this research estimates the following model:

$$\boldsymbol{Ineff}_{i,t} = \boldsymbol{\beta}_0 + \boldsymbol{\beta}_1 \boldsymbol{CSR\_Disclosure}_{i,t-1} + \sum \boldsymbol{\beta Controls}_{i,t-1} + \boldsymbol{\varepsilon}_{i,t} \quad (5)$$

Ineff represents investment inefficiency. The larger *Ineff*, the less efficient the investment. As explained earlier, *CSR_Disclosure* indicates whether the company discloses CSR. It takes the value of 1 if the firm publishes a stand-alone CSR report and 0 otherwise. A negative coefficient indicates a reducing effect of CSR disclosure on investment inefficiency and wise versus. *Controls* include a set of control variables as listed in Table 2. ε is an error term. The quality of corporate financial information is also affected by inefficient corporate investments, so the research uses lagged CSR disclosure and financial data to avoid contemporary endogeneity issues.

Following previous studies, the study chooses several firm characteristics associated with CSR disclosure and investment efficiency as control variables (Biddle et al., 2009; Chen S. et al., 2011; Zhong and Gao, 2017; Makosa et al., 2020; Liu and Tian, 2021). All control variables are lagged by one period.

To test hypotheses H2 and H3 with regard to the impact of the mediating variables on the relationship between CSR disclosure and firm investment efficiency, the research follows Baron and Kenny (1986), Hayes (2009), Hayes and Scharkow (2013), Wen and Ye (2014) and apply the mediated model test method for empirical testing. In the relationship between the independent variable *X* and the dependent variable *Y*, if *X* affects *Y* through the intermediate variable *M*, then *M* is said to be the mediating variable. If more than one mediating variable M_i is present at the same time, the effect is said to be the multiple mediating effect.

As the two mediating variables in this study, which measure the information asymmetry and the agency problem, have very different meanings, focusing, and calculations. There is no influence relationship or specific sequence between the two mediating variables selected in this study, so the mediating effect in this article is a parallel multiple mediating effect rather than chain mediation. The model equations and are as follows:

$$\boldsymbol{Opaque}_{i,t-1} = \boldsymbol{\varphi}_1 + \boldsymbol{a}_1 \boldsymbol{CSR\_Disclosure}_{i,t-1} + \sum \boldsymbol{\omega Controls}_{i,t-1} + \boldsymbol{\varepsilon}_{i,t} \quad (6)$$

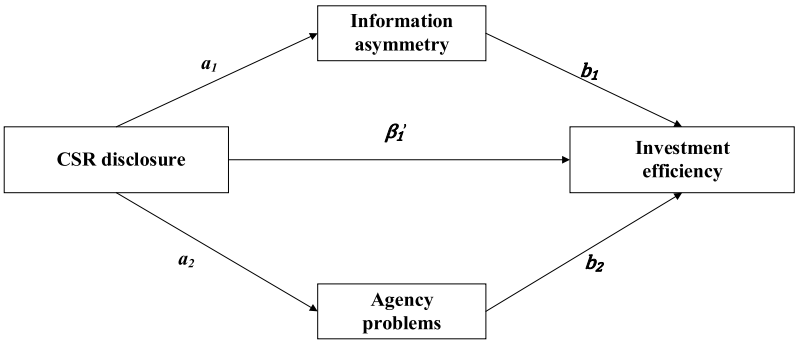

FIGURE 1
Model diagram of the multiple mediation effect.

$$Agcost_{i,t-1} = \varphi_2 + a_2 CSR\_Disclosure_{i,t-1} + \sum \lambda Controls_{i,t-1} + \varepsilon_{i,t} \quad (7)$$

$$Ineff_{i,t} = \beta_0' + \beta_1' CSR_{Disclosure_{i,t-1}} + b_1 opaque_{i,t-1} + b_2 Agcost_{i,t-1} + \sum \beta' controls_{i,t-1} + \varepsilon_{i,t'} \quad (8)$$

The approaches proceed as follows. First, the study estimates Eq. 5 and get the total effect of CSR disclosure on investment efficiency, β_1. Second, analyze the regression of *CSR_Disclosure* to *Opaque* in Eq. 6 and *Agcost* in Eq. 7 to test the significance of the regression coefficient, a_1 and a_2. Third, the coefficient b_1 and b_2 is the effect of *Opaque* and *Agcost* on *Ineff* after controlling for the effect of *CSR_Disclosure* in Eq. 8. The coefficient β_1' is the direct effect of *CSR_Disclosure* on *Ineff* after controlling for the effect of *Opaque* and *Agcost*. The model diagram is shown in Figure 1.

Please note, the indirect effect of information asymmetry (*Opaque*) and agency problems (*Agcost*) on the relationship between CSR disclosure and investment efficiency is measured by $a_i b_i$, while the direct effect of CSR disclosure on investment efficiency is equal to β_1'.

The study includes industry dummy variables to control for industry fixed effects, which may affect the relationship between firms' investment efficiency and their CSR disclosure decisions. Industry dummy variables are based on the industry code classified in Appendix 1. This research also includes dummy variables for each year in the sample period (i.e., year fixed effects) to control for changing economic conditions.

4.4 Methods

To test the hypotheses discussed here, this paper uses STATA to conduct multiple regressions to explore the impact of CSR disclosure on investment efficiency, with year and industry-fixed effects included which control for characteristics that vary over time and across industries. Given that all variables are collected at the firm level, data quality is analyzed prior to the regressions to ensure normal distribution. This study also tests the role of mediating effects.

5 Results

5.1 Descriptive statistics

Table 3 shows the descriptive statistics. The mean value of *Ineff* is 3.643%, which indicates that the average inefficient investment in the sample is 3.643%. The minimum value of *Ineff* is 0.048% and the maximum value is 26.045%, indicating that there is a relatively large difference in investment efficiency among companies in the sample. The mean value of *CSR_Disclosure* is 0.29, indicating that the percentage of companies disclosing stand-alone CSR reports in China is 29%, approximately one-third of the sample which is not high. Apart from the above variables, the means and medians of the other control variables are relatively close to each other, implying the sample is relatively balanced. *Opaque* has a mean (median) of 5.507 (3.813) and a standard deviation of 5.599, indicating a wide variation in information asymmetry among the sample companies.

