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The relationship between environmental disclosure and financial performance: mediating effect of economic development and information penetration

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ABSTRACT

What's the relationship between environmental disclosure and financial performance? To answer this question, our study focus on the heavy polluting enterprises in China from 2008 to 2019 to investigate the relationship between environmental disclosure and financial performance as well as the mediating effect of provincial level characteristics namely economic development and information penetration using hierarchical linear model (HLM). Findings show that there is positive relationship between both mandatory environmental disclosure and voluntary environmental disclosure and financial performance; economic development positively relates to corporate financial performance, and it also strengthens the relationship between environmental disclosure and financial performance; information penetration positively relates to corporate financial performance, but it weakens the relationship between environmental disclosure and financial performance. As time goes on, corporate financial performance will significantly rise in general.

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Environmental disclosure; financial performance; economic development; information penetration; hierarchical linear modeling

1. Introduction

Environmental issues have been and continue to be a major problem that firms confront. Given the fact that the operations of heavy polluting companies have great impact on the environment, it is necessary to investigate how the environmental performance of heavy polluting enterprises influences their financial performance. Recently, environmental information disclosure (EID) has become increasingly popular since it's an alternative approach to manage corporate environmental performance (Zeng et al., 2012). According to the stakeholder theory (Jones & Wicks, 1999) and asymmetric information theory, a firm's responsibility goes beyond maximizing shareholder returns, it also includes a focus on the environmental responsibility, ethical conduct of business operations and responsibility to other stakeholders (John, 2007),

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such as consumers, employees, suppliers, local communities and governments. Concretely, apart from the environmental benefits, environmental information disclosure also concerns stakeholders' information needs as well as social ethics (Blanco et al., 2009; Patten, 2002). In fact, other things equal, firms practicing stakeholder management will be relatively successful in conventional performance terms such as profitability, stability or growth (Donaldson & Preston, 1995).

Asymmetric information results in two principal-agent problems i.e., adverse selection and moral hazard (Mao et al., 2013). The quality of information disclosure of listed companies directly affects the internal and external information asymmetry (Jiang et al., 2016). Among the information disclosed by listed companies, financial accounting information occupies a central position in corporate information disclosure (Mao et al., 2013). Except for this, firms can also reduce information asymmetry by improving the disclosure quality of non-financial information such as social responsibility information (Dan et al., 2013) and environmental information. The obvious difference between environmental information disclosure and financial information disclosure lies in that financial information is mandatory disclosure items which have more obvious relationship with financial performance, while environmental information is largely voluntary disclosure items which have great uncertainty about the relationship with financial performance (Wen & Zhou, 2017). Compared to mandatory information disclosure, voluntary information disclosure can reflect the transparency of firms more objectively (Ho & Wong, 2001), in which case it's necessary to investigate the link between EID and financial performance. In China, the government issued a guide to environmental information disclosure of listed companies in 2010, which provided the mandatory disclosure items and voluntary ones. However, environmental information disclosure is not a popular practice among Chinese corporations (Zeng et al., 2012), which results in a low environmental information disclosure rate.

As mentioned above, unlike financial information disclosure, the relationship between EID and financial performance is uncertain. More specifically, does good environmental performance associate with a sound financial performance, or conversely? To answer this question, we'd better investigate the mechanism of how EID influences corporate financial performance. Bounded rationality and information asymmetry limits investors' overall and effective monitoring of corporate environmental behaviors (Yao et al., 2016), which puts firms pressures thus encourages firms to disclose environmental information. Therefore, to some large extent, what affects EID are external factors such as public pressure or social reputation (Wang et al., 2013), which may lead to a consequence that entities disclose information that is beneficial to them only but hide the unfavorable information (Dye, 1985). This helps improve corporate reputation, market competitiveness and enhance investors' confidence in investment, as a consequence has a positive economic impact on corporate financial performance (Salama, 2005).

Most previous studies investigated the single relationship between information disclosure and financial performance (Al-Tuwaijri et al., 2004; Gonenc & Scholtens, 2017; Raza & Jawaid, 2014; Su et al., 2016). We argue that the characteristics of the provinces that corporations locate in may have direct impact on financial

performance, or mediating effect on EID and financial performance. Take economic development for example, firms in economically developed provinces have better prospects of development. But the environmental problems caused by economic development are serious. Therefore, it is particularly important to establish a harmonious relationship between economic development and environmental protection (Zhang & Chi, 2001). The marginal utility of environmental quality is higher in more developed area (Wang & Huang, 2015), which results in a more sensitive feedback of environmental information. It is suggested that in more developed provinces, the relationship between environmental disclosure and financial performance may be strengthened.

Except for the economic development of provinces, there is another factor namely information penetration. The signaling theory suggests that the strength of signal may change in different environments (Connelly et al., 2011; Sanders & Boivie, 2004). When firms locate in an environment which lacks sufficient and effective information to distinguish one firm from another, relevant stakeholders need to collect additional information actively to assess firms' capability (Su et al., 2016). It is suggested that in a high information penetration province where there is more available information, investors have variable access to the information they need, which may reduce the impact of environmental disclosure on financial performance. Therefore, the relationship between environmental disclosure and financial performance may be weakened in a high-information-penetration place.

This paper has threefold contributions. First, the knowledge regarding the associations between environmental information disclosure and financial performance remain fragmented across different countries. In particular, some found strong correlation between them in the emerging market group, significantly higher than in the developed markets, the study based on China context examines the relationship between environmental information disclosure and financial performance in order to enrich existing literature. Second, this paper divides the environmental information disclosure into mandatory disclosure and voluntary disclosure, and this conclusion is helpful to test the effectiveness of government legislative policies concerning environmental information disclosure. What's more, in existing literature, economic development and information penetration are widely recognized to impact company's financial performance, however, they are mostly incorporated into the model as control variables, in this paper, we consider economic development and information penetration as moderating variables, then examine their moderating effect.

Combining the panel data with the hierarchical linear model, this paper examines the relationship between EID and corporate financial performance in China. Compared with other models with are mostly static, we add year variable to investigate the dynamic influence of annual flow on financial performance, and also add the provincial characteristic variables to investigate the heterogeneous direct impact on financial performance and the mediating effect on EID and financial performance. The remainder of this paper proceeds as follows. In part two we discuss the relevant studies and put forward our hypotheses; in part three we introduce our data source, variables and models; in part four we report our regression results; in the part five we discuss the conclusions.

2. Literatures and hypotheses

2.1. Environmental information disclosure and financial performance

By examining annual reports of American companies from 1901 to 1980, Hogner (1982) found that there was no formal environmental disclosure appeared in firm's annual reports until 1966. James and Lee (1989) then examined the annual reports of an Australian steel corporation for 100 years before 1885, and found that there was no environmental information appeared until 1950. Patten (1992) studied annual report of 21 oil companies from 1988 to 1989 and found that environmental information disclosure significantly increased, and there are increasing number of firms disclose environmental information over time, especially for those who have been known to have environmental problems (Ness & Mirza, 1991).

