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Original Research

Research on the Correlation between Environmental Performance and Financial Performance in China's Heavy Pollution Industries Based on RAGA-PP Model

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Abstract

With the rapid development of economy, environmental pollution is becoming more and more serious. Whether the environment and economy can achieve a win-win situation has always been a controversial issue. This paper conducts an empirical study on the correlation between environmental performance and financial performance of 16 heavy polluting industries in China. The evaluation index system is constructed by closely following the characteristics of high energy consumption and high pollution in heavy pollution industry, and the projection pursuit model based on RAGA is applied to measure the environmental performance and financial performance of enterprises, which can overcome the interference and limitation of artificial assignment of data structure by traditional methods and has the characteristics of strong anti-interference and high accuracy. On this basis, the relationship between the two is investigated by establishing a multiple regression equation, and the results show that the environmental performance of listed companies in China's heavy pollution industry has a negative relationship with financial performance, and the improvement of environmental performance does not bring about an overall improvement in financial performance. Finally, this paper makes an in-depth analysis of the causes of this result and puts forward some corresponding suggestions.

Keywords: environmental performance, financial performance, RAGA, projection pursuit model, heavy pollution industry

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Introduction

In the wake of rapid economic development, environmental issues have begun to attract widespread attention. China is now the world's largest emitter of greenhouse gases [1]. Earlier, the EU officially announced that various environmental measures aim to achieve climate neutrality by 2050 [2]. China has also recently announced a "double carbon" commitment: to achieve peak carbon emissions by 2030 and carbon neutrality by 2060. In addition, water pollution, soil pollution and other problems also show the seriousness of the current environmental problems.

In response to environmental pollution, the Ministry of Environmental Protection issued the Guidelines for Disclosure of Environmental Information of Listed Companies (Draft for Comments) in 2010, which clearly requires that listed companies in 16 types of heavy polluting industries should regularly disclose environmental information and issue annual environmental reports. In response to the increasingly stringent environmental regulations in recent years, companies are beginning to realize the importance of environmental protection and are increasing their investment in the environment [3]. However, the development process in most developing countries is often accompanied by a strong coupling relationship: economic development and environmental pollution [4]. How to develop the economy, while also taking into account the improvement of environmental benefits is a difficult problem that must be overcome at present. Therefore, it is no longer a wise choice to wait passively for the natural appearance of the turning point of the environmental Kuznets curve under the increasing environmental pressure [5]. In China, heavy polluting industries have become the focus of the government and the public because of their characteristics of high energy consumption and high pollution. How to form a scientific principle of interaction and balance mechanism between environmental performance and financial performance and apply it to concrete practice is an urgent problem to be solved in the process of economic development and construction in China.

At present, the relationship between environmental performance and financial performance has mainly formed three major theoretical schools of thought: the traditional school, the revisionist school, and the eclectic school.

The traditional school, represented by Walley and Whitehead [6], is rooted in neoclassical theory. They argue that conducting pollution control will increase the production cost of the firm. And when the marginal cost keeps increasing, the marginal net profit will decrease due to the improvement of pollution control and environmental performance. In the past, firms focused on ex-post pollution control and environmental investment was considered an additional cost at the same time. Based on this, Konar and Cohen [7] argued that firms with higher environmental regulation costs will face a competitive disadvantage. The new model proposed by Palmer et al. [8] suggested that profits were reduced when firms engaged in environmental regulation. He therefore argued that environmental constraints were an additional burden for profit-maximizing firms. Many scholars have supported the traditional school with empirical evidence. Hassel et al. [9] studied Swedish listed companies and found that environmental performance had a negative impact on the market value of the company. In a study of heavy polluting industries, Chen [10] found that environmental performance was negatively related to economic performance. Zhou et al. [11] examined the data related to 350 companies in the UK FTSE in the CDP report and found that in the short term, the carbon performance of companies was negatively correlated with financial performance. Guo and Pan [12] argued that the investment made to protect the environment affected the future financial performance of firms, and the two had an inverse relationship. Using data from 159 listed companies in typical heavy pollution industries in China, Yin et al. [13] found a negative relationship between environmental performance and financial performance of most firms in heavy pollution industries in China.

