The Impact of Environmental Information Disclosure on Enterprise Value

-- The Moderating Role of Institutional Shareholding and the Nature of Ownership

Yutong Song

Inner Mongolia University, Hohhot 010000, China.

Songyutong200105310023@163.com

Abstract. The construction of ecological civilization and the development of green finance have gradually become the theme of the times, so it is particularly important for enterprises to gradually realize voluntary scientific environmental information disclosure. This paper examines the "U" curve relationship between the quality of environmental information disclosure and enterprise value, as well as the moderating effects of institutional shareholding ratio and nature of ownership, using heavy pollution enterprises in Shanghai and Shenzhen of A-shares from 2015 to 2019 as a research sample. The results show that the relationship between environmental information disclosure and enterprise value of heavy polluters has a relationship of positive "U"-shaped curve; institutional shareholding has a positive moderating effect on the value effect of environmental information disclosure; the nature of ownership shows significant heterogeneity in the effect of environmental information disclosure on enterprise value, and the "U"-shaped value effect of environmental information disclosure of non-SOEs has a positive effect on the value effect of environmental information disclosure of heavy pollute enterprises. The "U"-shaped value effect of environmental information disclosure is more significant for non-SOEs. In further research, this paper conducts robustness analysis of enterprise value, monetary environmental information disclosure and non-monetary environmental information disclosure and endogeneity test. The findings of the study provide empirical evidence for improving the environmental information disclosure system and strengthening the supervision of SOEs, and also provide useful references for enterprises to comprehensively understand the value effect of environmental information disclosure, establish a management mechanism for enterprise environmental information disclosure and correctly view the importance of institutional investors.

Keywords: Environmental Information disclosure; Enterprise value; U-shaped relationship.

1. Introduction

In today's world, high economic growth is accompanied by the gradual deterioration of the environment, and in order to achieve long-term sustainable development, environmental issues have become a focus of concern for all sectors of society. As one of the main subjects of environmental pollution and damage, the extent to which the heavily polluting enterprises fulfill their responsibilities for environmental protection is naturally gaining strong attention from the public, stakeholders, regulators and other parties, thus also forcing management to consider environmental performance and environmental information disclosure in their corporate management. However, the various costs required to be invested for environmental protection in the traditional concept are inherently conflicting with the goal of maximizing enterprise interests, and merely voluntary environmental information disclosure suffers from generally low disclosure quality, incomplete, untrue, irregular or even non-disclosure of disclosed information. The "Evaluation Report on Environmental Responsibility Disclosure of Chinese Listed Companies" released in 2018 shows that less than 30% of the valid sample companies among listed companies in Shanghai and Shenzhen stocks issued relevant environmental responsibility reports, social responsibility reports and sustainable development reports in 2018. The study of the impact of the quality of environmental information

disclosure on the ultimate goal, corporate value of enterprises, is of great theoretical relevance to the survival and development of heavy pollute enterprises in today's policy and social environment.

Some researchers have argued that making environmental information disclosures can reduce the value of a firm because of potential environmental inputs and risks. Jianan Cai et al [1] found that environmental information disclosure has a significant negative impact on borrowing size, arguing that it is the environmental information that exposes the company's environmental risks, and can trigger creditors' concerns about the company's normal operations and debt service. However, Yude Xu et al [22]found that firms with high quality of information disclosure have significantly lighter bank financing constraints, and the effect of rising disclosure quality on new bank borrowing is more significant for non-state-owned firms. This suggests that increasing level of environmental disclosure can mitigate the negative impact of potential environmental risks on firm value. From a systems management perspective, Bei Lv et al[11] found a negative relationship between environmental information disclosure and firm value through the mediating effect on firm risk. Some scholars have also studied the impact of environmental information disclosure in conjunction with its effect on financial performance, expected cash flows and financing costs. Li Ren et al[13] found that environmental information disclosure has no effect on the cost of capital, but hard disclosure information has a negative effect on expected cash flows because the market believes that information on enterprise environmental expenditures is latent behind the disclosure. Kai Chang et al[2] empirically proved that environmental information disclosure through its effect on financial performance is significantly negatively related to firm value. Xuexin Liu et al[9] empirically demonstrate that increasing the level of carbon information disclosure increases the long-term value of firms through reducing the cost of equity financing.

But another part of researchers hold the opposite view. Yongjun Tang and Wenchao Ma et al.[16]empirically tested that the improvement of environmental information disclosure quality has a significant contribution to firm value, using unbalanced panel data of listed companies in heavy pollution industries from 2010 to 2016. Wen Dai et al[5]found that the quality of enterprise environmental information disclosure is positively related to enterprise value and that institutional stockholders can mitigate the value effect of environmental information disclosure. Based on empirical data of heavily polluting listed companies, Chengang Ye et al[23] found that the quality of environmental information disclosure has significantly negative relationship with the cost of equity financing. In terms of enterprise equity financing, Hongtao Shen et al[14]also found that environmental information disclosed by Chinese companies can significantly reduce the cost of equity capital, using a sample of listed companies in the heavy pollution industry. Hongjun Wu et al[20] also found that the level of environmental information disclosure is positively related to environmental performance through a study of listed companies in the chemical industry, and that high quality of environmental information disclosure can significantly reduce the cost of equity capital of enterprises. In terms of banking enterprise financing, Juan Ni et al[12]empirically found that environmental information disclosure can alleviate the degree of information asymmetry between banks and enterprises and reduce the bond financing cost of enterprises. It can be inferred that enterprise value can be improved by the reduction of financing cost when the level of environmental information disclosure is increased. In terms of expected cash flow effect, Shuhui Zhang et al[24] found that improving the quality of environmental information disclosure can improve enterprise value through the increase of expected cash flow, but the effect on reducing the cost of capital of enterprises is not significant. In terms of financial performance effect, Subin Wen et al[19] found that carbon information disclosure has a significant positive effect on financial performance in terms of return on assets and return on net assets.