What is environmental disclosure? According to the Association of Chartered Certified Accountants (ACCA), environmental disclosure is defined as the combination of information including objectives, explanations and numerical information, all of which reflect companies' environmental burdens and environmental efforts (Ong et al., 2016). There are two basic forms of environmental disclosure i.e., mandatory environmental disclosure and voluntary environmental disclosure. Iatridis and Alexakis (2012) investigated the financial differences between voluntary and non-voluntary disclosers and found that voluntary disclosure exhibited higher profitability and growth for the reason that firms were more eager to voluntarily disclose positive information. Bushman and Smith (2007) found that voluntary disclosure was related to contractual arrangements such as agency costs, regulatory compliance or debt covenants.

According to Walls et al. (2012), both political decision makers and industrial managers are more concern about the relationship between environmental disclosure and corporate performance, which is controversial in prior literatures. Jaggi et al. (1992) found a significant relationship between environmental performance and ROA in their study of 243 U.S. corporations. Konar and Cohen (2001) found that bad environmental performance negatively correlated with the intangible asset value of firms by investigating the largest publicly traded firms in the U.S., the Standard and Poor's 500. Hessels et al. (2011) used a dataset of 337 Dutch and Chinese firms to investigate the relationship between environmental sustainability and the financial performance of SMEs, and the result suggested a significant positive association between environmental sustainability and firm performance. Also, Ong et al. (2014) analyzed the relationship between environmental improvement and the financial performance of firms and found that efforts to embrace environmental improvement and activities may help financial performance of firms.

But numerous studies have found that there are also negative relationship between environmental performance and financial performance. Cordeiro and Sarkis (1997) focused on 13 firms in the U.S. pulp and paper sector in 1978 and found that there was a negative link between environmental performance and financial performance. Wagner (2005) found a U-shaped relationship between environmental and economic performance formulated in the paper for the fixed effects models, and the positive part of the relationship was found to be weak. Apart from all the relationship above, some studies also found that there was no significant relationship between

environmental performance and financial performance. For example, Khaled and David (2005) found that environmental performance had a neutral impact on firm performance by conducting static and dynamic panel data analysis.

Given different variables, backgrounds and investigating methods, the conclusions about the relationship between environmental information disclosure and economic performance are not coherent. In general, based on the signaling theory, we suggest that the relationship between environmental disclosure and financial performance are positive. The environmental disclosure may be a signal that reveals additional information to relevant stakeholders (Su et al., 2016). For example, according to King et al. (2005), firms use public act of certifications such as ISO 14001 which has specified a set of environmental management systems and practices to reduce information asymmetry and send a signal conveying a firm's unobservable characteristics. In that case, more favorable disclosure of environmental information enhances stakeholders' investment confidence, and weakens the psychological expectations of stakeholders regarding the deterioration of corporate financial performance. As a result, firms can not only increase the social reputation, but also increase sales revenue and the corporate value. Thus, we propose that:

H1. Environmental disclosure positively relates to corporate financial performance in environmentally sensitive companies.

2.2. The mediating effect of economic development

There might be a positive relationship between environmental disclosure and financial performance, but how does this positive impact work in different economic development markets? Although environmental information sends a positive signal to stakeholders, the strength of such a signal may vary in different marketing environments (Su et al., 2016). The responsibility of governments over environmental protection is growing (Schmidt, 2002), and external stakeholders such as customers and investors are also increasingly interested in firms' practices to environmental protection (Montiel et al., 2012; Zhang et al., 2020).

According to Kuznets (1955), there is a 'inverted U' curve relationship between economic growth and income gap. In the early stage of economic development, the low development of economy results in less environmental pollution, thus society is willing to sacrifice the environment to increase consumption. With the development of economy, the marginal utility of environmental quality gradually increases (Wang & Huang, 2015). Therefore, in an economic developed market where the environment has been undermined with the development of economy, governments and stakeholders are more sensitive to environmental information that is disclosed by firms. Hence, environmental disclosure may become an impactful tool for firms to increase social reputation, which can be an intangible resource leading to sustained competitive advantage (Deephouse, 2000) as well as solid financial performance.

By contraries, in a less developed market whose economy is in the early stage, the marginal utility of environmental quality is low, which means the external stakeholders and governments focus on the development of economy, and are not so sensitive to environmental information. In general, we suggest that in a more developed

market, the relationship between environmental disclosure and financial performance may be strengthened. In contrast, the relationship between environmental disclosure and financial performance in a less developed market may be diluted. We propose that:

H2. Economic development positively relates to corporate financial performance in environmentally sensitive companies.

H3. The relationship between environmental disclosure and financial performance is strengthened in economic developed markets than in less developed markets.

2.3. The mediating effect of information penetration

An increasing number of firms began to use social media to blog corporate news. According to Zhang (2015), among fortune 500 companies, 79% of them show fresh content on corporate blogs, 69% of them maintain a YouTube channel and 77% have an active Twitter account. Companies use these multiple social tools to communicate with stakeholders in terms of disclosure or surveillance (Barry & Fulmer, 2004). Since these social media are popular among the masses, it is even easier for stakeholders to get access to firms' information. Except for firms' own media communications, the external mass media such as newspaper, broadcast, network or television also play the role of regulators to supervise the operation of companies.

Mass media will facilitate the circulation of the information to stakeholders (Su et al., 2016) if there are some environmental practices. In a market where there is a high information penetration, stakeholders can easily get access to what they want about the firms, no matter good information or bad information. Good news are propitious to evaluate firm value for stakeholders. However, there is also negative information that travels through the markets freely, if stakeholders receive these news, they may recalibrate their impressions of the firms (Zavyalova et al., 2012). Take the product recall announcements for example, they're likely to be as wrongdoing because they violate social explanation about corporations' ability to act according to an implied promise of appropriate behavior (Zavyalova et al., 2012), which may affect firms' reputation. If stakeholders get these information, they will evaluate firms as bad impression.

In a market with low information penetration, due to the lack of social mass media surveillance, it's difficult for stakeholders to get access to abundant information and evaluate firms' value, which shows the importance of firms' voluntary information disclosure. Under the circumstances, the relationship between environmental disclosure and financial performance may be strengthened. In contrast, in an environment where there is a high information penetration, the positive relationship between environmental disclosure and financial performance may be weakened. The framework of this study is illustrated in Figure 1. Thus, we propose that:

H4. Information penetration positively relates to corporate financial performance in environmentally sensitive companies.

H5. The relationship between environmental disclosure and financial performance is weakened in high information penetration markets than in low information penetration markets.

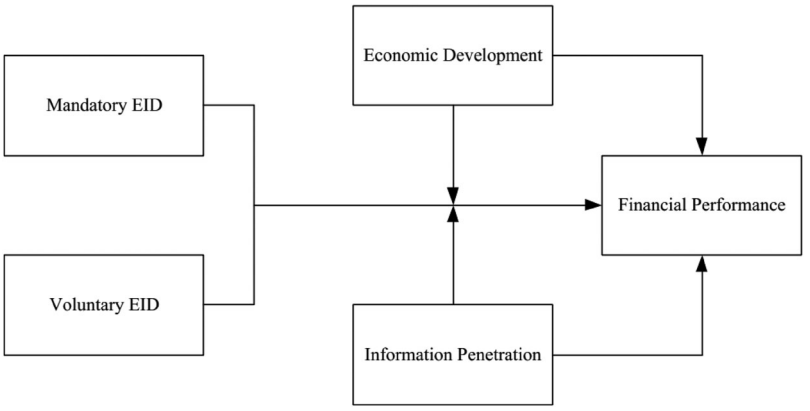

Figure 1. Framework of the study.
Sources: Author's estimation.

