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Research article

The impact of ownership structure on environmental information disclosure: Evidence from China

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ABSTRACT

Environmental information disclosure (EID) plays a crucial role in promoting sustainable practices and enhancing environmental accountability. The ownership structure of firms, which varies across different institutional settings, can significantly influence the extent to which they are willing and able to disclose environmental information. Drawing on voluntary disclosure theory and legitimacy theory, this study examines whether ownership structure (e.g. ownership concentration, institutional ownership, managerial ownership, and state ownership) influences the environmental information disclosure of Chinese firms. Using a panel data set of firms listed on the Shanghai Shenzhen 300 Index from 2009 to 2019, the results show that there has been an increase in environmental information disclosure in China in recent years. Furthermore, we find that managerial ownership is positively associated with environmental disclosure, whilst institutional ownership and state ownership are negatively associated with environmental disclosure. Additional analyses show that the relationship between ownership structure and EID and ownership structure is stronger in low-regulated industries, and the effects of managerial and state ownership on EID vary by firm size. The enforcement of the 2014 *Environmental Protection Law of the People's Republic of China* has also played a pivotal role in enhancing the nexus between ownership structure and EID and ownership structure.

1. Introduction

In recent years, stakeholders' demands for environmental information disclosure (EID) have been growing as environmental protection has become the focus of global attention (Zeng et al., 2010). At the recent UN Climate Change Conference of the Parties (COP 26) in Glasgow, countries adopted the *Glasgow Climate Pact*, which aims to transform the 2020s into a decade of climate action to limit the rise in global average temperatures to less than 1.5°. The aim of the EID approach is that with direct information readily available about a business's environmental risks, investors, local communities, consumers, employees, and the public can force firms to become greener (Zeng et al., 2012). EID has emerged as a vital component in the annual reports of firms as well as in other reports focusing on social responsibility and sustainability (Cheng and Feng, 2023). Gerged (2020) demonstrates the benefits of enterprise EID, which pertains to a firm's interaction with its surroundings and includes actions undertaken by management to improve and protect the overall environment. The utilization of EID initiatives and protocols can serve as effective measures to curb market inefficiencies, by reducing information asymmetry between managers and their stakeholders (Li et al., 2021).

Chinese listed firms have experienced increasing pressure to disclose their environmental impact from society, the media, and the government. An example of the latter is the progressive implementation of various regulations (e.g. the *Guidelines on Environmental Information Disclosure for Listed Firms* and the *Environmental Protection Law of the People's Republic of China*) on EID. As a result, firms are increasingly recognizing the significance of EID (Chang, 2013). Ownership structure has been recognized as an important corporate governance mechanism that might affect the level of EID (Baba and Baba, 2021). While existing research has explored the influence of ownership structure on EID (Khaireddine et al., 2020; Brammer and Pavelin, 2008; Cormier et al., 2005), they tend to focus on developed countries, with only a limited number of studies looking at developing/emerging countries (Li et al., 2022; Diantimala and Amril, 2018; Amosh and Mansor, 2020). Thus, this study aims to examine whether ownership structure can explain the observable differences in the level of EID by using a sample of firms listed on the Shanghai Shenzhen 300 Index from 2009 to 2019.

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Our findings are threefold. First, our study reveals that, notwithstanding the recent increase in EID, Chinese firms present lower levels of EID compared with their counterparts in developed economies. While specific sectors, such as the energy industry, exhibit a higher level of EID than others, it is noteworthy that the industry classification itself does not significantly contribute to the overarching dearth of EID within the Chinese context. This is underscored by the observation that there is minimal variance in EID levels across industrial sectors. Second, we find that firms with lower levels of institutional ownership, higher levels of managerial ownership, and lower levels of state ownership tend to disclose more environmental information. Third, additional analyses report a more pronounced correlation between ownership structure and EID and ownership structure in industries characterized by lower regulatory oversight, as opposed to those subject to stringent regulatory frameworks. This relationship holds for both small and large firms. Importantly, the enforcement of the *Environmental Protection Law of the People's Republic of China* in 2014 plays a crucial role in shaping the relationship between ownership structure and EID and ownership structures.

This study contributes to the existing literature in several ways. First, as pointed out by Li et al. (2013), the country of origin may play a significant role in determining the extent of corporate social responsibility (CSR) disclosure. While previous studies have examined the variability in CSR disclosure among developed countries (e.g. Sufian and Zahan, 2013; Mohd Ghazali, 2007; Rashid and Lodh, 2008; Oh et al., 2011), only a limited number of studies have addressed the EID aspect, especially in the context of developing countries (e.g. Wang et al., 2008; Xiao and Yuan, 2007; Chen et al., 2021; Li et al., 2013). Furthermore, little attention has been paid so far to the subject of EID in the context of China. Thus, we refine the scope of the existing literature and aim to enhance the understanding of how ownership structure might influence the level of EID in China, an area that is still under-researched. Second, we employ both voluntary disclosure theory and legitimacy theory due to the unique features of the Chinese setting, where environmental information is largely disclosed on a voluntary basis, while mandatory EID is gradually being required by the government. Our study provides novel theoretical insights into the relationship between ownership structure and EID and ownership structures, in contrast to previous literature that relied on agency theory or stakeholder theory (Wang et al., 2008; Chen et al., 2021; Li et al., 2013). Third, unlike previous studies (Zeng et al., 2010; Chang and Zhang, 2015) that concentrate on specific industries, our research considers all the different industries in China. This broader approach avoids potential bias in asserting inflated EID levels for the country, which might have resulted from the exclusive focus on selected industries in prior studies. Fourth, to the best of our knowledge, this study is the first to examine the role of implementing the *Environmental Protection Law of the People's Republic of China* on the relationship between EID and ownership structure. We demonstrate that this new initiative has had a significant effect on enhancing the relationship between ownership structure and EID and ownership structure in China, a finding that previous studies have not identified.

The remainder of this study is structured as follows. Section 2 presents the background, theoretical framework, and hypotheses development. The data and methodology are described in Section 3. Section 4 presents the findings and discussion. Section 5 concludes the study.

2. Background, theoretical framework and hypotheses development

2.1. The Chinese context, EID regulations and their evolution

China[1] has successfully transitioned from a planned economy to a market economy and has now become the world's second-largest economy (Jiang and Kim, 2015). As a result, China has witnessed a significant rise in its environmental challenges (Khan et al., 2021). In 2020, Chinese President Jinping Xi proclaimed that the nation's carbon emissions are projected to reach their peak in 2030, and that, concurrently, China is committed to actively working towards achieving carbon neutrality by 2060 (Lu et al., 2023; Gu et al., 2023; Wang and Zhao, 2023). Consequently, corporate EID has become the focus of attention in recent years.

In its commitment to advancing sustainable economic development, the Chinese government has elevated the importance of environmental concerns and has issued various regulations to oversee the EID of publicly listed firms (Gu et al., 2023). For instance, between 2003 and 2005, the Ministry of Ecological Environment in China initiated a phased approach, which mandated enterprises to 1) disclose environmental data; 2) establish environmental-quality announcement systems; 3) routinely disseminate pertinent environmental protection metrics; 4) promptly release information regarding pollution incidents, and 5) advocate for environmental public interest litigation (Gu et al., 2023). Subsequently, China introduced measures for the experimental implementation of an EID system in 2007, formally delineating the rights and responsibilities of enterprises and government entities concerning EID (He et al., 2023; Lu et al., 2023). To incentivize enterprises to proactively disclose environmental information to the public, the Chinese government and the Shanghai Stock Exchange undertook significant measures in 2008. These initiatives entailed issuing regulations such as the *Guiding Opinions on Reinforcing the Oversight and Administration of Environmental Protection for Listed Firms* and the *Guidelines on Environmental Information Disclosure for Listed Firms*. The primary objectives of these measures were to promote the transparency of environmental governance and foster greater environmental accountability (Zhao et al., 2023). For the first time, explicit requirements were established for the EID of listed firms (Wu and Hąbek, 2021). These requirements were particularly focused on firms operating in industries with significant environmental implications, including thermal power generation, steel production, cement manufacturing, electrolytic aluminium production, and mineral mining. Moreover, they were applicable to listed firms that featured on the list of severely polluting entities compiled by the environmental protection department. Thus, both mandatory and voluntary environmental information reporting requirements have coexisted (Wu and Hąbek, 2021).

