Pol. J. Environ. Stud. Vol. 32, No. 5 (2023), 4679-4697
DOI: *10.15244/pjoes/168264* ONLINE PUBLICATION DATE: 2023-08-04

Original Research

Does Corporate Environmental Responsibility Promote the Improvement of Corporate Economic Performance? – Based on the Perspective of Green Reputation

Rong Liu[1], Hongfeng Zhao[2], Jianyu Ren[3]*

[1]School of Management, Zhejiang University, Hangzhou 310058, China
[2]Hangzhou Commerce and Tourism Group Co. Ltd., Hangzhou 310003, China
[3]School of Economics, Zhejiang Gongshang University, Hangzhou 310018, China

Received: 27 April 2023
Accepted: 13 June 2023

Abstract

With the rapid development of the economy and the introduction of environmental policies, increasingly serious environmental problems are getting more and more attention. Studying how to motivate enterprises to actively fulfil their environmental responsibilities and establish the concept of green development is the key to achieving sustainable development. This paper selects a sample of large steel enterprises of the China Iron and Steel Industry Association from 2008 to 2017, and explores the effect of environmental responsibility of industrial enterprises on corporate economic performance and the transmission mechanism based on the perspective of the mediating effect of green reputation. The results show that corporate environmental responsibility (CER) has a significant positive effect on corporate performance. Green reputation has a significant mediating effect in the impact of corporate environmental responsibility on economic performance. In addition, the differences in the mediating effects of green reputation between corporate environmental responsibility and economic performance are explored in depth from the perspectives of regional heterogeneity and ownership heterogeneity. Finally, based on the findings, the paper suggests that corporate policy makers should balance environmental and economic benefits in their management, and promote the establishment of management systems and production methods that use environmental protection as a value leader and growth driver.

Keywords: corporate environmental responsibility, corporate economic performance, green reputation

*e-mail: jyren@mail.zjgsu.edu.cn

Introduction

Climate change is a common challenge for all mankind and is closely related to sustainable human development. The lessons of history tell us that the harm humans do to nature will eventually hurt humans themselves, and that economic growth at the expense of massive consumption of resources and ecological environment is unsustainable. As the global environmental crisis intensifies, energy supplies become increasingly tight and the global climate continues to deteriorate, environmental issues are receiving more and more focused attention and calls for companies to assume environmental responsibility are becoming louder and louder. As the main bearer of economic development, enterprises are bound to have an impact on the environment in the course of their operations. Companies should take responsibility for the environmental issues brought about by their own economic development and actively participate in the global governance of climate change.

Currently, China is facing serious challenges in protecting the ecological environment, such as reducing conventional pollutants, improving environmental quality and reducing CO2 emissions. Under the current severe environmental problems, enterprises must promote economic and ecological benefits simultaneously to achieve high quality, efficient and sustainable development. In their daily practice, enterprises must establish the green development concept of protecting nature and fulfill their responsibility for the prevention and treatment of environmental pollution. They should strengthen their environmental management measures and plan their development on the basis of the harmonious co-existence of man and nature. Moreover, the current state of the ecological environment nowadays requires enterprises not to passively fulfill their environmental responsibilities, but to actively and positively take up the responsibility of protecting the environment. The active implementation of environmental responsibility by enterprises is an important path to promote the green transformation of enterprises and to achieve a harmonious coexistence between man and nature.

Enterprises are important decision-making units in the economy and society, and are an important force in promoting the development of environmental protection. The sustainable development path of enterprises fulfillling their environmental responsibility has become an inevitable choice for all countries around the world to cope with climate change. With tightening resource constraints, serious environmental pollution and degraded ecosystems, enterprises must uphold the concept of saving resources and protecting the ecological environment in their daily operations. As market players, enterprises should actively fulfill their environmental responsibilities and disclose their performance on time. The active implementation of environmental responsibility by enterprises to promote the transformation of green production methods has a significant role to play in achieving a green and low-carbon transformation of society. And the fulfillment of environmental responsibility is a reflection of the internalization of environmental costs by enterprises. Therefore, it is important to explore the effect of corporate environmental responsibility (CER) on corporate performance and its transmission mechanism in order to tackle global climate change. And it is conducive to promoting enterprises to better fulfill their responsibility for ecological and environmental protection and to more clearly identify and optimize the sustainability of their production methods.