2.4. Methods

2.4.1. Sample and data source

Mandatory legal system is one of the important driving forces of enterprise information disclosure. On May 1, 2008, the Regulations of The State Council on The Disclosure of Government Information and the Measures for the Disclosure of Environmental Information (Trial) of the Ministry of Environmental Protection came into effect on the same day, requiring enterprises to disclose environmental information, which symbols the beginning of a new stage of more comprehensive disclosure of environmental information according to law in China. Therefore, we investigate the relationship between environmental information disclosure and financial performance starting the year of 2008. On September 14, 2010, the Ministry of Environmental Protection issued guidelines on Environmental Information Disclosure for Listed Companies, which designated 16 industries as heavily polluting, including thermal power, iron and steel, cement, electrolytic aluminum, coal, metallurgy, chemicals, petrochemicals, building materials, paper making, brewing, pharmaceutical, fermentation, textiles, tanning and mining. Meanwhile, according to existing literatures, such as García et al. (2017), Tiron-Tudor et al. (2019), Emma and Jennifer (2021) and García Meca and Ferrero (2021), sensitive and heavy polluting industries should have more social responsibility to disclose environmental information. Therefore, in this paper, all these industries considered, and our study consists of 531 samples which have a span of 12 years from 2008 to 2019. We collected data from Wind database, a database which has built a complete and accurate Chinese financial engineering data warehouse including stocks, funds, bonds, foreign exchange, insurance, macroeconomics, etc., to meet the needs of investors. Besides, we collected the data of environmental performance manually from the corporate annual reports, social responsibility reports or environmental reports that were disclosed in the Cninfo, the appointed information disclosure website by the China Securities Regulatory Commission or the official websites of firms. Table 1 shows the provincial distribution of the samples. Overall, samples are evenly distributed in different provinces, but we can find that the number and percentage of firms are larger in more developed

Table 1. Province distribution of samples.

Province	Number	Percentage (%)	Province	Number	Percentage (%)
Anhui	23	4.331	Liaoning	17	3.202
Beijing	32	6.026	Inner Mongolia	13	2.448
Fujian	14	2.637	Ningxia	7	1.318
Gansu	8	1.507	Qinghai	6	1.130
Guangdong	42	7.910	Shandong	39	7.345
Guangxi	12	2.260	Shanxi	24	4.520
Kweichow	9	1.695	Shaanxi	6	1.130
Hainan	5	0.942	Shanghai	32	6.026
Hebei	14	2.637	Sichuan	22	4.143
Henan	26	4.896	Tientsin	7	1.318
Heilongjiang	6	1.130	Tibet	3	0.565
Hubei	19	3.578	Xinjiang	9	1.695
Hunan	16	3.013	Yunnan	13	2.448
Jilin	13	2.448	Zhejiang	41	7.721
Jiangsu	32	6.026	Chongqing	9	1.695
Jiangxi	12	2.260	Total	531	100.000

Sources: Wind database of China.

provinces such as Beijing, Guangdong, Jiangsu, Shandong, Shanghai and Zhejiang, it indicates that there is a correlation between regional economic development and the distribution of firms.

2.5. Measurement of financial performance

Financial performance can be defined in different ways, and each way represents a slightly different aspect of corporate financial performance (Hessels et al., 2011). Many scholars have conducted researches related to corporate financial performance in different indicators. For instance, Gonenc and Scholtens (2017) used Tobin's Q, excess stock return, return on equity, business risk and systematic risk to measure financial performance; Konar and Cohen (2001) only used Tobin's Q to measure it. Hessels et al. (2011) used revenues and profits, Al-Tuwaijri et al. (2004) used an industry-adjusted annual return; Ong et al. (2016) used ROA, ROE and EPS as the indicators of corporate financial performance.

In this paper, we learn from Ong et al. (2016), use return on assets (ROA), return on equity (ROE) and earnings per share (EPS) as the proxies of financial performance. These accounting-based indicators (Orlitzky et al., 2003) capture a firm's internal efficiency in some way (Cochran et al., 1984). ROA can be divided into four indicators: sales profit rate, value-added rate, sales efficiency, and production efficiency, which includes information on profitability, value-added ability, sales ability, and production capacity (Wen & Zhou, 2017). ROE can be decomposed into three indicators: sales profit rate, asset turnover ratio and equity multiplier, which includes profitability, operational capability, capital structure (Wen & Zhou, 2017). EPS is the most important financial index to measure the profitability of listed companies, reflecting the profit level of common stocks. Stakeholder also uses EPS to evaluate companies' profitability potential and future stock prospects (Wang, 2004).

To enhance the understanding between compulsory sentimental disclosure and financial performance, we compared the average change of stock price of the 531 sample, with overall related field since 2007. In Figure 2, we can see that there are

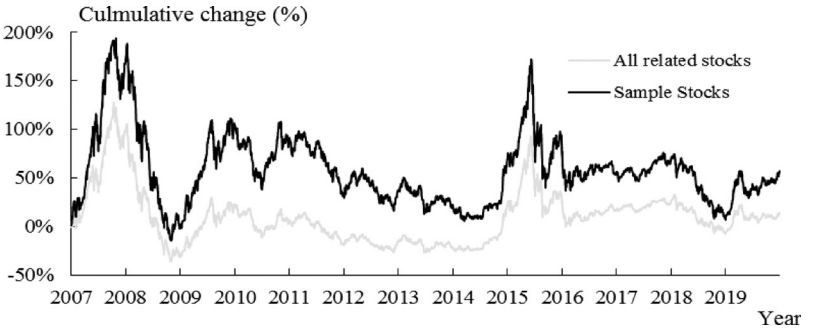

Figure 2. The differences of stocks performance between 531 sample stocks and other stocks of the same categories.
Sources: Wind database of China.

1782 environment related list companies that potentially do harm to the environment, 537 of which are forced to reveal the procedure to protect the environment, the rest do not reveal their action neither in company website nor annual report, The cumulative change is fabricated as follows: I use the sum of close prices (post dividend price) of the two type of company on Jan 3rd, 2007 as the beginning, on which day the sum of stock prices of 537 sample stock is 11,564, and the next day, the sum of stock prices of 537 sample stock is 11,673, since the cumulative change is based on the sum of stock prices on Jan 3rd, 2007, therefore the cumulative change of 537 sample stock on Jan 4th, 2007 is 0.94% and so on so forth. Therefore, it can be seen that firms with compulsory environmental disclosure requirement outperform that of the average performance of overall companies.