In 2014, the Standing Committee of the National People's Congress of the People's Republic of China enacted a revised iteration of the *Environmental Protection Law of the People's Republic of China*. This revised legislation mandated that entities categorized as "key polluters" were obligated to transparently disclose certain information to the general public. This included: releasing the names of the major pollutants they produced or discharged; providing details of their discharge methodologies, discharge concentrations and quantities, and instances of excessive discharges; and disclosing information about the establishment and operation of pollution mitigation facilities. This was done to ensure firms were subject to societal oversight (Zhang et al., 2023). In

[1] Defining the status of China, the second-largest economy, as developing, emerging or developed is subject to debate among experts. Beijing classifies China as a "developing" country in the World Trade Organization. However, the World Bank and United Nations Development Program classify China as an "upper middle income" country, while the International Monetary Fund calls the country an "emerging and developing economy."

2021, the General Office of Ecology and Environment of the State Council released the *Reform Plan of the Environmental Information Disclosure System in Accordance with the Law*. This plan categorically stipulated the gradual establishment and implementation of a compulsory EID system by the year 2025 (Gu et al., 2023). The progression of laws, regulations, and guidelines associated with the disclosure of environmental information reflects the Chinese government and regulatory bodies' growing interest in the environmental dimension of CSR.

Nevertheless, it is worth noting that the disclosure of environmental information presently exists within a semi-mandatory and voluntary framework that is characterized by limited engagement, incomplete data, and a lack of standardization (Wang et al., 2023). A fully-fledged compulsory EID system has not been implemented to date, and EID remains reliant on voluntary participation (Gu et al., 2023). Overall, environmental information/ESG disclosure in China is still largely voluntary (Cheng and Feng, 2023; Wang et al., 2023). Fig. 1 shows the milestones in the evolution of major EID regulations in China from 2003 to 2021.

2.2. Theoretical framework: voluntary disclosure theory and legitimacy theory

Economic and socio-political theories serve as the foundation for elucidating the rationale behind firms' EID and their corporate governance mechanisms. These theories contribute to our understanding of corporate environmental reporting strategies which, in turn, underpin our ability to make predictions regarding the relationship between corporate governance mechanisms and the EID. Because EID in China currently operates as a combination of semi-mandatory and voluntary mechanisms, we employ voluntary disclosure theory (Bewley and Li, 2000) and legitimacy theory (Deegan et al., 2002; Naser et al., 2006) to explain the association between ownership structure and EID and ownership structures. Specifically, voluntary disclosure theory is employed to explain voluntary disclosures, whereas legitimacy theory is utilized to shed light on mandatory disclosures.

Voluntary disclosure theory, an economic theory, posits that managers are motivated to share positive information while withholding negative news (He and Loftus, 2014). When investors recognize that management is withholding information, but are uncertain of its content, they tend to reduce their estimate of the firm's value until a threshold point is reached. At this juncture, managers are incentivized to disclose positive information and withhold any potentially more adverse information they might possess (He and Loftus, 2014). Voluntary disclosure theory also offers a framework for rationalizing the factors influencing EID, as it contends that firms engage in cost-benefit analysis when deciding whether to disclose environmental information, and choose to do so only when the anticipated advantages surpass the associated costs (Li et al., 2017). In other words, a firm will disclose more environmental information when the perceived advantages of EID (such as the potential to enhance the firm's reputation) are heightened. In the Chinese context, EID is primarily voluntary despite the existence of a growing body of regulatory requirements (Cheng and Feng, 2023). However, voluntary disclosure may prove to be more effective than mandatory disclosure in comparing costs and benefits. For instance, while mandatory EID has been associated with increased corporate innovation and decreased industrial pollution, it may also exacerbate information asymmetry and give rise to agency costs (Cheng and Feng, 2023). This concern is particularly pertinent in emerging economies, where market mechanisms may lack the complexity and refinement typically observed in more advanced economies. In contrast, voluntary disclosure demonstrates a proactive willingness on the part of corporations to share internal information with the public.

Legitimacy theory underscores the necessity of considering the broader political, social, and institutional context when examining economic issues (Meng et al., 2013). Firms with inferior environmental performance face heightened political and social pressures that jeopardize their legitimacy. Consequently, it is anticipated that they would engage in more comprehensive EID in their financial reports, either as a means of compensation or to enhance their environmental image (Li et al., 2017; Meng et al., 2013; Deegan et al., 2002; Naser et al., 2006). Within the framework of mandatory regulations, EID predominantly serves as a tool for establishing legitimacy rather than functioning as an accountability mechanism (Meng et al., 2013) because corporations proactively react to governmental demands and adhere to legal requirements in their pursuit of legitimacy. As per this theory, EID is a consequence of external pressures, primarily stemming from government and public sources. Government pressure is evident in the direct implementation of laws and regulations, while public pressure takes an indirect and comparatively less forceful form, manifesting in public sentiment and market dynamics. In the Chinese setting, firms that are required to disclose environmental information face greater public scrutiny, and these social and political pressures lead to greater legitimacy concerns (Li et al., 2017; He and Loftus, 2014). The increased disclosure of environmental information is driven by the mounting

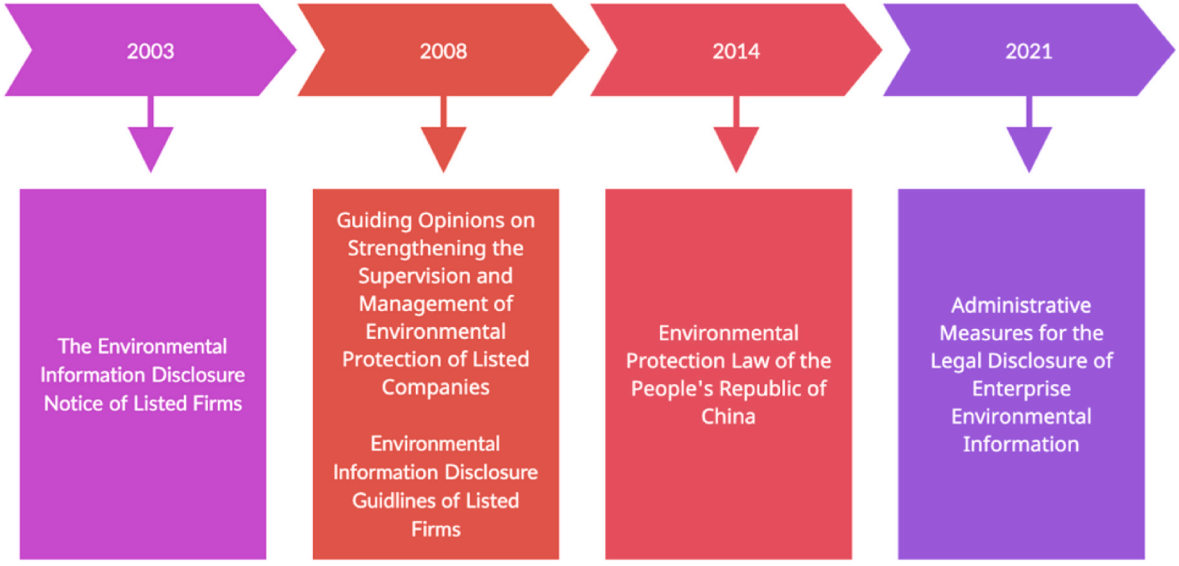

Fig. 1. The Timeline/Milestones/Evolution of EID regulations in China.
Note: From 2003 to 2021, major regulations related to EID in China are shown under the corresponding years.

demands of stakeholders aiming to legitimize their existence in response to the growing emphasis on environmental concerns (Li et al., 2017; Meng et al., 2013).

2.3. Literature review and hypotheses development

The ownership structure is a fundamental element of corporate governance mechanisms that differentiate the behaviours of firms (Acar et al., 2021). Many previous empirical studies have highlighted the impact of ownership structure on firms' EID and presented mixed findings (Ismail et al., 2018; Brammer and Pavelin, 2008; Chang, 2013; Cormier et al., 2005; He and Loftus, 2014). Regarding the EID issue, recent research has demonstrated that various forms of ownership structure can have an impact on EID. For example, Diantimala and Amril (2018) examine the impact of managerial and institutional ownership on corporate environmental disclosures in Indonesia and find that these two types of ownership are negatively correlated with firms' EID. Gerged (2020) investigates whether foreign ownership, managerial ownership, institutional ownership, and ownership concentration affect corporate environmental disclosures in Jordan and finds that foreign ownership is positively associated with corporate environmental disclosure, but managerial ownership, institutional ownership, and ownership concentration are negatively correlated with the amount of EID. By increasing the EID level, it has been found that information asymmetry can be reduced, thereby clarifying the conflict of interest between shareholders and management, and making management more accountable (Khaireddine et al., 2020).