In contrast to the traditional school, the revisionist school argues that environmental regulation can lead to a win-win situation for both social welfare and corporate interests, whereas the previous "traditional school" ignored the positive impact of the incentive to innovate. Porter and van der Linde [14] believed that one of the potential driving forces to enhance a company's competitive advantage was to improve its environmental performance. Because when the company faced high environmental pollution costs, it would be more motivated to research new technologies and production methods to achieve the goal of reducing environmental costs. Horváthová [15], a proponent of the Porter hypothesis, found that although environmental performance lagging one period had a negative impact on financial performance, environmental performance lagging two periods had a positive impact on financial performance. Arafat et al. [16] studied firms in Indonesia and if a firm's environmental performance was measured by Proper rating and financial performance was measured by ROA, then there was a positive relationship between the two. Alexopoulos et al. [17] specifically studied the relationship between environmental performance and financial performance in the Greek manufacturing industry. The study found that companies with excellent financial performance also had better results in environmental terms. Bartolacci et al. [18] analyzed data from 45 Italian companies from 2012-2015 and found a strong and positive association between financial and environmental performance. In addition, studies by Ong et al. [19], Abban and Hasan [20], Yan et al. [21], and Bai [22] validated the plausibility of the "Porter" hypothesis.

The eclectic school believes that the relationship between environmental performance and financial performance is not necessarily a positive or negative monotonic relationship. Schaltegger and Figge [23] argued that conducting environmental practices did not directly affect shareholder value. Iwata and Okada [24] studied data on Japanese manufacturing from 2004 to 2008 and found that each type of environmental performance had a different effect on the financial performance of a company. In a study, Liu and Duan [25] found that the form of the effect of a firm's environmental performance on financial performance was not simple and linear, but showed a U-shaped relationship. Song et al. [26], using data from Chinese listed companies for the period 2007-2011, found that conducting environmental management did not improve the financial performance of the current year, but significantly improved the financial performance of the firm in the following year. Qian and Xing [27] found that reducing carbon emissions did not bring returns to environmentally sensitive enterprises in Australia. Devie et al. [28] added environmental information disclosure as a mediating variable in his study. He found that when the behavioral measures related to the environment are different, it produced contradictory effects on financial outcomes. Boakye et al. [29] investigated the impact of conducting sustainable environmental practices on the financial performance of small and medium sized trading firms in the UK and found a significant non-linear (concave) relationship between the two.

From the current state of research, domestic and international scholars still do not agree on the research on the relationship between environmental performance and financial performance. Although there is an increasing amount of literature on the relationship between environmental performance and financial performance in China, most scholars substitute environmental performance with a single environmental indicator in their research because China lacks a rich and recognized environmental indicator system compared with foreign countries, which may cause bias in research results. Therefore, this paper takes China's heavily polluting industries as the research object. Based on the research of scholars such as Sun and Chen [30], this paper builds a relevant evaluation index system closely based on the industry characteristics and innovatively introduces the projection pursuit model based on RAGA to measure the environmental performance and financial performance of enterprises. So that the research results of the correlation between environmental performance and financial performance are more objective and reliable. On this basis, this paper investigates the relationship between environmental performance and financial performance of heavy polluting industries in China by establishing a multiple linear regression model, and analyzes the results to give relevant recommendations in a targeted manner. The academic contributions of this paper are mainly as follows:

(1) This paper considers the characteristics of heavy pollution industries to build the relevant evaluation index system, so that the index system is both comprehensive and more appropriate. From reading the references, we found that most scholars conducted their research with a relatively simple construction of the indicator system, especially the environmental performance indicator system. Scholars often choose a single indicator due to the difficulty of obtaining environmental information and the incomplete amount of information, and some scholars who use comprehensive indicators only study one major aspect of the enterprise, thus failing to make it more comprehensive to reflect the environmental performance of enterprises. After analyzing and studying the heavy pollution industry, a total of 18 specific indicators are selected from three aspects of environmental management, environmental pollution, and environmental investment to build the evaluation system in this paper. These indicators reflect the whole process of input-control-output in environmental protection, which not only visually and comprehensively reflect the internal environmental protection status of the enterprise, but also take into account the external influence, thus covering almost all environmental information related to the enterprise.