However,Some scholars argue that the effect of environmental information disclosure on firm value can not be illustrated by a single linear relationship. Huiyun Li et al [8] found that the level of carbon information disclosure showed a significant “U”-shaped influence relationship on enterprise value through the mediation of media attention. Xuexin Liu et al[9] found that increasing the level of carbon information disclosure can significantly increase the long-term value of the firm by reducing

the cost of equity financing, but has no effect on the short-term value of the firm. While from the public pressure perspective,Xiaohua Song et al[15] made an empirical study found that the effect of environmental information disclosure on the short-term value of enterprises showed a “U”-shaped effect, and the effect on the long-term value of enterprises showed a positive contribution.

In summary, this paper analyzes the relationship between environmental information disclosure and enterprise value by taking heavy pollute enterprise as the research object and introducing institutional shareholding ratio and nature of ownership as moderating variabless. The main contributions of this paper are: (1) The logic of the influence of environmental information disclosure on enterprise value is systematically organized through legitimacy theory and information transmission theory, and the "U"-shaped value effect of environmental information disclosure is empirically tested. (2) From the perspective of institutional shareholders, we investigate the contribution of their existence to the value effect of environmental information disclosure, and take into account the proportion of institutional shareholding in enterprise management. (3) After grouping the samples according to the nature of ownership, the relationship between environmental information disclosure and enterprise value is further analyzed heterogeneously to provide a policy basis for the government to strengthen environmental regulation of SOEs.

2. Theoretical analysis and research hypothesis

2.1 Environmental information disclosure and Enterprise value

According to the legitimacy theory, the production and operation activities of enterprises should conform to the dominant social values and public morality in order to seek a good image in the eyes of the society and the public, and to obtain a legitimate status that enables them to survive and develop continuously. And in today's social context of promoting green development and environmental protection, it has become an important expectation of the public for companies to actively undertake social and environmental responsibility. And Rchardson [29] , through developing a process model linking corporate social responsibility and capital market responses, found that corporate social responsibility behavior and disclosure of behavioral information affects the capital market process, has cash flow consequences for the firm, and influences the discount rate and affects financial performance. Enterprise’s behavior of proactively undertaking social responsibility affects enterprise value by influencing the expected cash flow[12][24], equity financing cost [9], and financial performance [2][19] of the company. On the one hand, heavy pollute enterprse's active participation in environmental information disclosure can eliminate the stereotypical pollution impression of society, establish an image of taking social environmental responsibility and complying with social standards, establish their legitimacy status, and gain the ability to operate and product continuously. A good social legitimacy status also means a reduction of potential future environmental lawsuits, penalty losses and financial risk for the firm, therefore, gaining favor from market investors and consumers, and having predictable cash inflows. Hasseldine[26] empirically demonstrates that information disclosure helps protect a firm's environmental reputation and protects its reputation from competitors. Social reputation, as an intangible asset, can also be a good way to enhance enterprise value. On the other hand, participation in environmental information disclosure means that companies need to increase their investment costs in environmental pollution control and environmental protection in order to truly reveal their image of quality environmental protection to the public. The potential environmental management activities under environmental information disclosure, such as research and development of environmental protection technology, upgrading of environmental protection equipment, and treatment of waste pollutants, will result in an inflated environmental protection investment in the accounting accounts, but in the short term, no increase in productivity is achieved through technological innovation and no increase in revenue, i.e., the marginal cost of environmental protection investment is greater than the marginal revenue. And the increase in environmental protection input costs will have a crowding-out effect on the company's regular operations, scale expansion and other expenditures, which is not conducive to business and enterprise

value growth. In short, there are costs and benefits for companies to gain legitimacy, and as the quality of environmental information disclosure improves, there is a critical point at which the value of the company increases or decreases.

Based on the signaling theory, environmental information disclosure by enterprises, as the dominant information subject, can make stock market investors more aware of the management and social responsibility of enterprises, and alleviate the degree of information asymmetry between enterprises and investors. High-quality environmental information disclosure contains effective environmental management information, which can be well integrated into the share price in an effective securities market, resulting in higher share price, more enterprise financing, and expected cash flow, which is conducive to higher enterprise value. At the same time, high quality environmental information disclosure is a signal that means the company has excellent environmental performance, so that investors face lower investment risk, and high quality information environmental information disclosure effectively reduces the cost of information gathering for investors, therefore, investors will demand lower investment returns. In this logic, firms make high quality environmental information disclosure can reduce the cost of equity capital and thus increase the value of the firm. Milgrom[28] tested the effect of good signals and bad signals on the share price of firms by developing an information economy model. Firms do not disclose information that is unfavorable to them, so firms with poor environmental performance also have low levels of environmental information disclosure and only perform impression management in a vague manner[20]. Therefore, for firms that make low-quality environmental information disclosures, investors perceive their low-quality disclosures as a desire to cover up negative environmental information. In other words, low quality environmental information disclosure is a bad sign of low environmental performance and investors will have pessimistic expectations about the firm, which will reduce the firm value. Low-quality environmental information disclosure does not allow investors to obtain effective information from the market, thus increasing their information gathering costs, increasing the financing costs of firms, and decreasing firm value. Based on the system management perspective, Bei Lv[11] and others empirically concluded that while enterprises make environmental information disclosure, it slows down the capital turnover of enterprises, causes uncertainty in operating efficiency, raises the business risk of enterprises, and reduces the enterprise value. And environmental information will disclose the environmental risk of the enterprise, which triggers creditors' concern about the normal production and operation and debt service of the enterprise[1]. Therefore, environmental information disclosure is a signal of business risk to pessimistic investors, which can increase investors' expected investment returns and crowd out enterprise profits. And high-quality information disclosure can significantly reduce credit risk for creditors, which in turn reduces the financing constraints of firms[22]. Therefore, this study argues that as the quality of environmental information disclosure increases, firm value decreases and then increases. Based on the above analysis, this study proposes hypotheses:

Hypothesis 1: There is a positive "U"-shaped relationship between the quality of environmental information disclosure and enterprise value. On the left side of the critical point a, the enterprise value decreases as the quality of environmental information disclosure increases; on the other side, the enterprise value increases as the quality of environmental information disclosure increases.