5.2 Base results

In Table 4, we report the results regression models with different settings on the impact on CSR disclosure on investment efficiency based on Eq. 5. The dependent variable is investment inefficiency (*Ineff*)—the proxy for investment efficiency, and the main variable of interest is *CSR_Disclosure*. Columns (1) and (2) show GLS regression results, and columns (3) and (4) show OLS regression results. As observed in columns (1) and (3), where all control variables are excluded, we find that the coefficients on *CSR_Disclosure* are significantly negative (−0.671 with t-value = −7.702 and −0.708 with t-value = −11.527). In columns (2) and (4), when all control variables are included, the negative relationship is still existing and relatively significant (−0.206 with t-value = −2.229 and −0.239 with t-value = −3.551). The coefficients of CSR disclosure (*CSR_Disclosure*) are significantly negative which suggest that CSR disclosure significantly reduces inefficient investment. This is consistent with the hypothesis H_1.

Column (5) and (6) presents the regression results with two subsamples: Overinvestment and underinvestment. According to Richardson (2006), both overinvestment and underinvestment are

TABLE 3 Descriptive statistics.

Variables	Observations	Mean	SD	Min	Median	Max
Ineff	18,431	3.643	3.811	0.048	2.499	26.045
CSR_Disclosure	18,431	0.296	0.457	0.000	0.000	1.000
Opaque	18,431	5.507	5.599	0.000	3.813	54.931
Agcost	18,431	0.045	2.362	−12.225	−0.232	17.096
SOE	18,431	0.411	0.492	0.000	0.000	1.000
Staff	18,431	7.781	1.290	1.946	7.713	13.223
ROA	18,431	0.042	0.064	−1.859	0.037	0.675
Cashflow	18,431	0.047	0.073	−0.565	0.046	0.876
Salary	18,431	15.320	0.740	10.779	15.289	18.942
Dual	18,431	0.239	0.427	0.000	0.000	1.000
Balance	18,431	0.685	0.605	0.000	0.508	4.000
Occupy	18,431	0.016	0.029	0.000	0.008	0.726
Board	18,431	2.144	0.201	1.099	2.197	2.996
Top1	18,431	0.349	0.150	0.003	0.330	0.900
Inst	18,431	0.415	0.236	0.000	0.427	3.267
ListAge	18,431	2.280	0.653	0.693	2.398	3.401

inefficient investments although they have different economic implications. Zamir et al. (2020) find CSR disclosures reduce underinvestment for large firms but do not constrain overinvestment in emerging Asian markets. Their findings indicate the potential different impact CSR disclosure has on underinvestment and overinvestment. Thus, it is helpful to study the impact of CSR disclosure on overinvestment and underinvestment separately.

The study defines overinvestment as the positive deviations (positive residual) from the expected investment and underinvestment as the negative deviations (negative residual) from the expected investment level. The coefficient of *CSR_Disclosure* is only significantly negative (−0.207 at 1% significance level) with the underinvestment subsample which suggests that CSR disclosure only reduces underinvestment, not overinvestment.

The results of the mediating effect tests in Table 5 show that the coefficient of the total effect of *CSR_Disclosure* on firms' inefficient investment is −0.239, which passes the test at the 1% significance level. After controlling for the effects of information asymmetry and agency problems, the direct effect of CSR disclosure on investment efficiency is −0.189. According to the Bootstrap test results for mediation effects in Table 6, the indirect effect of *Opaque* is −0.021, and 95% confidence interval is (−0.028, −0.016) and does not include 0; similarly, the indirect effect of *Agcost* is −0.028, and 95% confidence interval is (−0.039, −0.017) and also does not include 0, indicating that *CSR_Disclosure* will indirectly affect investment efficiency through *Opaque* and *Agcost*. The Bootstrap test results in Table 6 also show that the total mediating effects of information asymmetry and agency cost are also significant, but the difference between the two specific mediating effects is not significant. Hypothesis H2 and H3 are verified.

Table 7 reports regression results of estimating Eq. 5 using mandatory and voluntary disclosure subsamples respectively. Since *CSR*_Disclosure is defined as a dummy variable which equals 1 if the listed company discloses a stand-alone CSR report and 0 otherwise, the coefficients of *CSR_Disclosure* in Columns (1) and (2) capture the investment inefficiency difference between disclosed group and undisclosed group within voluntary and mandatory CSR subsamples respectively. Specifically, there are 15,368 total observations in Column (1), 2,401 observations with voluntary CSR disclosure and 12,967 observations without stand-alone CSR report. There are 16,030 total observations in Column (2), 3,063 observations with mandatory CSR disclosure and 12,967 observations without stand-alone CSR report.

For example, Column (1) compares the difference in investment inefficiency between firms that made voluntary CSR disclosures and those that did not disclose stand-alone CSR reports. The coefficient of *CSR_Disclosure* is −0.164 which is insignificant statistically. This means the investment inefficiency is lower but insignificant for firms that made voluntary CSR disclosure compared to firms that did not issue stand-alone reports. Similarly, Column (2) compares the difference in investment efficiency between firms that made mandatory CSR disclosures and those that did not disclose stand-alone CSR reports. The coefficient of *CSR_Disclosure* is −0.27 which is significant at 5% significance level. This means the investment inefficiency is significantly lower for firms that made mandatory CSR disclosure compared to firms that did not issue stand-alone reports. These results indicate that mandatory CSR disclosure is more effective in improving corporate investment efficiency, which is consistent with the hypothesis H_4.

In Column (3), this article adds another discrete variable *CSR_type* which equals to 1 if the firm does not issue any CSR report; equals to 2 if the firm issues voluntary disclosure; and equals to 3 if the firm issues mandatory disclosure. The coefficient of *CSR_type* in column (3) is significantly negative, suggesting that the degree of inefficient investment decreases as *CSR_type* increases, which is also consistent with the hypothesis H4.

TABLE 4 Regression results of the impact of CSR disclosure on investment efficiency.

