Does Environmental Information Disclosure Affect the Financial Performance of Commercial Banks? Evidence from China

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Abstract

The article uses hand-collected data regarding environmental information disclosure for Chinese 30 listed banks to investigate whether and how environmental information disclosure of banks affects the financial performance. We find that a more high-quality environmental information results in high financial performance and this effect is intertemporal, which means that the effect is more significant in the current period and one lagged period, while the effect is not significant in two lagged periods. The second major finding is that national banks have a more significant effect of environmental information disclosure on their financial performance compared to regional banks. Furthermore, we provide evidence that the regional green development environment moderates the relationship between environmental information disclosure and banks' financial performance.

1. Introduction

In recent years, how to cope with climate change, control environmental pollution and promote the harmonious coexistence between human and nature has become the core issue of global economic and social sustainable development. The impact of corporate production and operation activities on climate change and the environment is also receiving increasing attention. Listed companies are required to disclose not only financial information, but also social responsibility information including climate and environmental information. At the same time, the climate and environmental risks faced by financial institutions are also receiving increasing attention. In August 2016, seven ministries and commissions, including the Ministry of Finance and the People's Bank of China, jointly issued a programmatic document on green finance, "Guidance on Building a Green Financial System". It clearly states that "gradually establish and improve a mandatory environmental rights disclosure system for listed companies and debt-issuing enterprises". In June 2017, the Working Group on Climate-related Financial Disclosures (TCFD) of the United Nations Financial Stability Board released the "Working Group Recommendations Report on Climate-related Financial Disclosures" (the "TCFD Framework") to guide companies on how to disclose climate change-related financial risks and their resulting The TCFD Framework provides guidance to companies on how to disclose climate change-related financial risks and the development opportunities they present. In this context, the importance of environmental information disclosure by financial institutions is becoming increasingly apparent. As a representative of financial institutions and an important lever for economic regulation, the banking industry should take corporate environmental information disclosure as an important consideration for investment decisions on the one hand, and actively disclose its own environmental information to improve transparency on the other (Li and Hu, 2021). The current research on environmental information disclosure in the banking industry mainly focuses on the content and quality of information disclosure, and does not link it to the financial performance of banks. Therefore, this paper takes the banking industry as the research object, based on stakeholder theory and signaling theory, and uses public data and content analysis methods to obtain research data. Focusing on the impact of environmental information disclosure on banks' financial performance, the banks are further classified according to ownership heterogeneity, i.e., whether
they are national banks or not. Also, considering the heterogeneity of the regional green development environment, a green development index is introduced to observe the changes in the relationship between environmental information disclosure and banks’ financial performance in this external environment and the impact of different green development dimensions on this relationship.

Compared with previous literature, the marginal contributions of this paper are mainly in the following aspects. First, the existing literature on environmental information disclosure mainly focus on production enterprises, especially the heavy polluters. However, this paper obtains the environmental information disclosure status of 30 Chinese listed banks through extensive data collection, which brings important enlightenment to the environmental information disclosure of financial institutions. Second, most of the existing literature studies the factors affecting the financial performance of banks from bank operating indicators such as capital adequacy ratio and non-performing loan ratio or macro indicators such as GDP. In contrast, this paper explores the relationship between environmental information disclosure and listed banks’ performance from the perspective of environmental information disclosure, thus reinforcing the importance of environmental protection in the business process of commercial banks. Finally, this paper further explores the moderating role of regional green development environmental heterogeneity between environmental information disclosure and financial performance of listed banks. The findings of the study provide references for government departments to further promote green development and achieve a positive interaction between green financial development and green economic growth.

This paper has been divided into four parts. It begins by combing and reviewing the current research status of environmental information disclosure and related theories. The second part establishes a panel data model to analyze the relevant data of 30 listed Banks in China from 2009 to 2019 to quantitatively study the impact of environmental information disclosure on listed banks’ financial performance. It will then further analyze the heterogeneity of banks and the moderating effect of regional green development levels. Finally, combined with the empirical results analysis conclusions, corresponding countermeasures are proposed to improve the level of listed banks’ environmental information disclosure.

2. Literature Review And Hypothesis Development

2.1. Literature review

Environmental information disclosure is one aspect of social responsibility disclosure. Research on social responsibility and environmental information disclosure began with theoretical and descriptive analyses (Mobley, 1970; Gray, 1988; Li and Xiang, 2007). With continuous in-depth research on the determinants (Bi et al., 2012), economic consequences and market reactions (Xiao et al., 2015) of social responsibility and environmental information disclosure, the research on environmental information disclosure has also been improved. Scholars have studied the motivation of corporate environmental information disclosure from the perspective of external to society and internal to the firm. From the perspective of external pressure, institutional pressure (Bi et al., 2015), government linkage (Cui, 2017), and corporate reputation (Zeng et al., 2012) affect the level of corporate environmental information disclosure. And analyzed from
the internal perspective of corporate governance, the corporate governance framework directly affects the content and quality of environmental information disclosure (Tian, 2001). Related studies mainly consider management incentives (Liu and Zhang, 2017) and excessive compensation of senior managers (Li et al., 2019).