2.3.1. Ownership concentration and EID

In developed countries, corporate shares are distributed amongst a large number of shareholders whilst in emerging nations a high degree of ownership concentration is prevalent (Ismail et al., 2018). The majority of shares in Chinese publicly-traded corporations are held by a limited number of shareholders (Chen et al., 2021). Ownership concentration is an important factor affecting Chinese enterprises' environmental responsibility. In the pursuit of maximizing profits, major shareholders frequently prioritize their own interests over those of other stakeholders. In situations where resources are limited and the primary objective is to enhance shareholder wealth, these major shareholders often opt for production and management strategies that yield immediate financial gains, while placing less emphasis on fulfilling environmental responsibilities (Chen et al., 2021). Brammer and Pavelin (2008) find a significant and negative correlation between CSR disclosure and ownership concentration in the United Kingdom. Similarly, Cormier and Magnan (1999) reveal similar results in the Canadian context, although their focus is on firms' EID instead of CSR disclosure. They believe that where firms are closely held by individuals or families, there may be less pressure to publicly disclose additional information because it is already available to major shareholders. This aligns with legitimacy theory which posits that the extent of disclosure is contingent upon the level of exposure to public pressure (Li et al., 2017). In the context of environmental disclosure, rather than serving solely as a means to inform market investors, EID can also be utilized as a tool to mitigate the perceived risk of encountering social pressures. It can also be seen as a mechanism for managing the image of a firm's environmental practices. From the voluntary disclosure theory perspective, a higher degree of ownership concentration can increase costs because of the existence of asymmetric information between the firm and its stakeholders (Chang, 2013); thus, the firm would not voluntarily disclose environmental information if associated costs surpass the benefits (Li et al., 2017). However, Sufian and Zahan (2013) and Crisóstomo and Freire (2015) find that there is a positive association between ownership concentration and CSR disclosure in Bangladesh and Brazil, respectively. Muttakin and Subramaniam (2015) show that there is no significant relationship between ownership concentration and CSR disclosure in Indian firms, whilst Ismail et al. (2018) find no significant relationship between ownership concentration and the quality of firms' EID at the international level. According to the theoretical discussions above and the previous literature, this study proposes the following hypothesis:

H1. Ownership concentration is negatively associated with firms' EID levels.

2.3.2. Institutional ownership and EID

Institutional ownership relates to stock market investments by institutional investors, such as banks, corporations, pension funds, insurance firms, and mutual funds (Velte, 2020; Chang and Zhang, 2015). Institutional owners, who place greater emphasis on short-term financial gains, demonstrate reduced responsiveness to the requirements of society and other stakeholders. As a result, they are less inclined to legitimize their actions through EID as a means of projecting a favourable image to the market (Acar et al., 2021), as suggested by legitimacy theory. Moreover, a potential issue of free riders within the shareholder base can arise when only a fraction of shareholders bears the costs of actively engaging with the firm's management, but the benefits are shared amongst all, including those who have not contributed (Li et al., 2022). This free-rider dilemma can manifest between institutional investors and other shareholders. Therefore, greater institutional ownership may lead to more free riders and increase firms' costs because these institutional owners focus on short-term returns but also enjoy the benefits of long-term investments, such as EID practices. According to voluntary disclosure theory, firms are less likely to share environmental information if the associated costs outweigh the potential benefits (Li et al., 2017). Empirical research suggests an inverse relationship between institutional ownership and ESG disclosure/EID (Siew et al., 2016). For instance, Acar et al. (2021) show that there is a negative correlation between institutional ownership and EID using a sample of 72 countries and economic zones. Diantimala and Amril (2018) also found the same result in the Indonesian context from 2010 to 2014. However, Habbash (2016) contends that there is a positive correlation between institutional ownership and firms' EID in Saudi Arabia. One potential reason is that institutional owners have substantial voting power compared to other shareholders, and they tend to be more actively involved in corporate environmental management practices than non-institutional owners (Ismail et al., 2018). In contrast, Sartawi et al. (2014) find an insignificant relationship between institutional ownership and voluntary disclosure in Jordan, whilst Ismail et al. (2018) argue that there is no significant relationship between institutional ownership and the quality of firms' EID. Therefore, based on the discussions above, this study proposes the following hypothesis:

H2. Institutional ownership is negatively associated with firms' EID levels.

2.3.3. Managerial ownership and EID

Managerial ownership refers to the percentage of common shares owned by the CEO and executive directors (Eng and Mak, 2003). Managers who hold ownership stakes perceive that EID serves as a means to foster improved relations between the corporation and its stakeholders. They believe that robust EID enhances the firm's social image, particularly in terms of its commitment to environmental responsibility (Chang and Zhang, 2015), which is a way to gain legitimacy. Previous literature has reported mixed findings on the correlation between EID and managerial ownership. For instance, Uwuigbe and Olusanmi (2011) suggest that managerial ownership has a significant positive impact on the level of CSR disclosure in Nigeria. This finding indicates that firms with a higher degree of managerial ownership are more likely to prioritize environmental issues, as managerial owners are linked to the long-term survival of firms (Khlif et al., 2017). However, Amosh and Mansor (2020) revealed that managerial ownership has no impact on firms' EID in Jordan. On the other hand, Mohd Ghazali (2007) finds that lower managerial ownership is associated with more CSR disclosures based on data from Malaysian firms. Similar results are reported by

Diantimala and Amril (2018).

If an increase in managerial ownership motivates managers to emulate shareholder behaviour, then a higher level of managerial ownership is anticipated to result in greater EID (Donnelly and Mulcahy, 2008). This is indicated by legitimacy theory since the growing emphasis on environmental concerns has led to increased demand from stakeholders seeking to legitimize their existence, which, in turn, leads to a heightened disclosure of environmental information (Li et al., 2017; Meng et al., 2013). In China, managers typically do not hold significant shares (Jiang and Kim, 2015), which means that the level of managerial ownership is low. The practice of granting executive stock options to managers remains uncommon, and firms generally do not provide shares, restricted shares, or performance shares as part of managerial compensation packages, so it is difficult for managers to establish an entrenchment effect within the firm. This situation is markedly different from many developed countries, where a manager with even a small fraction of the firm's shares can become entrenched. Thus, we posit that the alignment effect may have a stronger impact in the Chinese context and greater managerial ownership can mitigate firms' costs by aligning the interests of management with those of other shareholders (Xiao and Yuan, 2007). Firms are more likely to disclose an enhanced level of environmental information voluntarily when its perceived benefits are dominant, as indicated by voluntary disclosure theory (Li et al., 2017). Therefore, supported by the theoretical discussions in the Chinese setting, we propose the following hypothesis:

H3. Managerial ownership is positively associated with firms' EID levels.

2.3.4. State ownership and EID

Governments are frequently identified as significant stakeholders with the capacity to shape corporate strategy and performance, including disclosure practices (Acar et al., 2021). In China, state-owned enterprises (SOEs) are either owned or under the control of the central or local government (Meng et al., 2013), whereas non-SOEs are either owned or controlled by collective entities, foreign investors, or individuals. Previous literature presents conflicting viewpoints and diverse outcomes concerning the link between government ownership and EID/CSR (Ismail et al., 2018). Some report advocate for a positive association between government ownership and disclosure. For example, Acar et al. (2021), Calza et al. (2016), Eng and Mak (2003), Naser et al. (2006), and Haddad et al. (2015) show a positive relationship between EID/CSR levels and state ownership. Others, such as Xiao and Yuan (2007), find no significant association between state ownership and corporate voluntary disclosure in China.

However, it has been contended that SOEs experience fewer incentives for EID, for which there are several contributing factors. First, state-owned shares are not publicly tradable, and state shareholders often prioritize wealth distribution and the preservation of social order over enhancing shareholder value (Xiao and Yuan, 2007). The differing priorities of state owners from other types of shareholders mean that, for SOEs, developing EID incurs higher costs, and, therefore (according to voluntary disclosure theory) reduces the incentive to disclose information. Second, given that the government typically serves as the sole or major shareholder in SOEs, it has alternative sources of environmental information and relatively easier access to various financing channels compared with non-SOEs (Eng and Mak, 2003). Third, social and environmental reports from such firms often face less scrutiny from civil society groups in comparison to non-SOEs (Ismail et al., 2018). This leads to less pressure on SOEs to disclose environmental information in China, as indicated by legitimacy theory. Finally, SOEs are less reliant on capital markets when financing their projects and may not have the incentive to provide information to improve their image, while firms with lower levels of state ownership are more likely to disclose environmental information and establish a good relationship with the capital market and the government (He and Loftus, 2014). A study by Argento et al. (2019), in the Swedish context, suggests that enterprises fully owned by the state tend to disclose less sustainability information compared with those partially owned by the state. In contrast to SOEs, which often receive government backing to meet political and societal objectives (Meng et al., 2013), non-SOEs possess stronger motivations for informing investors and other stakeholders through voluntary disclosure of additional environmental information. They aim to enhance communication with external investors regarding their firms' existing or potential competitive advantages, and EID is a means by which they also gain legitimacy. Therefore, from both the perspectives of SOEs and non-SOEs, greater state ownership indicates less EID in the Chinese setting. In accordance with the above evidence and discussion, this study proposes the following hypothesis:

H4. State ownership is negatively associated with firms' EID levels.

