

An Empirical Analysis of the Correlation between the Quality of Environmental Accounting Information Disclosure and the Proportion of Independent Directors in Heavy Polluting Power Industry

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Abstract—This project mainly analyzes the current situation of environmental accounting information disclosure of listed companies in the heavy pollution power industry, as well as the correlation between environmental accounting information disclosure and the proportion of independent directors, to obtain the quality of environmental information disclosure in the heavy pollution power industry, explore the existing problems and put forward solutions. Thus, it provides a theoretical basis for the standardization of enterprise environmental information disclosure standards in the whole field of environmental accounting, strengthens the supervision, strengthens the social responsibility of enterprises, and makes a contribution to the construction of beautiful China and the realization of sustainable development.

Keywords— Quality of environmental accounting information disclosure, Proportion of independent directors.

I. INTRODUCTION

With the rapid development of modern industrial society, environmental problems have become more and more prominent. It is destroying our earth home at an amazing speed and causing huge losses to the society. From the new Environmental Protection Law in 2022 introducing relevant concepts of sustainable development and ecological civilization construction, to the Outline of the 14th Five-Year Plan deepening the battle against pollution with higher standards, to the 20th National Congress report proposing to "further promote environmental pollution prevention and control", how to coordinate economic development and environmental protection has become the focus of attention from all walks of life today. It is also one of the main goals of policy formulation by governments around the world.^[1] Under the increasingly severe environmental problems, the accounting industry has devoted itself to environmental protection work and made great contributions to environmental protection, making environmental accounting become a booster of green development.^[2] However, there is not much research on the correlation between environmental information disclosure and the proportion of independent directors in China, nor is there any special environmental accounting information disclosure standards, nor is the proportion of environmental information disclosure in current enterprises high. At the same time, compared with other industries, the electric power industry has more serious environmental pollution. Therefore, it is imperative to study the correlation between the proportion of independent directors and environmental accounting information disclosure.

II. LITERATURE REVIEW

A. Foreign Research Status

Environmental accounting began in the 1970s, marked by the publication of F.A. Bemons's A Study on the Shifting

Social Costs of Pollution Control in the Accounting Monthly in 1971 and the publication of Accounting Problems of Pollution by J.J.Marlin in the second issue of the Accounting Monthly in 1973. In 1989, Pearce published A Blueprint for a Green Economy, which for the first time discussed the problem of physical accounting of environmental resources and linking environmental resources with national income accounts in a monetary way.^[3] In 1990, Gray wrote Green Accounting: The Accounting Profession after Pearce, which attracted wide attention. Since then, environmental accounting has been separated from social accounting and formed different branches.

Research on Environmental Information disclosure

In the 1970s, foreign research on environmental information disclosure began to appear, and the related research increased rapidly in the 1990s. Their increase promoted the development of related research, mainly focusing on environmental costs, how to report environmental liabilities, how to measure the environmental performance of enterprises and other issues. The authoritative research in this area mainly includes FASB Announcement No.5 Accounting for Contingencies, 93-4 Accounting for Environmental Liabilities and so on.^[3]

Research on influencing factors

① Perspective of social responsibility

In the empirical research of Al-Tuwaijri, Christensen and Hughes^[4] (2004) on the level of corporate environmental accounting information disclosure, the level of corporate environmental accounting information disclosure is measured by the recycling of pollutants. The research results show that environmental performance is significantly positively correlated with the level of environmental accounting information disclosure. Peter.M.Clarkson and YueLi^[5] (2008) also found a positive correlation between environmental performance and environmental accounting information disclosure through an empirical study of five heavy polluting

enterprises in the United States. Hughes^[6] (2001) found that there was a negative correlation between environmental disclosure and environmental performance, while Freedman and Wasley^[7] (1990) found no connection between the two. These conclusions are not uniform.

②Corporate business Perspective

There are many studies on the correlation between company size and environmental information disclosure in foreign countries. Gray (2001) and L.L.Engg and Y.T.Mak (2003) found that there was a positive correlation between company size and environmental accounting information disclosure through research; But Sarah.D.Starwick and Peter.A.Stanwick (1998)^[8] found that there was a negative correlation between the two. Krishna Udayasankar (2007) found that there was a U-shaped relationship between environmental accounting information disclosure and company size. Eriko Nashioka (2001) found that there was no significant relationship between the two.