2.6. Measurement of environmental disclosure

There are generally two methods to measure environmental disclosure. The first method is to quantify the level of environmental disclosure such as the number of environmental words (Craig & Ben, 1996; Zeghal & Ahmed, 1990), sentences (Ingram & Frazier, 1980) and pages (Gray et al., 1995; James & Lee, 1989; Patten, 1992). The second method is to measure the quality of environmental disclosure based on the content analysis. Concretely, researchers first sort the environmental information in annual reports into several categories, then analyze each of this issues using a 'yes or no' scoring methodology (Al-Tuwaijri et al., 2004). Most researchers (Al-Tuwaijri et al., 2004; Darrell & Schwartz, 1997; Huang & Kung, 2010; Shen & Feng, 2012) use the disclosure-scoring methodology to measure the environmental disclosure. We also adopted this one to measure the level of environmental disclosure of heavy pollution industry in China based on the content analysis method. According to the 'Guide to environmental information disclosure of listed companies' in China, there are generally eight mandatory environmental issues: (1) the occurrence of major environmental problems; (2) environmental impact assessment and implementation of the 'three simultaneous' system; (3) pollutant discharge standard; (4) the disposal of general industrial solid wastes and hazardous wastes; (5) the completion of the total emission reduction tasks; (6) payment of pollution charges; (7) implementation of clean

productions; (8) establishment and operation of environmental risk management systems. Meanwhile, there are seven voluntary environmental issues: (1) the concept of environmental protection for the operators; (2) environmental management organizational structures and environmental protection objectives; (3) environmental management; (4) environmental performance; (5) environmental public welfare project; (6) environmental protection system; (7) environmental investment. Consistent with the previous study (Shen & Feng, 2012; Yang et al., 2011), we scored the environmental issues in three dimensions: (1) saliency, if the environmental information was disclosed in the non-financial part, we assigned the weight 1, if it was disclosed in the financial part, we assigned the weight 2, and both in the financial part and non-financial part we assigned the greatest weight 3; (2) quantifying, if the environmental information was qualitative, we assigned the lowest weight 1, if the environmental information was quantitative, we assigned the weight 2, and if it was the monetary information, we assigned the weight 3; (3) timeliness, if the firm disclosed the current information, it would receive the weight 1, if it disclosed the future information, it would receive the weight 2, and if it was both current information and future information, it would receive the weight 3. To ensure the reliability of the variable, we collected and scored the issues of environmental information twice and the consistency of the two operations were up to 90%.

2.7. Measurement of provincial level variables

We have two provincial level effects i.e., economic development and information penetration. Prior studies have related economic development to capital economic development (Beck et al., 2010), financial openness (Chinn & Ito, 2006), total market capitalization (Su et al., 2016) or gross domestic product (Su et al., 2016). We measure economic development with GDP per capita of each province in China to eliminate the impact of population size. Prior studies have used circulation figures of daily newspapers (Dyck & Zingales, 2004; Su et al., 2016) to measure the information diffusion. We argue that nowadays people mainly obtain information on the internet, so we use the number of broadband installation of each province to measure the information penetration.

2.8. Measurement of control variables

We choose seven control variables in corporate level. Property right means if the corporation is state-owned corporation, we assigned 1, or we assigned 0. Total assets is to measure the corporate scales, in general, the total amount of assets of an accounting entity is equal to the total amount of assets in its balance sheet. Shareholder association means whether there is an association between the top ten shareholders of a firm, if it's true, we assigned 1, or we assigned 0. Centralization of power means if the chairman and the general manager have a concurrent position, it means there is a higher centralization of power, then we assigned 1, or we assigned 0. Number of management shares means how many stocks do managements hold. Executive compensation represents the number of top three remunerations of top executives. Ownership concentration indicates the proportion of the top ten shareholders. Table 2 shows all of our variables and its representative codes.

Table 2. Variables summary.

Level	Variable type	Specific variables	Variable representation
	Dependent variables	ROA	ROA
		ROE	ROE
		EPS	EPS
Corporate level	Independent variable	EID	EID
	Control variables	Property right	Z1
		total assets	Z2
		Shareholder association	Z3
		Centralization of power	Z4
		Number of management shares	Z5
		Executive compensation	Z6
		Ownership concentration	Z7
Provincial level	Moderator variables	GDP per capita	W1
		Broadband installation	W2

Sources: Author's estimation.

Table 3. Descriptive statistics of variables.

Variables	Min	Max	Mean	S.D.
ROA	−199.760	129.280	3.231	11.339
ROE	−156.730	871.500	4.522	27.763
EPS	−5.839	7.290	0.247	0.625
W1	9.176	11.680	10.715	0.519
W2	1.637	24.378	6.582	1.926
Z1	0.001	1.000	0.142	0.342
Z2	1.476	19.548	13.302	1.722
Z3	1.000	3.000	2.520	0.553
Z4	1.000	3.000	1.830	0.368
Z5	0.000	21.352	8.414	6.446
Z6	0.000	8.142	4.725	0.815
Z7	1.280	98.890	53.828	16.292
EID1	0	42	10.220	8.259
EID2	0	40	10.160	8.675

Sources: Author's estimation.

Table 3 shows the descriptive statistics of the variables. There are large differences between the maximum and minimum ROA and ROE. The mean ROA is 3.231, with standard deviation 11.339. The mean ROE is 4.522, with standard deviation 27.763, the statistics show that the financial performances of our sample firms behave quite differently. The mean EPS is 0.247 and the standard deviation is 0.625, it is relatively less different than ROA and ROE shows. The minimum W1 is 9.176, the maximum W1 is 11.680, the mean W1 is 10.715 and its standard deviation is 0.519, this means the GDP per capita gap between different provinces of our sample is not so large. But as it shows that the minimum W2 is 1.637, the maximum W2 is 24.378, the mean W2 is 6.582 and the standard deviation is 1.926, it indicates that the broadband installations are different among our sample provinces. The mean EID1 is 10.220, the mean EID2 is 10.160, the mandatory environmental disclosure is a little bit better than the voluntary environmental disclosure. Both mandatory environmental disclosure and voluntary environmental disclosure differ from different firms.

3. Model of analysis

We use hierarchical linear model (HLM) to investigate the relationship between environmental disclosure and financial performance of heavy polluting firms.

Hierarchical Linear Modeling (HLM) is a complex form of ordinary least squares (OLS) regression that is used to analyze variance in the outcome variables when the predictor variables are at varying hierarchical levels. It is particularly appropriate for research designs where data for participants are organized at more than one level, for example, nested data. Except for the corporate level, we seek to study how the flow of years and the characteristics of provinces have differential impacts on corporate financial performance. The three-level HLM provides a framework for us to examine how the environmental disclosure influences the corporate financial performance, and further, how the provincial characteristics and the flow of years influences the firms within it.

3.1. Unconditional means model

We carry out an unconditional model first for three reasons: (1) to test whether we need to use hierarchical linear technology; (2) to test the impact of province characteristics on corporate financial performance; (3) to test the ability of provincial characteristics to explain the variation of dependent variables. We set the models as follows:

$$\text{Level 1: } FP_{tij} = \beta_{0ij} + r_{tij} \tag{1}$$

$$\text{Level 2: } \beta_{0ij} = \gamma_{00j} + \mu_{0ij} \tag{2}$$

$$\text{Level 3: } \gamma_{00j} = \pi_{000} + e_{00j} \tag{3}$$

In this unconditional model, FP_{tij} is the financial performance of firm i in province j that tested at time t. β_{0ij} means the initial state of firm i in province j. γ_{00j} means the average initial state of province j. π_{000} means the total average initial state. r_{tij}, μ_{0ij} and e_{00j} are the random differences. $t = 2008, 2009 \cdots 2017$, $i = 1, 2 \cdots 531$, $j = 1, 2 \cdots 31$.