	(1)	(2)	(3)	(4)	(5)	(6)
	GLS	GLS	OLS	OLS	Overinvestment	Underinvestment
CSR_Disclosure	−0.671***	−0.206**	−0.708***	−0.239***	−0.165	−0.207***
	(−7.702)	(−2.229)	(−11.527)	(−3.551)	(−0.960)	(−2.608)
SOE		−0.507***		−0.516***	−0.700***	−0.376***
		(−4.830)		(−7.204)	(−3.671)	(−4.352)
Staff		−0.240***		−0.243***	−0.416***	−0.206***
		(−6.413)		(−8.891)	(−5.774)	(-6.564)
ROA		1.424***		0.367	3.630***	−0.916**
		(2.876)		(0.774)	(3.073)	(−2.100)
Cashflow		2.154***		2.977***	3.809***	1.442***
		(5.138)		(7.213)	(4.238)	(3.669)
Salary		−0.187***		−0.095**	−0.128	−0.229***
		(−3.140)		(−2.047)	(−1.104)	(−4.415)
Dual		0.143*		0.122*	0.252	−0.036
		(1.797)		(1.802)	(1.602)	(−0.497)
Balance		0.056		0.091	0.002	0.143*
		(0.652)		(1.356)	(0.014)	(1.916)
Occupy		1.375		1.702*	−0.506	2.090**
		(1.278)		(1.720)	(−0.210)	(2.192)
Board		−0.448**		−0.411***	−0.257	−0.485***
		(−2.320)		(-2.761)	(−0.682)	(−2.922)
Top1		−0.135		−0.190	0.020	−0.135
		(−0.347)		(−0.637)	(0.028)	(−0.400)
INST		0.965***		0.791***	1.324***	0.855***
		(5.658)		(5.328)	(3.699)	(5.630)
ListAge		−0.620***		−0.544***	−0.894***	−0.491***
		(−8.456)		(−9.963)	(−6.425)	(−7.905)
Constant	4.906***	11.156***	4.697***	9.677***	12.148***	10.933***
	(13.037)	(11.871)	(18.498)	(13.625)	(6.793)	(13.535)
Industry	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Observations	18,431	18,431	18,431	18,431	6,863	11,568
R^2	0.035	0.075	0.037	0.066	0.086	0.114

Note: This table reports regression results of estimating Eq. 5. All variables are defined in Table 2. The research adjusts standard errors for heteroskedasticity. Numbers in parentheses represent t-values. ***, **, and * indicate significance at the 1%, 5%, and 10% levels respectively.

6 Robustness check

To examine the validity of the results which indicate CSR disclosure improves investment efficiency, it runs a battery of additional tests. The study uses alternative measures of investment efficiency, alternative measures of CSR disclosure, alternative estimation methods, and several approaches to address endogeneity and self-selection bias.

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TABLE 5 Regression results from the mediating effect of information asymmetry and agency problems.

	(1)	(2)	(3)	(4)
	Ineff	Opaque	Agcost	Ineff
CSR_Disclosure	−0.239***	−0.278**	−0.431***	−0.189***
	(−3.551)	(−2.084)	(−10.196)	(−3.402)
Opaque				0.077***
				(2.914)
Agcost				0.065**
				(1.984)
SOE	−0.516***	−0.694***	0.027	−0.506***
	(−7.204)	(−6.724)	(0.607)	(−7.060)
Staff	−0.243***	−0.523***	−0.141***	−0.233***
	(−8.891)	(−13.254)	(−8.181)	(−8.456)
ROA	0.367	−5.688***	1.980***	0.414
	(0.774)	(-8.310)	(6.633)	(0.870)
Cashflow	2.977***	−11.059***	2.420***	3.095***
	(7.213)	(−18.582)	(9.323)	(7.412)
Salary	−0.095**	0.390***	0.498***	−0.110**
	(−2.047)	(5.835)	(17.096)	(−2.360)
Dual	0.122*	0.255***	0.128***	0.115*
	(1.802)	(2.613)	(3.001)	(1.709)
Balance	0.091	0.325***	−0.082*	0.088
	(1.356)	(3.350)	(−1.951)	(1.308)
Occupy	1.702*	10.171***	0.597	1.538
	(1.720)	(7.128)	(0.960)	(1.553)
Board	−0.411***	−0.762***	−0.575***	−0.389***
	(−2.761)	(−3.548)	(−6.137)	(−2.607)
Top1	−0.190	1.703***	−0.624***	−0.203
	(-0.637)	(3.971)	(-3.332)	(-0.682)
Inst	0.791***	0.194	0.220**	0.784***
	(5.328)	(0.904)	(2.359)	(5.280)
ListAge	−0.544***	0.315***	0.090***	−0.550***
	(−9.963)	(3.997)	(2.613)	(−10.077)
Constant	9.677***	6.197***	−4.925***	9.680***
	(13.625)	(6.051)	(−11.024)	(13.572)
Year	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes
N	18,431	18,431	18,431	18,431
R^2	0.067	0.037	0.100	0.066

Note: This table reports regression results of estimating Eqs 5–8. All variables are defined in Table 2. The research adjusts standard errors for heteroskedasticity. Numbers in parentheses represent t-values. ***, **, and * indicate significance at the 1%, 5%, and 10% levels respectively.

TABLE 6 Bootstrap test results for mediation effects.

	Regression coefficient		95% confidence interval
Indirect effect of *Opaque*	a_1b_1	−0.021	(−0.028, −0.016)
Indirect effect of *Agcost*	a_2b_2	−0.028	(−0.039, −0.017)
Total indirect effects	$a_1b_1 + a_2b_2$	−0.049	(−0.056, −0.043)
The difference between two indirect effects	$a_1b_1 - a_2b_2$	0.007	(−0.004, 0.019)
The direct effect	β_1'	−0.189	(−0.272, −0.106)

6.1 Alternative measure of investment efficiency

This article uses Chen's model to calculate investment efficiency as a robustness test. Chen S. et al. (2011) propose the following model (Eq. 8) to calculate investment efficiency, and several scholars demonstrate that the model is equally applicable to the Chinese capital market (Dai and Kong, 2017).

$$Inv_{i,t} = \eta_0 + \eta_1 NEG_{i,t-1} + \eta_2 SalesGrowth_{i,t-1} + \eta_3 NEG_{i,t-1} \times SalesGrowth_{i,t-1} + \varepsilon_{i,t} \quad (9)$$

In the model, *Inv* represents the proportion of new investment, and its definition is consistent with Eq. 1, and *SalesGrowth* is the growth rate of operating income for the company. *NEG* is a dummy variable that takes the value of 1 if *SalesGrowth* is negative and 0 otherwise. This research also introduces an interaction term between *NEG* and *SalesGrowth* in Eq. 8. All control variables are lagged by one period. Eq. 8 is estimated by year-industry, and the absolute value of the estimated residuals are used as a proxy for investment efficiency (*Ineff _Chen*). Table 8 reports the regression results. The coefficients of *CSR_Disclosure* in column (1) are all significantly negative, with the estimates of remaining control variables consistent with the previous results.