Most foreign scholars believe that profitability is positively correlated with environmental information disclosure, but some scholars hold different opinions. Miller (2002)^[9] found that there was a positive correlation between environmental information disclosure and profitability. However, Wagner (2002) found that environmental information disclosure was negatively correlated with profitability; Ayuso^[10] found that the quality of corporate environmental information disclosure is not affected by corporate profitability.

③Corporate governance perspective

Wilmhurst and Frost (2000) believed that the management mostly considered shareholders and legislation^[11]; Walter Aerts, Denis Cormier and Michel Magnan (2008) showed that investors' attention to the stock market is the determining factor of environmental information disclosure.^[12]

B. Current Status of Domestic Research

The research on environmental accounting started relatively late in China. Professor Ge Jiashu introduced the theories and methods of Western environmental accounting in his paper *Green Accounting Theory, a New Trend of Western Theory in the 1990s*, published in 1992, which first introduced the theory of environmental accounting into China. In March 2001, China established "Green Accounting Committee". In June 2001, with the approval of the Ministry of Finance, the Accounting Society of China established the seventh professional committee -- Environmental Accounting Professional Committee, marking a new stage for China's environmental accounting research.

Research on Environmental Information disclosure

In view of the environmental accounting information disclosure and related theoretical issues, Meng Fanli^[13] (1999) pointed out that the information provided by enterprise environmental accounting should include two aspects: one is the financial impact of environmental problems, the other is environmental performance. The content of enterprise environmental performance is mainly reflected in the implementation of environmental laws and regulations and the implementation results and reasons for not implementing,

environmental quality and environmental governance and the use of pollutants.

Study on influencing factors

①Perspective of social responsibility

There is not much correlation between environmental information disclosure and environmental performance in China. Wu Hongjun^[14] (2013) believed that enterprises with good environmental performance did not necessarily have a high level of environmental information disclosure. This is because environmental information disclosure will bring direct and indirect costs to enterprises. When the benefits of disclosing the information exceed the costs, the company will disclose the information. In addition, Wu Hongjun^[15] (2014) found that there is a positive correlation between environmental information disclosure and environmental performance of Chinese enterprises, which is the prerequisite for environmental information disclosure to resolve information asymmetry. Ding Shenghong^[16] (2022) concluded that there is a positive relationship between environmental information disclosure and environmental performance by comparing the correlation between environmental audit and environmental performance and adding environmental information disclosure.

②Corporate management perspective

Zhang Zetian and Li Bei (2020)^[17] found that the enterprise size of listed companies in the paper industry was significantly positively correlated with the level of environmental accounting information disclosure; Liu Cui (2015)^[18] divided the selected sample companies into two groups according to whether they disclosed carbon accounting information. The empirical results show that there are significant differences between the two groups of sample companies in some explanatory variables such as company size and ownership concentration. CAI and Wu (2020)^[19] pointed out that enterprise size is positively correlated with the level of corporate environmental accounting information disclosure. From the multiple regression analysis, it can be seen that the enterprise size is significantly positively correlated with the level of enterprise environmental accounting information disclosure, which is consistent with the expected hypothesis. With the continuous expansion of enterprise scale, it will attract the attention of all walks of life, especially environmental groups and media supervision, enterprises will disclose more environmental accounting information due to internal and external reasons.

CAI Jianfeng and Wu Jiao (2020)^[19] pointed out that the profitability of enterprises is positively correlated with the level of corporate environmental accounting information disclosure. When the profitability of enterprises increases, they will pay more attention to environmental protection and strengthen environmental protection measures, so as to achieve a balance between corporate profit and social responsibility. Lyu and Dong (2021)^[20] pointed out that enterprises with strong profitability and better development ability will use more resources for development, resulting in less investment in carbon information disclosure. Enterprises with weak profitability and poor development ability will want to improve their corporate image through information

disclosure so that investors will have a good evaluation on them. Bi Qian^[21] pointed out that the level of corporate profitability will have an impact on corporate carbon information disclosure and play a positive role in promoting it.

