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**The Impact of Ownership Structure on Environmental Information
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Abstract

Environmental information disclosure 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 their incentives and ability to disclose environmental information. Using a panel data set of firms listed in the Shanghai Shenzhen Commodity Selection Index 300 from 2009 to 2019, this study examines whether ownership structure (e.g. ownership concentration, institutional ownership, managerial ownership and state ownership) affects the environmental information disclosure of Chinese firms. The results show that environmental information disclosure in China has increased in recent years, but the level of environmental disclosure is relatively low compared to developed countries (e.g. the United States). Furthermore, we find that ownership concentration is positively associated with environmental disclosure, while institutional ownership, managerial ownership and state ownership are negatively associated with environmental disclosure. Additional analyses show that the firms with lower degrees of state ownership are more likely to disclose environmental information compared with their counterparts. Overall, this study provides managers, owners, and policymakers with practical recommendations related to the urgent need for a more coordinated integration of governance and environmental regulations to ensure the sustainability in the emerging market.

Keywords: corporate governance; ownership structure; environmental information disclosure; China; SHSZ300; fixed effect

1. Introduction

In recent years, stakeholders' demands for corporate environmental information disclosure (EID) have been increasing as environmental protection has become a global issue receiving increased 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 reverse the 2020s into a decade of climate action, limiting the rise in global average temperatures to less than 1.5 degrees. The aim of EID approach is that with direct information readily available about a business's environmental risks, investors, local communities, consumers, employees and the general public can force firms to become greener (Zeng et al., 2012). Chinese listed firms are increasingly facing environmental pressure from the government, society and media, and the government, society and stakeholders are gradually attaching importance to the EID of listed firms (Chang, 2013). EID and environmental performance have a significant impact on the financial performance, economic performance and business risk of listed firms, and EID has become an important feature in firm annual reports and other social responsibility and sustainability reports. Gerged (2020) demonstrated the benefits of enterprise EID. For example, EID pertains to a firm's relationship with its surroundings and encompasses the actions taken by management to enhance and safeguard the overall environment. The utilization of EID initiatives and protocols can serve as effective measures in curbing market inefficiencies by reducing information asymmetry between corporate managers and their stakeholders. Moreover, these initiatives can give rise to democratic concerns in modern societies, particularly in terms of the right to information.

China's large economy has transitioned from a planned economy to a market economy and has now become the world's second largest economy (Jiang and Kim, 2015). In the process, China's environmental challenges have increased significantly due to its impressive economic growth (Khan et al., 2021). Motivated by the environmental concerns in China, this study aims to examine EID at the firm level. In addition, in Chinese publicly-traded corporations, a small number of shareholders possess the majority of the shares. (Chen et al., 2021). In order to maximize profits, major shareholders often ignore the rights and interests of other stakeholders. Under the circumstance of limited resources and maximum shareholder wealth, major shareholders choose production and management that can bring direct benefits, while neglecting the fulfillment of environmental responsibility. Further, a free-rider mentality prevails among minority shareholders in China, weakening oversight of major shareholders and corporate executives. Although the Chinese government has introduced a series of environmental regulatory policies and regulations on environmental protection, such as the *Notice on Environmental Information Disclosure of Listed Firms* and the *Measures on Environmental Information Disclosure* issued by the State Environmental Protection Administration in 2003 and 2007 (Chang, 2013), respectively, China has not yet formed a mature regulatory system and an effective evaluation system. Moreover, China has a unique cultural and institutional environment, and this business culture leads to limited contact between management and external or foreign stakeholders (Rehman et al., 2020). Besides, it is a country that can have its own unique political structure, social norms and religious environment. For example, Marquis et al. (2013) argue that the goal of releasing a corporate social responsibility (CSR) report could include gaining good reputation from the government, which has a more powerful economic role than many developed countries.

In other regions of the world, agency theory has been the dominant framework for most relevant research in areas related to corporate governance (CG) and EID (Gerged, 2020; Che et al., 2020; Agyemang et al., 2020; Jacoby et al., 2019; Ganapathy and Kabra, 2017). However, stakeholder theory

also has an increasing influence on policymakers and businesses regarding CG and CSR matters (Freeman, 2010). In addition to these two theories, scholars have also adopted various theoretical frameworks such as legitimacy theory, management theory, signaling theory, institutional theory, and resource dependence theory when addressing different CG issues (Solikhah and Maulina, 2021; Ma et al., 2019; Amico et al., 2016; Meng, Zeng and Tam, 2013; Tang and Luo, 2010). Different CG mechanisms, including ownership structure, can play an important role in safeguarding the interests of stakeholders.

Regarding the EID issue, recent research has demonstrated that there are various forms of ownership structure that can have an impact on EID. The most commonly studied ones are managerial and institutional ownership. For example, Dintimala and Amril (2018) examined the impact of managerial and institutional ownership on corporate environmental disclosures in Indonesia. They found that these two factors are negatively correlated with firms' EID. Gerged (2020) investigated whether foreign ownership, managerial ownership, institutional ownership, and ownership concentration affect corporate environmental disclosures in Jordan and found 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 (Khairiddine, H., et al., 2020).

Extending previous work in other geographical areas, this study investigates the relationship between four types of ownership structure (i.e. ownership concentration, institutional ownership, managerial ownership, and state ownership) and EID, and proposes three main contributions. First, we refine the scope of the current literature which often focuses largely on CSR and not on EID (e.g. Sufian and Zahan, 2013; Mohd Ghazali, 2007; Rashid and Lodh, 2008; Oh, Chang, and Martynov, 2011). In doing so, we contribute to strengthen further the understanding on what influence the level of corporate EID in a said country that is still under-researched. Second, we extend the scope of what has been done in previous studies. When examining the ownership structure, few studies have yet to test for four types of ownership structure (Giannarakis, Andronikidis, and Sariannidis, 2019; Kang, Cheng, and Gray, 2007; Rao, Tilt, and Lester, 2012), and most scholars focus on some of them (Dintimala and Amril, 2018; Acar, Tunca Çaliyurt, and Zengin-Karaibrahimoglu, 2021; Akrouit and Othman, 2016). For instance, Dintimala and Amril (2018) investigated institutional ownership and managerial ownership; Acar, Tunca Çaliyurt, and Zengin-Karaibrahimoglu (2021) studied state ownership and institutional ownership; Akrouit and Othman (2016) examined family ownership and state/government ownership. This study considers not only the two most popular types of ownership structure (i.e. managerial ownership and institutional ownership), but also state ownership and ownership concentration, as these two factors are also essential in ownership structure. Huang (2020) reports that ownership concentration is important in the CG mechanisms, but its impact on firm performance is ambiguous. We show that ownership concentration is more powerful than any other type of ownership structure (i.e. institutional ownership, managerial ownership and state ownership) in influencing positively level EID echoing the work of Ma, Naughton and Tian (2010) on general firm performance. Third, by studying Chinese firms which are characterized by a large amount of state-owned enterprises (SOEs) can help to understand further their different prioritization process in determining the extent of EID compared to non-SOEs. However, previous studies so far set in the Chinese context (Li et al., 2017; Li et al, 2022) focused on the combination group of SOEs and non-SOEs, instead of studying

these two types of firms separately as we do in this study. Our study by comparing the effect of firm size (large firms vs small firms) and state ownership (SOEs vs non-SOEs), found that the relationship between EID and ownership structure for each group is different between the subgroups, which is a finding that previous studies would leave unidentified.