2.2 The moderating role of institutional shareholding in the relationship between the quality of environmental information disclosure and enterprise value

Institutional investors have a deep professional and information advantage, and have good foresight into the future development of companies, and can glimpse the potential value enhancement due to the social responsibility of companies to fulfill environmental protection. However, whether investors will pay more attention to the long-term value enhancement behind environmental performance or short-term immediate interests will make a difference in the importance they place on the level of environmental information disclosure. By dividing China's institutional investors into long-term and short-term investors, Wenjing Li et al[7] found empirically that environmental

performance only has an effect on the shareholding percentage of long-term institutional investors, and has no effect on the shareholding percentage of short-term institutional investors. Therefore, short-term institutional investors do not care about the environmental performance of firms when they choose firms to hold shares, and based on signaling theory, low environmental information disclosure is a signal of low environmental performance [25] , it can be assumed that the shareholding ratio of short-term institutional investors is higher when there is lower quality of environmental information disclosure. In contrast, long-term institutional investors are more inclined to hold stocks of firms with high levels of environmental disclosure due to the fact that they are more focused on the role of corporate legitimacy. Institutional investors, having the ability to check and balance shareholders and information advantage, play a pivotal role in monitoring enterprise social responsibility[18]. Therefore, long-term investors, who are more concerned about the role of environmental performance and enterprise legitimacy, will play a good role in monitoring and restraining management behavior to urge them to improve the level of enterprise environmental management and increase the level of voluntary environmental information disclosure, which further promotes the enhancement of enterprise value. And yet concentrated short-term investors at low levels of environmental disclosure, due to their short-sightedness, care more about their own short-term interests and conspire with management to form a strategic conspiracy, resulting in ignoring the environmental performance of the company, which increases the business risk of the company and the potential for pollution penalties, further reducing the value of the company. Therefore, institutional shareholding contributes to the increase of enterprise value at high levels of environmental information disclosure and the decrease of enterprise value at low levels of environmental information disclosure, i.e., it significantly contributes to the "U" shaped relationship between environmental information disclosure and enterprise value. Based on the above analysis, this study proposes the following hypotheses.

Hypothesis 2: Institutional shareholding has a positive moderating effect on the relationship between the quality of environmental information disclosure and enterprise value. A high level of institutional shareholding can lead to a more significant "U" shaped relationship between the quality of environmental information disclosure and enterprise value.

2.3 The moderating role of the nature of ownership in the relationship between the quality of environmental information disclosure and Enterprise value

Political factors play an important role in environmental information disclosure. Compared with non-state-owned enterprises(non-SOEs), state-owned enterprises (SOEs) receive more preferential support from national policies, have less regulation, and have a relatively non-profit-oriented nature, which results in stronger inertia in production and operation and lower operational efficiency[4] . Non-SOEs also have lower political legitimacy in society because of their weaker political ties compared to SOEs. In order to improve their market competitiveness and achieve their profit-seeking purpose, non-SOEs need to actively fulfill their social responsibility to increase their political legitimacy, build goodwill, shape their image, develop ways and opportunities to obtain more resources, and consolidate their market position, so their positive impact from disclosing environmental information is relatively higher[16].At the same time, disclosing environmental information requires upfront investment in environmental protection, while non-SOEs have weaker ability to resist business risks and are more prone to capital malfunction leading to lower enterprise value, or even bankruptcy when the improved quality of environmental information disclosure has not brought benefits to compensate for environmental costs. Therefore, compared with SOEs , Non-SOEs are more inclined to make high quality environmental information disclosure, and the high level of environmental information disclosure quality made by non-SOEs has a stronger contribution to enterprise value, and the low level of environmental information disclosure quality made by non-SOEs has a stronger inhibiting effect on enterprise value.Based on the above analysis, this study proposes the following hypothesis.

Hypothesis 3: The nature of ownership moderates the relationship between the quality of environmental information disclosure and enterprise value, and the "U" shaped value effect of environmental information disclosure is more significant in non-SOEs.

3. Research Design

3.1 Sample selection and data sources

This paper takes A-share heavy polluting companies listed on the Shanghai and Shenzhen stock exchanges from 2015-2019 as the research sample, and defines heavy polluting companies according to the Guidelines for Disclosure of Environmental Information of Listed Companies released on September 14, 2020. Data screening and processing process: (1) excluding ST and * ST class companies; (2) excluding data from 6 types of non-heavily polluting industries listed companies such as finance and insurance industry; (3) excluding listed companies engaged in environmental protection business; (4) excluding listed companies with abnormal financial data; (5) excluding listed companies with missing data; The final selection was 481 companies, with a valid sample size of 2410. To eliminate the effect of extreme values interfering with the results of the empirical analysis, the main variables were winsorized.

The environmental information disclosure data were collected manually from Wind database and the websites of listed companies, and the publicly released annual reports, social responsibility reports, sustainability reports and environmental reports of companies. Other data were obtained from CSMAR database and Wind database. The software for data processing was Stata15.0, Matlab and Excel.