At present, China's industrial structure is still dominated by heavy chemicals, and its energy structure is dominated by high-carbon fossil energy, which is characterized by high pollution and high emissions, and there is great pressure for green transformation and development. Enterprises should effectively fulfill their responsibility for ecological and environmental protection and promote the efficient completion of the green transformation of their production methods. As China has entered a new stage of development, the key to solving resource and environmental problems is to promote the active implementation of corporate environmental responsibility. This paper therefore examines the impact of corporate environmental responsibility on corporate performance, integrating corporate environmental responsibility with corporate strategic and financial objectives, and explores the study of the transmission mechanism of corporate environmental responsibility on corporate performance. Firstly, a theoretical analysis of the mechanism of the role of corporate environmental responsibility on corporate performance through green reputation. Secondly, the direction and extent of the impact of green reputation on corporate economic performance is empirically analyzed. Finally, an in-depth exploration of whether there are differences in the impact of corporate environmental responsibility on corporate performance based on the perspectives of regional heterogeneity and ownership heterogeneity. This paper expects the results of the study to contribute to the promotion of proactive environmental responsibility of corporate enterprises and to provide new ideas for improving environmental management systems and green production methods.

The main contents of this article are as follows. Section 2 is a review and overview of relevant research, Section 3 quantifies corporate environmental responsibility, and Section 4 is the methodology and research design. Section 5 presents the results of the empirical analysis, Section 6 contains a discussion based on the empirical results, and Section 7 contains the conclusions and recommendations.

Literature Review and Research Hypotheses

This section provides a review of the literature on the effects and transmission mechanisms of corporate

environmental responsibility on corporate economic performance, on the basis of which the corresponding theoretical hypotheses are formulated.

Corporate Environmental Responsibility

The concept of corporate environmental responsibility is inextricably linked to corporate social responsibility (CSR), and some scholars directly consider corporate environmental responsibility as a dimension of corporate social responsibility, defining it as the part of corporate socially responsible behaviour that relates to pollution prevention and cleaner production [1]. As recognition of corporate environmental responsibility continues to grow, companies, national governments and citizens are all showing a high level of concern for corporate environmental responsibility [2]. Corporate environmental responsibility is no longer studied as just one dimension of CSR, and the focus of scholarly research on CSR has shifted to corporate environmental responsibility [3].

Academia and industry have reached a consensus on corporate environmental responsibility, believing that undertaking corporate environmental responsibility is a necessary part of achieving sustainable development. In recent years, as people have become more and more concerned about environmental protection issues, enterprises and academics have become more specific and in-depth in their practical research on environmental management, and have tried to find ways and paths to effectively solve environmental problems.

Howard believes that environmental responsibility is a reasonable and legal decision and concrete social action by companies to achieve their own goals and corporate values through corresponding government policies [4]. Klassen and McLaughlin believe that environmental responsibility is a due obligation for companies, i.e. companies must give back to society when they use natural resources for economic benefits in order to achieve long-term corporate development [5]. Brummer states that environmental responsibility essentially means that companies should follow a sustainable development perspective, consume fewer resources and produce less waste in their production processes [6]. In terms of the concept of corporate environmental responsibility, Enderle, an American economic ethicist, argues that corporate environmental responsibility refers to the process of reducing the consumption of natural resources in the operation of a company, reducing the level of environmental load on various wastes and thus achieving sustainable development [7]. According to Enderle, corporate environmental responsibility consists of two aspects: firstly, energy saving, which reduces the demand on the environment. The second is the reduction of emissions, reducing the discharge of waste in the environment. According to Lööf et al. corporate environmental responsibility refers to the actions taken by companies to meet environmental ethical and legal requirements in order to achieve environmental sustainability [8]. Based on previous research, this study defines corporate environmental responsibility as the internalization of environmental costs by companies, which is the act of applying the concept of sustainable development to the process of production management and cost control in order to seek to maximize overall benefits.