The remainder of this study is structured as follows. The next section presents related theories, literature review, and the development of hypotheses. The methodology is provided in the third section. The fourth section presents the findings and discussion. The final section concludes the study.

2. Theoretical Framework and Hypotheses Development

2.1 Theoretical Framework

CG models vary by country, firm, and industry (Oliveira et al., 2006). As an emerging economy, China has a unique governance model that combines the board models of the United States and Germany, with its own uniqueness (Ding et al., 2010). This is one of the reasons why China is being further investigated as a salient case. For most relevant research in this field, agency theory is used as the main theoretical framework. In addition to agency theory (Jensen and Meckling, 1976), scholars have also theorized their empirical findings by using the stakeholder theory (Freeman, 2015), the legitimacy theory (Deegan, Rankin and Tobin, 2002), the institutional theory (Meyer and Rowan, 1977), the signaling theory (Spence, 1973) and the resource dependence theory (Pfeffer and Salancik, 1978) when studying the CG. Our study theorized the links between firms' EID and four types of ownership structure in China from using the agency theory, the legitimacy theory, and the stakeholder theory.

On one hand, the agency theory (Jensen and Meckling 1976, Donaldson and Davis, 1991; Ferraro, 2018) provides a rationale for establishing CG mechanisms to resolve conflicts of interest between management and owners. Following the agency theory, it can be hypothesized that EID can reduce information asymmetry between internal managers and external shareholders (Healy and Palepu, 2001; Jensen, 1988; Liao et al., 2015), and that suitable CG mechanisms can improve the quality of EID (Che et al., 2020). On the other hand, through the legitimacy theory lens (Naser et al., 2006), corporations attempt to justify their presence in society by legitimizing their activities. Wiseman (1982) emphasizes that legitimacy cannot be considered solely in terms of economic performance. The public is increasingly aware of the adverse effects of corporate operations. Pressure groups in society demand organizations to solve social problems. Thus, under this theory, a firm attempts to maintain its existence and continuity by voluntarily disclosing detailed information (e.g. environmental information) to society in order to demonstrate that it is a good citizen. Eventually, the stakeholder theory (Freeman, 2015) posits that firms should focus not only on creating value for shareholders, but also on the welfare of all stakeholders and their full interaction with the environment (Crisóstomo and Freire, 2015). Under the framework of stakeholder theory, firms that incorporate these issues into their strategies tend to be stakeholder-oriented firms, managing for the benefit of their stakeholders and building trust relationships with them based on mutual loyalty and justice. Stakeholder theory proposes that business and ethics must merge without conflict, and that such a fusion can increase competitive advantages and create value. In this context, firms that manage effectively for their stakeholders are sensitive to social values and expect to respect society and the environment. They tend to engage in EID activities that may target interactions with the environment and different stakeholders such as employees and several external stakeholders.

2.2 Hypotheses Development

Ownership structure is one of the fundamental elements of CG mechanisms that differentiates the behaviors of firms (Acar, Tunca Çaliyurt and Zengin-Karaibrahimoglu, 2021). Many previous empirical studies have highlighted the impact of ownership structures on firms' EID and presented mixed findings both in developed and developing/emerging contexts (Ismail, Abdul Rahman and Hezabr, 2018; Brammer and Pavelin, 2008; Chang, 2013; Cormier, Magnan and Van Velthoven, 2005; He and Loftus, 2014).

2.2.1 Ownership concentration and EID-related issues

Developed countries are experiencing a broad distribution of corporate shares among a large number of shareholders, while a high degree of ownership concentration is prevalent in emerging countries (Ismail, Abdul Rahman and Hezabr, 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 enterprises' environmental responsibility. The goal of EID is to maximize the value of stakeholders, who are committed to achieving sustainable development of the enterprise. Stakeholder theory suggests that large shareholders can play an important role in monitoring and reducing the opportunistic behavior of managers, because they have interests in maximizing wealth and have substantial power to secure those interests (Gerged, 2020). Therefore, firms with higher ownership concentration usually tend to meet the relevant EID requirements. For instance, Chang and Zhang (2015), Li et al. (2017) and Chang (2013) find that firms with centralized ownership disclose more environmental information in the Chinese context. Similarly, Sufian and Zahan (2013) and Crisóstomo and Freire (2015) stated that there is a positive association between ownership concentration and CSR disclosure in Bangladesh and Brazil, respectively. However, Brammer and Pavelin (2008) found a significant negative correlation between CSR disclosure and ownership concentration in the UK. This is consistent with the association between dispersed ownership and disclosure activism, suggesting that dispersed ownership promotes the amount of disclosure, so there is a negative correlation between ownership concentration and CSR disclosure. Cormier and Magnan (1999) revealed similar results in the Canadian context, but they focused 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. Besides, Muttakin and Subramaniam (2015) show that there is no significant relationship between ownership concentration and CSR disclosure with Indian firms. Suleiman, Ragab and Eldin (2014) and Ismail, Abdul Rahman and Hezabr (2018) found no significant relationship between ownership concentration and the quality of firms' EID from the international level. According to stakeholder theory and the results of most previous studies in the Chinese context, this study proposes the following hypothesis:

H1: Ownership concentration is positively correlated with the firms' EID level.