Some scholars have also focused specifically on the study of the relationship between environmental information disclosure and corporate performance or corporate value. Due to the different research perspectives, the conclusions are not consistent. Based on signaling theory and stakeholder theory, improving the level of environmental information disclosure can effectively reduce the information asymmetry between enterprises and stakeholders (Bloomfield et al., 2000), and win the trust and support of all stakeholders. Thus, a long-term and stable principal-agent relationship between the enterprise and each stakeholder can be achieved, further promoting the sustainable development of the enterprise (Cai and Chai, 2017). Research on social reputation theory suggests that high-quality environmental information disclosure can lead to good economic effects in the market, enhance positive consumer sentiment, and promote the growth of corporate performance. Studies within voluntary disclosure theory report that some good firms proactively disclose environmental information that is favorable to them, which distinguishes them from other firms. Environmental information disclosure has a positive relationship with corporate financial performance (Guidara et al., 2015; Wang et al., 2020). Based on legitimacy theory, environmental information disclosure is negatively related to the financial performance of firms (Liu and Zhang, 2017; Li et al., 2017; Tao et al., 2020). These studies claim that under external pressures, in order to satisfy stakeholders and achieve excellent environmental performance, companies disclose environmental information, which leads to increased costs and reduced financial performance. In addition, researchers have stated that social information disclosure of companies is important for financial performance, while environmental information disclosure is not related to financial performance (Qiu et al., 2014).

The above literature analysis reveals that the relationship between environmental information disclosure and corporate performance is inconclusive. Possible reasons are the differences in sample selection or research methods and the choice of influencing mechanisms. As an important force to support green development, financial institutions play a key role in resource allocation. It is important for them to fulfill their environmental responsibilities and disclose environmental information. Therefore, this paper selects listed banks as a representative of financial institutions to study the impact of financial institutions' disclosure of environmental information on their financial performance and the impact mechanism.

### 2.2. Hypothesis development

In response to global climate change, green finance is trending towards mainstream development, and climate and environmental information disclosure is an important aspect of the green finance sector. Information asymmetry is one of the main barriers faced in the development of green finance. And signaling theory and stakeholder theory suggest that improvements in information disclosure can effectively reduce information asymmetry between firms and stakeholders (Bloomfield et al., 2000).
Therefore, enhancing environmental information disclosure by financial institutions can effectively remove the information transparency barrier in the green financial market. In addition, signaling theory suggests that by disclosing environmental information that is beneficial to them, firms can signal to various stakeholders that they are fulfilling their social responsibility, which helps them to improve their social image and market competitiveness and enhance their financial performance (Michael, 1973). First, environmental information disclosure by listed banks can help them identify and prevent environmental risks and reduce the cost of risk. The failure of enterprises to comply with environmental protection standards is subject to legal sanctions, which indirectly increases the credit risk faced by credit banks (Aintablian et al., 2010). By disclosing loans to “two high and one capital” industries, banks clarify the possible environmental risks associated with loans, which in turn establishes a risk management process and reduces the cost of risk. Secondly, environmental information disclosure helps listed banks build a green reputation for environmental protection and gain support from stakeholders. In recent years, the public's awareness of environmental protection has gradually increased. Banks that actively support environmental protection are more likely to be recognized and, at the same time, more likely to gain support from green investors and government regulators in the capital market (Zhang et al., 2020), which in turn promotes increased resources for bank projects and improved financial performance.

Our first hypothesis is:

**Hypothesis 1**

Environmental information disclosure can improve the bank financial performance.

In reality, the positive impact of corporate environmental information disclosure on financial performance tends to be sustained. For one thing, due to the large amount of uncontrollable "noise" interference in the real market (Kyle, 1985), it is difficult for some information users to obtain comprehensive and timely environmental information disclosed by firms in a short period of time. Meanwhile, it takes a process from the performance of environmental information disclosure of enterprises to win the trust of information users and respond accordingly before it can be finally translated into financial performance (Li and Shi, 2016). In addition, in order to improve the level of environmental information disclosure, companies must make energy-saving and emission reduction reforms, which lead to green technological innovation. However, the transformation of technological innovation into productivity requires a process and has a slow impact on corporate financial performance. Therefore, corporate environmental information disclosure affects not only the financial performance of the current period, but also the operating performance of the next period or even future periods. For another thing, the impact of environmental information disclosure on financial performance is also time-sensitive due to the timeliness of information. Therefore, this impact will gradually diminish.

Our second hypothesis is:

**Hypothesis 2**
The impact of environmental information disclosure on bank financial performance is intertemporal.

3. **Empirical Methodology**

This chapter designs an empirical study on how environmental information disclosure affect the financial performance of listed banks, based on the two previous hypotheses. The following four aspects will be addressed: sample selection and data sources, variable selection and definition, empirical model setting, and empirical analysis findings.

3.1. **Sample selection and data source**

3.1.1. **Sample selection**

This paper selects the annual unbalanced panel data of 30 listed banks in China from 2009 to 2019. Among the 30 listed banks, there are six large commercial banks, including Bank of China, Agricultural Bank of China, Industrial and Commercial Bank of China, China Construction Bank, Bank of Communications, and Postal Savings Bank of China. There are also eight joint-stock banks, including Industrial Bank, Minsheng Bank, Shanghai Pudong Development Bank, China Merchants Bank, Ping An Bank, Huaxia Bank, Everbright Bank and CITIC Bank. And Beijing Bank, Nanjing Bank, Ningbo Bank, Guiyang Bank, Jiangsu Bank, Shanghai Bank, Hangzhou Bank, Changsha Bank, Tianjin Bank, Zhongyuan Bank, Harbin Bank, Xiamen Bank, and Shengjing Bank, a total of 13 commercial banks. And Chongqing Rural Commercial Bank, Shanghai Rural Commercial Bank, and Qingdao Rural Commercial Bank, a total of 3 rural commercial banks.