The Relationship Between Corporate Environmental Responsibility and Corporate Economic Performance

According to neoclassical economics, the voluntary pursuit of environmental protection by firms is detrimental to their economic interest objectives, causing environmentally responsible firms to add additional expenses [9]. For profit-maximizing firms, this may prompt them to avoid or reduce the cost of spending on pollution control. In short, the fulfillment of environmental responsibility by companies is likely to compromise their financial performance. The Bohidar study found that corporate environmental protection practices instead increased corporate profitability [10]. As can be seen, there are inconsistent findings on whether corporate environmental responsibility helps to increase the firm's own benefits.

The current research on the relationship between corporate environmental responsibility and corporate performance is inconsistent in terms of empirical results, with four main forms of relationship: positive, negative, non-linear and non-significant. Some studies have argued that corporate environmental responsibility has a negative impact on corporate performance, mainly because it diverts financial resources and reduces economic efficiency, and the benefits of environmental governance are not sufficient to offset its costs [11]. For example, Alfonso et al. identify a new type of 'greenwashing' behaviour in a case study of the Volkswagen Group, based on the Communicative Constitution of Organizations perspective. This behaviour avoids investment in environmental improvements and therefore shows better financial performance, challenging the dominant view of corporate environmental responsibility research [12]. Some scholars have focused on the case of excessive corporate commitment to environmentally responsible behaviour. Using data from the American Customer Satisfaction Index (ACSI) for US companies over the period 2008-2016, Ioannis et al. found a negative relationship between green product innovation (GPI) and the ACSI index [13]. Choi et al. studied the impact of related party transactions on corporate environmental responsibility The results showed that the marginal cost of corporate environmental responsibility is greater than the benefits for financially constrained firms, thus discouraging financially constrained firms from engaging in corporate environmental responsibility activities [14]. Other studies have concluded that there is a non-linear relationship between corporate

environmental responsibility and corporate performance as well as a non-significant relationship between the two. For example, using a sample of Chinese A-share listed chemical companies from 2006 to 2017, Peng et al. found a non-linear relationship between environmental responsibility and environmental performance using a generalized method of moments (GMM) model study [15]. Li et al. empirically showed that the effect of green behaviour on corporate financial performance is ambiguous and found that in emerging economies with high information asymmetry, it is difficult for stakeholders to identify corporate green behaviour [16].

However, the majority of current research proves that corporate environmental responsibility can improve corporate performance [17]. Stakeholder theory [18], institutional theory [19] and the natural resource base view [20] argue that corporate environmental behaviour can be seen as a potential tool to obtain resources as well as shareholder support, help reduce the likelihood of future environmental penalties and financial risks to the firm [21], meet consumer demand for purchasing green products [22], show higher returns in capital markets and attract green investment funds and thus access to financial resources [23]. Zhang empirically examined the impact of firm-level green innovation on export product quality using data related to Chinese exporters. The study found a positive relationship between green innovation and export product quality [24]. Jiang et al. conducted a regression analysis on data from Chinese energy industry firms, and the results showed that positive corporate environmental responsibility has a positive impact on corporate financial performance [25]. Bai and Meng empirically demonstrated that corporate environmental responsibility has a positive impact on corporate performance based on upper echelons theory and stakeholder theory, using Chinese listed manufacturing companies as a research sample [26].