3.2. Random-intercept model

To examine the relationship between environmental disclosure and financial performance, as well as the impact of provincial differences and the flow of years, we further construct the HLM random-intercept model. We put YEAR variance in level 1, corporate level variance EID and some control variances in level 2, and provincial level variances in level 3. The random-intercept model assumes that the intercept of dependent variable varies with groups, but the regression slope of each group is fixed. So we construct the model as follows:

$$\text{Level 1: } FP_{tij} = \beta_{0ij} + \beta_{1ij} YEAR_{tij} + r_{tij} \tag{4}$$

$$\text{Level 2: } \beta_{0ij} = \gamma_{00j} + \gamma_{01j} EID_{tij} + \gamma_{02j} Z_{tij} + \mu_{0ij} \tag{5}$$

$$\beta_{1ij} = \gamma_{10j} + \mu_{1ij} \tag{6}$$

$$\text{Level 3: } \gamma_{00j} = \pi_{000} + \pi_{001} W_{00j} + e_{00j} \tag{7}$$

$$\gamma_{01j} = \pi_{010} + e_{01j} \tag{8}$$

$$\gamma_{02j} = \pi_{020} + e_{02j} \tag{9}$$

$$\gamma_{10j} = \pi_{100} + e_{10j} \tag{10}$$

In this model, $YEAR_{tij}$ means the time variable measured at time t of firm i in province j. EID_{tij} means environmental information disclosure index of firm i in province j at time t. Z_{tij} means control variables of firm i in province j at time t. W_{00j} refers to the characteristics of province j. β_{0ij} means the initial state of firm i in province j. β_{1ij} is the development track of firm i in province j with the changing of *YEAR*. γ_{01j} is the relationship between independent variables and dependent variables of firm i in province j. γ_{02j} is the relationship between control variables and dependent variables of firm i in province j. γ_{00j} and γ_{10j} are the average initial states of province j. π_{001} is the relationship between provincial level variables and dependent variables. $\pi_{000}, \pi_{010}, \pi_{020}, \pi_{100}$ are the intercepts, which mean the total average initial states. $r_{tij}, \mu_{0ij}, \mu_{1ij}, e_{00j}, e_{01j}, e_{02j}, e_{10j}$ are the random differences.

3.3. Random-intercept and random-slope model

The random-intercept and random-slope model assumes that both the intercept and slope of dependent variable vary with groups, it allows interactions between different levels. Except for the direct impact of each level, we also want to investigate the interactions of provincial-level and firm-level. So we construct the random-intercept and random-slope model as follows:

$$\text{Level 1: } FP_{tij} = \beta_{0ij} + \beta_{1ij} YEAR_{tij} + r_{tij} \tag{11}$$

$$\text{Level 2: } \beta_{0ij} = \gamma_{00j} + \gamma_{01j} EID_{tij} + \gamma_{02j} Z_{tij} + \mu_{0ij} \tag{12}$$

$$\beta_{1ij} = \gamma_{10j} + \gamma_{11j} EID_{tij} + \gamma_{12j} Z_{tij} + \mu_{1ij} \tag{13}$$

$$\text{Level 3: } \gamma_{00j} = \pi_{000} + \pi_{001} W_{00j} + e_{00j} \tag{14}$$

$$\gamma_{01j} = \pi_{010} + \pi_{011} W_{01j} + e_{01j} \tag{15}$$

$$\gamma_{02j} = \pi_{020} + e_{02j} \tag{16}$$

$$\gamma_{10j} = \pi_{100} + \pi_{101} W_{10j} + e_{10j} \tag{17}$$

$$\gamma_{11j} = \pi_{110} + \pi_{111} W_{11j} + e_{11j} \tag{18}$$

$$\gamma_{12j} = \pi_{120} + e_{12j} \tag{19}$$

In this model, *YEAR*, *EID*, *Z* and *W* have the same meaning with what we described above. β_{0ij} means the initial state of firm i in province j. β_{1ij} is the development track of firm i in province j with the changing of *YEAR*. γ_{00j} and γ_{10j} are the average initial states of province j. γ_{01j} and γ_{11j} are the relationships between independent variables and dependent variables of firm i in province j. γ_{02j} and γ_{12j} are the relationships between control variables and dependent variables of firm i in province j. π_{001}, π_{011}, π_{101}, π_{111} are the relationship between provincial level variables and dependent variables. $\pi_{000}, \pi_{010}, \pi_{020}, \pi_{100}, \pi_{110}, \pi_{120}$ are the total average initial states. $r_{tij}, \mu_{0ij}, \mu_{1ij}, e_{00j}, e_{01j}, e_{02j}, e_{10j}, e_{11j}, e_{12j}$ are the random differences.

4. Results

4.1. Correlation test

Before data processing, we need to centralize the data. Table 4 shows the correlation coefficients of our variables after centralized. It can be seen that there are significant correlations between most variables. The variance inflation factor (VIF) refers to the ratio of variance when there is multicollinearity between explanatory variables and when there is no multicollinearity between them. The larger the VIF, the more serious the multicollinearity is, and generally if VIF is larger than 10, there exists serious multicollinearity. Table 4 shows that all of our VIFs are around 1 and it means there is no multicollinearity in our models.

4.2. Unconditional means model test

Table 5 shows the result of unconditional means model. In Table 5, τ_{jt}^2 is the variance of provincial level, τ_t^2 is the variance of corporate level, and σ_ε^2 means the

Table 4. Variable correlation coefficient.

	EID1	EID2	W1	W2	Z1	Z2	Z3	Z4	Z5	Z6	Z7
EID1	1	0.521***	0.137***	−0.035**	−0.012*	−0.035*	−0.038***	−0.024*	0.021	0.143***	0.130***
EID2		1	0.182***	−0.052***	−0.096***	−0.042***	−0.039***	−0.021***	0.038***	0.132***	0.033**
W1			1	−0.124***	−0.093***	0.129***	−0.087***	−0.079***	0.115***	0.258***	0.074***
e	e			1	0.024	−0.073***	−0.055***	0.021	0.024***	0.009	−0.017***
Z1					1	0.134***	0.024***	0.070***	−0.079***	−0.039***	0.092***
Z2						1	−0.032**	0.046***	−0.016*	0.061***	0.214***
Z3	e						1	0.048***	−0.098***	−0.124***	−0.150***
Z4								1	−0.128***	−0.038***	0.151***
Z5									1	0.113***	−0.029**
Z6										1	0.109***
Z7											1
VIF	1.05	1.07	1.13	1.02	1.04	1.08	1.06	1.05	1.05	1.11	1.13

***$p < 0.01$.
**$p < 0.05$.
*$p < 0.1$.
Sources: Author's estimation.

Table 5. Unconditional means model result.