For the sake of data availability and feasibility of the study, the data of listed banks are selected for this paper. Additionally, this sample interval was selected for the research because of the following reasons. On the one hand, in 2009, the China Banking Association issued the "Guidelines on Corporate Social Responsibility of Banking Financial Institutions in China", which required the establishment of a CSR disclosure system. In the same year, commercial banks disclosed detailed environmental responsibility information in their "social responsibility reports"; on the other hand, we manually collected data from all listed banks that issued "social responsibility reports" since 2009, of which 30 banks disclosed detailed environmental information.

3.1.2. **Data source**

In terms of data sources, environmental information disclosure data were collected manually from listed banks' social responsibility reports, sustainability reports and environmental reports through content analysis methods. Data on other financial indicators of banks were obtained from CSMAR database and Wind database. Missing data were filled by querying the banks' annual reports. In order to reduce the
effect of outliers on the study results, 1% and 99% tails were applied to all continuous variables in this paper.

3.2. Variables selection

3.2.1. Explained variables

This paper analyses the impact of environmental information disclosure on the financial performance of listed banks, so financial performance is the explained variable in this paper. There are generally two calculation methods for financial performance: the market index method and the book index method. The former is an external valuation that reflects the investor’s confidence in the company’s operating status; The latter is an internal valuation that reflects the utilization, allocation and output of company resources by managers. However, due to the speculative nature of China’s securities market, the volatility of the data will change over time and the validity of the data and the effect of trading price discovery will be affected. Therefore, compared with the market index method, the financial index method can reflect the company’s operating level more accurately. Based on the above analysis, in this paper, we take a return on total assets to measure financial performance. The construction process is as follows:

\[
ROA = \frac{NetProfit}{TotalAsset}
\]

1

3.2.2. Explanatory variables

This paper attempts to explain the impact of environmental information disclosure on the financial performance of listed banks by measuring the quality of environmental information disclosure. Generally, environmental information disclosure is measured according to the company’s environmental disclosure content and degree of disclosure (Beck et al., 2010). Most of the existing literature uses content analysis of disclosure scoring method to study corporate environmental information disclosure (Yang et al., 2020; Wang et al., 2019). However, as a financial institution, the content of environmental information disclosure of a commercial bank is different from that of a general production enterprise. It mainly includes two aspects: one is the information related to the environmental impact of financial institutions’ own business activities and investment and financing activities; the other is related information about the impact of climate and environmental factors on the opportunities and risks of financial institutions. Therefore, in order to judge the accuracy and objectivity, as well as the availability of information, we are based on the recommendations of the International Climate-Related Financial Information Disclosure Working Group (TCFD) framework, combined with the actual situation of listed banks in China at this stage, and draw lessons from Li and Hu (2021) for environmental information disclosure of listed banks content analysis, to assess the content of the environmental information disclosure of listed banks from 10 secondary indicators under four dimensions of green management, green operations, green finance, green performance. The details are shown in Table 1. On this basis, with reference to Katmon et al. (2017) measuring corporate social responsibility disclosure covering quantitative and qualitative content
analysis methods, environmental information is divided into currency or quantity-related information and non-monetary or quality-related information, so as to quantify the level of environmental information. It also stipulates qualitative and quantitative combined disclosure, with a score of 2; only qualitative disclosure with a score of 1; if no disclosure, the score is 0. Then directly add up the scores of each disclosure item to find the scores of environmental information disclosure of each sample bank. Finally, the final environmental information disclosure index (EDI) is obtained according to formula (2).

\[
EDI_{it} = \frac{\sum_{j=1}^{n} SCDI_{ijt}}{TEDI}
\]

where \( SCDI_{ijt} \) is the score of the \( j \)th component of EID for bank \( i \) in year \( t \), TEDI represents the best environmental information disclosure score, which is a full score of 20, and \( EIDI_{it} \) is the final score of bank \( i \) in year \( t \), in which \( j = 1, 2, ..., 10 \) and \( t = 2019, 2014, ..., 2019 \). Higher score indicates great degree of EID.

| First level indicator | Second level indicator |
|-----------------------|------------------------|
| 1. Green governance   | 1.1 Green concept (0,1,2) |
| (Maximum score 6 points) | 1.2 Green policy (0,1,2) |
|                       | 1.3 Environmental risk prevention and control(0,1,2) |
| 2. Green operation    | 2.1 Green promotion (0,1,2) |
| (Maximum score 10 points) | 2.2 Green procurement (0,1,2) |
|                       | 2.3 Green service (0,1,2) |
|                       | 2.4 Environmental risk disclosure (0,1,2) |
|                       | 2.5 Green operation performance (0,1,2) |
| 3. Green finance      | 3.1 Green finance practice (0,1,2) |
| (Maximum score 4 points) | 3.2 Green finance performance (0,1,2) |

### 3.2.3. Control variables

In accordance with extant literature (Wu and Wang, 2020; Liu and Liu, 2013), control variables relevant to bank financial performance were adopted in the analyses. Net interest margin (NID) is expressed by the evaluation yield of interest-earning assets minus the average cost rate of interest-bearing liabilities. Capital adequacy ratio (CAR) is expressed by the ratio of regulatory capital to risk-weighted assets. The non-performing loan ratio (NPL) is equal to the proportion of substandard, doubtful and loss loans in
total loans. Cost-to-income ratio (CIR) is measured by the ratio of business and management expenses to operating income. The loan-to-deposit ratio (DLR) is equal to the ratio of total loans to total deposits.