3. Research methodology

3.1. Data and sample

This study employs the data from Bloomberg and China Stock Market & Accounting Research (CSMAR) from 2009 to 2019. The data on environmental disclosure score (EDS), board size (BS), CEO duality (DUAL), board independence (BIND), audit type (BIG4), profitability (ROA), market-to-book ratio (MKTB), leverage (LEV), total assets (FS), and industry (IND) was obtained from Bloomberg. Data for board meetings (BM), ownership concentration (OWCONCEN), institutional ownership (INSTITOW), managerial ownership (MANGOW) and state ownership (STATEOW) was obtained from CSMAR. We chose 2009 as the starting point since the data on EDS is limited before 2009. In 2006 and 2008, China issued the *Interim Measures for Public Participation in Environmental Impact Assessment* and the *Environmental Information Disclosure Measures*, respectively (Agyemang et al., 2020). According to the *Clean Production Promotion Law* and *Environmental Impact Assessment Law*, enterprise EID has begun to be implemented since 2003. This study selects Shanghai Shenzhen 300 (SHSZ300) Index A-shares with large market capitalization and good liquidity as the sample. The Commodity Selection Index (CSI) 300 has two sub-indices: the CSI 100 index and the CSI 200 index, and its current total assets under management are around 11,016 million dollars based on the data from Bloomberg. Therefore, this index is considered to be the reference for Chinese stock exchanges, and also the equivalent of the Standard & Poor's (S&P) 500 Index. The sample firms cover 11 industries: financials, real estate, telecommunications, consumer discretionary, industrials, technology, health care, consumer staples, basic materials, energy, and utilities. Firms that did not have the necessary data for the analysis were excluded. The final sample consists of 300 firms with 2025 firm-year observations.

3.2. Variable definitions and measurement

To explore the impact of the four ownership structures on the EID of Chinese firms, EDS was used to measure the level of EID (Van Hoang et al., 2021; Fahad and Nidheesh, 2021). The EDS is part of the Bloomberg ESG disclosure score. Bloomberg compiled the indicator directly from firms' environmental disclosure levels, which range from 0.1 to 100. According to Bloomberg, the higher the score, the more transparent the environmental issues. Data sources include firm annual reports, CSR reports, press releases, sustainability reports, firm websites, Bloomberg surveys, and third-party research (Ifada and Indriastuti, 2021; Fahad and Nidheesh, 2021).

Regarding independent variables, OWCONCEN is a unique indicator for Chinese firms extracted from CSMAR, which is measured by the percentage of common stock held by the top ten largest shareholders. INSTITOW is the percentage of shares held by institutional investors (Gerged, 2020); MANGOW is the percentage of shares held by managers and board members; STATEOW is a dummy variable, which equals 1 if

the firm is a SOE and 0 otherwise (Meng et al., 2013).

For control variables, BIG4, ROA, MKTB, LEV, FS, BS, BM, DUAL, BIND, IND, and year were selected for this study to consider their potential impact on EID (Gerged, 2020; Wang et al., 2008; Xiao and Yuan, 2007). BIG4 is the dummy variable which is 1 if the listed firm is audited by the Big Four; otherwise, it is 0 (Gerged, 2020). Odoemelam and Ofoegbu (2018) find that audit type is significantly positively associated with overall environmental reporting in South Africa and Nigeria. ROA is measured by using the ratio of net income to total assets (Gerged, 2020). Tang and Luo (2010) argue that high-profit firms voluntarily disclose more information than low-profit firms to highlight their differences and avoid unnecessary losses. The next control variable is MKTB, using the firm's market value divided by its book value (Wang et al., 2019). Andrikopoulos and Kriklani (2013) find that the market-to-book (P/B) ratio is significantly correlated with the breadth of EIDs. LEV is defined as the ratio of total debt to total assets (Brammer and Pavelin, 2006, 2008; Karim et al., 2006; Wang et al., 2019). Empirical evidence from McGuire et al. (1988) and Orlitzky and Benjamin (2001) shows that a firm's financial leverage is positively related to EID levels. Eng and Mak (2003) and Cormier and Magnan (2003) find a significant negative correlation between these two factors. FS is measured using the natural logarithm of total assets (Meng et al., 2013). Wang et al. (2019) suggest that firm size should be considered, and Zeng et al. (2010) find that EID levels increase with firm size as larger firms are more likely to be subject to public scrutiny. They are also more willing to disclose environmental information to reduce agency costs (Cormier and Gordon, 2001).

BS is measured by the total number of directors on the board (Gerged, 2020). Some researchers, such as Mak and Li (2001), Yoshikawa and Phan (2003), Yatim et al. (2006) and Khanchel (2007), suggest that boards should be small because it is difficult to organize large boards. In contrast, other scholars (Cucari et al., 2018; Agyemang et al., 2020; Gerged, 2020; Ganapathy and Kabra, 2017; Liao et al., 2015) argue that large boards of directors may lead to greater corporate participation in EID practices. The reason for this is that increasing the number of board members expands the breadth of knowledge and expertise within it, thus reducing agency problems, and enabling board members to develop their own capabilities and, in turn, enhance their firm's EID level. BM refers to the total number of board meetings held each year (Agyemang et al., 2020). Vafeas (1999) reveals that board activities, measured by the number of board meetings, are an essential dimension of board operations, and they help overcome agency conflict. A reduction in the frequency of board meetings affects management's control and delays the delivery of critical decisions and information to various stakeholders. Researchers generally agree that the quality of disclosed environmental information tends to improve as the number of board meetings increases (Peters and Romi, 2014; Agyemang et al., 2020). Furthermore, DUAL is a binary variable, set to 1 if the same person holds both the CEO and chairman positions and 0 otherwise (Gerged, 2020). Several studies have found that CEO duality is inversely associated with EID levels, suggesting that CEO duality may increase conflicts of interest that can impact a firm's transparency process (Gerged, 2020; Alfraih, 2016; Chau and Gray, 2010; Freitas Neto and Mol, 2017). However, Jizi et al. (2014) pointed out that there is a positive correlation between CEO duality and EID. A reason for this might be that powerful CEOs raise their firms' EID levels, an action which enhances their professional reputation, and raises their tenure and compensation prospects. BIND is calculated by dividing the number of independent non-executive directors by the number of board members (Wang et al., 2019). Chen and Jaggi (2000), Gul and Leung (2004), Byard et al. (2006), Cheng and Courtenay (2006), and Ahmed et al. (2006) conclude that the higher the proportion of independent directors on the board, the more transparent the firm's environmental information is, as independent directors will be able to encourage management to disclose more information. In contrast, Michelon and Parbonetti (2012) find that board independence has a significant negative impact on environmental disclosure.

To control for industry and year, dummy variables (IND and YEAR) for these two factors were also included (Elfaitouri, 2014). "Industry" is considered a significant factor affecting EID (Bewley and Li, 2000; Boesso and Kumar, 2007; Cormier and Gordon, 2001; Wang et al., 2004). Firms in environmentally sensitive industries may disclose environmental information to justify their operations (Boesso and Kumar, 2007). Heavily polluting firms face stricter government regulations and are required to disclose environmental information (Meng et al., 2013). Yekini and Jallow (2012) observe that well-known industries tend to develop high levels of EID to meet public expectations. Gamerschlag et al. (2010) argue that firms in the energy supply and consumption industries appear to disclose more environmental information than firms in the service and other industries. This result is consistent with the study by Yekini et al. (2015). For the year dummy variable, EDS may change from year to year due to relevant regulations or corporate disclosure activities, so it is crucial to control for the year.