When constructing the financial performance evaluation system, this paper specially introduces three financial indicators, including inventory turnover, fixed asset turnover and quick ratio, which reflect the characteristics of heavy polluting industries, such as large production volume, large pollution and many physical products, so as to make the final evaluation result of financial performance reflect the characteristics of the industry.

(2) In this paper, the projection pursuit model based on RAGA is used to evaluate the environmental performance and financial performance, so as to overcome the shortcomings of the traditional models. At present, scholars mainly use methods such as data envelopment and hierarchical analysis when evaluating and measuring the performance as well as quality related to this field. Although these traditional methods have been used maturely, they have a certain degree of subjective defects. When the index system is not easy to quantify, the use of these methods will easily lead to large deviations in the research results. In contrast, RAGA-PP model not only effectively resists interference and improves the accuracy of the results, but also is simple and easy to operate, thus making the performance evaluation results in this paper more objective and reliable.

Material and Methods

Hypothesis

With the continuous development of the economy, enterprises are no longer a single entity in the market,

but also need to consider all aspects of the factors. The stakeholder theory believes that when pursuing profit maximization, a company must also deal with the relationship between the company and its stakeholders. The stakeholders are no longer just the internal stakeholders of the enterprise; they are involved in all aspects related to the development of the enterprise. The government and the public are also part of the stakeholders. The government can provide various resources and development opportunities for the enterprise, and at the same time, it will also put forward corresponding requirements and regulations on the development of the enterprise, such as environmental policies. If an enterprise neglects environmental protection, the government will regulate or fine it, which will then indirectly affect the trust of the public and other stakeholders in the enterprise and eventually affect the economic development of the enterprise. At the same time, in addition to handling the relationship with stakeholders in the development process, enterprises also need to assume social responsibility. When fulfilling social responsibilities, in addition to the most basic fulfillment of corporate internal responsibilities, it is also necessary to be responsible for the society and the environment. Under the background that the theory of sustainable development is deeply rooted in the hearts of the people, only by earnestly fulfilling various environmental protection responsibilities can companies go further. At present, although the government has put forward various environmental management measures, the long-standing "extensive" economic development mode has not been completely transformed. The development idea of "pollution first, governance later" has not been eradicated in enterprises, especially in heavily polluting industries. High energy consumption and high pollution make environmental protection costs high, and the current level of green innovation is not enough to support the losses caused by high environmental protection costs, which affects the financial benefits of enterprises, which seriously dampens the enthusiasm of enterprise environmental management. Based on this, this article proposes the following hypothesis:

H1: There is a negative correlation between corporate environmental performance and financial performance.

Data Sources

This article takes 16 heavy polluting industries in China as the research object and selects relevant data from 2017-2019 to explore the relationship between environmental performance and financial performance. Taking into account the reliability and availability of data, some industries with less environmental information disclosure are eliminated. On this basis, this article also did the following screening: (1) Deleted the companies marked with *ST and ST. (2) Deleted companies that have a series of factors that seriously affect the empirical results, such as discontinuous or missing data. (3) Considering the huge workload of manual data collection, only Shanghai listed companies are studied in this topic. Through sorting, 459 research samples are finally obtained.

The data in this article mainly come from the Resset database and the annual financial statements and corporate social responsibility reports of related companies such as www.cninfo.com. The original data are collected manually and the target data are sorted and analyzed using Excel, MATLAB software and SPSS software.