	ROA	ROE	EPS
τ_{jt}^2	0.067	0.064	0.080
τ_t^2	0.422	0.353	0.563
σ_ε^2	0.904	0.933	0.822
ρ_1	4.810%	4.740%	5.461%
ρ_2	30.294%	26.148%	38.430%
ρ_3	64.896%	69.112%	56.109%

Sources: Author's estimation.

variance of investigating year. According to this three variances, we can figure out the cross-level correlations. For the dependent variable ROA, $\rho_1 = \tau_{jt}^2/(\tau_{jt}^2 + \tau_t^2 + \sigma_\varepsilon^2)$=4.810%, which means provincial characteristics can explain 4.810% of the ROA variation; $\rho_2 = \tau_t^2/(\tau_{jt}^2 + \tau_t^2 + \sigma_\varepsilon^2)$=30.294%, which means corporate characteristics can explain 30.294% of the ROA variation; $\rho_3 = \sigma_\varepsilon^2/(\tau_{jt}^2 + \tau_t^2 + \sigma_\varepsilon^2)$=64.896% means the remaining 64.896% variation can be explained by random variables of testing years. Similarly for ROE, ρ_1=4.740% means provincial characteristics can explain 4.740% of the ROE variation; ρ_2=26.148% means corporate characteristics can explain 26.148% of the ROE variation; ρ_3=69.112% means random variables explain the remaining 69.112% variation of ROE. Lastly for EPS, ρ_1=5.461% indicates 5.461% variation of EPS can be explained by provincial characteristics; ρ_2=38.430% indicates that 38.430% of the EPS variation can be explained by corporate characteristics, and the remaining ρ_3=56.109% is explained by the random variables of testing years.

4.3. Random-intercept model

Table 6 shows the result of random-intercept model which does not add the year variable. In this model, there is no interaction among each level. We can find that in the corporate level, the regression coefficient between mandatory environmental information disclosure (EID1) and ROA is 0.162, and it is statistically significant at the 5% level, which means there is a positive relationship between mandatory environmental disclosure and ROA, each unit of change in EID1 will cause a 16.2% change in ROA. Similarly, the regression coefficient between EID1 and ROE is 0.129, the regression coefficient between EID1 and EPS is 0.213, and both of which have passed the 1% significant tests, which indicates that there are positive relationship between mandatory environmental disclosure and ROE, EPS, each unit of change in EID1 will cause a 12.9% change in ROE and 21.3% change in EPS. We conclude that mandatory environmental disclosure positively relates to financial performance.

The regression, coefficients between EID2 and ROA is 0.112, the regression coefficient between EID2 and ROE is 0.083, and the regression coefficient between EID2 and EPS is 0.137, all of them are statistically significant, which means voluntary environmental disclosure positively relates to financial performance, each unit of change in EID2 will cause a 11.2% change in ROA, 8.3% change in ROE and 13.7% change in EPS. Both mandatory and voluntary environmental disclosure have positively significant impact on financial performance, therefore **hypothesis 1 is supported**, and active disclosure of environmental information can improve corporate

Table 6. Random-intercept model result without year variable.

variables	ROA	ROE	EPS
C	0.164*	0.272***	0.237**
	(0.092)	(0.009)	(0.018)
EID1	0.162**	0.129***	0.213***
	(0.000)	(0.000)	(0.000)
EID2	0.112**	0.083***	0.137***
	(0.000)	(0.000)	(0.000)
Z1	−0.024	−0.046	−0.016
	(0.547)	(0.258)	(0.669)
Z2	−0.008	−0.004	0.024*
	(0.524)	(0.752)	(0.054)
Z3	−0.073***	−0.055**	−0.062***
	(0.002)	(0.014)	(0.002)
Z4	0.044	−0.012	−0.003
	(0.210)	(0.738)	(0.920)
Z5	0.034***	0.011	−0.025**
	(0.009)	(0.407)	(0.030)
Z6	0.113***	0.083***	0.162***
	(0.000)	(0.000)	(0.000)
Z7	0.095***	0.073***	0.106***
	(0.000)	(0.000)	(0.000)
W1	0.328***	0.328***	0.342***
	(0.000)	(0.000)	(0.001)
W2	0.007	0.051***	0.039**
	(0.741)	(0.007)	(0.027)

***$p < 0.01$.
**$p < 0.05$.
*$p < 0.1$.
Sources: Author's estimation.

financial performance, no matter mandatory information disclosure or voluntary information disclosure. The regression coefficients of EID1 are universally larger than that of EID2, which means mandatory information disclosure is more effective in promoting financial performance than voluntary disclosure. Generally, EID1 and EID2 have the most significant impact on EPS, the less significant impact on ROA, and the least significant impact on ROE comparing this three financial indicators.

In the provincial level, the regression coefficient between W1 and ROA is 0.328, and it is significant at the 1% level, which means the relationship between economic development and ROA is positive, each unit of change in economic development will cause a 32.8% change in ROA. Similarly, the regression coefficient between W1 and ROE is 0.328, and the regression coefficient between W1 and EPS is 0.342, and they are both statistically significant at the 1% level, which means economic development has a significant relationship with ROE and EPS, each unit of change in economic development will cause a 32.8% rise in ROE and 34.2% rise in EPS. Overall, the relationship between economic development and financial performance is positive, **hypothesis 2 is supported.** The more developed a province is, the better its firms' financial performance is, the result is similar to Mao et al. (2013) who compared the positive phenomenon between developed and developing areas of China and concluded that the reason derived from the transparency of the data disclosed.

The regression coefficient between W2 and ROA is 0.007, and it fails to pass the significant test, hence there is no significant relationship between information penetration and ROA. But the regression coefficients between W2 and ROE, EPS are 0.051 and 0.039, and both of them are significant at the 1% level and 5% level, which

means information penetration positively relates to ROE and EPS, each unit of change in information penetration will cause a 5.1% change in ROE and 3.9% change in EPS. In general, high information penetration in a province can positively influence firms' financial performance, **hypothesis 4 is supported.**

For the control variables, the regression coefficients of shareholder association (Z3) are −0.073 on ROA, −0.055 on ROE and −0.062 on EPS, and all of them have passed the significant tests. It means there is a negative relationship between shareholder association and financial performance. The associations between the top ten shareholders will negatively influence firms' financial performance. The regression coefficients between executive compensation (Z6) and financial performance are 0.113 on ROA, 0.083 on ROE and 0.162 on EPS, and all of them have passed the 1% significant tests, which means appropriately improving executive compensation is beneficial for improving corporate financial performance. The regression coefficients of ownership concentration (Z7) is 0.095 on ROA, 0.073 on ROE and 0.106 on EPS, and have passed the 1% significant tests. We can infer that the ownership concentration has a positive impact on financial performance.

Table 7 shows the result of random-intercept model that add the year variable. In this part we intend to examine whether the corporate financial performance changes over time. In other words, whether the flow of year affects the corporate financial performance besides the influence factors we have examined above. We can find in Table 7 that taking 2008 as the base year, there is an increasing trend of financial performance from 2009 to 2019. In general the regression coefficients are positive, few of the years are negative. In the first three or four years, the regression coefficients are not significant, but from 2013, the regression coefficients begin to be significant, especially ROA, which indicates that generally the corporate financial performance rises over time.

Year variable added, the regression coefficients between EIDs and financial indicators decrease compared to Table 6 (e.g., the regression coefficient between EID1 and ROA is 0.162 in Table 6, but it decreases to 0.149 in Table 7), indicating that the relationship between environmental disclosure and financial performance is weakened when year variable is added, but still significant, **hypothesis 1 is supported again.** We analyze that the addition of time variable partially shares the growth of corporate financial performance, thereby weakening the relationship between environmental disclosure and financial performance. Similarly, the relationship between economic development and financial performance is weakened when adding time variable, the regression coefficients of W1 in Table 6 are 0.328 on ROA, 0.328 on ROE and 0.342 on EPS, but in Table 7 it drops to 0.102 on ROA, 0.251 on ROE and 0.304 on EPS. They are still significant though **so hypothesis 2 is supported again.**

It is worth noting that the regression coefficients of information penetration (W2) increase compared to Table 6. In Table 6, the regression coefficients of information penetration are 0.007 on ROA, 0.051 on ROE and 0.039 on EPS, and they increase to 0.028 on ROA, 0.075 on ROE and 0.043 on EPS. All of these regression coefficients have passed the significant tests, so **hypothesis 4 is supported again.** We analyze that the popularity of broadband is getting higher and higher over time, and information plays an important role between enterprises and stakeholders. Therefore, the information penetration is becoming more effective to the corporate financial performance.