3.3. Model specification

Based on previous studies (Acar et al., 2021; Akrout and Othman, 2016; Amosh and Mansor, 2020; Chang and Zhang, 2015; Ismail et al., 2018), the following model is proposed to examine the relationship between the four types of ownership structure and EID:

$$EDS_{it} = c + \beta_1 OWCONCEN_{it} + \beta_2 INSTITOW_{it} + \beta_3 MANGOW_{it} + \beta_4 STATEOW_{it} + Controls_{it} + \varepsilon_{it} \quad (1)$$

Where EDS is the environmental disclosure score, extracted from Bloomberg based on a firm's level of environmental disclosure. Bloomberg summarizes a firm's EDS (on a scale of 0.1–100), with higher scores indicating higher levels of environmental disclosures. OWCONCEN is ownership concentration, which is the percentage of common stock held by the top ten largest shareholders; INSTITOW is institutional ownership, measured by the percentage of shares held by institutional investors; MANGOW is the shares held by board members and their relatives as a percentage of total issued shares; STATEOW is a dummy variable, which equals 1 if the firm is a SOE and 0 otherwise. Control variables (Controls) include audit type (BIG4), profitability (ROA), market-to-book ratio (MKTB), leverage (LEV), firm size (FS), board size (BS), board meetings (BM), CEO duality (DUAL) and board independence (BIND). Industry effect and year effect are also controlled by dummy variables: i is the firm and t is the year. β is the regression coefficient; c is the constant term; ε is the error term. All definitions and measurements of variables used in the study are shown in Table 1.

This study conducted the Breusch and Pagan (1980) Lagrange multiplier (LM) test and Hausman (1978) test to select the most suitable model for examining the relationship between EID and the four ownership structures, which included pooled/linear, fixed effect (FE), and random effect (RE). First, the LM test indicates that the RE model has a better fit than the pooled model, as the p-value is 0.000 (lower than 0.05). In addition, the Hausman test reports that the FE model is more suitable than the RE model because the corresponding p-value is 0 ($p < 0.01$). Therefore, among the three regression models, the FE model is considered the most suitable one for this study. However, we present the results of three regression models for comparison purposes.

4. Findings and discussion

4.1. Descriptive statistics

Table 2 presents the descriptive statistics for all variables used in this study. According to the results, the EDS ranges from 0.423 to 51.938, with mean and median values of 15.012 and 12.403, respectively. The overall level of EID is below average, which means that most firms do not disclose enough environmental information to their stakeholders.

Table 1
Variable definitions and measurement.

	Variable Name	Abbreviation	Definition/Measurement
Dependent Variables	Environmental disclosure score	EDS	Compiled based on the firm's environmental disclosure level, ranging from 0.1 to 100. An indicator of environmental transparency. The higher the score, the more transparency of environmental issues.
Independent Variables	Ownership concentration	OWCONCEN	The percentage of ordinary shares held by the top ten largest shareholders.
	Institutional ownership	INSTITOW	The percentage of shares held by institutional investors.
	Managerial ownership	MANGOW	The percentage of shares held by board members and their relatives from the total number of issued shares.
	State ownership (Dummy 0/1)	STATEOW	If more than 50% of the shares owned by the state (SOEs), the dummy variable is set to 1, otherwise, it is 0 (non-SOEs).
Control Variables	Audit type (Dummy 0/1)	BIG4	If the listed firm is audited by the big 4 auditing firms, the dummy variable is set to 1, otherwise, it is 0.
	Profitability	ROA	The ratio of net income to the total assets.
	Market-to-book ratio	MKTB	The firm's market value divided by its book value.
	Leverage	LEV	The ratio of total debts to total assets.
	Firm size	FS	The natural logarithm of total (short and long-term) assets reported by the firm.
	Board size	BS	The total number of directors on the board.
	Board meetings	BM	The total number of meetings held by the board, either regular or emergency meetings per year.
	CEO duality (Dummy 0/1)	DUAL	If the same person holds the CEO and the chairman positions, the dummy variable is set to 1, otherwise, it is 0.
	Board independence	BIND	The number of independent non-executive directors divided by the number of board members. Independence is defined according to the firm's criteria.
	Industry (Dummy)	IND	1-11 for eleven industries which are financials, real estate, telecommunications, consumer discretionary, industrials, technology, health care, consumer staples, basic materials, energy and utilities.

Pan (2012) applied a numerical rating system to describe EID scores, focusing on heavily polluting firms in China, and finds that EID levels are low, the overall quality of EID is poor, and firms have limited environmental awareness. However, the number of disclosing firms is increasing. Tang and Luo (2010) found similar results after they studied 169 Chinese firms in 21 different industries in 2008. Furthermore, Meng et al. (2013) use a disclosure score to measure EID and conclude that both the quantity and quality of corporate EID are relatively low due to the infrequent stakeholder involvement in EID activities.

Furthermore, this study examines the EDS for each industry to determine whether the category of industry plays a significant role in influencing low levels of environmental disclosure. Table 3 shows that most firms within their industry have relatively low levels of environmental disclosure compared to their industry average EID levels and have a relatively wide range of EDS from minimum to maximum (from 1 to 50), except for the technology sector and consumer staples sector (from 2 to 40). However, the difference in EDS between industries is not obvious. Generally, firms in the energy industry disclose the most information (21.354 on average), followed by firms in the telecommunications industry (about 18). The rest of the industries range from approximately 11 to 14. Fig. 2 shows the average, minimum and maximum values for EDS by industry category. It reveals that the basic materials category has the widest variation, with both maximum and minimum values occurring within this industry, but that the energy sector has the narrowest variation. When considering mean EDS, the energy sector has the highest average value, which suggests that energy firms disclose relatively more information than firms in other sectors. In contrast, real estate and technology disclose relatively less environmental information. Fig. 3 depicts the trends in EDS from 2009 to 2019. While there have been some fluctuations, the general trend in EID has been on an upward trajectory. This implies that certain sectors, such as the energy industry, tend to provide more environmental information; and highlights that China has made some progress in enhancing its EID practices over the past 11 years. However, the Giannarakis et al. (2020) study of firms in the United States finds that the average environmental disclosure level is around 0.56 out of 1, which means that, on average, firms disclose 56% of their environmental information. Thus, when compared with developed countries (e.g. the United States), the EID level of 15% (0.15 out of 1) in China is relatively low.

In terms of independent variables, the average for OWCONCEN is 67.017, meaning that, on average, around 67% of ordinary shares are held by the top ten largest shareholders. This indicates a high level of

Table 2
Descriptive statistics.

Variable	Obs	Mean	Median	Std.Dev.	Min	Max
EDS	1896	15.012	12.403	9.928	.423	51.938
OWCONCEN	2022	67.017	67.305	16.302	20.79	100.00
INSTITOW	2004	68.334	71.350	18.853	3.77	100.00
MANGOW	2022	3.51	0.003	10.313	0	77.988
STATEOW	2025	.069	0	.253	0	1
BS	2005	10.207	9	2.824	5	19
BM	2006	10.876	10	5.678	2	57
DUAL	2008	.165	0	.372	0	1
FS	2017	11.37	11.168	1.855	6.383	17.22
BIND	2006	38.34	36.364	6.882	10	80
ROA	2015	5.923	3.659	6.272	−16.412	43.381
MKTB	2020	3.222	2.228	2.944	.481	38.436
LEV	2016	4.558	2.745	4.514	1.039	28.81
BIG4	1657	.998	1	.049	0	1

Table 3
Descriptive statistics of EDS by industry category.

Industry	Obs	Mean	Median	Std. Dev.	Min	Max
Financials	408	13.86	10.714	9.453	2.326	48.214
Real estate	70	11.628	9.302	9.67	2.326	44.961
Telecommunications	56	18.434	14.729	11.583	1.55	51.938
Consumer discretionary	264	14.386	11.628	9.409	1.55	48.837
Industrials	362	15.517	13.178	9.057	1.087	50.388
Technology	105	11.591	9.302	6.607	2.326	39.535
Health care	148	15.583	10.078	11.972	2.326	48.062
Consumer staples	105	13.293	11.628	7.612	1.933	40.31
Basic materials	209	16.847	13.178	11.432	.423	51.938
Energy	92	21.354	17.442	11.67	1.933	42.636
Utilities	77	14.839	14.729	7.501	4.651	41.085

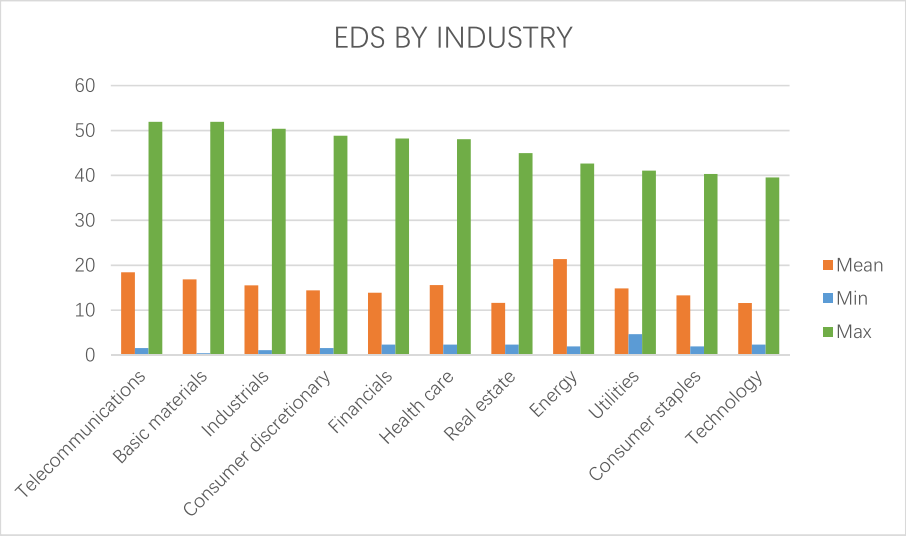

Fig. 2. Histogram of Environmental Disclosure Score (EDS) by Industry.
Notes: The orange, blue and green bars stand for the average, minimum and maximum values of EDS, respectively. Each group of three-colored bars belongs to one industry. The horizontal axis shows the industry categories and the vertical axis is the EDS. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