2.2.2 Institutional ownership and EID-related issues

Institutional ownership relates to stock market investments by institutional investors, such as banks, corporations, pension funds, insurance firms, mutual funds (Velte, 2020; Chang and Zhang,

2015). Traditional agency theory assumes that institutional investors are only interested in short-term financial performance, and they will discourage intensive ESG spending to enhance shareholder value (Velte, 2020). As a result, they pay less attention on long-term firm performance or goals, including environmental disclosure activities. Moreover, Meng, Zeng and Tam (2013) mentioned that based on legitimacy theory, EID is a response to the great pressure of institutional and public stakeholders. For enterprises with poor performance, more EIDs can be used to explain their performance and as a means of showing their environmental legitimacy. Some scholars, such as Acar, Tunca Çalıyurt and Zengin-Karaibrahimoglu (2021), stated that there is a negative correlation between institutional ownership and EID using a sample of 72 countries/economic zones. Dintimala and Amril (2018) also found the same result in the Indonesian context from 2010 to 2014. However, Habbash (2015) contend 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, Abdul Rahman and Hezabr, 2018). Barako, Hancock and Izan (2006) found that institutional ownership was positively associated with voluntary disclosure including EID. Besides, Sartawi et al. (2014) found insignificant relationship between institutional and voluntary disclosure in Jordan; Ismail, Abdul Rahman and Hezabr (2018) argued that there is no significant relationship between institutional ownership and the quality of firms' EID. Therefore, this study proposes the following hypothesis:

H2: Institutional ownership is negatively correlated with the firms' EID level.

2.2.3 Managerial ownership and EID-related issues

Managerial ownership refers to the extent to which managers and executive directors who hold common stocks of the firms (Eng and Mak, 2003). Eng and Mak (2003) also argue that agency problems are greater when managerial ownership is low. That is, managers have greater incentives to spend perks and less incentives to maximize job performance (Eng and Mak, 2003; Dintimala and Amril, 2018). Therefore, outside shareholders will strengthen the monitoring of managers' behavior to reduce agency problems. Oversight by outside shareholders adds to the firm's costs. However, scrutiny from outside shareholders may be reduced if managers are able to provide voluntary disclosures. Therefore, voluntary disclosure is a substitute for surveillance and there is a negative relationship between managerial ownership and voluntary disclosures. Mohd Ghazali (2007) pointed that lower managerial ownership is associated with more CSR disclosures based on data from Malaysian firms. Results show that firms disclose more environmental information when managerial ownership is lower (Dintimala and Amril, 2018). While, Donnelly and Mulcahy (2008) argue that managerial ownership has no effect on voluntary disclosure. Amosh and Mansor (2020) also revealed similar results that managerial ownership has no impact on firms' EID in Jordan. Chang and Zhang (2015) contend that, based on China's heavily polluting industries, the impact of managerial ownership on EID is not significant. However, Uwuigbe (2011) suggests that managerial ownership structure has a significant positive impact on the level of CSR disclosure in Nigerian context. This result means that the higher the degree of managerial ownership, the more willing firms are to be environmentally friendly, as managerial owners are linked to the long-term survival of firms. Therefore, supported by agency theory and most of the prior findings, this study proposes the following hypothesis:

H3: Managerial ownership is negatively correlated with the firms' EID level.

2.2.4 State ownership and EID-related issues

The government is often found as one of the influential stakeholders that can influence corporate strategy and performance, including disclosure practices (Acar, Tunca Çalıyurt, and Zengin-Karaibrahimoglu, 2021). The goals of the state as an owner are often different from those of private shareholders. For example, it may place more emphasis on maximizing social welfare than maximizing shareholder wealth. Therefore, the goals of SOEs include not only profits, but also social goals, such as increasing employment. Moreover, compared with private enterprises, SOEs are more likely to obtain political and financial support from the government, and government leaders are also motivated to help SOEs. In addition, when large SOEs are in financial distress, the government is more likely to bail them out. If we follow some research (Acar, Tunca Çalıyurt, and Zengin-Karaibrahimoglu, 2021) inspired by the legitimacy theory, SOEs need to legitimize their status in exchange for government support, so they may disclose their CSR activities regardless of profitability. Calza et al. (2016) revealed that for enterprises in which the government holds a majority stake, management is willing to disclose more information to reflect its social and environmental responsibilities and exhibits superior environmental positivity. In line with this argument, Zeng et al. (2010) found that state-owned enterprises (SOEs) in China have received much attention and support from the government due to the current national system, and they are willing to raise the EID level to reflect their social responsibility. The results of many previous studies show a positive relationship between voluntary disclosure levels and state ownership (Eng and Mak, 2003; Naser et al., 2006; Wang, O and Claiborne, 2008; Haddad et al., 2015; Khelif et al., 2017). Akrouf and Othman (2016) noted that the existence of state ownership might improve corporate environmental reporting practices in the Middle Eastern and North African (MENA) contexts. Muttakin and Subramaniam (2015) and Mohd Ghazali (2007) pointed out that the extent of CSR disclosure is positively correlated with state ownership in India and Malaysia, respectively. In addition, Amran and Devi (2008) argue that owning the shares by a government agency gives it the power to intervene and provide pressure on the firms to disclose additional information to meet public expectations.

However, there are some studies arguing that SOEs face less pressure on voluntary disclosure and thus there is a negative relationship between state ownership and the EID. For example, it has been argued that 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 be triggered to disclose environmental information and establish a good relationship with the capital market and the government (He and Loftus, 2014). Moreover, a study by Argento, Grossi, Persson and Vingren (2019) suggests that state ownership significantly affects SOEs' sustainability disclosures. Fully SOEs disclose less sustainability information than partially ones in Sweden. Besides, some empirical studies suggest that the association between state ownership and EID is not significant. For instance, Xiao and Yuan (2007) found no significant association between state ownership and corporate voluntary disclosure in China focusing on 559 firms in 2002. Therefore, given the mixed findings in previous literature, this study proposes the following hypothesis:

H4: State ownership is correlated with the firms' EID level.

3. Research Methodology

3.1 Data and Sample

This study employs the data from Bloomberg and China Stock Market & Accounting Research (CSMAR) for the period of 2009 to 2019. Data including EDS, board size (BS), CEO duality (DUAL), board independence (BIND), audit type (BIG4), profitability (ROA), market-to-book ratio (MKTB), leverage (LEV), total assets (TA) and industry (IND) are from Bloomberg. Data for board meetings (BM), ownership concentration (OWCONCEN), institutional ownership (INSTITOW), managerial ownership (MANGOW) and state ownership (STATEOW) were obtained from CSMAR. We choose 2009 as the starting point due to the fact that 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 have begun to be implemented. This study selects Shanghai Shenzhen 300 Index (SHSZ300) A shares with large market capitalization and good liquidity as the research sample. The CSI 300 has two sub-indices: the CSI 100 index and the CSI 200 index, and its current total assets under management is 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 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 lacking the data needed for the analysis were excluded to avoid extreme outliers. The total number of observations and total number of firms are 2025 and 300, respectively.