3.3. Empirical model setting

For the purpose of empirically analysing the impact of environmental information disclosure on the financial performance of listed banks, the article proposes model (3) to verify the hypothesis:

Based on the above analysis, we use an OLS regression with year fixed effects and standard errors clustered at bank year level. To be specific, we estimate the following equation:

\[ \text{ROA}_{i,t} = \beta_0 + \beta_1 \times \text{EDI}_{i,t} + \gamma_i \times \text{Controls}_{i,t} + u_i + n_t + \epsilon_{i,t} \]

Where ROA is the explained variable, EDI is the explanatory variable, Controls are the above control variables, \( i = 1,2,\ldots,N \) represents the sample of listed banks, and \( t = 2009,2010,\ldots,2019 \) represents time. \( \alpha \) is the constant term of the model, and \( \beta \) is the estimated coefficient of the corresponding variables. Besides, \( \mu \) is the time fixed effect, \( n \) is the bank fixed effect, and \( \epsilon \) is the standard error term.

Further, we introduce the financial performance of banks to lag one and two periods into models to verify hypothesis 2:

\[ \text{ROA}_{i,t-1} = \beta_0 + \beta_1 \times \text{EDI}_{i,t} + \gamma_i \times \text{Controls}_{i,t} + u_i + n_t + \epsilon_{i,t} \]

\[ \text{ROA}_{i,t-2} = \beta_0 + \beta_1 \times \text{EDI}_{i,t} + \gamma_i \times \text{Controls}_{i,t} + u_i + n_t + \epsilon_{i,t} \]

3.4. Findings of empirical analysis

3.4.1. Statistical description

As shown in Table 2, the maximum value of ROA of listed banks is 1.4666 and the minimum value is 0.4823, indicating that there is a certain difference in the return on total assets of the 30 selected listed banks. For the explanatory variables, the maximum value of the EDI is 0.75, while the average value is 0.47, revealing that the average quality of bank EDI is generally low and there is a big gap in the environmental information disclosure quality among different banks. This situation may be due to the negligence of environmental information disclosure in China's commercial banks and the inconsistent timing of the disclosure of environmental information across listed banks. The average value of the capital adequacy ratio is 12.61%, and the median is 12.37%, indicating that the distribution of capital adequacy ratio is right-skewed. Simultaneously the minimum value is 10.07%, revealing that some banks have greater pressure on capital replenishment. The non-performing loan ratios of listed banks are within
a reasonable range and have shown a gradual decline in recent years. The standard deviations of the
cost-to-income ratio and the deposit-loan ratio are both large, indicating that the cost-to-income ratio and
the deposit-loan ratio fluctuate greatly, and there is a significant difference in the level of operation and
management among banks.

| Variables | Mean   | Standard Deviation | Minimum value | Media value | Maximum value | Observed value |
|-----------|--------|--------------------|---------------|-------------|---------------|----------------|
| ROA       | 1.0017 | 0.2109             | 0.4823        | 1.0019      | 1.4666        | 258            |
| EDI       | 0.4733 | 0.1383             | 0.1000        | 0.5000      | 0.7500        | 258            |
| NID       | 2.2692 | 0.4671             | 1.3200        | 2.2700      | 4.2682        | 258            |
| CAR       | 12.6072| 1.4706             | 10.0700       | 12.3650     | 16.7700       | 258            |
| NPL       | 1.2269 | 0.4345             | 0.4000        | 1.2300      | 2.3900        | 258            |
| CIR       | 31.4835| 6.0806             | 20.520        | 30.5150     | 56.5700       | 258            |
| DLR       | 71.3499| 11.6487            | 42.1900       | 71.0500     | 109.4886      | 258            |

Below is a graph of trends in the development of environmental information disclosure index of different
types of commercial banks based on statistical data.

From the above statistical description and the graph of the development trend of environmental
information disclosure index, we can see that the level of environmental information disclosure
development of listed banks in China is still relatively low, and the development varies greatly among
different types of banks. For large commercial banks, the development of environmental information
disclosure has been relatively synchronised and the level of environmental information disclosure has
been steadily increasing. Among joint-stock commercial banks, Industrial Bank, as an ‘equator bank’,
excelled in the development of environmental information disclosure. However, there are still relatively
large gaps in the development of environmental information disclosure by city commercial banks and
rural commercial banks. Among them, Shanghai Bank performed well in environmental information
disclosure overall, and Ningbo Bank's environmental information disclosure improved faster.

3.4.2. Empirical estimation analysis

First of all, examine the impact of environmental information disclosure on the bank's current financial
performance. See the first column in Table 3, the results show that EDI is significantly positively related to
ROA at the 1% level. This indicates that environmental information disclosure does result in the increased
bank financial performance. Environmental information disclosure means that the bank has undertaken
and fulfilled its environmental responsibilities, displayed and passed a good image of social
responsibility awareness to the society, thereby obtaining policy support including environmental protection subsidies and tax incentives provided by regulatory authorities, thus hypothesis 1 is supported.