Table 7. Random − intercept model result with year variable.

variables	ROA	ROE	EPS
C	−0.047	0.273**	0.198*
	(0.625)	(0.014)	(0.059)
EID1	0.149***	0.116***	0.215***
	(0.000)	(0.000)	(0.000)
EID2	0.126***	0.073***	0.121***
	(0.000)	(0.000)	(0.000)
Z1	−0.047	−0.053	−0.015
	(0.240)	(0.216)	(0.632)
Z2	−0.010	−0.005	0.024**
	(0.443)	(0.740)	(0.054)
Z3	−0.073***	−0.060**	−0.06***
	(0.002)	(0.013)	(0.002)
Z4	0.040	−0.016	−0.005
	(0.242)	(0.679)	(0.876)
Z5	0.028**	0.005	−0.027**
	(0.028)	(0.673)	(0.024)
Z6	0.101***	0.081***	0.157***
	(0.000)	(0.000)	(0.000)
Z7	0.088***	0.069***	0.106***
	(0.000)	(0.000)	(0.000)
W1	0.102***	0.251***	0.304***
	(0.000)	(0.000)	(0.000)
W2	0.028*	0.075***	0.043***
	(0.082)	(0.000)	(0.011)
YEAR			
2009	−0.005	−0.052	0.030
	(0.930)	(0.364)	(0.572)
2010	0.093	−0.012	0.117**
	(0.107)	(0.855)	(0.047)
2011	−0.016	0.154**	0.001
	(0.776)	(0.011)	(0.992)
2012	0.012	0.189***	−0.092
	(0.866)	(0.003)	(0.102)
2013	0.127**	−0.096	−0.015
	(0.032)	(0.136)	(0.798)
2014	0.173***	−0.056	0.002
	(0.004)	(0.369)	(0.973)
2015	0.276***	0.050	0.032
	(0.000)	(0.465)	(0.619)
2016	0.343***	0.079	0.074
	(0.000)	(0.282)	(0.279)
2017	0.651***	0.272***	0.179**
	(0.000)	(0.000)	(0.012)
2018	0.725***	0.316***	0.192**
	(0.000)	(0.000)	(0.012)
2019	0.793***	0.339***	0.194**
	(0.000)	(0.000)	(0.012)

***$p < 0.01$.
**$p < 0.05$.
*$p < 0.1$.
Sources: Author's estimation.

4.4. Random-intercept and random-slope model test

Table 8 shows the result of random-intercept and random-slope model test. In this model, we consider the interaction between corporate level and provincial level. Firstly in the year level, it still shows an increasing trend of financial performance as Table 7 shows above, which augment our conclusion that the corporate financial performance is rising with time going by. Then in the corporate level, the effect of

Table 8. Random-intercept and random-slope model result.

Variables	ROA	ROE	EPS
C	−0.175**	0.141	−0.062
	(0.031)	(0.236)	(0.375)
EID1	0.152***	0.131***	0.242***
	(0.000)	(0.000)	(0.000)
EID2	0.034***	0.052***	0.113***
	(0.000)	(0.000)	(0.000)
Z1	−0.061**	−0.042	−0.034
	(0.000)	(0.184)	(0.279)
Z2	−0.004	−0.005	0.029*
	(0.668)	(0.732)	(0.056)
Z3	−0.066***	−0.058**	−0.065***
	(0.003)	(0.015)	(0.003)
Z4	0.044	−0.007	0.006
	(0.197)	(0.854)	(0.854)
Z5	0.025**	0.005	−0.026**
	(0.048)	(0.732)	(0.031)
Z6	0.092***	0.074***	0.146***
	(0.000)	(0.000)	(0.000)
Z7	0.088***	0.067***	0.106***
	(0.000)	(0.000)	(0.000)
W1	0.028	0.153***	0.113***
	(0.231)	(0.000)	(0.000)
W2	0.034**	0.089***	0.032*
	(0.046)	(0.000)	(0.063)
EID1*W1	0.148***	0.073***	0.194***
	(0.000)	(0.000)	(0.000)
EID2*W1	0.078***	0.016	0.043**
	(0.000)	(0.414)	(0.037)
EID1*W2	−0.041*	−0.073***	0.014
	(0.090)	(0.000)	(0.911)
EID2*W2	−0.029*	−0.013*	−0.007
	(0.052)	(0.060)	(0.565)
YEAR			
2009	0.014	−0.042	0.061
	(0.798)	(0.460)	(0.238)
2010	0.135**	0.020	0.199***
	(0.014)	(0.735)	(0.000)
2011	0.068	−0.077	0.152***
	(0.228)	(0.197)	(0.005)
2012	0.113**	−0.098	0.097*
	(0.047)	(0.109)	(0.079)
2013	0.249***	0.013	0.216***
	(0.000)	(0.839)	(0.000)
2014	0.310***	0.067	0.260***
	(0.000)	(0.302)	(0.000)
2015	0.413***	0.084	0.310***
	(0.000)	(0.210)	(0.000)
2016	0.466***	0.225***	0.358***
	(0.000)	(0.001)	(0.000)
2017	0.721***	0.394***	0.407***
	(0.000)	(0.000)	(0.000)
2018	0.794***	0.576***	0.683***
	(0.000)	(0.000)	(0.000)
2019	0.837***	0.723***	0.812***
	(0.000)	(0.000)	(0.000)

***$p < 0.01$.
**$p < 0.05$.
*$p < 0.1$.
Sources: Author's estimation.

mandatory information disclosure and voluntary information disclosure on financial performance is basically the same as that in Table 7. It still shows a positive relationship between EID and financial performance, **hypothesis 1 is supported again.** And then in the provincial level, economic development (W1) and information penetration (W2) still positively relate to financial performance, **hypothesis 2 and hypothesis 4 are supported again.**

Now we focus on the interaction between corporation level and provincial level. The regression coefficient between EID1*W1 and ROA is 0.148, and it is significant at the 1% level, it means the relationship between mandatory environmental disclosure and ROA is strengthened when adding the variable economic development. Similarly, the regression coefficient between EID1*W1 and ROE is 0.073, the regression coefficient between EID1*W1 and EPS is 0.194, and both of them have passed the 1% significant tests. It indicates that economic development of provinces can positively mediate the relationship between mandatory environmental disclosure and financial performance. The regression coefficient between EID2*W1 and ROA is 0.078, and it is statistically significant at the 1% level, which means the economic development positively mediates the relationship between voluntary environmental disclosure and ROA. The regression coefficient between EID2*W1 and EPS is 0.043, and it is statistically significant at the 5% level, it also means economic development will positively mediate the relationship between voluntary environmental disclosure and EPS. The regression coefficient between EID2*W1 and ROE is 0.016, but it is not significant. In general, the results indicate that economic development can positively mediate the relationship between voluntary environmental disclosure and financial performance. Overall, we suggest that the relationship between environmental disclosure and financial performance is strengthened in more developed markets than in less-developed markets, **hypothesis 3 is supported.**