③Corporate governance perspective

Xiao Hua and Zhang Guoqing (2008) argued that after major environmental events, in order to relieve public pressure, the management will use the environmental information disclosure in the annual report to offset its negative impact, so as to maintain a good corporate social image.^[22] Meng Liyuan (2010) proved that corporate governance structure has an important impact on the disclosure.^[23]

To sum up, the above research at home and abroad shows that this research is developing in depth. China's environmental accounting research has made great progress, but there is still a certain gap with the developed countries, the theoretical basis is not perfect, can not fully coordinate the relationship between enterprise production and operation and environmental protection^[24]. According to the relevant literature of environmental accounting, China focuses on the research on the correlation between environmental accounting information disclosure, financial performance and enterprise market performance in this neighborhood. The research on the influencing factors is rich, but most of them are based on the earlier enterprise data, and the research timeliness is not enough. Therefore, this paper attempts to start from the Shanghai and Shenzhen A-share listed heavy power enterprises, using the latest data up to 2021 for analysis and research. In addition, there is no special accounting standards in the field of environmental accounting information disclosure in China, and the proportion of environmental information disclosure in the current enterprise accounting system is not high, so enterprises have not done enough in this aspect. Therefore, according to the results of the research on the influencing factors of environmental accounting information disclosure, it is necessary to put forward some suggestions for the heavy power industry to improve the level of environmental information disclosure.

III. RESEARCH DESIGN

A. Sample Selection and Data Sources

In this project, A total of 81 enterprises were selected from the A-share listed companies in the heavy power industry listed in Shanghai Stock Exchange and Shenzhen Stock Exchange as the research object. In the selection process, the following enterprises were eliminated: ①Due to the short founding time and small scale of GEM enterprises, they are mainly high-tech enterprises, which have less pollution than traditional enterprises, do not belong to high-pollution enterprises, and have incomplete disclosure data, one GEM enterprise is excluded. ②Considering the influence of extreme values on statistical results, 2 companies *ST and *PT were excluded. ③Considering that the newly listed companies may not accurately reflect the authenticity of environmental accounting information disclosure, a total of 11 newly listed companies from 2018 to 2022 were excluded.

Among the 67 enterprises after the above screening, 7

enterprises did not disclose environmental information, and 19 enterprises did not belong to the high pollution enterprises. Therefore, the data of 41 enterprises in the power industry from 2019 to 2021 were finally selected as samples, with a total of 123 samples.

This paper selects the company's annual report data and the official website data of each enterprise to study the environmental accounting information disclosure. The data come from Shenzhen Stock Exchange, Shanghai Stock Exchange, Juchao Information website and some enterprises' official websites.

B. Research Hypothesis

Corporate governance is a science that balances ownership and management. These interests determine the efficiency and core competitiveness of enterprises, which is of great significance to the long-term stable development of enterprises. Among them, internal control can ensure the authenticity of accounting information, and the proportion of independent directors plays an important role in internal control. With the increasingly serious environmental problems and the proposal of the concept of green development, environmental information disclosure has been paid more and more attention. High level of environmental information disclosure can bring positive social impact to enterprises, make independent directors pay more attention to green responsibility, and promote the improvement of internal control of the company. Therefore, this paper explores the correlation between environmental accounting information disclosure and the proportion of independent directors.

Hypothesis: The level of environmental accounting information disclosure is positively correlated with the proportion of independent directors.

Independent director refers to the director who is independent of the company's shareholders and does not hold positions in the company, and has no important business or professional connection with the company or the company's management, and makes independent judgment on the company's affairs. The participation of independent directors in the board of directors increases the independence, fairness, transparency and objectivity of the board of directors, and supervises the board of directors to make correct and compliant decisions, thus effectively affecting the quality of environmental accounting information disclosure. Therefore, this paper assumes that there is a positive correlation between the level of environmental accounting information disclosure and the proportion of independent directors.

C. Variable Selection and Model Establishment

When Xiao Shufang (2005) studied^[25] the forms of environmental information disclosure in China, he suggested that the contents of disclosure of listed companies in China mainly include environmental investment, ISO and other environmental related certification. In addition, the environmental information recommended to be disclosed in the Announcement on the Disclosure of Enterprise Environmental Information issued by the State Environmental Protection Administration includes five aspects: enterprise

environmental protection policy, total pollutant emission, enterprise environmental pollution control, environmental protection compliance, and environmental management.

Combined with the above research results and the actual situation in China, eight items were selected to score the

environmental accounting information disclosure of enterprises, and the average score was taken as the quality index of environmental accounting information disclosure.

TABLE I. Environmental Accounting Information Disclosure Items.