Then examine the intertemporal impact of environmental information disclosure on bank financial performance. See the second and third column in Table 3, the regression results show the relationship between environmental information disclosure and the lagged bank financial performance. When environmental information disclosure spans one year, the impact on bank financial performance is significantly related at the level of 10% and the regression coefficient is 0.1264. This is, for every one percentage point increase in the level of environmental information disclosure in the current period, the bank financial performance is expected to increase by 0.1264 percentage points in the next year. It is mainly attributed to the lag effect of banks’ environmental information disclosure. It takes a process for stakeholders to respond from the bank's environmental information disclosure, and then transform it into financial performance. While in a two-year inter-period analysis, it is found that the bank's environmental information disclosure has no significant impact on inter-period financial performance. This shows that the intertemporal impact of environmental information disclosure on the financial performance of banks does exist, but this impact generally only lasts for one period, which proves the hypothesis 2. The possible explanation is that the current environmental information disclosure is only at the stage of oath, and the mechanism of environmental information disclosure has not really been brought into play, so that environmental information disclosure cannot be effectively transformed into productivity to promote financial performance, resulting in its limited ability to influence business performance. In addition, the environmental information disclosure by banks reflects their social responsibility commitment, which mainly brings to banks the influence of reputation and social status, which is time-sensitive and gives an impact on banks’ financial performance in a short period of time, but this reputation effect may disappear in a long time. However, with the development of green finance, the breakthrough of the bottleneck of financial technology will be translated into the impact on banks’ financial performance from the operational cost and governance efficiency, which in turn makes the impact of environmental information disclosure quality on financial performance have a long-term effect.
Table 3
The impact of environmental information disclosure on banks' financial performance.

| Variables | ROA     | L.ROA   | L2.ROA  |
|-----------|---------|---------|---------|
| Current period | One-period lag | Two-period lag |
| EDI       | 0.2305*** | 0.1264* | 0.0088  |
|           | (3.70)   | (1.92)  | (0.13)  |
| NID       | 0.0375   | -0.0208 | -0.0688*|
|           | (0.86)   | (-0.47) | (-1.68) |
| CAR       | 0.0522***| 0.0547***| 0.0550***|
|           | (6.36)   | (6.54)  | (6.36)  |
| NPL       | 0.0058   | 0.0565  | 0.0931**|
|           | (0.18)   | (1.60)  | (2.37)  |
| CIR       | -0.0104***| -0.0092***| -0.0076***|
|           | (-5.31)  | (-4.28) | (-3.26) |
| DLR       | -0.0004  | -0.0003 | 0.0005  |
|           | (-0.42)  | (-0.26) | (0.35)  |
| Constant C| 0.6708***| 0.5152***| 0.6404***|
|           | (3.73)   | (2.97)  | (3.17)  |
| Year fixed effect | Yes | Yes | Yes |
| bank fixed effect | Yes | Yes | Yes |
| N         | 258     | 228    | 198    |
| adj. $R^2$| 0.5698  | 0.5424 | 0.5203 |

Notes: ***, ** and * represent significance levels of 1%, 5% and 10%, respectively. The standard errors of the estimates are reported in parentheses.

3.4.3. Robustness test

To ensure the reliability of the conclusions obtained, this paper conducted a series of robustness tests. The results are presented in Table 4:

1. Changing the method of measuring bank financial performance. The main analysis in the article uses the return on total assets (ROA) to measure financial performance, and the following uses the
return on net assets (ROE) as an auxiliary proxy variable to examine the impact of environmental information disclosure on bank financial performance. See the first column in Table 4, the results are still positively related significantly.

2. Changing the sample period. This article further divides the sample into two periods, as shown in second and third column of Table 5. The second column is the sample regression result from 2009 to 2013, and the third column is the sample regression result from 2014 to 2019. The results show that the EDI coefficients of the two periods are significantly positive, indicating that the conclusion of this article do not change due to the change of the sample period, and the relationship between environmental information disclosure and bank financial performance remains stable.

3. Eliminating extreme values. Earlier in this article, the sample was subjected to a 1% tail-shrinking treatment. On this basis, the sample was further treated with 5% tail-shrinking at both ends to reduce the possible negative impact of extreme items on the regression results. See the fourth column in Table 4, the results indicate that the regression results after the above-mentioned tailing treatment have not changed substantially.

| Variable | 2009 ~ 2013 | 2014 ~ 2019 |
|----------|-------------|-------------|
|          | (1) (2) (3) (4) |             |
| ROE      | ROA         | ROA         | ROA         |
| EDI      | 4.2395***   | 0.2272**    | 0.1848**    | 0.2280***   |
|          | (4.09)      | (2.15)      | (2.12)      | (3.71)      |
| Controls | Yes         | Yes         | Yes         | Yes         |
| Constant C | 21.8254*** | 0.2384      | 0.6447***   | 0.5011***   |
|          | (8.52)      | (0.58)      | (3.04)      | (2.72)      |
| Year fixed effect | Yes | Yes | Yes | Yes |
| Bank fixed effect | Yes | Yes | Yes | Yes |
| N        | 258         | 98          | 160         | 258         |
| adj. $R^2$ | 0.7058     | 0.4655      | 0.5037      | 0.5887      |

Notes: ***,** and * represent significance levels of 1%, 5% and 10%, respectively. The standard errors of the estimates are reported in parentheses.