3.2 Variable definitions and measurement

In order to explore the impact of the four ownership structures on the EID of Chinese firms, EDS was selected as the dependent variable 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 the percentage of shares held by the state (Ismail, Abdul Rahman and Hezabr, 2018).

For control variables, BIG4, ROA, MKTB, LEV, TA, BS, BM, DUAL, BIND, IND and year were selected for this study considering their potential impact on EID (Gerged, 2020; Wang, O and Claiborne, 2008; Xiao and Yuan, 2007). Regarding BIG4, the dummy variable is set to 1 if the listed firm is audited by the Big Four; otherwise, it is 0 (Gerged, 2020). Odoemelam and Ofoegbu (2018) found that audit type is significantly positively associated with overall environmental reporting in South Africa and Nigeria. ROA is measured using the ratio of net income to total assets (Gerged, 2020). Tang and Luo (2010) argue that highly profitable firms voluntarily disclose more information than low-profitable firms in order to show their differences and avoid unnecessary losses because existing or potential investors may mistake the firm for a "lemon good". The next control variable is MKTB, using the firm's market value divided by its book value (Wang et al., 2019). Andrikopoulos and Krikliani (2013) found that the market-to-book (P/B) ratio is significantly correlated with the breadth of EIDs,

but another study by Andrikopoulos, Samitas and Bekiaris (2014) showed no positive relationship between P/B ratio and CSR disclosures. LEV is defined as the ratio of total debt to total assets (Brammer and Pavelin, 2006, 2008; Karim, Lacina and Rutledge, 2006; Wang et al., 2019). Empirical evidence from McGuire, Sundgren and Schneeweis (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) found a significant negative correlation between these two factors, while Alsaeed (2006) did not find any relationship between financial leverage and EID levels. Wang et al. (2019) suggested that firm size should be considered. Zeng et al. (2010) found that EID levels increase with firm size. Larger firms are more likely to be subject to public scrutiny. In addition, they are 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, Kent and Clarkson (2006) and Khanchel (2007), suggest that boards should be small because it is difficult to organize large boards. In contrast, some other scholars (Cucari, Esposito De Falco and Orlando, 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 is that increasing the number of board members provides a variety of knowledge and expertise that can reduce agency problems and help improve board members' capabilities, thereby enhancing EID problems (Mohammad Rabi, 2019).

BM refers to the total number of board meetings held each year (Agyemang et al., 2020). Vafeas (1999) revealed 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, consistent with agency theory. Researchers generally agree that the quality of disclosed environmental information tends to improve as the number of board meetings increases (Peter and Romi, 2014; Agyemang et al., 2020). However, Giannarakis, Konteos and Sariannidis (2014) studied the impact of board meetings on CSR disclosure and found that it is not significant.

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 potential reason could be that more powerful CEOs have raised EID levels, making them considered successful and increasing their tenure or 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, Li and Weintrop (2006), Cheng and Courtenay (2006), and Ahmed, Hossain and Adams (2006) all concluded 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) found no significant relationship between board independence and sustainability disclosure, but 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 as 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). Heavy polluting firms face stricter government regulation and are required to disclose environmental information (Meng, Zeng and Tam, 2013). Yekini and Jallow (2012) observe that well-known industries tend to develop high levels of EID to meet public expectations. However, Alsaeed (2006) found no significant relationship between industry type and EID level. Gamerschlag, Möller and Verbeeten (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, Adelopob and Andrikopoulos (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, Tunca Çalıyurt and Zengin-Karaibrahimoglu, 2021; Akrouit and Othman, 2016; Amosh and Mansor, 2020; Chang and Zhang, 2015; Ismail, Abdul Rahman and Hezabr, 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 to 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 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 the percentage of shares held by the state. Control variables (Controls) include audit type (BIG4), profitability (ROA), market-to-book ratio (MKTB), leverage (LEV), firm size (TA), 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.

To select the most suitable model among pooled/linear, fixed effect (FE) and random effect (RE) to examine the relationship between EID and the four ownership structures, this study conducted Breusch and Pagan Lagrangian multiplier (LM) test and Hausman test. Regarding independent variables, 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 (1978) 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 as the most suitable one for this study.

4. Findings and Discussions

4.1 Descriptive analysis

Table 2 presents a descriptive analysis of all variables 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. As a result, the overall level of EID is below average, which means that most firms do not disclose enough environmental information to their stakeholders. A recent paper by Wang et al. (2021) pointed out that the environmental responsibility score of Chinese SOEs is lower than that of private enterprises. In addition, Ane (2012) applied a numerical rating system to describe EID scores, focusing on heavily polluting firms in China, and found that EID levels are low; the overall quality of EID is poor; and firms have weak environmental awareness. However, the number of disclosing firms is increasing. Tang and Luo (2010) found similar results when they studied 169 Chinese firms in 21 different industries in 2008. Their study uses a direct aggregation approach to measure EID levels. In addition, we find that the level of EID in heavily polluting industries is higher than that in non-polluting industries. Furthermore, Meng, Zeng and Tam (2013) used a disclosure score to measure EID and concluded that both the quantity and quality of corporate EID are relatively low due to the infrequent stakeholder involvement in EID activities. One reason behind this may be the lack of education on sustainable development, resulting in a weak social group's environmental impact and low enthusiasm for managing corporate environmental issues (Ma et al., 2019).

Moreover, this study examines the EDS for each industry to find out whether industry category is a significant factor in low levels of environmental disclosure (see Table 3). The study found 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 approximately 1 to 50), except for technology sector and consumer staples sector (from around 2 to 40). However, among these industries, the differences of their EDS are moderate. In particular, firms in energy industry disclose the most information (21.354 on average), followed by firms in telecommunications industry (about 18). The rest of the industries range from approximately 11 to 14. Figure 1 shows the average, minimum and maximum values for EDS by industry category and Figure 2 presents the numbers of firms in each industry category and their corresponding percentages. It can be seen that basic materials has the widest variation, with both maximum and minimum values in this industry, but energy sector has the narrowest variation. However, if the average EDS is considered, energy sector has the highest average value, suggesting that energy firms disclose relatively more information than firms in other sectors. Real estate and technology disclose relatively less environmental information. Then Figure 3 depicts the trends in EDS from 2009 to 2019. Despite some decreases over these years, the overall trend in EID is increasing. Therefore, it can be concluded that specific industries (such as energy) disclose relatively more environmental information; and China has improved its EID over the past 11 years.