6.2 Alternative measure of CSR disclosure

In Table 8, the study analyzes the effect of an alternative measure of CSR disclosure on investment efficiency. This research uses CSR scores from the Hexun database[4] as a proxy for CSR disclosure to test its effect on investment efficiency. The study needs to point out that compared to RKS, Hexun is more suitable for measuring the CSR performance, rather than CSR disclosure (Zhong et al., 2019). The results using the Hexun database in the research is just for robustness check purposes.

The coefficients of *CSR_Disclosure* in column (2) are significantly negative, with the estimates of remaining control variables consistent with previous results.

6.3 Alternative estimation methods

Table 8 also reports the regression results using firm fixed effects. The main results control for industry and year fixed effects. As a robustness test, the study further controls for firm fixed effects. The results remain robust. The coefficients of *CSR_Disclosure* in Table 8 are significantly negative, with the estimates of remaining control variables consistent with previous results.

6.4 Robustness check—2SLS regression

Investment efficiency might also influence CSR disclosure which causes a reverse causality problem. For example, firms with high overall investment efficiency and good financial functioning are more likely to issue CSR reports. To rule out such reverse causality from interfering with the estimation results, this study looks for exogenous instrumental variables and re-estimates the model using the 2-step least square method (2SLS). Following Song et al. (2017), this research calculates the ratio of the number of CSR disclosures over the total number of firms in the same industry-year (*CSR_rate*) as the first instrumental variable. Following Benlemlih and Bitar (2018), the study calculates the industry-year average of overall CSR scores (*CSR_Ind*) from the Hexun database as the second variable.

On one hand, *CSR_rate* and *CSR_Ind* both satisfy the relevance requirement of instrumental variables as companies in the same year and industry share similar characteristics and information environments. On the other hand, *CSR_rate* and *CSR_Ind* do not directly affect firms' investment efficiency, which also satisfies the exogeneity requirement.

Table 9 reports 2SLS regression results. Column (1) and column (3) show the results of the first stage regression using *CSR_rate* and *CSR_Ind* as instrumental variables respectively. The coefficients of both instruments are significant at the 1% significance level, which is consistent with the findings of Song et al. (2017); Benlemlih and Bitar (2018). Column (2) and column (4) show the second stage regression results using *CSR_rate* and *CSR_Ind* as instrumental variables respectively. The coefficient of *CSR_Disclosure* on inefficient investment remains significantly negative at the 1% and 5% significance level respectively, indicating *CSR_Disclosure* improves investment efficiency after considering the interference of reverse causality. These results corroborate the reliability of the main findings.

6.5 Robustness test—Propensity score matching test

The results might also be subject to self-selection bias. So, this article follows Wang and Chang (2021) and adopt propensity score

4 Hexun database was founded in 1996, standing out from the early financial and securities information services in China and establishing the first financial information vertical website. After 26 years of dedicated cultivation, Hexun.com has gradually established its dominant position and brand influence.

TABLE 7 Regression results about the mandatory vs. voluntary CSR disclosure.

	(1)	(2)	(3)
	Voluntary CSR disclosure	Mandatory CSR disclosure	Full samples
CSR_Disclosure	−0.164	−0.270**	
	(−1.453)	(−2.142)	
CSR_Type			−0.128**
			(-2.204)
SOE	−0.484***	−0.512***	−0.504***
	(−4.237)	(−4.527)	(−4.799)
Staff	−0.260***	−0.241***	−0.238***
	(−6.144)	(−6.003)	(−6.311)
ROA	1.184**	1.158**	1.432***
	(2.214)	(2.183)	(2.891)
Cashflow	2.241***	2.193***	2.153***
	(4.815)	(4.882)	(5.137)
Salary	−0.239***	−0.157**	−0.185***
	(−3.564)	(−2.457)	(−3.102)
Dual	0.114	0.103	0.144*
	(1.323)	(1.212)	(1.817)
Balance	0.030	0.016	0.054
	(0.327)	(0.174)	(0.627)
Occupy	1.625	1.522	1.377
	(1.396)	(1.337)	(1.280)
Board	−0.409*	−0.464**	−0.448**
	(-1.897)	(-2.245)	(-2.320)
Top1	−0.084	−0.339	−0.141
	(−0.198)	(−0.813)	(−0.362)
INST	0.998***	1.110***	0.969***
	(5.358)	(6.058)	(5.675)
ListAge	−0.598***	−0.638***	−0.621***
	(−7.598)	(−8.148)	(−8.477)
Constant	11.816***	10.857***	11.246***
	(11.257)	(10.806)	(12.044)
Year	Yes	Yes	Yes
Industry	Yes	Yes	Yes
N	15,368	16,030	18,431
R^2	0.069	0.076	0.078

Note: This table reports regression results of estimating Eq. 5 using mandatory vs. voluntary disclosure sub-samples. All variables are defined in Table 2. The research adjusts standard errors for heteroskedasticity. Numbers in parentheses represent t-values. ***, **, and * indicate significance at the 1%, 5%, and 10% levels respectively.

matching (PSM) with different matching methods: k-nearest neighbor matching (k = 1, k = 2, k = 5) and radius matching (r = 0.001). The 1-1 nearest neighbor PSM matching is all with put-back sampling. As shown in Table 10, *CSR_Disclosure* remains significantly negatively related to investment efficiency under different PSM methods. The balance test results of PSM in Appendix 2.