3.4.4. Endogenous test

Aiming at the endogenous problems that may arise from the above-mentioned baseline regression results, this paper uses a two-stage instrumental variable method to examine. Refer to the research of Bai
and Liu (2021), choosing the one-period lag (L.EDI) and two-period lag (L2.EDI) of the environmental information disclosure index as the instrumental variables of Edi. See the first and second column in Table 5, the first-stage F value of instrumental variables is 142.404, indicating that instrumental variables are highly correlated with Edi, and there is no weak instrumental variable problem. Simultaneously the Hansen J statistic of the over-identification test is 0.001, which satisfies the exclusion hypothesis of instrumental variables. The Edi coefficient in the second column is significantly positive at the level of 5%, indicating that the conclusion that environmental information disclosure can improve bank financial performance is robust after considering the missing variables and other issues.

| (1)                      | (2)                      |
|--------------------------|--------------------------|
| Variable                 | EDI                      | ROA                      |
| The first-stage          |                          |                          |
| EDI                      | 0.2978**                 | 0.2978**                 |
|                          | (2.90)                   |                          |
| L.EDI                    | 0.7240***                |                          |
|                          | (12.27)                  |                          |
| L2.EDI                   | 0.1187**                 |                          |
|                          | (2.13)                   |                          |
| Controls                 | Yes                      | Yes                      |
| Constant C               | 0.1657*                  | -0.1493                  |
|                          | (1.69)                   | (-0.84)                  |
| Year fixed effect        | Yes                      | Yes                      |
| Bank fixed effect        | Yes                      | Yes                      |
| N                        | 198                      | 198                      |
| adj. $R^2$               | 0.6889                   | 0.6275                   |

Notes: ***, ** and * represent significance levels of 1%, 5% and 10%, respectively. The standard errors of the estimates are reported in parentheses.

4. Further Research

4.1. Heterogeneity analysis
In view of the obvious differences in the scale of assets, property rights and business areas of different banks, this article refers to the research of Xiong et al. (2021) to group the sample banks. The large state-owned banks and joint-stock banks are merged into country banks (Country), and city listed banks and rural listed banks are merged into local banks (Local), to examine whether there are differences in the impact of environmental information disclosure on bank financial performance in the two samples. Figure 4 plots the trend of changes in the average value of environmental information disclosure levels for different types of banks. Although the absolute level of environmental information disclosure is not high, it still shows an upward trend in general. In addition, there are differences in the level of environmental information disclosure of different types of banks. The level of environmental information disclosure of country banks is significantly higher than that of local banks.

Table 6 reports the group regression results of the sample banks. The results show that the regression coefficient of $Edi$ is significantly positive for country banks regardless of whether it is the current period or two lagging periods. While the $Edi$ regression coefficient of local banks is significantly positive only when they lag by two periods, indicating that the performance improvement brought by the environmental information disclosure of local banks is more time-lagging than that of country banks. It may be that the difference in the nature of commercial banks’ equity brings about differences in their governance structure, investment and financing management, etc., and the impact of their environmental information disclosure on financial performance also differs to some extent. Large state-owned and joint-stock banks are affected by political factors, and their policy execution ability and efficiency are higher than that of city listed banks and rural listed banks, so environmental information disclosure is relatively mature. Furthermore, the positive externalities brought by social responsibility have gradually emerged, making environmental information disclosure have a significant positive effect on bank performance. In contrast, urban and rural commercial banks are still in the initial development stage of carrying out environmental information disclosure. During this period, most of the projects are less profitable, the preliminary assessment cost is high, and the reputation effect cannot be formed in a short period of time, which leads to their low motivation to disclosure environmental information and thus has a certain lag in performance improvement.
Table 6
Heterogeneity analysis regression results.

| Variable | (1) | (2) | (3) | (4) | (5) | (6) |
|----------|-----|-----|-----|-----|-----|-----|
|          | Country | Local | Country | Local | Country | Local |
| EDI      | 0.1627** | 0.0205 |       |     |     |     |
|          | (2.37) | (0.10) |       |     |     |     |
| L.EDI    |       | 0.1619** | 0.0807 |     |     |     |
|          |       | (2.28) | (0.33) |     |     |     |
| L2.EDI   |       | 0.1874** | 0.4838** |     |     |     |
|          |       | (2.44) | (2.05) |     |     |     |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Constant | 0.5177*** | 1.7688*** | 0.5309** | 1.8543*** | 0.4513** | 1.6156** |
|          | (2.71) | (4.45) | (2.61) | (4.12) | (2.18) | (2.49) |
| Year fixed effect | Yes | Yes | Yes | Yes | Yes | Yes |
| Bank fixed effect | Yes | Yes | Yes | Yes | Yes | Yes |
| N        | 180 | 78 | 163 | 65 | 146 | 52 |
| adj. $R^2$ | 0.7173 | 0.4053 | 0.7102 | 0.4224 | 0.7233 | 0.4782 |

Notes: ***, ** and * represent significance levels of 1%, 5% and 10%, respectively. The standard errors of the estimates are reported in parentheses.

4.2. Influence mechanism analysis

In the benchmark regression analysis section, this paper empirically tests the positive incentive effect of environmental information disclosure on banks' financial performance, but do their effects change among themselves depending on the level of other variables? This paper further analyzes whether the direction and extent of the effect of environmental information disclosure on banks' financial performance is significantly influenced by the regional green development environment.

Nowadays, green development has become a new engine for high-quality economic development. Some scholars have analyzed the connotation of green development from the perspectives of growth quality, green living, and environmental governance. They claim that green development is the separation of economic growth from high consumption and high emissions with the support of green policies and related systems, thus forming a resource-saving and environment-friendly society (Hu and Zhou, 2014; Shi, 2018). Through the previous analysis, the impact of environmental information disclosure on banks' financial performance also depends, to some extent, on the level of green development of society. Specifically, the level of green development of the bank's environment affects the bank's motivation to
disclose environmental information, and environmental information disclosure acts on the cost of capital incurred in the bank's business process. In the process of increasing the level of green development, the public's environmental awareness increases. In building a green reputation, banks that disclose environmental information are more likely to absorb low-cost funds and reduce financing costs by expanding customer resources and carrying out green projects, thus having an impact on bank performance. In view of this, based on the previous analysis, this paper introduces the green development environment and examines its moderating effect on the relationship between environmental information disclosure and bank financial performance.