The regression coefficient between EID1*W2 and ROA is −0.041, and it is statistically significant at the 10% level. The relationship between mandatory environmental disclosure and ROA is positive (as has been testified above), but the interaction of mandatory environmental disclosure and information penetration is negatively related to ROA, it means the variable information penetration will negatively mediate the relationship between mandatory environmental disclosure and ROA. Similarly, the regression coefficient between EID1*W2 and ROE is −0.073, and it is significant at the 1% level. It also shows a negative mediating effect of information penetration between mandatory environmental disclosure and ROE. The regression coefficient between EID1*W2 and EPS is 0.014, and it is not significant. We can draw the conclusion that information penetration will negatively mediate the relationship between mandatory environmental disclosure and financial performance. The regression coefficient between EID2*W2 and ROA is −0.029, and it is significant at the 10% level, which means on the premise of a positive relationship between voluntary environmental disclosure and ROA, the addition of information penetration will negatively mediate the relationship between voluntary environmental disclosure and ROA. The regression coefficient between EID2*W2 and ROE is −0.013, and it is significant at the 10% level, again it means information penetration will negatively mediate the relationship between voluntary environmental disclosure and ROE. The regression

coefficient between EID2*W2 and EPS is −0.007, but it is not significant. Still, we find that information penetration can negatively mediate the relationship between voluntary environmental disclosure and financial performance. In general, we suggest that the relationship between environmental disclosure and financial performance is weakened in high information penetration markets than in low information penetration markets, **hypothesis 5 is supported.**

5. Discussion

Our study tries to find the relationship between environmental disclosure and corporate financial performance. The result shows that environmental disclosure can positively relate to financial performance. This is because Chinese government is increasingly strict to corporate environmental performance, under which context companies with poor environmental performance will not only be punished by government, but their production capacities will also be limited by industrial policies. This conclusion is consistent with the researches of Hessels et al. (2011), Ong et al. (2014), etc. In the short term, it will increase financial burden if companies add environmental expenditures, but in the long run, good environmental performance will improve the efficiency of the enterprise's resource utilization and get supports from the government and the society.

We take mandatory environmental disclosure and voluntary environmental disclosure separately to investigate if there is difference between mandatory environmental disclosure and voluntary environmental disclosure on impacting financial performance. Results show that in general, regression coefficients of mandatory environmental disclosure is larger than that of voluntary environmental disclosure. Our result then is in accordance with the argument defended by Patten (2002) and García Meca and Ferrero (2021) environmental information disclosure can be a legitimizing tool instead of a means of providing transparent accountability about social and environmental performance. Meanwhile, the former is what the government requires firms to disclose compulsively; firms must disclose it according to their actual situations. Operators have greater freedom to manipulate the disclosure of voluntary environmental contents. Enterprises, for its own interests, will conceal its adverse information and only disclose the information that is beneficial to themselves. So as is shown in our regression results, mandatory information disclosure is more effective in promoting financial performance than voluntary disclosure does.

We add year variable in the second model to examine if the flow of year has impact on corporate financial performance. According to the result, overall there is an increasing trend of ROA, ROE and EPS from 2008 to 2019. It indicates that with the flow of year, the society is developing rapidly, the only way for companies to survive is to upgrading their financial strength constantly in such a fast developing environment, otherwise they will be eliminated in the fierce market competition. In the provincial level, we find that economic development and information penetration of different provinces has positive impact on financial performance. First, the developed economy will promote the development of companies. If a firm is in an economically developed province, the fierce market competition will promote the firm to

improve its own ability, which will be beneficial to the long-term development. Second, information asymmetry is a severe problem between enterprises and stakeholders. If a firm is with high information permeability, there are many channels for stakeholders to obtain information, which will alleviate information asymmetry, help external stakeholders get better understanding of the firm and this is good for the development of the firm in the long run.

We have found that the relationship between economic development and financial performance is positive, and then we examined whether the interaction of economic development and environmental disclosure has positive or negative impact on financial performance. The result shows that the interactional item can positively relate to corporate financial performance, which means economic development can positively mediate the relationship between environmental disclosure and financial performance, proved by Deephouse (2000) and Wang and Huang (2015). It is not strange that if firms are located in economically developed provinces, external stakeholders may have greater confidence on the development of firms. When firms disclose environmental information, the marginal benefits of environmental information disclosure on corporate financial performance are greater in economically developed provinces. Therefore economic development positively mediates the relationship between environmental disclosure and financial performance.

Additionally, we have known that information penetration can positively relate to financial performance, but the interactional item of environmental disclosure and information penetration negatively relates to financial performance, which means that information penetration negatively mediates the relationship between environmental disclosure and financial performance. We analyze that in a high-information-penetration province, it's easy for stakeholders to get access to abundant information and evaluate firms' value, therefore the environmental disclosures of companies aren't as important as that in low-information-penetration provinces. This conclusion is consistent with Barry and Fulmer (2004) as well as Zavyalova et al. (2012), which demonstrates that more information penetration implies more disclosure and surveillance, and is beneficial to companies' financial performance. Under the circumstances, the relationship between environmental disclosure and financial performance is weakened by information penetration. The signs of the key variables are in line with our expectations. This is because that when the command of compulsory environmental disclosure is proposed, the local government resolutely carries out the policy and subsidies will be transferred from local government to the listed companies. For investors, they believe that after equipped with the improved pollution reduced technologies with little actual cost, the cost of the company will declined, directly enhancing the profit and other financial index of the company.

It is worth mentioning that this paper provides a vital reference for studying the impact of corporate environmental information disclosure on corporate financial performance. Meanwhile, economic development and information penetration are integrated into the model for comprehensive consideration, which provides a novel perspective for clarifying the relationship between the environmental information disclosure and corporate financial performance. Our results further confirm the reliability of existing researches such as Patten (2002), Barry and Fulmer (2004), Zavyalova

et al. (2012) as well as García Meca and Ferrero (2021). Such findings support the studies on corporate environmental legitimacy for companies from sensitive industries, which tend to disclose their environmental information to protect their reputation. In other words, the government's mandatory legislation is conducive to strengthening the willingness and behavior of enterprises to disclose environmental information, and thus improving their financial performance.

Finally this study has also some limitations. Firstly, concerning the data sources, all information disclosure data being collected only form companies' annual reports, without considering other means of disclosing information, which may Compromise the comprehensiveness of the disclosing information data. Secondly, the impact may not be constant throughout the magnitude of the disclosure, i.e., the coefficient of impact factor may change as the scale of the firm varies or the value of content and information released, which are not shown or discussed in this paper. In the later work, the observations need to be divided into more specific categories and more associated methodologies will be used to investigate the study. Despite its limits, this study should be a benchmark in assessing the relationship between the environmental information disclosure and corporate financial performance in China context, offering considerable room for future investigations.

Ethical approval

This article does not contain any studies with human participants or animals performed by any of the authors.

Informed consent

Informed consent was obtained from all individual participants included in the study.

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