3.2 Variable definition

3.2.1 Explanatory variable: environmental information disclosure

Table 1. Selection of environmental information disclosure indicators

Classification	Indicator Setting	Assign values		
		Undisclosed	Qualitatively Disclosed	Both Disclosed
Monetized Environmental Information Disclosure Indicators	Afforestation fees	0	1	2
	Pollutant charge	0	1	2
	Emergency cost for major environmental issues	0	1	2
	Litigation costs arising from major environmental issues; environmental-related damages, fines	0	1	2
	Environmental protection investment or borrowing	0	1	2
	Environmental incentive income	0	1	2
	Benefits of pollution reduction	0	1	2
	Revenue from waste utilization	0	1	2
	Enterprise environmental protection allocation,subsidy and tax reduction	0	1	2
Demonetized Environmental Information Disclosure Indicators	Environmental management objectives	0	1	2
	Environmental information disclosure system	0	1	2
	Environmental protection measures and environmental improvement	0	1	2
	Whether to implement the adopted certification	0	1	2
	Type and amount of resources consumed	0	1	2
	Type and quantity of pollutants	0	1	2
	The condition for pollutant emission compliance	0	1	2
	Is independent social responsibility/sustainability report available?	Yes/0		No/2
	Is independent environmental report available?	Yes/0		No/2

In this paper, content analysis method is used to score and weight the indicators set by the evaluation criteria through reviewing publicly disclosed reports such as annual reports and social responsibility reports of enterprises. For the setting of evaluation criteria and indicators, this paper refers to the study of Jianfeng Wu et al[21] , which divided environmental information disclosure into monetized environmental information disclosure and non-monetized environmental information disclosure from the dimension of whether it can be monetized or not. 9 indicators of monetized environmental information and 9 indicators of non-monetized environmental information were set, 18 indicators for a total. Due to the relatively high reference and reliability of quantitative data, companies are scored 2 if they disclose quantitatively, 1 if they disclose qualitatively, and 0 if they do not disclose. The details are shown in Table 1.

Each item is given the same weight to circumvent subjectivity, and the final score of enterprise environmental information disclosure index EDI is obtained after assigning weighting. the formulae for the environmental information disclosure index EDI, monetized environmental information disclosure index EDIF, and non-monetized environmental information disclosure index EDINF are shown below. The higher the value, the better the quality of the enterprise's environmental information disclosure.

$$EDI_{i,t} = \frac{\sum_{j=1}^{18} EDI_{i,j,t}}{36}$$

$$EDIF_{i,t} = \frac{\sum_{j=1}^{9} EDIF_{i,j,t}}{18}$$

$$EDINF_{i,t} = \frac{\sum_{j=1}^{9} EDINF_{i,j,t}}{36}$$

i is the enterprise, t is the year, j is the environmental information disclosure index, $EDI_{i,j,t}$is the score of environmental information disclosure index of enterprise i in year t, $EDIF_{i,j,t}$is the score of monetized environmental information disclosure index of enterprise i in year t, and $EDINF_{i,j,t}$ is the score of non-monetized environmental information disclosure index of enterprise i in year t. $EDI_{i,t}$is the index of environmental information disclosure of enterprise i in year t, $EDIF_{i,t}$is the index of monetized environmental information disclosure of enterprise i in year t, and $EDINF_{i,t}$ is the index of non-monetized environmental information disclosure of enterprise i in year t.

3.2.2 Explained variable: enterprise value

In this paper, with reference to the studies of domestic and foreign scholars, TobinQ, a relative value indicator, is selected as an indicator of enterprise value, and TobinQA from the CSMAR database is chosen.TobinQ value integrates the current and future situation of the enterprise, i.e., it shows the value of the present as well as the potential profitability of the enterprise in the future, so that it can measure the enterprise value scientifically and aptly[8].

3.2.3 Moderating variables: institutional shareholding, nature of ownership

The institutional shareholding ratio is taken from the Wind database, and the data is divided into 2 classes according to the 1/2 quartile, representing high institutional shareholding ratio and low institutional shareholding ratio respectively; in addition, the nature of ownership in the CSMAR database divides the sample of all companies into SOEs and non-SOEs, assigning a value of 1 if the company is a state-owned enterprise and 0 otherwise.

3.2.4 Controlling variables

Referring to the study by Yongjun Tang et al [17], firm size, profitability, solvency, financial leverage, ownership concentration, book-to-market ratio, and net cash flow from operating activities were selected as control variables. And to better explain the endogeneity of the study subjects, the year and industry are controlled to eliminate the non-observable factors on industry and year.

The specific definitions of the explanatory variables, explanatory variables, and control variables are shown in Table 2. The descriptive statistics of each variable are shown in Table 3.

Table 2. Definition of variables

Variable Type	Variable Name	Variable Symbols	Variable Explanation
Explained variables	Enterprise value	TobinQ	TobinQ=Market value/Replacement cost
Explanatory variables	Quality of environmental information disclosure	EDI	Reference to the indicator system and assigning values
Moderating variables	Institutional shareholding ratio	INST	High_INST for institutional holdings greater than the median, otherwise Low_INST
	Nature of ownership	SOE	State-owned enterprises are assigned a value of 1, non-state-owned enterprises are assigned a value of 0
Control variables	Company size	SIZE	Ln（Total Assets）
	Profitability	ROA	Return on total assets, EBITDA/Average total assets
	Solvency	RLA	Asset-liability ratio, Total liabilities/Total assets
	Financial leverage	LEV	Change in earnings per share of common stock / Change in EBITDA
	Ownership concentration	OC	Percentage of shareholding of the largest shareholder
	Book-to-market ratio	BTM	Shareholders' equity/company market value
	Net cash flow from operating activities	OCF	Net cash flow from operating activitie s/Total assets at the end of the period
	Year	Year	Dummy variables for the year
	Industry	Industry	Dummy variables for the industry

Table 3. Descriptive statistics of each variable

Variables	Mean	Median	Standard	Minimum	Maximum
Enterprise value	2.209	1.770	1.376	0.867	8.022
Quality of environmental information	0.404	0.404	0.189	0.038	0.885
Institutional shareholding ratio	44.400	46.550	23.480	0.835	90.000
Nature of ownership	0.405	0.000	0.491	0.000	1.000
Company size	22.590	22.360	1.327	20.110	26.300
Profitability	0.043	0.034	0.056	-0.142	0.211
Solvency	0.363	0.345	0.190	0.050	0.813
Financial leverage	1.543	1.051	1.985	-0.068	15.980
Ownership concentration	35.090	33.370	14.560	9.440	74.570
Book-to-market ratio	0.936	0.579	1.077	0.000	5.631
Net cash flow from operating activities	0.064	0.061	0.064	-0.105	0.238

3.3 Model Setting

In order to analyze the impact of environmental information disclosure quality on enterprise value, the following fixed-effects regression analysis model (1) is constructed with reference to the study of Qiongwen Cheng[4] , as follows.

$$TobinQ_{i,t} = \alpha_0 + \alpha_1 EDI_{i,t} + \alpha_2 {EDI_{i,t}}^2 + \alpha_i Controls_{i,t} + \sum Year + \sum Industry + \varepsilon_{i,t} \quad (1)$$

Where, i denotes the ith sample firm and t denotes the time of observation. In the model, α_1 is used to test the primary linear relationship between the quality of environmental information disclosure and enterprise value, and α_2 is used to test the "U" shaped relationship between the quality of environmental information disclosure and enterprise value.