TABLE 8 The relation between CSR disclosure and firms' investment efficiency in robustness check.

	(1)	(2)	(3)
	Ineff _Chen	Ineff	FE
CSR_Disclosure	−0.241** (−2.366)		−0.249* (−1.660)
CSR_Score		−0.007*** (−3.055)	
SOE	−0.263**	−0.520***	−0.653***
	(−2.241)	(−4.988)	(−2.805)
Staff	0.110***	−0.247***	−0.244***
	(2.675)	(−6.704)	(−3.572)
ROA	3.612***	1.883***	2.138***
	(6.936)	(3.616)	(3.781)
Cashflow	0.939**	2.179***	1.714***
	(2.112)	(5.197)	(3.721)
Salary	−0.065	−0.178***	−0.323***
	(−0.998)	(−2.977)	(−3.802)
Dual	0.261***	0.143*	0.110
	(3.066)	(1.794)	(1.053)
Balance	0.206**	0.059	−0.064
	(2.231)	(0.691)	(−0.504)
Occupy	−1.484	1.366	1.392
	(−1.314)	(1.269)	(1.104)
Board	−0.250	−0.455**	−0.571**
	(−1.188)	(−2.358)	(−1.994)
Top1	1.332***	−0.115	0.194
	(3.130)	(−0.295)	(0.307)
Inst	−0.115	0.959***	1.247***
	(−0.625)	(5.633)	(5.777)
ListAge	−0.208**	−0.632***	−1.088***
	(−2.557)	(−8.655)	(−5.229)
Constant	5.738***	11.205***	12.349***
	(5.574)	(12.049)	(8.683)
Year	Yes	Yes	Yes
Industry	Yes	Yes	No
Firm	No	No	Yes
N	18,505	18,422	18,431
R^2	0.054	0.077	0.044

Note: This table reports regression results of estimating Eq. 5 using alternative investment inefficiency measurement, alternative measure of CSR, disclosure, and alternative estimation method. All variables are defined in Table 2. The research adjusts standard errors for heteroskedasticity. Numbers in parentheses represent t-values. ***, **, and * indicate significance at the 1%, 5%, and 10% levels respectively.

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TABLE 9 2SLS regression results.

	(1)	(2)	(3)	(4)
	Stage 1	Stage 2	Stage 1	Stage 2
CSR_rate	0.730***			
	(163.936)			
CSR_Ind			0.012***	
			(71.170)	
CSR_Disclosure		−0.355***		−0.306**
		(-3.509)		(-2.125)
SOE	0.035***	−0.495***	0.083***	−0.502***
	(6.270)	(−5.236)	(10.358)	(−5.273)
Staff	0.029***	−0.230***	0.054***	−0.234***
	(15.178)	(−6.634)	(20.323)	(−6.587)
ROA	0.059***	1.216**	0.034	1.199**
	(2.652)	(2.481)	(1.143)	(2.446)
Cashflow	−0.045**	2.323***	−0.009	2.323***
	(−2.397)	(5.556)	(-0.361)	(5.554)
Salary	0.021***	−0.153***	0.032***	−0.157***
	(7.152)	(−2.732)	(7.982)	(−2.767)
Dual	−0.008**	0.139*	−0.008	0.140*
	(−2.067)	(1.827)	(−1.504)	(1.831)
Balance	0.005	0.070	0.005	0.069
	(1.113)	(0.868)	(0.822)	(0.857)
Occupy	−0.071	1.383	−0.068	1.381
	(−1.448)	(1.309)	(−1.032)	(1.305)
Board	0.008	−0.442**	0.005	−0.442**
	(0.829)	(-2.447)	(0.408)	(-2.446)
Top1	0.024	−0.158	0.041	−0.163
	(1.245)	(−0.435)	(1.518)	(−0.450)
INST	0.043***	0.935***	0.059***	0.933***
	(5.419)	(5.662)	(5.531)	(5.631)
ListAge	0.028***	−0.586***	0.043***	−0.589***
	(7.268)	(−8.701)	(7.772)	(−8.697)
Constant	−0.608***	10.534***	−1.225***	10.624***
	(−12.818)	(12.005)	(−18.547)	(11.820)
Year	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes
N	18,431	18,431	18,422	18,422
R^2	0.864	0.077	0.593	0.077

Note: This table reports 2SLS, regression results using *CSR_rate* and *CSR_Ind* as the instrumental variable. All variables are defined in Table 2. The research adjusts standard errors for heteroskedasticity. Numbers in parentheses represent t-values. ***, **, and * indicate significance at the 1%, 5%, and 10% levels respectively.

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TABLE 10 Results after PSM methods.

	(1)	(2)	(3)	(4)
	1–1 match	Nearest-neighbor (k = 2)	Nearest-neighbor (k = 5)	Radius-match (r = 0.001)
CSR_Disclosure	−0.261**	−0.205**	−0.224**	−0.207**
	(−2.246)	(−1.962)	(−2.482)	(−2.221)
SOE	−0.434***	−0.501***	−0.529***	−0.499***
	(−3.007)	(−3.878)	(−4.930)	(−4.700)
Staff	−0.114**	−0.162***	−0.206***	−0.225***
	(−1.982)	(-3.236)	(-4.988)	(-5.770)
ROA	2.252**	2.961***	2.848***	1.631***
	(2.447)	(3.747)	(4.292)	(3.066)
Cashflow	3.200***	2.782***	2.325***	2.281***
	(4.419)	(4.656)	(4.633)	(5.325)
Salary	−0.144	−0.142*	−0.124*	−0.181***
	(−1.577)	(−1.807)	(−1.902)	(−2.957)
Dual	0.260*	0.175	0.168*	0.147*
	(1.936)	(1.532)	(1.815)	(1.824)
Balance	0.176	0.179	0.053	0.040
	(1.323)	(1.558)	(0.560)	(0.457)
Occupy	0.038	1.818	1.610	1.733
	(0.019)	(1.046)	(1.165)	(1.559)
Board	−0.514*	−0.677***	−0.420**	−0.462**
	(−1.734)	(−2.633)	(−1.970)	(−2.340)
Top1	0.590	0.236	−0.209	−0.158
	(1.002)	(0.463)	(-0.495)	(-0.399)
INST	0.314	0.585**	0.870***	0.960***
	(1.131)	(2.478)	(4.444)	(5.534)
ListAge	−0.695***	−0.577***	−0.589***	−0.625***
	(−6.023)	(−5.767)	(−7.195)	(−8.343)
Constant	9.499***	10.121***	9.805***	11.000***
	(6.626)	(8.114)	(9.607)	(11.455)
Year effects	Yes	Yes	Yes	Yes
Industry effects	Yes	Yes	Yes	Yes
Observations	6,082	8,873	12,743	17,870
R^2	0.080	0.083	0.084	0.072