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 ownership concentration in China, as more than half of common shares are centrally held. The minimum and maximum¹ figures are 20.79 and 101.16, respectively. The results for OWCONCEN are more significant than those in some of previous studies because scholars, such as Li et al. (2017), measured this variable by using only the largest shareholder instead of top ten shareholders. However, in the sample of this study, 56% of the firms are large firms and they may have

¹ 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.

a wide variety of shareholders, so if using only the largest shareholder may cause bias in the results. The average value of INSTITOW is 68.334, indicating that institutional owners hold the majority of shares in most firms. Although the descriptive statistics for OWCONCEN and INSTITOW are similar, they are two different concepts. Around 42% of the total 2025 observations is when OWCONCEN is greater than INSTITOW, which means that many firms have either institutional owners or other types of shareholders within their largest 10 shareholders. These shareholders can be private, public and equity ownership. For example, one of the 300 firms is China Shipbuilding Industry Corporation (CSIC). According to CSMAR, it has mutual fund ownership which is related to national defence and military. Another example is China Molybdenum Company Limited (CMOC). Based on the information from CSMAR, private equity and government fund also play a crucial role in the top 10 shareholders. Therefore, OWCONCEN and INSTITOW need to be examined separately. Moreover, the maximum and minimum for MANGOW are 77.988 and 0, respectively, and its average is 3.51. It means that managerial owners are not dominant for most of the firms and some firms do not have managerial owners. The mean value is consistent with the result displayed by Dintimala and Amril (2018) that around 3%-4% of the total issued shares are held by managerial owners. One can also observe that STATEOW holds an average of 8.362, which is not as high as expected, as the median is 0. This means that more than half of the firms in the sample are not SOEs, so the mean is not relatively high even if it has a maximum of 92.191. Most of the previous studies used a dummy variable for STATEOW, such as the studies by Zeng et al. (2012) and Meng et al. (2014).

4.2 Correlation analysis

Table 4 and Table 5 provide the results of the correlation matrix and variance inflation factor (VIF) for all variables. Among the independent variables, only MANGOW is weakly negatively 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 of these independent variables are below 0.8. Furthermore, Table 5 again confirms that there is no multicollinearity problem, since the values of VIF are below 10 (Wang et al., 2019).

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 significant and positively correlated with EDS at the 1% significance level, which indicates that firms are likely to disclose environmental information when the degree of ownership concentration is high. This finding is consistent with **H1** and supported by stakeholder theory which suggests that EID can build a good reputation among stakeholders, which not only increases firm value, but also is a competitive advantage in the market. Therefore, firms with higher ownership concentration usually tend to meet the relevant EID requirements. Chang and Zhang (2015), Li et al. (2017) and Chang (2013) pointed out that firms with higher ownership concentration disclose more environmental information in China. Similarly, Sufian and Zahan (2013) and Crisóstomo and Freire (2015) found a positive relationship between ownership concentration and CSR disclosure in Bangladesh and Brazil, respectively.

Second, INSTITOW is negatively correlated with EDS at the 1% significance level, suggesting that firms with greater institutional ownership disclose less environmental information. The result is

consistent with **H2**. Traditional agency theory posits that institutional investors prioritize short-term financial gains and discourage extensive spending on ESG initiatives to maximize shareholder value (Velte, 2020). Consequently, they tend to overlook long-term firm performance and goals, such as engaging in environmental disclosure activities. Additionally, according to Meng, Zeng, and Tam (2013), legitimacy theory suggests that organizations resort to EID as a response to mounting pressure from institutional and public stakeholders. In the case of underperforming enterprises, increased use of EID serves as a way to explain their poor performance and demonstrate their commitment to environmental legitimacy. This finding is supported by both agency theory and legitimacy theory. Acar, Tunca Çaliyurt, and Zengin-Karaibrahimoglu (2021) conducted a study across 72 countries/economic zones and discovered a negative association between institutional ownership and EID. Similarly, Dintimala and Amril (2018) observed a similar pattern in the Indonesian context during the period from 2010 to 2014.

Third, there is a significant and negative relationship between EDS and MANGOW. Thus **H3** is supported and the finding is in line with agency theory. According to Eng and Mak (2003), when managerial ownership is low, there is a higher likelihood of agency problems. In other words, managers have greater incentives to use firm resources for personal benefits instead of maximizing job performance (Eng and Mak, 2003; Dintimala and Amril, 2018). Consequently, external shareholders play a crucial role in monitoring managerial behavior to minimize agency problems. However, this monitoring process comes at an additional cost to the firm. Nonetheless, if managers are able to provide voluntary disclosures, the scrutiny from outside shareholders may be reduced. Hence, voluntary disclosure serves as a substitute for surveillance, and there exists a negative correlation between managerial ownership and voluntary disclosures. The study by Eng and Mak (2003) discovered that voluntary disclosure increases as managerial ownership decreases in Singapore. Similarly, Mohd Ghazali (2007) observed that lower managerial ownership is associated with more CSR disclosures based on data from Malaysian firms. Furthermore, research conducted by Dintimala and Amril (2018) revealed that firms tend to disclose more environmental information when managerial ownership is lower.

Finally, STATEOW has a significant and negative impact on EDS. Thus, **H4** is accepted. This finding indicates that firms with a high level of state ownership 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 level of state ownership are more likely to be triggered to disclose environmental information, and establish a good relationship with the capital market and the government (He and Loftus, 2014). A study by Argento, Grossi, Persson and Vingren (2019) suggests that state ownership significantly affects SOEs' sustainability disclosures. Fully SOEs disclose less sustainability information than partially ones in the Swedish context, so there is a negative relationship between state ownership and sustainability disclosures.

4.4 Robustness tests and additional analyses

Estimations in the static panel data model are conducted using either fixed effect or random effects model (Saini and Singhania, 2019). However, the conditions for applying static panel models are not always acknowledged. Model (1) prescribes a static model that is consistent only if the current values of explanatory variables are not influenced by past realizations of the dependent variable. If lagged values of ownership structure variables impact current EDS, the static effect estimators become biased. To achieve consistent and unbiased estimates, it is necessary to consider the past realizations of

ownership structure variables alongside the dependent variable. According to Fulgence et al. (2022), while the fixed effect method may help regulate the impact of unobservable firm-specific factors, it may not completely eliminate the endogeneity issue. Therefore, this study conducted lagged effect regression and two-stage least squares (2SLS) regression in Table 8. They are used to address potential endogeneity issues in model (1). Both regressions show similar results as displayed in the FE regression in Table 6, which means that there is no endogeneity in model (1) and the findings are robust in this study.