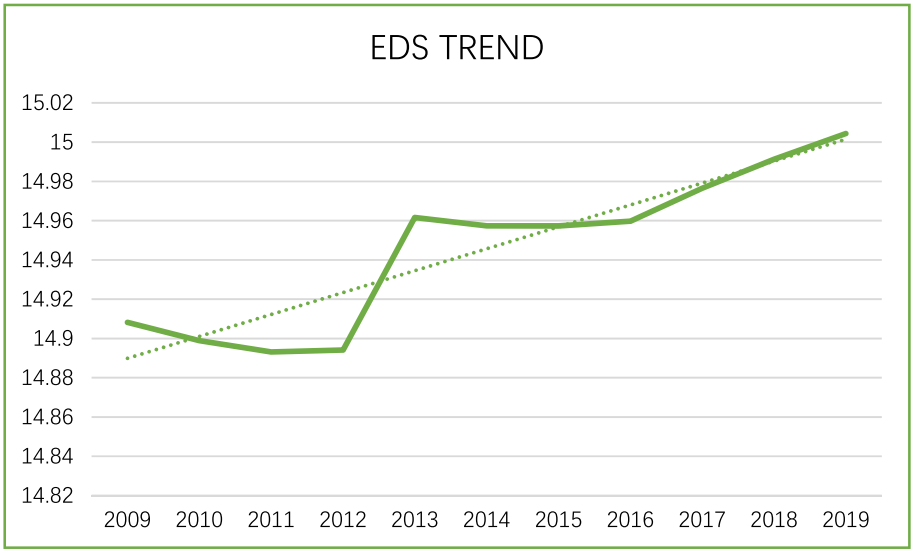

Fig. 3. Line Chart of Environmental Disclosure Trend from 2009 to 2019.
Notes: The full line stands for the actual environmental disclosure score over the 11 years, and the dotted line shows the general trend of the environmental disclosure. The horizontal axis is the year and the vertical axis is the environmental disclosure score.

ownership concentration in China. The minimum and maximum[2] figures are 20.79 and 101.16, respectively. The average value of INSTITOW is 68.334, indicating that institutional owners hold the majority of shares in most firms. Moreover, the maximum and minimum for MANGOW are 77.988 and 0, respectively, and its average is 3.51, which means that on average, managers hold 3.5% of the equity or shares in the firms. This finding is consistent with the previous study by Diantimala and Amril (2018) that around 3%–4% of the total issued shares are held by managers. The data reveals that STATEOW exhibits an average value of 0.069, given the median concentration at 0. This suggests that a significant majority of firms within our sample are non-SOEs, contributing to a relatively moderate mean despite the maximum value of 1.

4.2. Correlation analysis

Tables 4 and 5 present the results of the correlation matrix and variance inflation factor (VIF) for all variables. Among the independent variables, only MANGOW is insignificantly correlated with EDS. OWCONCEN is significantly positively correlated with EDS, and INSTITOW and STATEOW are significantly negatively associated with EDS. The pairwise correlations do not show potential multicollinearity issues in the model because the differences between these independent variables are relatively low. Furthermore, Table 5 again confirms that there is no multicollinearity problem since the values of VIF are below 10 (Wang et al., 2019).

[2] The maximum is not an extreme outlier because the reason for 101.16 higher than 100 is that OWCONCEN uses total shares outstanding as its denominator, but some shareholders also possess shares that are not outstanding.

Table 4
Pairwise correlations.

Variable	EDS	OWCONCEN	INSTITOW	MANGOW	STATEOW	BIG4	ROA	MKTB	LEV	FS	BS	BM	DUAL	BIND
EDS	1.000													
OWCONCEN	0.173***	1.000												
INSTITOW	−0.136***	−0.353***	1.000											
MANGOW	−0.013	−0.055**	0.061***	1.000										
STATEOW	−0.089***	0.195***	−0.070***	−0.092***	1.000									
BIG4	0.023	−0.014	0.021	−0.007	0.019	1.000								
ROA	−0.150***	−0.061***	0.160***	0.269***	−0.112***	0.028	1.000							
MKTB	−0.199***	−0.120***	0.104***	0.306***	−0.032	0.031	0.598***	1.000						
LEV	0.033	0.045**	−0.220***	−0.181***	0.008	−0.035	−0.434***	−0.318***	1.000					
FS	0.280***	0.294***	−0.316***	−0.287***	0.026	−0.042*	−0.537***	−0.563***	0.762***	1.000				
BS	0.025	−0.017	−0.082***	−0.214***	0.087***	−0.000	−0.263***	−0.215***	0.553***	0.343***	1.000			
BM	0.118***	−0.038*	0.017	0.071***	−0.067***	−0.007	−0.118***	−0.065***	0.055**	0.006	−0.045**	1.000		
DUAL	−0.031	−0.112***	0.086***	0.246***	−0.056**	0.022	0.131***	0.153***	−0.069***	−0.076***	−0.107***	0.020	1.000	
BIND	0.086***	0.127***	−0.074***	−0.013	0.049**	−0.009	−0.002	−0.022	−0.062***	−0.008	−0.349***	0.046**	0.071***	1.000

Note: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 5
Variance inflation factor (VIF).

Variable	VIF	1/VIF
FS	4.691	.213
LEV	3.363	.297
MKTB	2.179	.459
ROA	1.84	.543
BS	1.831	.546
OWCONCEN	1.486	.673
INSTITOW	1.305	.766
BIND	1.259	.794
MANGOW	1.225	.817
DUAL	1.095	.913
STATEOW	1.061	.943
BM	1.038	.963
BIG4	1.005	.995
Mean_VIF	1.798	.995

4.3. Regression analysis

Table 6 presents and compares the pooled, RE and FE (baseline model) estimates of the impact of the four types of ownership structure on the EDS. First, OWCONCEN is insignificantly correlated with EDS. which is not in line with **H1**. This is consistent with the study of Muttakin and Subramaniam (2015) who report that there is no significant correlation between ownership concentration and CSR disclosure in the Indian context. Ismail et al. (2018) discovered no significant association between ownership concentration and the firms' EID on a global scale. One potential reason for this is that the significant ownership concentration (within a few families and the government) minimizes the concern for accountability (Naser et al., 2006), such as EID. Consequently, firms have limited motivation to engage with EID.

Table 6
Pooled, RE and FE regression.

	Pooled	RE	FE
Variable	EDS	EDS	EDS
OWCONCEN	−0.021*	0.013	−0.021
	(-1/964)	(0/416)	(-1.226)
INSTITOW	−0.035*	−0.056*	−0.035***
	(-2.017)	(-1.924)	(-2.610)
MANGOW	0.086***	0.041	0.086***
	(4.521)	(0.861)	(3.243)
STATEOW	−2.591***	−0.051	−2.591***
	(-5.435)	(-0.048)	(-2.639)
BIG4	2.598	6.166	2.598
	(0.752)	(1.237)	(0.514)
ROA	−0.040	−0.012	−0.040
	(-1.219)	(-0.139)	(-0.721)
MKTB	−0.173**	−0.006	−0.173
	(-3.032)	(-0.034)	(-1.206)
LEV	−0.767***	−0.310*	0.767***
	(-6.625)	(-1.761)	(-7.986)
FS	3.460***	2.112***	3.460***
	(8.207)	(3.985)	(12.415)
BS	0.294***	0.169	0.294***
	(5.163)	(0.890)	(2.724)
BM	0.269***	0.197***	0.269***
	(6.685)	(3.571)	(6.383)
DUAL	0.042	−0.188	0.042
	(0.076)	(-0.163)	(0.067)
BIND	0.041	−0.026	0.041
	(1.305)	(-0.491)	(1.124)
Constant	−33.958***	−21.621***	
	(-5.094)	(-2.790)	
F-value	.		30.470
R-squared	0.326		0.326
Industry control	Yes	Yes	Yes
Year control	Yes	Yes	Yes
Observations	1552	1552	1552

Notes: *t* statistics are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Second, INSTITOW is negatively correlated with EDS at the 1% significance level, suggesting that firms with greater institutional ownership disclose less environmental information. Thus, **H2** is supported. Our results are consistent with Siew et al. (2016) who propose an inverse relationship between institutional ownership and ESG disclosure, including EID. Similarly, Diantimala and Amril (2018) discovered a negative association between institutional ownership and EID in the Indonesian context during the period from 2010 to 2014. This can be ascribed to the challenge of free riders within the shareholder base, wherein a subset bears the costs of engaging with the firm's management but the rewards are distributed to all, creating a free-rider predicament (Li et al., 2022). Institutional owners, prioritizing short-term objectives, can benefit from long-term goals like EID, but firms may be less inclined to disclose if costs outweigh benefits, which aligns with voluntary disclosure theory (Li et al., 2017). Furthermore, consistent with legitimacy theory, institutional owners focusing on short-term gains may be less inclined to address societal demands, thus having limited motivation to use EID as a strategy to present a favourable market image (Acar et al., 2021).