In this paper, the variance inflation factor VIF is used to test the multi-collinearity of the model, and the VIF is less than 3 and there is no multi-collinearity. The results of Hausman-specification-test showed that the p-value was 0, so fixed effects should be used for regression analysis.

4. Analysis of empirical results

4.1 Relationship between environmental information disclosure and enterprise value

Table 4. The results of fixed effects regression

	(1)	(2)	(3)
Variable	TobinQ	TobinQ	TobinQ
EDI	-0.094	-2.781***	-1.824***
	(0.224)	(0.483)	(0.457)
EDI^2		3.348***	2.418***
		(0.534)	(0.502)
SIZE			-0.465***
			(0.066)
ROA			4.012***
			(0.402)
RLA			0.300
			(0.209)
LEV			0.003
			(0.008)
OC			-0.018***
			(0.004)
BTM			-0.009
			(0.031)
OCF			0.042
			(0.306)
INST			0.018***
			(0.001)
SOE			-0.149
			(0.158)
_cons	2.238***	2.642***	12.605***
	(0.496)	(0.495)	(1.507)
R^2	0.247	0.263	0.375
R^2_Ad	0.049	0.067	0.205
Industry	Control	Control	Control
Year	Control	Control	Control

Standard errors in parentheses * p < 0.1, ** p < 0.05, *** p < 0.01, the same below.

This paper draws lessons from Lind and Mehlum's[27]study to test for the existence of a "U" curve relationship between variables. The results of the baseline regression of EDI on TobinQ are shown in Table 4. First of all, the "U"-shaped relationship requires that the coefficient α1 of EDI is significantly negative and the coefficient α2 of EDI2 is significantly positive. According to the results of regression (1), the regression coefficient of EDI on TobinQ is -0.094, but it is not significant. Regression (2) further adds EDI2 and finds that the regression coefficient of EDI2 is 3.348 and significant at 1% confidence level while the regression coefficient α1 of the primary term EDI is -2.781 and significant at 1% confidence level. The regression coefficients α1 and α2 are -1.824 and 2.418 respectively, which are significant at 1% confidence level and still satisfy condition one after adding the control variables. The second requirement is that the curve is significantly steep at the two endpoints, and the slope of the curve is positive when EDI takes the minimum value EDImin and positive when it takes the maximum value EDImax. Since the focus of this paper is on the curve relationship between the quality of environmental information disclosure and enterprise value, and the control variables do not affect the curve shape, then the formula (1) can be simplified to formula (2) when analyzing the curve shape. According to formula 3, Equation (2) takes the first derivative of the independent variable EDI as the slope of the curve ROA'. According to the results of EDI descriptive statistics that EDImax is 0.885, EDImin is 0.038, ROA is 2.456 and ROA is -1.640, condition 2 is satisfied. Finally, it is required that the critical point (inflection point) lies within the range of EDI values. Inflection point of the curve is in the situation that the first-order derivative is equal to 0, so let formula (3) be 0 to find the critical point a of the curve, see formula (4). The critical point a is 0.366, which is within the

range of EDI values and satisfies condition 3. Therefore, the relationship between the quality of environmental information disclosure and enterprise value satisfies the positive "U" curve, and the critical point of the sample studied in this paper is 0.377, so hypothesis one is proved. Enterprises need to increase the high-quality disclosure of information to promote the enhancement of enterprise value and sustainable development of enterprise.

$$TobinQ_{i,t} = \alpha_0 + \alpha_1 EDI_{i,t} + \alpha_2 {EDI_{i,t}}^2 \quad (2)$$

$${TobinQ_{i,t}}' = \alpha_1 + 2\alpha_2 EDI_{i,t} \quad (3)$$

$$a = -\alpha_1 / 2\alpha_2 \quad (4)$$

4.2 Heterogeneity Tests

4.2.1 Analysis of the Moderating Effect of Institutional Shareholding

Table 5. Regression results of the moderating effect of institutional shareholding

	(1) High_INST	(2) Low_INST	(3) High_INST	(4) Low_INST
Variable	TobinQ	TobinQ	TobinQ	TobinQ
EDI	-4.377***	-0.414	-3.388***	0.372
	(0.687)	(0.676)	(0.644)	(0.662)
EDI^2	4.487***	0.867	3.592***	0.251
	(0.721)	(0.805)	(0.672)	(0.785)
SIZE			-0.509***	-0.383***
			(0.096)	(0.094)
ROA			4.802***	3.265***
			(0.588)	(0.554)
RLA			-0.075	0.312
			(0.314)	(0.295)
LEV			0.000	-0.000
			(0.009)	(0.012)
OC			-0.003	-0.019***
			(0.005)	(0.006)
BTM			0.026	0.001
			(0.039)	(0.052)
OCF			-0.298	0.158
			(0.437)	(0.429)
INST			0.032***	0.012***
			(0.004)	(0.003)
SOE			-0.141	-0.040
			(0.256)	(0.218)
_cons	3.970***	2.490***	13.256***	10.749***
	(0.224)	(0.450)	(2.212)	(2.000)
R^2	0.243	0.408	0.364	0.462
R^2_Ad	-0.034	0.186	0.122	0.253
Industry	Control	Control	Control	Control
Year	Control	Control	Control	Control

In this paper, the median institutional shareholding ratio is taken to divide the firms into two subsamples, high institutional shareholding ratio High_INST and low institutional shareholding ratio Low_INST. The regression of formula (1) is conducted for both subsamples. The regression results are shown in Table 5. According to Table 5, after adding the control variables, regression (3) shows that the regression coefficient of EDI2 in the High_INST group is 3.592, which is significant at 1% confidence level, and the regression coefficient of EDI is -3.388, which is significant at 1% confidence level, while regression (2) shows that both EDI2 and EDI in the Low_INST group are still insignificant. Compared with the companies with low institutional shareholding, the U-shaped relationship between the quality of environmental information disclosure and enterprise value is more significant, indicating that institutional shareholding plays a positive moderating role in the influence of environmental information disclosure on enterprise value.