Variable Selection and Processing

(1) Environmental performance (EP). The concept of environmental performance was first proposed by American scholars Bragdon and Marlin [31] in the 1970s, and has since been deepened by scholars. Foreign scholars have mainly used the CEP index or specific pollution emission data published by the TRI database in the United States to measure the environmental performance of companies in their studies. In contrast, China has not yet formed a similar environmental performance evaluation system and a special database, so scholars used relevant substitute indicators to operate when researching. Scholars such as Hu [32] and Zhang et al. [33] measured environmental performance based on unit operating income pollution discharge fees; Scholars such as Wang and Zhao [34] comprehensively evaluated the environmental performance of enterprises based on whether they have passed ISO14001 certification, whether they had received environmental penalties, and the rate of environmental governance expenses. Based on other scholars, this paper combines the characteristics of heavy pollution industries, and measures environmental performance from three aspects: environmental protection investment, environmental management, and environmental pollution. Specific indicators are shown in Table 1. Among them, the "three simultaneous" system indicators indicate that the safety facilities and equipment in the construction project must be designed, constructed, and put into use at the same time as the main project. Environmental protection investment indicators refer to the amount of environmental protection investment in the year disclosed by the company through its annual statement or independent social responsibility report, etc., mainly for relevant environmental protection equipment. Environmental protection costs mainly include pollution treatment costs, environmental fines and other subsequent environmental treatment costs disclosed in the relevant statements. Among the indicators of pollutant exceeding standards, pollutants mainly include industrial "three wastes" such as sulfur dioxide, nitrogen oxides, particulate matter, COD, and waste residue.

In the index system of environmental performance, for the four quantitative indicators of environmental

Table 1. Environmental performance indicator system.

Target level	Criterion level	Specific indicators
Environmental performance (B)	Environmental management (C_1)	Environmental management system certification (D_1)
		„Three simultaneity" system (D_2)
		Basic system for environmental governance (D_3)
		Emergency plan for environmental governance (D_4)
		Environmental monitoring system (D_5)
		Environmental information disclosure system (D_6)
		Independent social responsibility reporting (D_7)
		Detailed disclosure of environmental information (D_8)
		pollutant discharging license (D_9)
	Environmental pollution (C_2)	Pollutant exceeding standard (D_{10})
		Major environmental accident (D_{11})
		Environmental litigation (D_{12})
		Environmental fines (D_{13})
		Disclosure of emissions of „three wastes" (D_{14})
		Energy consumption (D_{15})
	Environmental protection investment (C_3)	Environmental investment (D_{16})
		Environmental protection tax (D_{17})
		Environmental protection cost (D_{18})

Note: D_1-D_9 are specific indicators of environmental management; D_{10}-D_{15} are specific indicators of environmental pollution; D_{16}-D_{18} are specific indicators of environmental protection investment.

fines, environmental protection investment, environmental protection tax and environmental protection cost, the data are mainly obtained from the specific data disclosed in the relevant statements of the company. For the other qualitative indicators, this paper adopts the content analysis method to deal with them. Content analysis is a specialized method for making objective and systematic quantitative analysis of the content of a document. It can reveal the implicit content by combining quantitative and qualitative approaches. When analyzing the specific content in this article, if the report discloses the indicator, it will be assigned a value of 1, otherwise it will be assigned a value of 0; for the disclosed content, it will be assigned a value of 1 if it is disclosed in detail, and a value of 0 if it is not detailed. In addition, for the indicator of pollutants exceeding the standard, the value is 2 if all the standards are exceeded, 1 for part of the standards, and 0 if the standards are not exceeded.

(2) Financial performance (FP). Academic research on the financial performance of enterprises has matured. Most scholars used indicators such as ROA or Tobin's Q when studying related issues, while some scholars used hierarchical analysis or the balanced scorecard method to conduct research. When measuring financial performance, this paper selects indicators that fit the industry based on the characteristics of the heavy pollution industry with a high proportion of fixed assets and inventories from four aspects: profitability, solvency, operating capability and development capacity of enterprises for comprehensive evaluation. The specific data are obtained from the company statements. The specific indicators are shown in Table 2.

(3) Control variables. In order to eliminate the influence of other unknown factors as much as possible, the growth rate of operating income (Grow), total asset turnover ratio (Tat), asset-liability ratio (Alr), equity concentration (H1), and the percentage of state-owned shareholding (Shares) are selected as control variables in this paper.

Models Construction

When measuring environmental performance and financial performance, this paper innovatively introduces a projection pursuit model based on the RAGA algorithm. The model has been widely used in industry, agriculture, and remote sensing, but is less used in management disciplines. Scholars Liu and Liu [35] adopted the method in evaluating the quality of environmental information disclosure, and the results showed that the method was highly applicable and

Table 2. Financial performance indicator system.