Third, MANGOW is significantly and positively correlated with EDS. Thus, **H3** is supported, and the finding is in line with the previous literature (e.g. Uwuigbe and Olusanmi, 2011; Khlif et al., 2017). Uwuigbe and Olusanmi (2011) find that managerial ownership exerts a significantly positive influence on the extent of CSR disclosure in Nigeria. This suggests that firms with greater levels of managerial ownership are more inclined to prioritize environmental concerns, given the managerial owners' connection to the long-term viability of the firms (Khlif et al., 2017). Theoretically, legitimacy theory posits that heightened attention to environmental concerns increases stakeholder demand for validation, leading to an upswing in environmental information disclosure (Li et al., 2017; Meng et al., 2013). Managers believe that robust EID enhances the firm's social image, reinforcing its commitment to environmental responsibility (Chang and Zhang, 2015), and thereby strengthening legitimacy. Additionally, higher managerial ownership can potentially align management interests with those of other shareholders, which contributes to cost reduction (Xiao and Yuan, 2007). Consequently, firms are more likely to engage in voluntary environmental information disclosure when the perceived benefits outweigh the costs, which aligns with the principles of voluntary disclosure theory (Li et al., 2017). In the Chinese context, managers typically lack substantial ownership stakes (Jiang and Kim, 2015), which results in low managerial ownership. Unlike many developed countries, executive stock options and equity-based compensation are infrequently granted in Chinese firms, making it challenging to establish entrenched positions for managerial owners, so manager-owners hardly have the opportunity to attain empowerment and secure entrenched positions within the firm. Hence, in the absence of entrenched positions, the correlation between voluntary disclosure and managerial ownership should be positive (Donnelly and Mulcahy, 2008).

Finally, STATEOW has a significant and negative impact on EDS. Thus, **H4** is supported. This finding is in line with voluntary disclosure theory, which suggests that conflicts may arise between the priorities of state owners and other shareholders, potentially resulting in increased costs for firms, and leading to reduced voluntary EID. Moreover, social and environmental reports from such firms often undergo less scrutiny from civil society groups compared to non-SOEs (Ismail et al., 2018). This reduces the pressure on SOEs to disclose environmental information in China, as indicated by legitimacy theory. Furthermore, SOEs rely less on capital markets for project financing and may lack the incentive to provide information to enhance their image. In contrast, firms with lower levels of state ownership are more likely to disclose environmental information and foster positive relationships with the capital market and the government (He and Loftus, 2014). In addition, non-SOEs are highly motivated to inform investors and other stakeholders through voluntary disclosure of additional environmental information (Meng et al., 2013). They aim to enhance communication with external investors regarding the firm's current or potential competitive advantages, and EID serves as a means to establish legitimacy. In summary, greater state ownership tends to result in less EID in the Chinese context, as supported by a study of Argento et al. (2019), which indicates that fully government-owned enterprises in the Swedish context tend to disclose less sustainability information compared to those with partial state ownership.

Table 7 summarizes the FE regression results for the relationship between EDS and the four types of ownership structure, and their corresponding theoretical underpinning.

4.4. Endogeneity issues and additional analyses

The issue of endogeneity has the potential to result in inconsistent estimations and erroneous inferences, potentially yielding deceptive conclusions and unsuitable theoretical interpretations (Ullah et al., 2018, 2021). In certain cases, this bias might even cause coefficients to exhibit an incorrect direction or sign (Ullah et al., 2021). In a FE model, firm-specific fixed effects are integrated into the econometric model either by adding a group of firm-specific indicator variables to the regression or by conducting internal transformations (differencing) to remove the time-invariant components (Ullah et al., 2018). This procedure effectively eliminates unmeasured variables at the time-invariant industry and firm levels. Nevertheless, the use of FE estimation comes into play when grappling with endogeneity in situations where firm-specific attributes (time-invariant) are correlated with the explanatory variable. According to Fulgence et al. (2022), while the FE method may help alleviate the impact of unobservable firm-specific factors, it may not fully eliminate the issue of endogeneity. For instance, although ownership structure can affect EID, it is plausible that EID can also influence ownership structure. For example, shareholders increasingly consider environmental factors when making their investment decisions. The extent of EID can shape shareholder perception, influencing their decisions to either buy or sell shares, thus impacting the ownership structure over time. Therefore, we conduct the Two-Stage Least Squares (2SLS) method with instrumental variables in our analysis (Wang et al., 2019). The results reported in Table 8 (Model 1) are consistent with our main findings in Table 6, and hence our findings are not sensitive to the issue of endogeneity.

Second, to address the potential simultaneous relationship between ownership structure and EID, we estimate a lagged effect model (Wang et al., 2019). According to Saini and Singhania (2019), the prerequisites for utilizing static panel models are not always adequately considered. For instance, we utilized a FE estimation approach, which has the potential to manage unobservable variations, assuming strict exogeneity. Strict exogeneity implies that a firm's current ownership structures (independent variables) are not influenced by any alterations in a firm's past EDS (dependent variable) (Ullah et al., 2018). If the lagged value of EDS impacts current ownership structures, the static effect estimators become biased. Therefore, we utilized the lagged effect regression to address potential endogeneity issues. The results shown in Model 2 of Table 8 are comparable to our main findings, thus further confirming that our findings are robust.

Table 7
Summary of FE regression results.

Variable	Relationship with EDS	Whether The Hypothesis Is Accepted	Whether Supported by Theories
OWCONCEN	Insignificant Negative (−)	Not accepted	Not applicable
INSTITOW	Significant at 1% Negative (−)	Accepted	Yes
MANGOW	Significant at 1% Positive (+)	Accepted	Yes
STATEOW	Significant at 1% Negative (−)	Accepted	Yes

Table 8
Endogeneity: Two-stage least squares (2SLS) and lagged effect regression.

	2SLS	Lagged Effect
Variable	EDS	EDS
OWCONCEN	−.022	
	(-1.100)	
INSTITOW	−.037**	
	(-2.480)	
MANGOW	067**	
	(2.171)	
STATEOW	−5.075***	
	(-3.015)	
L.OWCONCEN		−0.020
		(-1.077)
L.INSTITOW		−0.037**
		(-2.533)
L.MANGOW		0.065**
		(2.241)
L.STATEOW		−2.992***
		(-3.079)
Control variables	Yes	Yes
Industry control	Yes	Yes
Year control	Yes	Yes
Observations	1351	1354
F-value	28.146	28.409
R-squared	0.333	0.337

Notes: *t* statistics are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

To increase the robustness of the findings, this study employed three additional analyses. First, we divide the firms into two groups: 'high-regulated' industries, which include financials, telecommunications, industrials and energy; and 'low-regulated' industries which include real estate, consumer discretionary, technology, health care, consumer staples, basic materials, and utilities.[3] Chen et al. (2021) contend that it is imperative not to overlook the varied impacts when evaluating different firms or industries because industry characteristics is an essential factor impacting firms' EID. The level of firms' focus on corporate EID varies when one takes into account the characteristics of different types of firms or industries. The unique nature of corporate production and operations in different industries results in distinct environmental impacts, leading to varying stakeholder expectations and levels of media attention. Production processes in heavily polluting/high-regulated firms are recognized as of significant concern with detrimental environmental effects. These firms are obliged to manage the pollutants generated during their production operations. Failure to do so can result in adverse consequences for their reputation, stock prices, and overall firm value. Additionally, firms in the lower-polluting/low-regulated category face stricter governmental regulations, compelling them to engage in EID practices. Table 9 illustrates that the relationship between EDS and ownership structure is more significant for low-regulated industries when compared with high-regulated industries. This finding is aligned with the discussion of Chen et al. (2021), and it is also supported by legitimacy theory which suggests more pressure pushes low-regulated industries to disclose environmental information in order to gain legitimacy. Therefore, this finding is consistent with the results of the baseline model.