4.2.2 Property rights heterogeneity analysis

In this paper, the sample firms are divided into two subsamples, state-owned enterprises and non-SOEs, and the regression of formula (1) is conducted for each of the two subsamples to test the difference of the value effect of environmental information disclosure in the two subsamples, and the regression results are shown in Table 6. The results of Table 6 show that after adding control variables, the "U" shaped relationship between the quality of environmental information disclosure and enterprise value is significant for non-state enterprises compared to SOEs. Hypothesis 3 is proved. The need for non-state-owned enterprises to disclose relatively higher quality environmental information in order to obtain social legitimacy status and the weak ability to resist business risks both enhance the significance of the value effect of environmental information disclosure. State-owned enterprises, which are already in a more advantageous position of social legitimacy, with easy access to resources and financing, and with weaker regulation, have relatively limited value effects from their environmental information disclosure.

Table 6. Regression results of the moderating effect of the nature of ownership

Variable	(1)SOE	(2)Non-SOE	(3)SOE	(4)Non-SOE
	TobinQ	TobinQ	TobinQ	TobinQ
EDI	-1.474**	-2.323***	-0.602	-1.548**
	(0.701)	(0.707)	(0.675)	(0.665)
EDI^2	1.400**	3.401***	0.797	2.529***
	(0.683)	(0.860)	(0.650)	(0.809)
SIZE			-0.449***	-0.422***
			(0.083)	(0.098)
ROA			3.729***	3.522***
			(0.609)	(0.535)
RLA			0.515*	0.386
			(0.291)	(0.290)
LEV			-0.003	0.013
			(0.007)	(0.015)
OC			-0.009**	-0.023***
			(0.005)	(0.006)
BTM			0.012	-0.099*
			(0.032)	(0.058)
OCF			0.032	0.071
			(0.416)	(0.424)
INST			0.013***	0.019***
			(0.002)	(0.002)
_cons	2.084***	2.968***	11.641***	11.807***
	(0.201)	(0.607)	(1.884)	(2.159)
R^2	0.210	0.316	0.309	0.421
R^2_Ad	-0.016	0.126	0.103	0.255
Industry	Control	Control	Control	Control
Year	Control	Control	Control	Control

4.3 Robustness and endogeneity tests

In order to enhance the robustness of the research results, this paper also conducts robustness tests and endogeneity tests on the value effect of environmental information disclosure.

4.3.1 Robustness test of replacing firm value

In order to avoid the possible infirmity of the empirical results caused by different calculation ways of firm value, the TobinQ values calculated by other ways from the CSMAR database were selected to replace the firm value in this study, and the regression results were re-run and shown in Table 7 and the conclusion of the "U" shaped relationship in the previous study still holds.

Table 7. Results of robustness tests for replacing firm value

	(1)	(2)	(3)	(4)	(5)	(6)
Variable	TobinQB	TobinQB	TobinQC	TobinQC	TobinQD	TobinQD
EDI	-3.614***	-2.688***	-8.069***	-5.684***	-9.437***	-6.851***
	(0.663)	(0.644)	(0.762)	(0.731)	(0.855)	(0.821)
EDI^2	3.688***	2.710***	8.632***	6.428***	9.642***	7.194***
	(0.734)	(0.707)	(0.844)	(0.803)	(0.946)	(0.902)
SIZE		-0.358***		-1.021***		-1.009***
		(0.092)		(0.105)		(0.118)
ROA		5.000***		8.015***		9.416***
		(0.566)		(0.642)		(0.721)
RLA		0.558*		-0.713**		-0.747**
		(0.294)		(0.334)		(0.375)
LEV		0.009		0.002		0.004
		(0.011)		(0.012)		(0.014)
OC		-0.021***		-0.012*		-0.011
		(0.005)		(0.006)		(0.007)
BTM		0.002		0.152***		0.172***
		(0.044)		(0.050)		(0.056)
OCF		-0.783*		-0.259		-0.674
		(0.430)		(0.489)		(0.549)
INST		0.022***		0.007***		0.009***
		(0.002)		(0.002)		(0.003)
SOE		-0.185		-0.279		-0.350
		(0.222)		(0.252)		(0.283)
_cons	3.216***	10.634***	4.708***	27.361***	5.433***	27.726***
	(0.681)	(2.122)	(0.783)	(2.409)	(0.877)	(2.707)
R^2	0.205	0.292	0.376	0.458	0.375	0.455
R^2_Ad	-0.006	0.101	0.211	0.311	0.209	0.307
Industry	Control	Control	Control	Control	Control	Control
Year	Control	Control	Control	Control	Control	Control

4.3.2 Robustness tests of replacing the quality of environmental information disclosure

Table 8. Robustness test results for replacing the environmental information disclosure quality

	(1)	(2)	(3)	(4)
Variable	TobinQ	TobinQ	TobinQ	TobinQ
EDIF	-2.286***	-1.580***		
	(0.433)	(0.408)		
$EDIF^2$	2.484***	1.807***		
	(0.467)	(0.438)		
EDINF			-1.474***	-0.923***
			(0.367)	(0.342)
$EDINF^2$			2.066***	1.502***
			(0.439)	(0.408)
SIZE		-0.460***		-0.482***
		(0.065)		(0.066)
ROA		4.023***		4.162***
		(0.403)		(0.400)
RLA		0.276		0.267
		(0.209)		(0.209)
LEV		0.003		0.002
		(0.008)		(0.008)
OC		-0.018***		-0.018***
		(0.004)		(0.004)
BTM		-0.007		-0.000
		(0.031)		(0.031)
OCF		0.033		0.038
		(0.306)		(0.306)
INST		0.018***		0.018***
		(0.001)		(0.001)