Target level	Criterion level	Specific indicators
Financial performance (E)	Profitability (F_1)	Earnings per share (H_1)
		Net assets income rate (H_2)
		Return on assets (H_3)
		Net interest rate on assets (H_4)
		Net profit rate on sales (H_5)
	Solvency (F_2)	Current ratio (H_6)
		Quick ratio (H_7)
		Equity ratio (H_8)
		Cash ratio (H_9)
	Development capacity (F_3)	Growth rate of net profit (H_{10})
		Growth rate of net assets (H_{11})
	Operating capability (F_4)	Inventory turnover (H_{12})
		Accounts receivable turnover (H_{13})
		Current asset turnover (H_{14})
		Fixed asset turnover (H_{15})

Note: H_1-H_5 are specific indicators of Profitability; H_6-H_9 are specific indicators of Solvency; H_{10}-H_{11} are specific indicators of Development capacity; H_{12}-H_{15} are specific indicators of Operating capability.

advanced in this field. The projection pursuit model was first proposed and used by Kruskal and Shepard [36] in 1974. It is a data analysis method used to process and analyze high-dimensional data, which has the advantages of good robustness, strong anti-interference and high accuracy. A variety of intelligent optimization algorithms such as ant colony algorithm and genetic algorithm have been widely used to solve the projection index function, but they generally have disadvantages such as early convergence, easy to be trapped in local optimum and slow operation speed. This paper selects an accelerated genetic algorithm based on real number coding, which can use the real value coding of decision variables to quickly reduce the range of outstanding individuals and approach the best point. It has obvious advantages in terms of computational accuracy, efficiency and merit-seeking performance, which can alleviate some problems of traditional algorithms to a certain extent. The specific steps of the model are as follows.

1) Normalize the sample. Let the evaluation sample be $\{x^*(i,j)|i = 1, 2, ..., n; j = 1, 2, ..., p\}$. To eliminate the magnitude effect of each index, the sample is normalized:

$$x(i,j) = (x^*(i,j) - x_{min}(j))/(x_{max}(j) - x_{min}(j)) \quad (1)$$

Where $x_{max}(j)$ and $x_{min}(j)$ are the maximum and minimum values of the j^{th} index, and $x(i, j)$ is the data after normalization of the indicator.

2) Construction of projection indicator function. The projection pursuit method is to synthesize the p-dimensional data $\{x^*(i,j)|i = 1, 2, ..., n; j = 1, 2, ..., p\}$. into a one-dimensional projection value $z(i)$ with $a = \{a(1), a(2), ..., a(p)\}$ as the projection direction.

$$z(i) = \sum_{j=1}^{p} a(j)x(i,j), i = 1,2,\dots,n \quad (2)$$

When constructing the integrated projection index, it is required that the projection points of the projection value $z(i)$ are locally as dense as possible, while overall scattered. Thus, the projection indicator function can be expressed as:

$$Q(a) = S_z D_z \quad (3)$$

Where S_z is the standard deviation of the projection value $z(i)$ and D_z is the local density of the projection value $z(i)$.

$$S_z = \sqrt{(\sum_{i=1}^{n}(z(i) - E(z))^2)/(n-1)} \quad (4)$$

$$D_z = \sum_{i=1}^{n}\sum_{j=1}^{p}(R - r(i,j)) \cdot u(R - r(i,j)) \quad (5)$$

where $E(z)$ is the mean value of $z(i)$; R is the window radius of local density, which can generally take the value of $0.1Sz$; $r(i, j)$ denotes the distance between samples, $r(i, j) = |z(i)-z(j)|$; $u(t)$ is the unit step function,

which has the value of 1 when $t \geq 0$ and the value of 0 when $t<0$.

3) Establish a projection optimization model. The optimal projection direction is determined by solving the problem of maximizing the projection index function:

$$Q(a) = S_z D_z \quad (6)$$

Constraints: $\sum_{j=1}^{p} a^2(j) = 1$

4) Solve the optimization model. Based on the above model, MATLAB software is used to run the RAGA algorithm to get the best projection direction *a(j)*, and then the projection direction is brought into Equation (2) to get the final projection value *z(i)*. The environmental performance and financial performance of this paper are obtained by the above method and process.