Second, we categorize the firms into small and large firms based on their market capitalization. Table 9 presents the results of these two groups. The findings for both groups are similar to those in the baseline model. We find a significant impact of INSTITOW on EDS on INSTITOW for both small and large firms. However, we demonstrate that the effect of managerial ownership and state ownership on EDS varies between small and large firms.. The reason for this can be that managerial ownership and state ownership may play different roles for small and large firms in disclosing environmental information.

Third, we finally divide our sample into two groups: before and during 2014, and after 2014. The reason for this is that in 2014, a more stringent environmental protection law was introduced to further enhance EID in China, as discussed previously. This law places the responsibility for environmental protection on both individuals and organizations, outlining various penalties for environmental misconduct by individuals, organizations, and local governments (Ullah et al., 2022). In light of these developments, we conducted an examination to assess the effect of the 2014 *Environmental Protection Law of the People's Republic of China* on the relationship between EID and ownership structures in the pre-and post-implementation period. The empirical results presented in Table 9 reveal a significant correlation between the four types of ownership structure and EID after the enactment of the law. This finding indicates that the implementation of this legislation has played a crucial role in affecting the nexus between ownership structures and EID in China.

5. Conclusion

In recent years, due to increasingly alarming levels of environmental degradation, EID has emerged as a practical approach to address environmental pollution. Despite China being the world's second-largest economy (Jiang and Kim, 2015) and the largest carbon emitter, the current literature on EID in the Chinese context remains limited, with most previous studies concentrating on CSR and specific ownership structures, leaving a gap in comprehensive research on EID in China.

Using a sample of 300 firms listed in the SHSZ300 index from 2009 to 2019, this study examines the relationship between ownership structure (i.e. ownership concentration, institutional ownership, managerial ownership and state ownership) and firms' EID and ownership structure (i.e. ownership concentration, institutional ownership, managerial ownership and state ownership) in China. We find that despite the growth of EID in recent years, the EID level of Chinese firms is relatively low when compared to developed countries. Our findings show that some industries (such as energy) disclose more environmental information than others; however, the industry category is not a critical factor contributing to the overall low level of environmental disclosure in China, as there is little variance in EID across industries. Additionally, our results show that when firms have a lower level of institutional ownership, a higher level of managerial ownership, and a lower level of state ownership, they tend to disclose more environmental information. Furthermore, additional analyses show that the correlation between ownership structure and EID and ownership structure is notably more pronounced in industries with lower regulatory oversight compared with those that are highly regulated; both small and large firms exhibit a willingness to disclose environmental information, but the impact of managerial ownership on EID on managerial ownership tends to be more substantial among small firms, while the impact of state ownership on EID on state ownership has a more pronounced influence among large firms. Moreover, the enforcement of the *Environmental Protection Law of the People's Republic of China* in 2014 has played a pivotal role in increasing the influence of ownership structure on EID on ownership structures in China.

Our findings can contribute to a deeper understanding of the EID landscape in China. We suggest that investors who are interested in non-

[3] In this study, high-regulated industries include financials, telecommunications, industrials and energy, and low-regulated industries include real estate, consumer discretionary, technology, health care, consumer staples, basic materials and utilities. The categorization is based on the *Regulations of Environmental Inspection on Firms Assessing to or Refinancing on the Stock Market*, which identifies certain industries, such as metals, mining, construction, electricity, petroleum and chemicals, and food and beverages, as polluting (Lu and Abeysekera, 2014). Additionally, industries such as banking and insurance, telecommunications and transportation are recognized as having high consumer awareness in China. Consequently, all polluting industries and those with high consumer awareness are considered high-regulated industries, while the remaining industries fall under the low-regulated category.

Table 9
FE regression by industry type, firm size and the implementation of the environmental protection law.

	Industry Type		Firm Size		Implementation of the environmental protection law (2014)	
	High-regulated	Low-regulated	Small	Large	Pre	Post
Variable	EDS	EDS	EDS	EDS	EDS	EDS
OWCONCEN	0.030	0.005	−0.020	0.034	−0.013	−0.009
	(1.149)	(0.217)	(-0.833)	(1.485)	(-0.572)	(-0.408)
INSTITOW	−0.009	−0.046**	−0.053***	−0.052***	−0.001	−0.057***
	(-0.449)	(-2.208)	(-2.704)	(-2.763)	(-0.061)	(-3.249)
MANGOW	0.003	0.094***	0.135***	−0.016	0.137***	0.107***
	(0.046)	(2.922)	(4.313)	(-0.351)	(3.416)	(3.169)
STATEOW	−2.402*	−5.451***	−1.479	−3.301**	−1.421	−2.846*
	(-1.873)	(-3.060)	(-1.034)	(-2.427)	(-1.491)	(-1.765)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Industry control	Yes	Yes	Yes	Yes	Yes	Yes
Year control	Yes	Yes	Yes	Yes	Yes	Yes
Observations	793	759	710	844	496	1056
F-value	12.055	15.110	8.336	11.221	8.751	28.462
R-squared	0.272	0.241	0.249	0.344	0.278	0.309

Notes: *t* statistics are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

financial issues (such as EID), should evaluate firms' ownership structure because these factors are correlated to the EID level. Managers also need to strengthen the quality of their environmental information. To enhance the value-generating capacity of EID, it is imperative that environmental information is reliable, pertinent, and can be clearly understood by stakeholders.

Our study also offers practical recommendations for firms. First, they should consider advancing EID standards, encouraging the creation of dedicated environmental reports, and introducing third-party assurance mechanisms. Leveraging corporate governance mechanisms can enable a timely response to external market demands and effectively enhance the quality of EID. Second, they should recognize the growing pressure from the government and the public, and incorporate environmental concerns into their strategic planning processes. Third, they should consider prioritizing and enhancing their environmental management systems, establishing dedicated environmental departments, implementing environmental performance evaluation systems, and integrating environmental behaviour assessments into employee performance evaluations by creating a system of incentives and penalties. Finally, they should consider concentrating on refining production methods to make their processes more environmentally sustainable.

Our results have significant implications for regulators. First, there exists a significant disparity, in the realm of EID, between Chinese listed firms and those listed in the United States or Europe. Given that enhanced corporate environmental information availability can enhance capital market efficiency and attract investors, regulators should investigate the reasons behind the reluctance of Chinese listed firms to engage in more comprehensive disclosure, and formulate corrective actions. Second, there is a need for a comprehensive improvement in addressing the issue of EID in all industries, rather than focusing solely on specific industry types. When formulating policies related to EID engagement, policymakers should consider the diversity in ownership types and industry characteristics, and special attention should be paid to low-regulated industries. Third, the enforcement of pertinent laws will demonstrate their effectiveness in enhancing firms' EID in China, and regulators should further refine their regulatory processes to enact more effective regulations. Fourth, the Chinese Securities Regulatory Commission (CSRC) should enhance its green finance policies to meet the capital financing requirements and also utilize market-based mechanisms to regulate and oversee the environmental management practices of listed firms, ultimately enhancing firms' EID level. Finally, policymakers should be aware that institutional ownership and state ownership do not necessarily guarantee higher levels of EID. Therefore, it is necessary to implement a more stringent set of voluntary and mandatory measures in China to lead institutional owners, such as mutual funds and state and private pension funds, to become more responsible and play a greater role in stewarding their firms towards environmental disclosure and climate action (Slager et al., 2023). Overall, it is essential for all stakeholders to collaborate in the pursuit of sustainable development. By doing so, the efficiency of corporate governance mechanisms and the decision-making process can be enhanced, ultimately leading to improved EID levels within firms.

This study has several limitations. First, China has unique socialist national characteristics with a financial system and corporate governance structure different from other countries, so these findings may be limited to the Chinese context. Second, due to data constraints, this study does not include other forms of ownership structures, such as foreign ownership. This study also relies on secondary data, but scholars in the future might benefit from using qualitative data. Third, future research may employ theories other than voluntary disclosure theory and legitimacy theory and may investigate the role of CEOs as moderators when examining the relationship between corporate governance and EID.

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CRediT authorship contribution statement

Mengdi Wei: Data curation, Formal analysis, Methodology, Writing – original draft, Writing – review & editing, Conceptualization, Investigation, Project administration, Resources. **Yan Wang:** Conceptualization, Supervision, Validation, Writing – review & editing. **Stéphanie Giamporcaro:** Conceptualization, Supervision, Validation, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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