In order to increase the robustness of the findings, this study employed three additional analyses. First, this study divides 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 utilities². Figure 4 illustrates that, on average, high-regulated industries tend to disclose more environmental information compared to low-regulated industries. This disparity can be attributed to the stringent regulations imposed on high-regulated industries. Since the low-regulated industries constitute a significant proportion of all industry types, the study includes both high-regulated and low-regulated industries in order to investigate these two subsets. The FE regression results presented in Table 9 for high-regulated industries are similar to those in Table 6, which represents the findings for the entire sample. However, the results for low-regulated industries in Table 9 are less statistically significant, with only INSTITOW and MANGOW showing a negative and significant relationship with EDS. These findings align with previous studies indicating that high-regulated industries tend to disclose more environmental information compared to low-regulated industries due to stricter regulations from the government and increasing pressure from the public (Zeng et al., 2010; Meng, Zeng and Tam, 2013).

Second, it divides the firms into small firms and large firms according to their market capitalization. Table 9 presents the FE regression results of these two groups. The findings for large firms are consistent with those in the baseline model. In terms of small firms, the results are not significant but within expectations. Two reasons behind this difference between small and large firms are as follows: large firms account for more market capitalization than small firms and around 67.3% of the 300 firms are large firms; comparing to small firms, large firms are more likely to be subject to public scrutiny and willing to disclose environmental information to reduce agency costs (Cormier and Gordon, 2001). Therefore, significant results are found with large firms rather than small firms.

Third, this study conducted FE regression for both SOEs and non-SOEs (Table 9). These two groups are divided based on whether the state holds more than 50% of the total shares of the firm. If STATEOW is more than 50, the firm is classified as a SOE, otherwise it is a non-SOE. With regards to non-SOEs, the results are similar to those in the baseline model shown in Table 6. In terms of SOEs, none of the four types of ownership structure has significant impact on the EDS, which is contrary to the baseline model results in Table 6. This is reasonable for two following reasons: SOEs account for around 22.7% of the 300 firms in the data set and the total observations for SOEs occupies only approximately 6.9% of the total 2025 observations; SOEs are less reliant on capital markets when

² 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 Companies Assessing to or Refinancing on the Stock Market*, which identifies certain industries, such as metals, mining, construction, electricity, petroleum and chemicals, 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.

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 be triggered to disclose environmental information and establish a good relationship with the capital market and the government (He and Loftus, 2014). Therefore, there is a difference between SOEs and non-SOEs.

5. Conclusion

In recent years, under the situation of increasingly serious environmental degradation, EID is considered as a practical method to deal with the environmental pollution of enterprises. China has now become the world's second largest economy (Jiang and Kim, 2015), and as the largest carbon emitter, its impact on environmental issues cannot be ignored. However, previous literature on EID in the Chinese context is still limited, and most previous studies have focused on CSR or only several popular types of ownership structure.

Using a sample of 300 listed firms in SHSZ300 from 2009 to 2019, this study examined the relationship between firms' EID and ownership structure (i.e. ownership concentration, institutional ownership, managerial ownership and state ownership) in China. Taking EDS as the dependent variable, the FE regression is used for the baseline empirical analysis. The findings are as follows. First, although EID has been on the rise for many years, the EID level of Chinese enterprises still needs to be improved because EDS is relatively low compared to developed countries. For example, Giannarakis, Andronikidis, and Sariannidis (2019) studied firms in the United States and found 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. Second, some industries (such as energy) disclose more environmental information than others, which is consistent with previous studies (Zeng et al., 2010; Agyemang et al., 2020; Tang and Luo, 2010). Industry category is not a significant factor contributing to the low level of overall environmental disclosure, as the levels vary little across all industries. Third, when firms have higher ownership concentration (Chang and Zhang, 2015; Li et al., 2017; Chang, 2013), lower institutional ownership (Acar, Tunca Çaliyurt and Zengin-Karaibrahimoglu, 2021; Dintimala and Amril, 2018), lower managerial ownership (Eng and Mak, 2003; Dintimala and Amril, 2018) and lower state ownership (Argento, Grossi, Persson and Vingren, 2019), they tend to disclose more environmental information. It is worth noting that while the descriptive statistics for OWCONCEN and INSTITOW may be similar, they represent distinct concepts. Approximately 42% of the total 2025 observations indicate instances where OWCONCEN surpasses INSTITOW. This suggests that a significant number of firms have their largest 10 shareholders composed of institutional owners, as well as other types of shareholders such as private, public, and equity owners. Therefore, OWCONCEN and INSTITOW have contrary relationship with EDS. Finally, high-regulated industries tend to disclose more environmental information compared to low-regulated industries due to stricter regulations from the government and increasing pressure from the public (Zeng et al., 2010; Meng, Zeng and Tam, 2013); comparing to small firms, large firms are more likely to be subject to public scrutiny and willing to disclose environmental information to reduce agency costs (Cormier and Gordon, 2001); 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 be triggered to disclose environmental information and establish a good relationship with the capital market and the government (He and Loftus, 2014).

These findings have significant implications for managers, owners, and policymakers in China. Firstly, considering the relatively low overall level of EID, it is crucial to implement regulations or

laws that strengthen the supervision of EID within enterprises. Additionally, it is essential for the public to enhance their awareness of sustainability, particularly among stakeholders whose interests are connected to corporate EID. Secondly, the study reveals that there are no substantial disparities in EID levels across the 11 industries during the sample period. This indicates the need for a comprehensive improvement in addressing the issue of EID, rather than focusing solely on specific industry types. Although existing literature often emphasizes heavily polluting industries, suggesting they have comparatively higher EID levels, this study demonstrates that the differences are marginal. Thirdly, it is advisable for firms to increase ownership concentration while reducing institutional and managerial ownership. Although state ownership is a governance matter that firms may have limited control over, there is a growing recognition in China regarding the need to distribute some of the state-owned shares to the public. By doing so, the efficiency of CG mechanisms and the decision-making process can be enhanced, ultimately leading to improved EID levels within firms.

In addition to the above findings and recommendations, this study has several limitations. First, China has unique socialist national characteristics and a financial system and CG structure different from other countries, so the findings may be limited to the Chinese context. Second, with respect to alternative forms of ownership structures, such as foreign ownership, this study is constrained by data limitations and does not encompass them. Third, future research may gain insights from other theories than agency theory, legitimacy theory, or stakeholder theory, and may investigate CEO-level attributes as moderators when establishing the relationship between CG and EID.

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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 the 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 to the total number of issued shares.
	State ownership	STATEOW	The percentage of shares held by the state.
Control Variables	Audit type (Dummy BIG4 0/1)		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.
	Total assets	TA	The sum of all short and long-term assets as 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 own 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.