Based on the aforementioned assumptions, in this topic, the explanatory variable is set as the financial performance of the enterprise, and the explanatory variable is set as the environmental performance of the enterprise accordingly. This article will use relevant methods of econometrics to construct a multiple regression model to explore the relationship between environmental performance and financial performance. The specific model is as follows:

$$FP = \alpha_0 + \alpha_1 EP + \sum Control + \varepsilon \quad (7)$$

Among them, FP represents the financial performance of the company, and the specific value is calculated by the RAGA-PP method. EP represents the environmental performance of the company, which is also calculated by the RAGA-PP method. Control denotes the control variables, and the specific indexes are described in the control variables section. α is the regression coefficient, and ε is the random error.

Results and Discussion

Descriptive Statistical Analysis

Before conducting the related analyses, descriptive statistical analyses of environmental performance, financial performance, and each control variable are conducted to facilitate the characterization of each sample. (Table 3)

As we can see in Table 3, there is a significant difference between the environmental performance and financial performance of the companies within the heavily polluting industries. The company with the lowest environmental performance score is only

Table 3. Variable description statistical analysis.

	N	Min	Max	Mean	Variance
EP	459	.7622	3.7303	2.7205	.335
FP	459	.2232	1.9960	1.0913	.030
Grow	459	-73.8480	259.2250	16.5100	1188.537
Tat	459	.1409	3.5872	.7914	.267
Alr	459	11.3340	96.4810	48.2003	349.289
H1	459	.0905	.8251	.4019	.024
Shares	453	.0000	84.1543	2.7091	97.469

Table 4. Correlation test.

	FP	EP	Grow	Tat	Alr	H1	Shares
FP	1						
EP	-.179**	1					
Grow	-.070	.220**	1				
Tat	-.097*	.317**	.051	1			
Alr	.110*	-.545**	.019	-.109*	1		
H1	.102*	.083	-.058	-.064	.044	1	
Shares	.035	-.060	-.038	-.048	.099*	.154**	1

Note: **. At the level of 0.01 (double-tailed), the correlation was significant; *. At the level of 0.05 (double-tailed), the correlation was significant.

Table 5. Variance table of EP and FP.

	Sum of squares	Degrees of freedom	Mean square	F	Significant
Regression	199.418	6	33.236	57.997	.000[b]
Residual	255.591	446	.573		
Total	455.009	452			

Note: a. Dependent variable: FP; b. Predictor variable: (Constant), EP, Grow, Tat, Alr, H1, Shares

0.7622, while the company with the highest score is 3.7303, and the average score for the whole industry is 2.7205. From the financial performance score results, the company with the lowest score has only 0.2232 points, while the company with the highest score has 1.9960 points, with an average of 1.0913 points. Compared with the gap in environmental performance scores, the gap in financial performance scores among companies is even smaller.

Correlation Analysis

In this paper, Pearson correlation test is performed before regression analysis of the variables as a way to determine whether there is a significant relationship between the variables (Table 4).

The test results show that financial performance is significantly related to environmental performance at the level of 0.01, and environmental performance has a suppressive effect on financial performance, which is largely consistent with the hypothesis. Among the control variables, total asset turnover ratio, gearing ratio and equity concentration all have significant effects on the financial performance of the companies, while the growth rate of operating income and the percentage of state-owned shares ownership have insignificant effects.

Regression Analysis

This paper uses SPSS26.0 software to verify the constructed multiple regression model. The data were standardized before regression, and then the significance of the equations was tested by ANOVA. This article sets the significance level to 5%, and the obtained variance test results are shown in Table 5.

Table 6. Regression coefficient table of EP and FP.

	Coefficient	T	Significant
(Constant)	—	.107	.915
EP	-.099	-2.740	.006
Grow	.219	6.138	.000
Tat	.248	6.900	.000
Alr	-.517	-14.326	.000
H1	.148	4.098	.000
Shares	-.008	-.224	.823

As can be seen from the variance analysis in Table 5, the F-test value of the multiple regression equation is 57.997, with significance = 0.000, which is much less than 0.05. This regression equation passed the significance test and is statistically significant, indicating that the equation has a significant linear correlation.