Types of variables	Disclosure items	Points	Remarks
Environmental information disclosure	Environmental protection policy for enterprises	3	3 points for combining qualitative and quantitative, 2 points for quantitative, 1 point for qualitative, and 0 point for undisclosed
	Total pollutant discharge	3	3 points for combining qualitative and quantitative, 2 points for quantitative, 1 point for qualitative, and 0 point for undisclosed
	Corporate environmental pollution control	3	3 points for combining qualitative and quantitative, 2 points for quantitative, 1 point for qualitative, and 0 point for undisclosed
	Environmental protection Law-abiding	3	3 points for combining qualitative and quantitative, 2 points for quantitative, 1 point for qualitative, and 0 point for undisclosed
	Environmental management	3	3 points for combining qualitative and quantitative, 2 points for quantitative, 1 point for qualitative, and 0 point for undisclosed
	Environmental protection measures and programs adopted by the enterprise	3	3 points for combining qualitative and quantitative, 2 points for quantitative, 1 point for qualitative, and 0 point for undisclosed
	Environmental certification has been passed	3	3 points for combining qualitative and quantitative, 2 points for quantitative, 1 point for qualitative, and 0 point for undisclosed
	Environmental protection investment	3	3 points for combining qualitative and quantitative, 2 points for quantitative, 1 point for qualitative, and 0 point for undisclosed

Therefore, the environmental accounting information disclosure quality index is used as the regressors of the multiple linear regression model, and the proportion of independent directors is used as the regressors. Regression analysis is conducted on 123 samples of 41 enterprises, and the regression elements are defined in TABLE II.

TABLE II. Definition of Variables in Multiple Linear Regression Model.

Types of Variables	Variable Name	Expected Symbol	Remarks
Regressor	Environmental accounting information disclosure Index		Proportion of independent directors
Regressors	Proportion of independent directors	+	Number of independent directors/Number of board of directors *100%

Taking environmental accounting information disclosure index as regressor and the proportion of independent directors as regressor, a bivariate regression model is established :

$$\ln Y_i = \beta_0 + \beta_1 \ln X + \varepsilon$$

IV. EMPIRICAL ANALYSIS

A. Descriptive Statistics

As can be seen from TABLE III, the mean value of the

environmental accounting information disclosure quality index of listed companies in China's heavily polluting electric power industry is 1.21, the maximum value is 2.25, the minimum value is 0.25, and the range is 2. It shows that there is a big gap in the level of environmental accounting information disclosure in China's heavy pollution power industry, and there is still room for improvement.

The average value of the proportion of independent directors of listed companies in China's heavy pollution electric power industry is 0.36, the maximum value is 0.5, the minimum value is 0.25, and the range is 0.25. It shows that the proportion of independent directors in China's electric power industry is basically in line with relevant regulations, but there are still a few enterprises that do not pay enough attention to the role of independent directors.

TABLE III. Descriptive Statistics.

	Maximum	Minimum	Average	Range
Environmental Accounting Disclosure Index	2.25	0.25	1.21	2.00
Proportion of independent directors	0.5	0.25	0.36	0.25

B. Correlation analysis

TABLE IV. Correlation Analysis.

	lnY	lnX
lnY	1	0.113047
lnX	1.033073	1

It can be seen from TABLE IV that there is a mutual promotion between the quality of environmental accounting information disclosure and the proportion of independent directors. The higher the quality of environmental accounting information disclosure, the higher the proportion of independent directors; The higher the proportion of independent directors is, the higher the quality of environmental accounting information disclosure is.

C. Empirical analysis and test

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.181441	0.264878	4.460324	0.0000
LNx	1.033073	0.258271	3.999951	0.0001
R-squared	0.116786	Mean dependent var	0.129023	
Adjusted R-squared	0.109487	S.D. dependent var	0.359297	
S.E. of regression	0.339058	Akaike info criterion	0.690836	
Sum squared resid	13.91020	Schwarz criterion	0.736562	
Log likelihood	-40.48639	Hannan-Quinn criter.	0.709410	
F-statistic	15.99961	Durbin-Watson stat	1.830191	
Prob(F-statistic)	0.000110			

Fig. 1. Regression Results.

It can be seen from Fig.1 that the judgment coefficient R^2 of the regression model is 0.116786, and the adjusted R^2 is 0.109487, indicating that the explanatory variables in the model have limited explanation for the explained variables. Since the standard of the judgment coefficient R^2 is affected by the discipline, in the multiple regression analysis of social science research, scholars believe that when $R^2 > 0.1$, the explanatory power of the explanatory variable in the model to the explained variable can be accepted. The judgment coefficient R^2 in the model is $0.116786 > 0.1$, so the explanatory power of the explanatory variable to the explained variable is acceptable.