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	101.16
INSTITOW	2004	68.334	71.350	18.853	3.77	101.14
MANGOW	2022	3.51	0.003	10.313	0	77.988
STATEOW	2025	8.362	0	18.343	0	92.191
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
BIND	2006	38.34	36.364	6.882	10	80
TA	2017	762000	70849.23	2820000	591.702	3.01e+07
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

Table 4: Pairwise correlations

Variable	EDS	OWCONCEN	INSTITOW	MANGOW	STATEOW	BIG4	ROA	MKTB	LEV	TA	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	-0.106***	0.200***	-0.075***	-0.143***	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					
TA	0.052**	0.263***	-0.264***	-0.088***	-0.047**	-0.004	-0.190***	-0.180***	0.522***	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

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 5: Variance inflation factor (VIF)

Variable	VIF	1/VIF
LEV	2.193	.456
ROA	1.849	.541
MKTB	1.822	.549
BS	1.791	.558
TA	1.679	.596
OWCONCEN	1.363	.734
INSTITOW	1.299	.77
MANGOW	1.223	.818
BIND	1.222	.818
DUAL	1.095	.913
STATEOW	1.095	.914
BM	1.038	.964
BIG4	1.005	.995
Mean_VIF	1.436	.995

Table 6: Pooled, RE and FE model regression results

Variable	Pooled EDS	RE EDS	FE EDS
OWCONCEN	0.104*** (5.833)	0.086*** (3.036)	0.157*** (3.985)
INSTITOW	-0.052*** (-3.482)	-0.060** (-1.973)	-13.078*** (-13.807)
MANGOW	0.064** (2.180)	0.015 (0.306)	-0.178* (-1.655)
STATEOW	-0.098*** (-6.443)	-0.084*** (-6.168)	-0.037*** (-2.628)
BIG4	5.604 (0.983)	6.166 (1.472)	5.228 (1.328)
ROA	-0.033 (-0.575)	-0.135** (-2.215)	-0.084 (-1.299)
MKTB	-0.835*** (-6.116)	-0.611*** (-4.417)	-0.514*** (-3.473)
LEV	-0.263*** (-3.204)	-0.180 (-1.423)	0.126 (0.531)
TA	-0.000* (-1.739)	0.000*** (3.358)	0.000 (0.218)
BS	0.390*** (3.427)	-0.310** (-2.174)	-0.007 (-0.040)
BM	0.223*** (4.969)	0.254*** (4.557)	0.272*** (4.541)
DUAL	0.576 (0.812)	-0.607 (-0.702)	-1.000 (-1.045)
BIND	0.105*** (2.645)	0.040 (0.924)	0.067 (1.522)
Constant	0.499 (0.078)	10.291* (1.749)	886.278*** (13.767)
<i>F</i> -value	15.267		30.550
<i>R</i> -squared	0.114		0.239
Industry control	Yes	Yes	Yes
Year control	Yes	Yes	Yes
Observations	1552	1552	1552

t statistics in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 7: Summary of FE regression results and corresponding theoretical underpinning

Variable	Relationship with EDS	Theoretical Underpinning
OWCONCEN	Significant at 1%	Stakeholder theory
	Positive (+)	
INSTITOW	Significant at 1%	Agency theory and legitimacy theory
	Negative (-)	
MANGOW	Significant at 10%	Agency theory
	Negative (-)	
STATEOW	Significant at 1%	Not applicable
	Negative (-)	

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

Variable	2SLS EDS	Lagged Effect EDS
OWCONCEN	0.129*** (6.259)	
INSTITOW	-0.051*** (-3.046)	
MANGOW	0.031 (0.901)	
STATEOW	-0.189*** (-7.498)	
L.OWCONCEN		0.102*** (3.510)
L.INSTITOW		-0.070** (-2.214)
L.MANGOW		0.003 (0.056)
L.STATEOW		-0.102*** (-7.423)
Constant	-3.103 (-0.470)	5.725 (0.942)
Control variables	Yes	Yes
Industry control	Yes	Yes
Year control	Yes	Yes
Observations	1351	1354
<i>F</i> -value		
<i>R</i> -squared	0.093	

t statistics in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 9: FE model regression results by firm size and state ownership

	High-regulated Industries	Low-regulated Industries	Small Firms	Large Firms	SOEs	Non-SOEs
Variable	EDS	EDS	EDS	EDS	EDS	EDS
OWCONCEN	0.238*** (4.022)	0.051 (0.949)	0.079 (1.479)	0.175*** (2.626)	-0.003 (-0.016)	0.160*** (3.862)
INSTITOW	-16.240*** (-11.934)	-9.505*** (-7.113)	-15.595*** (-5.690)	-12.441*** (-10.456)	-6.557 (-0.942)	-13.955*** (-13.752)
MANGOW	-0.086 (-0.489)	-0.241* (-1.737)	-0.044 (-0.416)	-0.942*** (-3.260)	17.671 (0.686)	-0.170 (-1.555)
STATEOW	-0.036** (-2.165)	-0.027 (-1.016)	0.043* (1.932)	-0.057*** (-2.883)	-0.139 (-0.986)	-0.054* (-1.914)
Constant	1019.359*** (11.881)	700.069*** (7.196)	1126.389*** (5.695)	809.614*** (10.564)	423.486 (0.976)	952.097*** (13.699)
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	708	844	95	1457
F-value	24.696	10.681	12.189	21.272	1.693	26.750
R-squared	0.327	0.177	0.226	0.301	0.354	0.228

t statistics in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Figure 1: Histogram of Environmental Disclosure Score (EDS) by Industry. The orange, blue and green bars stand for the average, minimum and maximum values of EDS, respectively. Each group of these three coloured bars belongs to one industry. The horizontal axis shows the industry categories and the vertical axis is the EDS.