From the above scholars' research, it can be seen that as green growth gradually becomes the core of economic development, fulfillling environmental responsibility does not mean that enterprises give up the pursuit of economic benefits, but rather promote sustainable economic development through green investment. In the process of production and operation, enterprises should actively fulfill their environmental responsibilities and apply the concept of sustainable development to production management and cost control, which can help them save production costs and management expenses. At the same time, it can stimulate innovation, research new technologies that are more energy-efficient and environmentally friendly, improve production efficiency, reduce pollution emissions, effectively avoid government penalties for exceeding environmental pollution standards, and at the same time enjoy preferential tax policies for enterprises that meet environmental protection standards and improve their corporate image. Ultimately, this will have an impact on the financial performance of the company and lead to improved financial performance. Therefore, we propose the following hypothesis:

Hypothesis H1: Corporate environmental responsibility has a positive impact on corporate economic performance.

More research is now beginning to delve into the transmission mechanisms between corporate environmental responsibility and corporate economic performance. By examining the impact pathways and mechanisms of environmental responsibility in more detail, we can guide the environmental management practices of enterprises.

The Transmission Mechanism of Corporate Environmental Responsibility to Corporate Economic Performance

Currently, there is an increasing amount of research in the field of environmental protection in enterprises, both at home and abroad, which focuses on the following two aspects when studying the relationship between environmental protection and economic growth. One is whether the implementation of environmental management measures by enterprises can achieve a balance or optimization between economic growth and environmental protection? The other is the relationship between the impact of a company's implementation of environmental protection responsibilities on aspects of business operations, such as on innovation, investment, reputation, employment, credit, etc. As these interrelationships are decisive for environmental sustainability and human well-being, they have received scholarly attention in their respective fields.

In recent years, in addition to exploring the relationship between corporate environmental responsibility and corporate performance, scholars have also attempted to identify potential mechanisms through which corporate environmental responsibility affects corporate performance. Some scholars have explored some important transmission mechanisms, including regional differences [27], political legitimacy of firms [28], non-institutional factors such as traditional culture [29], the number of environmental patents [30], employee behaviour [31], advertising [32], environmental regulations [33, 34], external investor sentiment [35], and the tenure of chief executive officers [36]. However, the potential mechanisms between corporate environmental responsibility and performance are complex and still under-researched, and further research is needed to elucidate this link. This paper will therefore delve into the potential transmission mechanism of corporate environmental responsibility on corporate performance from a green reputation perspective.

As consumers become increasingly aware of environmental protection, more and more people are refusing to buy and use products with high energy consumption and high pollution. In the current social context of emphasising environmental protection, environmental responsibility is an important factor

affecting corporate reputation, and actively assuming environmental responsibility has become an important way for companies to manage their reputation. Especially when negative events occur, a good green reputation can provide a strong endorsement for a company [37], thus preventing stakeholders from attributing negative events to a company's malicious intentions and taking punitive activities such as boycotts or negative publicity. In this context, the fulfillment of environmental responsibility is receiving more and more attention from enterprises, and the role of green reputation is gradually becoming apparent. A green reputation is an important intangible asset of a company, with characteristics such as profitability [38]. A good green reputation can win the recognition and support of stakeholders and thus create benefits for the company [39].

Most studies have found that companies' environmental protection behaviours are effective in enhancing their green reputation [40]. Environmental protection behaviours such as implementing environmental protection policies, using renewable energy sources, actively meeting emission reduction targets and forming green teams of corporate employees all play an important and positive role in the creation of green reputation [41]. Hillen argues that corporate reputation is more sensitive to corporate social responsibility and that a good reputation requires companies to actively engage in social responsibility [42]. Hsu's findings suggest that corporate environmental responsibility has an informative and persuasive advertising effect, which enhances corporate reputation [43]. Some scholars have shown through empirical studies that active participation in environmental management activities improves organizational reputation and attractiveness [44, 45]. Many companies are trying to improve their environmental position by informing the public about their environmental efforts. To this end, companies are applying green marketing strategies to enhance their green reputation to help gain a competitive advantage and attract eco-conscious consumers [46].

Indeed, one of the main objectives of active corporate environmental responsibility is to make sustainability reports and environmental disclosures available to the public to help companies maintain a good reputation. Advanced environmental technologies can help companies not only produce eco-friendly products that build a good reputation with their customers, but also achieve environmental cost advantages in the company's production process.