It can be seen from Fig.1 that the F statistic of the regression model is 15.99961, $P=0.0000$, indicating that the model is generally significant, and a linear regression model can be established.

It can be seen from Fig.1 that the coefficient of the intercept term is 1.181441, and the probability corresponding to the t value is 0.0000, indicating that the intercept term of the equation is significant. The t value of the proportion of independent directors is 3.999951, and the probability P is 0.0001, so the proportion of independent directors is significant. It can be concluded that the proportion of independent directors is an important factor affecting the level of environmental accounting information disclosure of listed companies in the heavy pollution power industry.

The existence of heteroscedasticity will lead to the bias of the variance of OLS estimation. In order to prevent the misdirection caused by ignoring heteroscedasticity, it is necessary to carry out heteroscedasticity test. This article adopts White's general heteroscedasticity test (White).

According to the test results in Fig.2, the P values of F statistic and $n \cdot R^2$ statistic of White test are 0.4826 and 0.4760 respectively, which are not statistically significant. Therefore, heteroscedasticity does not exist.

Heteroskedasticity Test: White

F-statistic	0.732978	Prob. F(2,120)	0.4826
Obs*R-squared	1.484470	Prob. Chi-Square(2)	0.4760
Scaled explained SS	2.932756	Prob. Chi-Square(2)	0.2308

Fig. 2. White Heteroscedasticity Test.

In order to avoid the influence of autocorrelation on the confidence interval and t-statistic of the regression results, the Durbin-Watson d test was used to judge the correlation of the residual series. In TABLE IV, it can be obtained that $DW=1.830191$, and there is no autocorrelation between d_U and $4-d_U$.

D. Robustness Check

In order to make the research results more robust and enhance the credibility of the research results, this paper uses the sub-sample method to conduct the robustness test, and divides 41 enterprises into seven regions according to the geographical division: North China, Northeast China, East China, Central China, South China, Southwest China and Northwest China. The regression results show that the positive and negative and significant regression coefficients of the proportion of independent directors and environmental accounting information disclosure are consistent with the above test results, which proves that the research conclusions are robustness.

The conclusions drawn in this article are as follows:

The proportion of independent directors is significantly positively correlated with the level of environmental accounting information disclosure, and it passes the t test, which is consistent with the hypothesis. It shows that the participation of independent directors makes the work of the board of directors more independent, fair and transparent, and can effectively disclose environmental accounting information.

V. CONCLUSIONS AND SUGGESTIONS

A. Conclusions of the Study

This paper finds that the proportion of environmental accounting information disclosure of listed companies in China's heavy pollution electric power industry is high, but the information quality is deficient, mainly based on qualitative description. This article empirically tests the correlation between the quality of environmental accounting information disclosure and the proportion of independent directors, using 41 heavily polluting power companies listed in the Shanghai and Shenzhen A-shares from 2019 to 2021 as samples. Further research finds that there is a significant positive correlation between the proportion of independent directors and the quality of environmental accounting information disclosure, and the two have a positive mutual promotion effect.

B. Suggestions and Implications

① Establish and improve the part of accounting standards related to environmental accounting. Clearly stipulating the environmental information disclosure items of listed companies, forcing enterprises to disclose environmental accounting information, specifically can be classified according to large, medium and small enterprises and heavy pollution non-heavy pollution enterprises disclosure.

② Strengthen the supervision function of the government. Strengthen the audit of certified public accountants for environmental accounting, provide environmental protection incentives or tax incentives for enterprises with high quality of environmental information disclosure, and provide special funds for small and medium-sized enterprises to help improve the quality and level of environmental accounting information disclosure.

③ Enhance the environmental awareness of enterprise management and accounting personnel. The relevant environmental accounting knowledge training for accounting personnel should be carried out to improve the ability of accounting personnel to measure, analyze and assess environmental information, so as to make the management pay attention to environmental benefits and drive the enterprise to better carry out environmental information disclosure.

④ Improve the internal control system of the enterprise. A good internal control system can improve the authenticity and accuracy of accounting information and avoid false behavior of enterprises. Increasing the proportion of independent directors within an appropriate range can improve the internal organizational structure of the board of directors, thereby strengthening internal control and improving the quality of environmental accounting information disclosure.

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