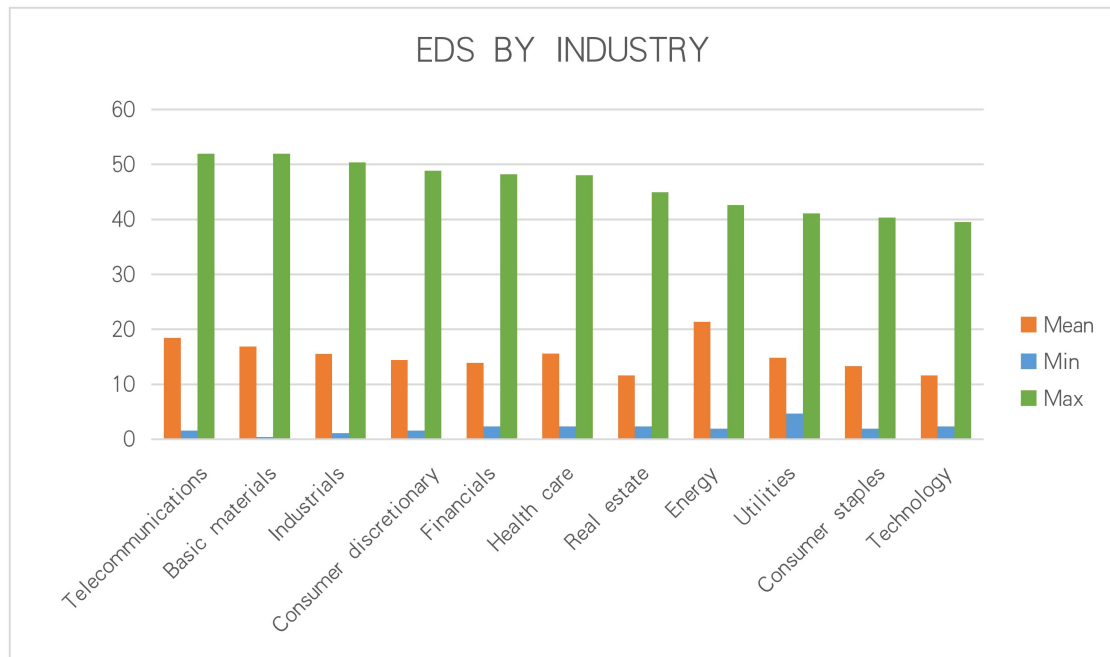


Figure 2: Histogram of Firm Numbers by Industry. The horizontal axis shows the industry categories and the vertical axis is the number of firms in each industry.

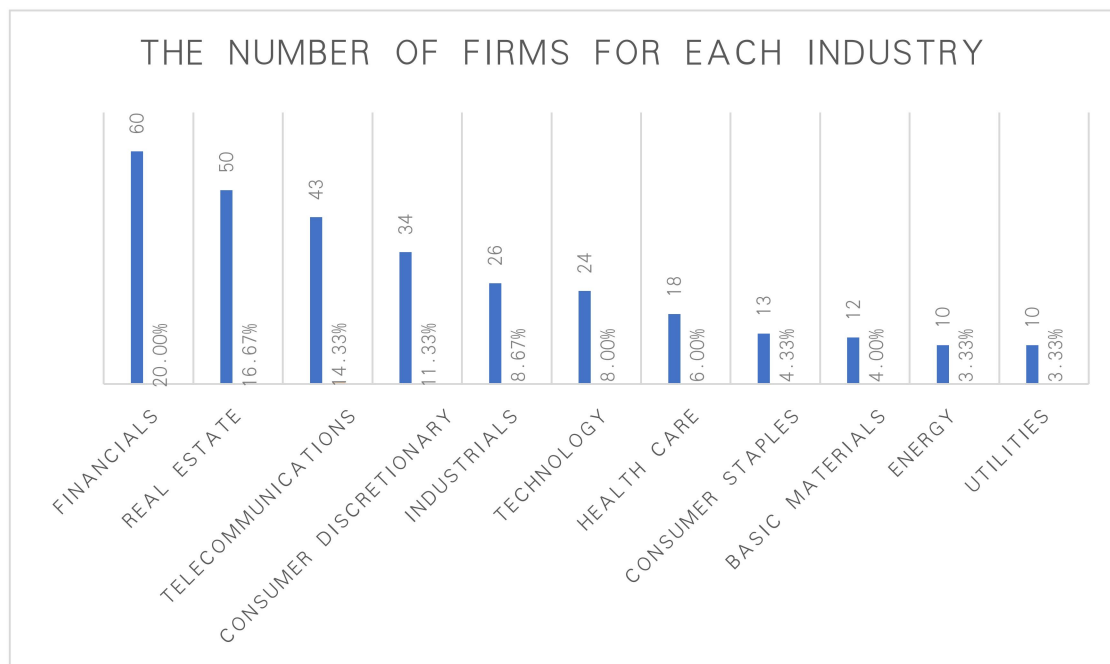


Figure 3: Line Chart of Environmental Disclosure Trend from 2009 to 2019. The full line stands for the actual environmental disclosure score over the 11 years, and the dotted line shows the general trend of the environmental disclosure. The horizontal axis is the year and the vertical axis is the environmental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

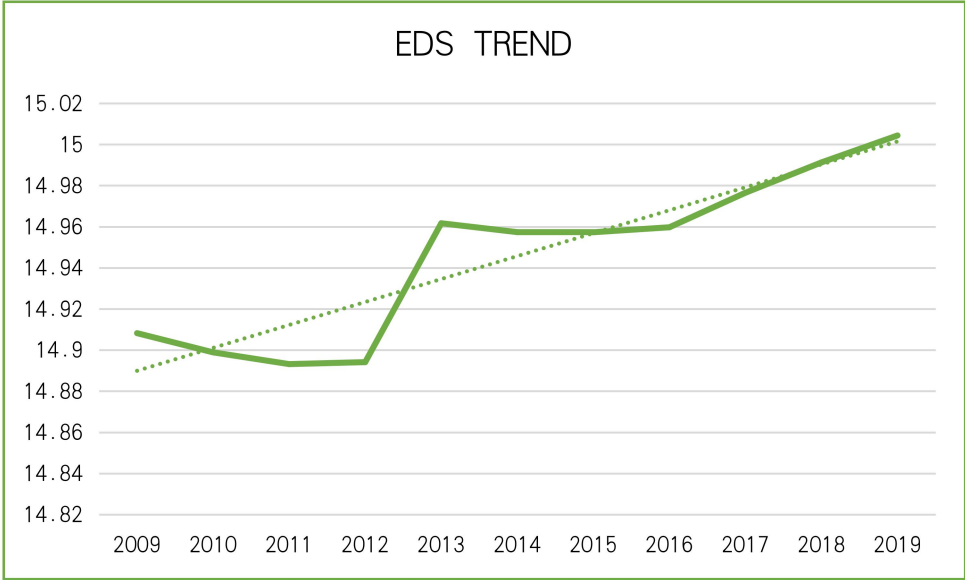


Figure 4: Histogram of Average Environmental Disclosure Score (EDS). The bar on the left is the average EDS of high-regulated industries and the bar on the right stands for the average EDS of low-regulated industries. The vertical axis is the EDS.