For the measurement of green development environment, this paper refers to the study of Zhang et al. (2020) and chooses the green development index (GDI) as the measurement index of regional green development level. The green development index is derived from the China Green Development Index Report, which discloses in detail the inter-provincial and urban green development indexes of China in previous years. For urban listed banks and rural listed banks, this paper adopts the green development index of the province where the head office is located; for large state-owned banks and national joint-stock banks, since the report does not disclose the national green development index, this paper draws on Zhang et al. (2020) and adopts the weighted average sum of the inter-provincial green development index instead, with the weight being the proportion of each province's (city's) GDP to the national GDP.

Based on the research of Wen et al. (2005), this paper adds the green development index (GDI) and the product term of environmental information disclosure and green development index (EDI*GDI) on the basis of model (3), and the model is as follows:

\[
ROA_{i,t} = \beta_0 + \beta_1 \times EDI_{i,t} + \beta_2 \times GDI + \beta_3 \times GDI \times EDI + \gamma \times Controls_{i,t} + u_i + n_t + \epsilon_{i,t}
\]

The first column in Table 7 reports the regression results of model (6). The results show that the regression coefficient of EDI*GDI is significantly positive, indicating that when the level of green development is high, the environmental information disclosure of banks has a greater positive impact on financial performance. The improvement of regional green level provides a good green development environment for local banks to carry out environmental information disclosure, which reduces the cost of capital in the operation process of banks and thus improves their financial performance.

In addition, the Green Development Index GDI includes three first-level indicators. One is the degree of greening of economic growth (GDE), which includes indicators such as green growth efficiency and development of three industries, reflecting the degree of resource consumption and environmental pollution in economic activities. The second is the bearing potential of resources and environment (GDR), including abundant resources and ecological protection, environmental pressure and climate change, reflecting the quality of regional ecology and environment and the richness of natural resources; the third is government policy support (GDS), including indicators of green investment, infrastructure and environmental governance, reflecting the government's support and response to green development.
Among them, the carrying potential of resources and environment represents the local natural endowment and reflects the "green" aspect of green development, while the greenness of economic growth and government policy support represent the contribution of local economy and policies to green development and reflect the "development" aspect of green development.

In order to further clarify the impact of different green development dimensions on the economic benefits of banks' environmental information disclosure, this paper uses GDE, GDR and GDS as indicators of the level of green development, and regression analysis of model (6) is conducted again. See the second, third and fourth columns of Table 7, the results show that the coefficients of EDI*GDE and EDI*GDS are significantly positive, indicating that under the conditions of high green economic growth, banks' environmental information disclosure is conducive to attracting more investment in green projects and better profit prospects; meanwhile, the government's strengthening of policy support for green development is conducive to increasing banks' business development space and reducing the capital in the operation process Costs. Therefore, environmental information disclosure has a relatively positive impact on the financial performance of banks. However, the coefficient of EDI*GDR is significantly negative, revealing that the carrying potential of resources and environment does not enhance the economic benefits from banks' environmental information disclosure. The reason for this may be that the carrying potential of the resource environment is closely related to natural endowment. Compared with the western region, the eastern region, where the sample banks are concentrated, has poorer natural endowment conditions, which means that the level of "greenness" in the region will not promote banks' environmental information disclosure to improve their financial performance. Only when the region actively develops a green economy and provides corresponding policy support to fully protect or rationally utilize ecological resources, can bank environmental information disclosure lead to better economic performance.
Table 7
Regression results of the adjustment effect of the green development environment.

| Variable       | (1)     | (2)     | (3)     | (4)     |
|----------------|---------|---------|---------|---------|
| EDI            | 0.1651**| 0.1852***| 0.1128* | 0.1452**|
|                | (2.35)  | (2.77)  | (1.70)  | (2.05)  |
| EDI*GDI        | 0.2098* |          |         |         |
|                | (1.74)  |          |         |         |
| EDI*GDE        |         | 0.4024** |         |         |
|                |         | (2.00)   |         |         |
| EDI*GDR        |         |         | -0.7963***|        |
|                |         |         | (-2.73) |         |
| EDI*GGR        |         |         |          | 0.5106* |
|                |         |         |          | (1.87)  |
| Controls       | Yes     | Yes     | Yes     | Yes     |
| Constant C     | 0.8128***| 0.7420***| 0.7365***| 0.8320***|
|                | (6.03)  | (5.77)  | (5.91)  | (6.32)  |
| Year fixed effect| Yes     | Yes     | Yes     | Yes     |
| Bank fixed effect| Yes     | Yes     | Yes     | Yes     |
| N              | 258     | 258     | 258     | 258     |
| adj. $R^2$     | 0.5761  | 0.5495  | 0.5637  | 0.5502  |

Notes: ***, ** and * represent significance levels of 1%, 5% and 10%, respectively. The standard errors of the estimates are reported in parentheses.

5. Conclusion

This paper compares the content of banks' environmental information disclosure, constructs a scoring system, and then empirically investigates the effect of environmental information disclosure on financial performance by studying the annual reports, social responsibility reports, and sustainability reports of 30 Chinese listed banks from 2009–2019. The main finding of the study is that an increase in the level of environmental information disclosure can improve banks' financial performance; however, the effect of this effect is intertemporal and diminishes year by year. Regressing banks into national and local bank groups, it is found that the effect of environmental information disclosure on financial performance is more pronounced for national banks, while this effect has a lag for local banks. In further analysis of the
influence mechanism, it is found that the regional green development environment plays a moderating role between environmental information disclosure and banks' financial performance, i.e., the level of regional green development enhances the positive influence of banks' environmental information disclosure on financial performance.