Finally, we perform regression analysis to test whether the variables passed the significance test and to determine the correlation results based on the regression coefficients (Table 6).

As can be seen from Table 6, the regression coefficient of environmental performance is -0.099 and the significance is 0.006, indicating that it has passed the significance test at the level of 5%.

Table 7. Collinearity diagnosis.

Dimension	Eigenvalue	Condition index	Variance ratio						
			(Constant)	EP	Grow	Tat	Alr	H1	Shares
1	1.366	1.000	.00	.14	.04	.12	.13	.15	.13
2	1.032	1.151	.05	.01	.33	.08	.29	.13	.05
3	1.015	1.160	.00	.15	.29	.11	.02	.09	.31
4	.999	1.169	.94	.00	.03	.01	.01	.00	.01
5	.911	1.225	.00	.47	.06	.40	.00	.06	.07
6	.876	1.249	.01	.00	.21	.26	.30	.27	.07
7	.800	1.306	.00	.22	.05	.01	.26	.30	.36

However, we can see that the regression coefficient of environmental performance is a negative value, indicating that the better the environmental performance of an enterprise is, the worse its financial performance will be. This result verifies Hypothesis 1 proposed in this paper. The fact that active environmental protection practices do not bring the expected economic benefits may be related to the industry characteristics of China's heavy polluting industries and the stage of China's economic development. At the same time, it may become a roadblock on the road to environmental protection for many enterprises, thus discouraging them to actively engage in environmental protection practices.

In addition, we perform a multicollinearity analysis on the variables to check whether there is a high correlation between the explanatory variables in the multiple linear regression equation. In this paper, independent covariance diagnosis is performed (Table 7).

The existence of multicollinearity is proved when the characteristic roots of several dimensions are about 0; when the conditional index is greater than 10 also suggests that there may be multicollinearity in our equation. The results of the diagnostics show that the values of the characteristic roots of all the variables in a total of seven dimensions are much greater than 0, and three dimensions are greater than 1. Meanwhile, the maximum value of the conditional indicator is 1.306, which is much lower than the critical value of 10. This indicates that there is no problem of multicollinearity among the variables of this equation, and the regression results are accurate and valid.

Conclusions

This paper reviewed the current status of research on environmental performance and financial performance by domestic and international scholars, and proposed the research hypothesis based on theories of stakeholders, social responsibility and sustainable development. The hypothesis of this paper is argued through empirical tests: there is a negative relationship between environmental performance and financial performance of most enterprises in heavy pollution industry in China, which is different from the findings of many scholars who pointed out that improving environmental performance of enterprises can enhance financial performance.

This result may be caused by a number of reasons. First of all, the heavy pollution industry, due to its high energy consumption and high pollution industry specificity, has long acquired high economic benefits at the cost of high consumption of resources and environment. Although the view of sustainable and green development has gradually gained popularity in recent years, the thorough transformation and upgrading of heavy polluting industries still requires a relatively long process. Second, for heavy polluting industries, the whole process of improving environmental performance takes a long period of time from input to output. From the elimination of backward production capacity, upgrading machinery and equipment to the development of circular economy, etc., all need to invest huge amounts of money. These initial investment costs need to be slowly recovered in the later development and gradually produce economic benefits. The current financial performance of China's heavy pollution industry is not yet able to make up for this part of the cost, which results in the more investment in environmental protection, the worse the financial performance. Finally, compared to the huge environmental fines and other environmental penalties abroad, the cost of environmental pollution violations by Chinese enterprises is relatively low. In addition, most consumers are still most concerned about price and quality when buying products. Environmental protection products have not yet reflected the absolute advantages, resulting in the actual production of enterprises still have a fluke mentality, not fully practice the concept of green development. It is clear that the pathway of improving environmental performance to ultimately reap greater corporate benefits has not been well realized in China's heavily polluting industries. At the same time, it takes a long time for environmental investment to reach profitability. And the current environmental investment in China's heavy polluting industries has not yet entered the profitability period, which will discourage companies from investing in environmental protection.