SOE		-0.153		-0.161
		(0.158)		(0.158)
_cons	2.632***	12.539***	2.349***	12.812***
	(0.496)	(1.506)	(0.493)	(1.509)
R^2	0.259	0.372	0.256	0.372
R^2_Ad	0.062	0.203	0.059	0.202
Industry	Control	Control	Control	Control
Year	Control	Control	Control	Control

In order to exclude the errors in data collection of environmental information disclosure quality, this paper refers to the study of Hongxia Gao[6] and replaces EDI with EDIF and EDINF, and conducts the regressions respectively. The regression results are shown in Table 8, and the conclusion of the "U" shaped relationship in the previous study still holds.

4.3.3 Endogeneity test

Considering the possible causal inversion in the relationship between environmental information disclosure quality and enterprise value, in order to further address the endogeneity issue, this paper uses the first-order lagged term of environmental information disclosure index(EDI.L) as the instrumental variable, uses TobinQ of other different measures, and performs two stage least square method (2SLS),refering to the study of Juan Lu[10]. The results are presented in Table 9.The comparative analysis shows that the quality of environmental information disclosure shows a significant U-shaped relationship with firm value, which is consistent with the previous findings.

Table 9. Results of the endogeneity test

	(1)	(2)	(3)	(4)
Variable	TobinQ	TobinQB	TobinQC	TobinQD
EDI.L	-3.000***	-3.382***	-6.477***	-6.178***
	(0.843)	(1.200)	(1.242)	(1.404)
$EDI.L^2$	2.716***	2.866**	5.959***	5.473***
	(0.904)	(1.287)	(1.333)	(1.507)
SIZE	-0.448***	-0.546***	-0.579***	-0.609***
	(0.030)	(0.043)	(0.045)	(0.051)
ROA	7.310***	7.650***	11.339***	11.109***
	(0.534)	(0.760)	(0.787)	(0.890)
RLA	0.491***	1.035***	0.805***	0.742***
	(0.159)	(0.227)	(0.235)	(0.266)
LEV	0.004	0.004	0.012	0.012
	(0.013)	(0.018)	(0.019)	(0.021)
OC	-0.005***	-0.008***	0.004	0.003
	(0.002)	(0.003)	(0.003)	(0.003)
BTM	-0.152***	-0.192***	-0.137***	-0.160***
	(0.033)	(0.047)	(0.049)	(0.055)
OCF	-0.279	-0.047	0.111	0.494
	(0.442)	(0.629)	(0.651)	(0.737)
INST	0.014***	0.016***	0.006***	0.006***
	(0.001)	(0.002)	(0.002)	(0.002)
SOE	-0.071	-0.222***	-0.212**	-0.346***
	(0.057)	(0.082)	(0.084)	(0.096)
_cons	12.012***	14.663***	15.710***	16.848***
	(0.631)	(0.898)	(0.930)	(1.051)
R^2	0.451	0.372	0.449	0.443
R^2_Ad	0.442	0.361	0.440	0.434
Industry	Control	Control	Control	Control
Year	Control	Control	Control	Control

5. Conclusion and Policy Recommendations

This paper examines the U-shaped relationship between the quality of environmental information disclosure and enterprise value, as well as the moderating effect of institutional shareholding ratio

and property rights, taking Shanghai and Shenzhen A-share heavy polluters as the research sample. The conclusions of this paper are as follows:

(1) There is a significant positive U-shaped relationship between the quality of environmental information disclosure and enterprise value of heavily polluting enterprises; there is a negative relationship between environmental information disclosure quality and enterprise value when the level of environmental information disclosure is below the critical value of 0.377, but environmental information disclosure and enterprise value are positively correlated when the level of environmental information disclosure is higher than the critical value of 0.377.

(2) Institutional shareholding has a positive moderating effect on the U-shaped relationship between the quailty of environmental information disclosure and enterprise value, and the U-shaped value effect of environmental information disclosure is more significant in the sample of companies with high shareholding of institutional investors.

(3) After grouping regression of the samples using the nature of ownership, it was found that there were significant differences in the main effects. The nature of ownership has a moderating effect on the "U" relationship between the quality of environmental information disclosure and enterprise value, and the "U" value effect of environmental information disclosure of non-SOEs is more significant. However, the effect of SOEs is not significant, and the nature of SOEs will weaken the value effect of environmental information disclosure.

This paper puts forward the following policy recommendations.

Government regulators should further standardize the content and manner of environmental information disclosure, and make unified regulations on the evaluation system of environmental information disclosure in order to give full play to the role of social supervision, better promote enterprises to make high-quality environmental information disclosure.

(2) The management of enterprises should realize the importance of environmental information disclosure, establish a perfect environmental information disclosure management mechanism, and incorporate the quality of environmental information disclosure into the enterprise performance assessment to realize the overall improvement of environmental information disclosure level.

(3) Enterprises should pay attention to improving the level of environmental information disclosure while releasing signals of good investment prospect to further attract investment from institutional investors, so as to achieve further significant improvement of enterprise value.

(4) The regulatory authorities should improve relevant laws and regulations and strengthen environmental supervision of state-owned enterprises, so as to achieve the significant "U" value effect of environmental information disclosure of SOEs and encourage SOEs to disclose high-quality environmental information. At the same time, non-SOEs should vigorously increase the quality of the environmental information disclosed.

References

[1] Jianan Cai, Zhiqing Li, Ping Jiang. Empirical study on impact of listed companies' environmental information disclosure on bank credit [J]. China Population, Resources and Environment, 2018, 28(S1): 121-124.