Note: This table reports the main regression results after different PSM, methods. All variables are defined in Table 2. The research adjusts standard errors for heteroskedasticity. Numbers in parentheses represent t-values. ***, **, and * indicate significance at the 1%, 5%, and 10% levels respectively.

TABLE 11 The result of sub-sample test (state-owned enterprises and CSR performance).

	(1)	(2)	(3)	(4)
	SOE = 1	*SOE = 0*	*High quality CSR*	*Low quality CSR*
CSR_Disclosure	−0.320***	−0.057	−0.265**	−0.106
	(−2.933)	(−0.417)	(−2.532)	(−1.044)
SOE			−0.507***	−0.468***
			(−4.699)	(−4.304)
Staff	−0.300***	−0.219***	−0.232***	−0.259***
	(−6.435)	(−4.049)	(−5.970)	(−6.567)
ROA	−0.240	1.327**	1.287**	1.227**
	(−0.266)	(2.157)	(2.487)	(2.379)
Cashflow	1.709***	2.715***	2.233***	2.366***
	(2.972)	(4.628)	(4.986)	(5.321)
Salary	0.008	−0.303***	−0.163***	−0.186***
	(0.104)	(−3.625)	(−2.610)	(−2.959)
Dual	−0.067	0.194**	0.127	0.119
	(−0.495)	(1.970)	(1.533)	(1.433)
Balance	0.112	0.093	0.065	0.004
	(0.808)	(0.855)	(0.726)	(0.048)
Occupy	1.880	0.875	1.595	1.469
	(1.224)	(0.603)	(1.428)	(1.313)
Board	−0.295	−0.615**	−0.510**	−0.392*
	(−1.179)	(−2.294)	(−2.530)	(−1.928)
Top1	−0.463	0.220	−0.148	−0.289
	(−0.905)	(0.397)	(−0.364)	(−0.709)
INST	0.816***	1.005***	0.977***	1.021***
	(3.106)	(4.496)	(5.432)	(5.679)
ListAge	−0.634***	−0.604***	−0.597***	−0.650***
	(−5.751)	(−6.284)	(−7.972)	(−8.562)
Constant	8.710***	12.337***	10.851***	11.231***
	(6.970)	(9.489)	(11.059)	(11.376)
Year effects	Yes	Yes	Yes	Yes
Industry effects	Yes	Yes	Yes	Yes
Observations	7,567	10,864	16,409	16,428
R^2	0.119	0.043	0.082	0.076
Empirical p-value	0.050*			

Note: This table reports SOE, and non-SOE, high and low-quality of CSR, sub-sample tests. All variables are defined in Table 2. The research adjusts standard errors for heteroscedasticity. Numbers in parentheses represent t-values. ***, **, and * indicate significance at the 1%, 5%, and 10% levels respectively. The empirical *p*-value is used to test the significance of the coefficient (*CSR_Disclosure*) difference between groups, which is obtained through 1,000 times of self-sampling (Bootstrap).

7 Additional analysis

7.1 CSR disclosure and investment efficiency: Nature of ownership

State-owned enterprises (SOE) remain dominant in the Chinese capital market[5] and pressured by the State-Owned Assets Supervision and Administration Commission of the State Council (SASAC) to issue CSR reports (Zhao, 2012). SOE take more state and society-assigned responsibilities and SOE executives, who are politically motivated, are more enthusiastic to respond to CSR disclosure requirements and implement them effectively (Song et al., 2017). Consequently, compared to non-SOE, the investment behavior of SOE firms might be more influenced by CSR disclosure. In this part, this study separates firms according to their different ownership background to explore whether there is a difference in the role of CSR disclosure on investment efficiency between SOE and non-SOE.

Table 11 shows the regression results with SOEs and non-SOEs subsamples respectively. In Column (1) with the SOE subsample, the coefficient of *CSR_Disclosure* is −0.32 and significant at the 1% significance level. While In Column (2) with the non-SOE subsample, the coefficient of *CSR_Disclosure* is −0.057 and insignificant. The results suggest that CSR disclosure's role in improving investment efficiency is only significant with state-owned enterprises. This might be caused by SOEs' unique business objectives which are more social-focused than economic gains-focused. SOEs' primary business indicator is not pure profit generating, but rather the preservation of corporate assets and images. Accordingly, they are more likely to have "moral motives" for CSR disclosure. In contrast, non-SOEs' business objective is profit maximization, with CSR a mere incidental part of the business process. As a result, CSR disclosure is of limited use to non-SEOs and might contain limited information.

7.2 CSR disclosure and investment efficiency: CSR performance

Table 11 also presents the effect of CSR disclosure on investment efficiency for different CSR performance subsamples. Firms with good CSR performance are more likely to send positive signals of "good citizenship" through the publication of CSR reports ("signaling effect"). This article posits that such reports are more likely to trigger a significant impact of CSR disclosure on investment efficiency. Previous studies have found a positive impact of CSR performance on investment efficiency (Benlemlih and Bitar, 2018; Lin et al., 2021). The question naturally rises that whether CSR performance will affect the impact of CSR disclosure on investment efficiency and awaits us to answer.

Based on the CSR rating data published by RKS, this study divides the sample into two groups: high CSR performance and low CSR performance based on each industry's median score. The coefficient of *CSR_Disclosure* is −0.265 and significant at the 5% significance level for better CSR performance subsample and −0.106 and insignificant for poor CSR performance subsample. This study can conclude that CSR disclosure's effect on investment efficiency is more pronounced for companies with higher-quality CSR practices.