In view of the above conclusions, this paper makes the following recommendations: First, the government can give some financial support to enterprises that carry out environmental protection equipment renewal and reconstruction. The government can provide financial support and policy preferences to enterprises according to the level of environmental management and the degree of pollution control. For enterprises with perfect internal environmental management system and strict pollution control, the government can give financial support according to a certain percentage of the cost of environmental protection equipment when purchasing new environmental protection equipment and using it for environmental protection and pollution prevention, which can effectively make up for part of the environmental protection costs and make enterprises less burdened with environmental protection and thus more active in responding to environmental protection policies for environmental management. Secondly, the government and banks should strictly implement the "green credit" policy and regulate environmental protection by raising the environmental access threshold for enterprise credit. The government can issue relevant documents to classify various types of projects, and at the same time, classify them on the basis of classification. Projects should be classified

as polluting or non-polluting based on whether they pollute the environment. At the same time, within the pollution category, the projects are further graded according to the degree of pollution. For ordinary projects, banks can grant loans as usual. For high pollution projects, the bank can directly reject its loan request, thus cutting off the economic source of high energy consumption and high pollution enterprises for blind expansion, which is conducive to guiding such enterprises to change their development path. For low pollution projects, banks can grant loan amounts according to grades and encourage enterprises to change their investment directions, which can also effectively curb the impulse of enterprises to invest in polluting projects. In addition, the government should raise the cost of environmental pollution for companies that break the rules. In addition to raising the cost of environmental fines that enterprises face directly, the government can also link them to corporate loans and government subsidies. When the enterprise takes out a loan or applies for a government subsidy, the bank and the government can evaluate its history of fines to determine the amount of the loan or subsidy. This measure can increase the cost of non-compliance and make enterprises aware of the serious consequences of polluting the environment. Finally, enterprises with good environmental management should be given some encouragement and assistance. The environmental management activities of heavily polluting enterprises can be evaluated every two years through professional institutions and the evaluation reports should be made public. The government can give certain subsidies and rewards to enterprises that have good assessment results or have usually received environmental commendations. When environmental protection expenditure becomes an essential cost for heavy polluters, appropriate incentives and support will motivate enterprises to consciously and seriously improve their environmental performance to obtain this additional environmental benefit.

For the enterprise itself, it should set up the long-term goal of sustainable development, not just limited to short-term interests. Companies can establish a sound environmental cost accounting system to account for and monitor their environmental management activities in real time. This is beneficial to the follow-up of environmental protection, but also to reduce unnecessary duplication of expenditure. From the previous analysis in this paper, it is clear that the environmental performance of enterprises within the heavy pollution industry varies widely. Therefore, companies with poor environmental performance can learn from companies with good environmental performance in order to improve themselves more quickly. In addition, heavy polluting enterprises should also focus on improving their production methods and carrying out green production. In addition to avoiding environmental pollution as much as possible, heavy polluting enterprises can also develop advanced technologies to properly handle waste in the production process and turn waste into treasure, which can both reduce resource waste and gain benefits. At the same time, an enterprise with an advanced environmental protection technology can also sell its own environmental protection technology on the market. It can not only promote enterprises to continuously research and improve their own technology, but also stimulate more companies to develop advanced environmental technologies in order to gain a greater competitive advantage. In the long run, it will be an effective way to promote environmental performance to improve economic performance. Finally, according to the test results, the environmental performance and financial performance of heavy polluting industries are not a win-win situation at present, while green management is the future development trend. Therefore, companies can work on innovative product forms, develop new technologies, etc. to enhance the competitiveness of their products. Thus, the financial performance of enterprises can be improved by seeking new development and competitive advantages without damaging the environment.

Although this paper introduces a more applicable method for the evaluation of environmental performance and financial performance, there is also some room for improvement. Since the sample size of this paper is limited to listed companies in Shanghai, and due to the difficulty of obtaining some environmental information, there are a large number of qualitative indicators of environmental performance, and the projection pursuit model cannot completely overcome the subjectivity brought by the content analysis method, which may produce some bias to the research results. These factors should be overcome as much as possible in future studies to make the conclusions more objective and reliable.

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Conflict of Interest

The authors declare no conflict of interest.

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