[2] Kai Chang. The effect of environmental information disclosure on financial performance-empirical evidence from cross-sectional data of heavy-pollution industries in China [J]. Collected Essays on Finance and Economics, 2015(01):71-77.

[3] Haisheng Chen, Dan Lu. Research on correlation between R&D investment and enterprise value [J]. Soft Science, 2011, 25(02): 20-23.

[4] Qiongwen Cheng, Feng Liu. Research on the impact of environmental information disclosure on corporate value based on the empirical data of listed companies in heavy-polluting industries [J]. Science and Technology Management Research, 2022, 42(01): 177-185.

[5] Wen Dai, Yinan Dong, Shuyan Chen. An empirical analysis of the relationship between institutional investors, environmental information disclosure quality and enterprise value[J]. Statistics and Decision Making, 2016(12): 162-165.

[6] Hongxia Gao, Haiyan Zhu, Fanjun Meng. Does the quality of environmental information disclosure affect the cost of debt financing? Empirical evidence from listed companies in China's environmentally sensitive industries [J]. Journal of Nanjing Audit University, 2018, 15(06): 20-28.

[7] Wenjing Li, Xiaoyan Lu. Do institutional investors care firm environmental performance? Evidence from the most polluting Chinese listed firms [J]. Journal of Financial Research, 2015(12): 97-112.

[8] Huiyun Li, Shaoyan Fu, Peng Gao. Media attention, carbon disclosure and corporate value[J]. Statistical Research, 2016, 33(09): 63-69.

[9] Xuexin Liu, Xiaoxuan Du, Xiaoxu Kong, Yulin Zhang. Carbon information disclosure level, equity financing cost and enterprise value[J]. Journal of Technology Economics, 2021, 40(08): 116-125.

[10] Juan Lu, Bin Li, He Li. Does the environmental index disclosure promote the export of enterprises[J]. Journal of International Trade, 2020(08): 100-114.

[11] Bei Lv, Yanan Li. On the relationship between environmental information disclosure and corporation value from the perspective of system management [J]. Chinese Journal of Systems Science, 2020, 28(02): 123-128.

[12] Juan Ni, Lingwen Kong. Environmental information disclosure, bank credit decisions and debt financing cost: Evidence from the listed company in heavy polluting industries of A-Shares in Shanghai stock market and Shenzhen stock market [J]. Economic Review, 2016(01): 147-156+160.

[13] Li Ren, Zhe Hong. A study on the channel through which environmental disclosure influence firm value [J]. Business and Management Journal, 2017, 39(03): 34-47.

[14] Hongtao Shen, Jiaxing You, Jianghong Liu. On the environmental inspection for refinancing, environmental disclosure and the cost of equity capital [J]. Journal of Financial Research, 2010(12): 159-172.

[15] Xiaohua Song, Xiao Jiang, Jingjing Han, Caiping Zhao, Yiwei Guo, Zhongfu Yu. Research on the value effect of enterprise carbon information disclosure-based on the adjustment of public pressure [J]. Accounting Research, 2019(12): 78-84.

[16] Yongjun Tang, Wenchao Ma, Li Xia. Quality of environmental information disclosure, internal "level" and enterprise value empirical evidence from listed companies in heavy polluting industries [J]. Accounting Research, 2021(07): 69-84.

[17] Yongjun Tang, Li Xia. Environmental investment, environmental information disclosure quality and corporate value [J]. Science and Technology Management Research, 2019, 39(10): 256-264.

[18] Lei Wang, Jing Qu, Xinmin Liu. Heterogeneous institutional investor portfolio, environmental information disclosure and corporate value [J]. Journal of Management Science, 2019, 32(04): 31-47.

[19] Subin Wen, Liu Liu Zhou. The influencing mechanism of carbon disclosure on financial performance--"inverted U-shaped" moderating role of media governance[J]. Management Review, 2017, 29(11): 183-195.

[20] Hongjun Wu. Disclosure of environmental information, environmental performance and cost of equity capital [J]. Journal of Xiamen University (Arts & Social Sciences), 2014(03): 129-138.

[21] Jianfeng Wu, Chengang Ye, Meng Liu. Environmental performance, political connections and environmental information disclosure-evidence from heavy polluting industries listed in Shanghai stock exchange [J]. Journal of Shanxi University of Finance and Economics, 2015, 37(07): 99-110.

[22] Yude Xu, Tingwei Li, Jinming Hong. Institutional environment, information disclosure quality and bank debt financing constraints--Empirical evidence from A-share listed companies in Shenzhen[J]. Finance & Trade Economics, 2011(05): 51-57.

[23] Chengang Ye, Zi Wang, Jianfeng Wu, Li Hui. External governance, environmental information disclosure and the cost of equity financing [J]. Nankai Business Review, 2015, 18(05): 85-96.

[24] Shuhui Zhang, Xuanxuan Shi, Lei Wen. Can environmental information disclosure enhance enterprise value? --Empirical evidence from Shanghai, China[J]. Comparative Economic & Social Systems, 2011(06): 166-173.

[25] Al-Tuwaijri S A, Christensen T E, Hughes Ii K E. The relations among environmental disclosure, environmental performance, and economic performance: a simultaneous equations approach[J]. Accounting, organizations and society, 2004, 29(5-6): 447-471.

[26] Hasseldine J, Salama A I, Toms J S. Quantity versus quality: the impact of environmental disclosures on the reputations of UK Plcs[J]. The British accounting review, 2005, 37(2): 231-248.

[27] Lind J T, Mehlum H. With or without U? The appropriate test for a U-shaped relationship[J]. Oxford bulletin of economics and statistics, 2010, 72(1): 109-118.

[28] Milgrom P R. Good news and bad news: Representation theorems and applications[J]. The Bell Journal of Economics, 1981: 380-391.

[29] Richardson A J, Welker M, Hutchinson I R. Managing capital market reactions to enterprise social responsibility [J]. International Journal of Management Reviews, 1999, 1(1): 17-43.