7.3 CSR disclosure and investment efficiency: Institutional holdings

Previous literature recognizes that stock ownership plays a vital role in limiting agency conflicts and enhancing firm value (Bathala et al., 1994). Institutional shareholding has been widely used as a proxy for external regulation. Empirical studies show that institutional holdings may influence managers' planning horizons and investment behavior (Eng and Shackell, 2001). Specifically, the higher the institutional shareholding, the stricter the external regulation and the lower the probability that firms engage in irresponsible activities (Christensen. et al., 2017). Therefore, this research investigates the impact of CSR disclosure on investment efficiency in different shareholding conditions.

This study separates the sample based on the criteria whether the institutional investors' shareholding is higher than the annual industry median. A higher than industry median institutional investors' shareholding suggests a higher level of external regulation. Table 12 reports the subsample test results. In Column (1), the coefficient of *CSR_Disclosure* for low institutional holdings subsample is −0.033 and insignificant. In Column (2), the coefficient of *CSR_Disclosure* for high institutional ownership subsample is −0.313 and significant at the 1% significance level. The results indicate that the effect of CSR disclosure on investment efficiency is more pronounced for firms with higher institutional holdings or more strict external regulation.

7.4 CSR disclosure and investment efficiency: Industry competition

Earlier studies demonstrate that industry competition determines a company's external living environment and critically influences its internal business decisions (Nickell, 1996; Karuna, 2007; Fosu, 2013; Lyu et al., 2022). When a company belongs to a more competitive industry, it usually takes a series of actions to differentiate itself from other competitors in order to be favored by investors and other stakeholders. CSR is widely considered a competitive strategy that allows companies to differentiate themselves from tier rivals (Flammer, 2015; Jia, 2020; Long et al., 2020). According to strategic management theories, implementing CSR practices and making CSR disclosure are both effective strategies companies could use to send positive signals to the market (Porter and Kramer, 2006). In other words, industry competition level is an important factor influencing firms' internal motivation for CSR disclosure.

This research predicts that industry competition strengthens the relationship between CSR disclosure and investment efficiency. The article uses Herfindahl–Hirschman Index (HHI) to measure industry competition. HHI is a commonly accepted measure of industry competition. It measures competition by squaring the market share of each firm competing in the same market and then summing the resulting numbers. The higher the HHI, the less competitive the industry is and the lower the HHI, the more competitive the industry is.

5 SOE accounted for over 60% of China's market capitalization in 2019 according to Hissey (2019) "Investing in Chinese State-Owned Enterprises".

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TABLE 12 The result of sub-sample testing (institutional holdings and Herfindahl-Hirschman index).

	(1)	(2)	(3)	(4)
	Low institutional holdings	High institutional holdings	Low HHI	High HHI
CSR_Disclosure	−0.033	−0.313***	−0.288**	−0.128
	(−0.238)	(−2.706)	(−2.541)	(−0.787)
SOE	−0.384**	−0.545***	−0.438***	−0.538***
	(−2.545)	(−4.226)	(−3.421)	(−2.895)
Staff	−0.253***	−0.235***	−0.235***	−0.282***
	(−4.714)	(−4.888)	(−5.201)	(−4.032)
ROA	1.039	1.682**	0.550	2.820***
	(1.541)	(2.291)	(0.919)	(3.111)
Cashflow	2.363***	2.299***	1.942***	2.344***
	(3.988)	(3.836)	(3.866)	(3.046)
Salary	−0.264***	−0.074	−0.172**	−0.220**
	(−3.033)	(−0.959)	(−2.321)	(−2.121)
Dual	0.052	0.271**	0.042	0.317**
	(0.497)	(2.296)	(0.437)	(2.227)
Balance	0.082	0.276**	0.059	0.032
	(0.764)	(1.977)	(0.561)	(0.208)
Occupy	0.818	2.803*	0.878	1.981
	(0.525)	(1.886)	(0.664)	(1.056)
Board	−0.125	−0.735***	−0.337	−0.715**
	(−0.465)	(−2.799)	(−1.419)	(−2.114)
Top1	0.395	0.494	−0.070	−0.346
	(0.753)	(0.881)	(−0.145)	(−0.499)
INST			1.125***	0.856***
			(5.345)	(2.879)
ListAge	−0.515***	−0.567***	−0.736***	−0.415***
	(−5.265)	(−5.700)	(−8.119)	(−3.201)
Constant	11.544***	9.897***	10.520***	12.656***
	(8.556)	(7.979)	(9.112)	(7.976)
Year effects	Yes	Yes	Yes	Yes
Industry effects	Yes	Yes	Yes	Yes
Observations	9,267	9,187	12,008	6,423
R^2	0.064	0.117	0.090	0.062
Empirical p-value	0.064*	0.093*		

Note: This table reports regression results with low vs. high institutional shareholdings and low vs. high HHI., The research adjusts standard errors for heteroscedasticity. Numbers in parentheses represent t-values. ***, **, and * indicate significance at the 1%, 5%, and 10% levels respectively. The empirical *p*-value is used to test the significance of the coefficient (*CSR_Disclosure*) difference between groups, which is obtained through 1,000 times self-sampling (Bootstrap).

Table 12 report the regression results. In Column (3), the coefficient of *CSR_Disclosure* for Low HHI (high competition) subsample is −0.288 and significant at 5% significance level. While in Column (4), the coefficient of *CSR_Disclosure* for High HHI (low competition) subsample is only −0.128 and insignificant. The results indicate that the effect of CSR disclosure on investment efficiency is more pronounced among companies in highly competitive industries.

This might be explained by the stronger desire of firms from those fiercely competitive industries to gain favor and recognition from investors and shareholder. The more competitive the industry in which a company operates, the greater the pressure to survive, and the more likely the company will regulate their business practices through CSR disclosure and actively fulfill their obligations.