These research findings are enlightening for fully understanding the relationship between environmental information disclosure and bank financial performance, and listed banks to improve environmental information disclosure to promote green financial development and ecological civilization construction.

First, listed banks should actively carry out environmental information disclosure work and continuously improve the quality of environmental information disclosure. Environmental information disclosure is not only a social responsibility of listed banks to establish a good social image, but also a re-examination of their own environmental and climate risks. At the same time, high-quality and more complete information disclosure can not only help banks respond more comfortably to changes in the regulatory environment under strict disclosure supervision requirements, but also help investors assess the banks' own value. Therefore, listed banks must recognize the positive impact of environmental information disclosure on their financial performance, in addition to its public good of environmental protection, especially as the economic benefits of environmental information disclosure by banks are growing with the improvement of regional green development.

Second, explore incentive mechanisms for environmental information disclosure in different types of banks and implement differentiated strategic measures. Due to the late mandatory environmental information disclosure by Chinese financial institutions, the cost for banks to carry out environmental information disclosure is large, and compared to the well-funded state-owned banks and joint-stock banks, urban and rural commercial banks will be less motivated to carry out environmental information disclosure. Therefore, state-owned banks should be guided to further standardize their environmental information disclosure system, give full play to the positive impact and driving effect of environmental information disclosure on business performance, increase the amount of financial subsidies according to the size of each commercial bank and policy implementation, and establish a perfect financial and tax compensation mechanism to motivate small and medium-sized banks to carry out environmental information disclosure. At the same time, we will enhance the interaction and sharing of resources between state-owned banks and non-state-owned banks, making full use of the strong capital and advanced technology of state-owned banks and the flexible organizational structure and stronger development vitality of non-state-owned banks, so that they can work together to improve the quality of environmental information disclosure and its financial performance.

Third, government departments should accelerate the development and implementation of unified environmental information disclosure standards to provide clear guidelines for financial institutions. On the basis of the "Guidelines for Environmental Information Disclosure by Financial Institutions (for Trial Implementation)", further improve and formulate environmental information disclosure standards applicable to various types of financial institutions, establish a system of key quantitative indicators for
environmental information disclosure related to investment and financing activities of financial institutions, and provide specific operational guidelines for the collection, analysis and disclosure of environmental information. At the same time, government departments should make efforts to improve the level of local green development and provide a favorable green development environment for listed banks to carry out environmental information disclosure, thus increasing their enthusiasm for environmental information disclosure.

Finally, all sectors of society should jointly promote environmental information disclosure to better utilize the green reputation effect, thereby reducing the cost of disclosure. Among them, listed banks should disclose their green financial strategies and measures in accordance with the environmental information disclosure standards of financial institutions and strengthen green data disclosure, thus establishing their green image and enhancing the brand awareness of green finance. The news media should strengthen the dissemination of green information, increase the coverage of listed banks' behavior of improving environmental information disclosure, reduce information asymmetry, smooth the channels of environmental information disclosure, and play the role of banks' green reputation. On the one hand, government departments should improve the environmental information disclosure system and promote the economic disclosure of green information of listed banks so that the public and investors can grasp and monitor the fulfillment of banks' environmental responsibilities; on the other hand, green education activities should be vigorously carried out to strengthen the publicity and guidance of green investment. As a result, stakeholders such as the public and investors will give priority to banks with high green reputation in their economic decisions.

This study also has some limitations. First, manual scoring was used in the content analysis to evaluate banks' environmental information disclosure, which is subjective to some extent. Then, this study only took some data from Chinese listed banks. Future studies could include a more comprehensive sample to examine the impact of environmental information disclosure on banks' financial performance.

**Declarations**

**Author contribution** Bin Xi: responsible for the idea of this manuscript, software provision, revision of this manuscript and language checking

Jiali Dai: investigation, conceptualization, formal analysis and writing original draft

Yun Liu: conceptualization, review and editing, supervision

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**Data availability** The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request

**Ethics approval** I would like to declare on behalf of my co-authors that the work described was an original research that has not been published previously and not under consideration for publication elsewhere, in
Consent to participate  Informed consent was obtained from all individual participants included in the study.

Consent for publication  The participant has consented to the submission of the article research to the journal.

Competing interests  The authors declare no competing interests

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Figures
Figure 1

The development trend of environmental information disclosure index of large commercial banks. The environmental information disclosure index of each bank in the chart is broadly consistent.

Source: Based on social responsibility reports of listed banks and manual collation
The development trend of environmental information disclosure index of joint-stock commercial banks. Among them, Industrial Bank, as an 'equatorial bank', has maintained a relatively stable and high trend.

**Source:** Based on social responsibility reports of listed banks and manual collation
Figure 3

The development trend chart of environmental information disclosure index of part of city commercial banks and rural commercial banks. The level of environmental information disclosure development of city commercial banks and rural commercial banks overall are below large commercial banks.

Source: Based on social responsibility reports of listed banks and manual collation
Figure 4

The trend of changes in the average value of environmental information disclosure levels for different types of banks. The upper and lower bars represent the plus or minus 1 unit standard deviation of the sample in the current year.

Source: Based on social responsibility reports of listed banks and manual collation