8 Conclusion

This study investigates the influence of CSR disclosure on investment efficiency and the underlying mechanisms. The findings suggest that CSR disclosure improves investment efficiency with a sample of Chinese listed firms. Specifically, the results show CSR disclosure has a significant impact on underinvestment, but no significant effect on overinvestment. This finding is in harmony with Benlemlih and Bitar (2018) which find that CSR has a significant effect on underinvestment, but not overinvestment. The study also shows evidence that mandatory CSR disclosure is more effective in improving corporate investment efficiency than voluntary CSR disclosure, possibly due to a lack of uniform format and content regulation for voluntary disclosure. The findings suggest that information asymmetry and agency cost act as mediating roles in this process. This study uses various tests to demonstrate the robustness of the empirical results. Furthermore, CSR disclosure by state-owned equities (SOEs) is more effective in increasing investment efficiency. And CSR disclosure by enterprises with better CSR performance, higher institutional holdings, and enterprises in more competitive industries also increases investment efficiency more effectively.

Based on the findings, the following policy recommendations are made: First, the positive impact of CSR disclosure on investment efficiency suggests that CSR disclosure could improve company reputation and increase company value as an information medium. Companies' CSR disclosure can boost market confidence and attract more potential investors, lowering financing costs, improving investment efficiency, and increasing company value. Government should continue to actively implement CSR disclosure policies through tax incentives or mandatory legislation to encourage more companies to join the ranks of disclosing CSR information. In the long run, companies would be more likely to engage in social responsibility activities and develop a steady and healthy growth.

Second, currently, not all publicly traded companies are required to publish CSR reports and there is a lack of guidance for CSR reports' formats, contents, and elements. This will hinder investors' appropriate understanding of CSR reports and increases the opportunity of managerial misbehavior. Regulators are recommended to provide more detailed guidance on the format, content, and elements of the CSR disclosure report. Furthermore, government, external institutions, consumers, and other relevant stakeholders should strengthen external monitoring to prevent firms from using CSR disclosure as a "greenwash" or "show".

This study does have several limitations which mainly stem from its failure to conduct detailed analysis of the content of CSR reports. Future research could dive into the tone, mood, content, and readability of firms' CSR disclosure using textual analysis and sentiment analysis, investigate their impact on corporate governance, and link to different stakeholder groups and audiences. Given the lack of evaluation metrics for CSR disclosure, it also calls for future studies to address the measurement and evaluation of firms' CSR disclosure quality.

Data availability statement

The raw data supporting the conclusion of this article will be made available by the authors, without undue reservation.

Author contributions

FH and MC contributed to the conceptualization and design of the study. MC wrote the original draft and contributed to analyzing it. RL contributed to the review and editing of the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Appendix 1

TABLE A1 Industry classification corresponding to the industry code.

Industry code	Industry
A	Agriculture, forestry, animal husbandry, and fishery
B	Mining
C	Manufacturing
D	Electricity, heat, gas, and water production and supply
E	Construction
F	Wholesale and retail
G	Transportation, storage, and postal services
H	Accommodation and catering industry
I	Information transmission, software, and information technology services
K	Real estate industry
L	Leasing and business services
M	Scientific research and technical service industry
N	Water conservancy, environment, and public facilities management
R	Culture, sports, and entertainment
S	Public management, social security, and social organization

Appendix 2

This study used four matching measures: k-nearest neighbor matching (k = 1, k = 2, k = 5) and radius matching (r = 0.001). Before matching, the study conducted a balance test and found that the control variables between the treatment and control groups were significantly different. After matching, the standardized deviations of most variables are decreased to less than 10%. And the *t*-test is not significant. The results show that there is no significant difference in the matching variables between the two groups after the matching. The balance test results are shown in Appendix 1. Here the study only gives the balance test results for k-nearest Neighbor-match (k = 1) and Radius-match (r = 0.001). The 1-1 nearest neighbor PSM matching is all with put-back sampling.

TABLE A2 The balance test results of PSM.

Variable	Pre&Post-match	Mean		*t*-test		
		CSR_Disclosure = 1	*CSR_Disclosure* = 0	Bias%	T-value	*p*-value
SOE	Pre-match	0.609	0.327	58.80	36.760	0.000
	Neighbor-match	0.580	0.590	−2.10	−1.030	0.303
	Radius-match	0.580	0.587	−1.400	−0.690	0.492
Size	Pre-match	23.230	21.920	105.10	69.980	0.000
	Neighbor-match	23.000	23.010	−0.30	−0.150	0.881
	Radius-match	23.01	23.02	−0.300	−0.140	0.892
Dual	Pre-match	0.165	0.270	−25.60	−15.350	0.000
	Neighbor-match	0.174	0.163	2.60	1.430	0.151
	Radius-match	0.173	0.172	0.300	0.160	0.872
Lev	Pre-match	0.492	0.417	37.50	23.050	0.000
	Neighbor-match	0.482	0.486	−2.20	−1.090	0.277
	Radius-match	0.482	0.484	−0.900	−0.440	0.657
INST	Pre-match	0.517	0.372	64.80	39.900	0.000
	Neighbor-match	0.500	0.507	−3.00	−1.500	0.134
	Radius-match	0.501	0.510	−4.100	−1.970	0.0480
Top1	Pre-match	0.377	0.338	25.30	16.020	0.000
	Neighbor-match	0.369	0.372	−2.40	−1.120	0.261
	Radius-match	0.369	0.376	−4.900	−2.330	0.0200
ROA	Pre-match	0.048	0.039	13.50	8.130	0.000
	Neighbor-match	0.048	0.046	2.50	1.370	0.170
	Radius-match	0.0476	0.0482	−1	−0.520	0.602
Balance	Pre-match	0.627	0.709	−13.60	−8.380	0.000
	Neighbor-match	0.627	0.641	−2.40	−1.240	0.213
	Radius-match	0.628	0.631	−0.600	−0.300	0.762
Board	Pre-match	2.198	2.122	37.80	23.870	0.000
	Neighbor-match	2.191	2.197	−2.90	−1.400	0.163
	Radius-match	2.191	2.195	−1.800	−0.900	0.370
Indep	Pre-match	0.375	0.373	3.90	2.460	0.014
	Neighbor-match	0.373	0.373	−1.10	−0.560	0.575
	Radius-match	0.373	0.373	−0.900	−0.420	0.675