The fulfillment of environmental responsibility by companies not only means improving their reputation, but also improving their production processes, enhancing efficiency and ultimately improving corporate performance. Many studies have also looked at the impact of green reputation on corporate performance [47]. Based on signal theory, existing studies and analyses believe that the higher the green reputation generated by the overall environmental performance of the enterprise, the better the performance of the enterprise [48]. Tang et al. found that fulfillling environmental responsibility can release signals that enterprises is actively taking on environmental responsibility, which brings a good external reputation to enterprises and thus helps to improve economic performance [30]. Investors exhibit higher levels of expected stock price returns for companies with better green reputations, and considering green reputation information significantly improves investors' ability to predict future corporate earnings [49]. Charles et al. studied the impact of pressure from organizational and regulatory stakeholders to influence corporate green practices, resulting in an enhanced environmental reputation and improved financial performance [50]. Brammer et al. show that corporate reputation capital is strengthened as corporate environmental responsibility behaviour is supported and recognised by stakeholders, and that accumulated reputation capital can further motivate companies to fulfill their environmental responsibilities to stakeholders and improve corporate performance [51]. It has been argued that firms gain competitive advantages through environmental responsibility, such as increased sales and productivity and corporate reputation, which can lead to better financial and stock market performance [52]. Some scholars have found that corporate reputation can mitigate the negative effects of negative corporate behaviour on customer satisfaction [13]. And a poor green reputation may signal to stakeholders that a firm's production processes are less efficient, that the firm may be subject to closer scrutiny and criticism from nearby environmental groups or the media, to consumer boycotts and rejections, and even to potential financial losses from government environmental regulatory penalties and environmental liability disputes, among other things. The results of Flammer's study also suggest that firms with a good reputation for environmental responsibility suffer less negative reactions from ecologically harmful behaviour [21]. Francescod et al. consider corporate environmental responsibility as a professionalised corporate asset that enhances corporate reputation, and argue that environmental involvement and corporate reputation provide insurance-like protection for corporate competitiveness [53]. Peng et al. empirical study suggests that corporate fulfillment of environmental responsibility enhances reputation, which in turn generates positive economic performance for the firm [54]. Therefore, based on the above analysis, the following hypothesis is proposed in this paper:

Hypothesis H2: There is a positive incentive effect of corporate environmental responsibility on corporate economic performance through green reputation.

Based on the above, an analytical framework for the impact of corporate environmental responsibility on corporate economic performance has been constructed based on the literature review, and the mechanism of the impact of corporate environmental responsibility on economic performance has been explored with a focus on the reputation perspective. Therefore, it is

necessary to effectively measure the extent of corporate environmental responsibility before specifically analyzing the mechanisms of its impact on corporate performance.

Measurement of Corporate Environmental Responsibility

In recent years, as the standard of living of the population continues to improve, the academic and industrial communities have been paying increasing attention to corporate environmental responsibility, but there is still a lack of research in quantifying corporate environmental responsibility. The measurement of corporate environmental responsibility is a prerequisite for analysing the impact of environmental responsibility on corporate performance. Assessing the environmental responsibility of different companies not only helps managers to understand the differences between companies, but also provides a favourable reference for improving corporate performance.

Data

After more than 70 years of development, China has become the world's number one manufacturing country. However, the rapid development of the manufacturing industry has also brought about serious environmental problems. Industries recognized worldwide as highly polluting and difficult to reduce emissions include steel, petrochemicals and cement. These industries still account for a high proportion of the industrial structure in China. In recent years China is vigorously promoting quality and efficiency improvement in the industrial sector, and the steel industry is being monitored as a key sector. In 2022, the China Iron and Steel Industry Association announced that China's annual crude steel production was about 1.01 billion tonnes, and China's crude steel production has accounted for more than 50% of global output for five consecutive years. Steel is the food of industry and is a pillar basic material required for China's national economy, social development and national defence construction. This paper therefore selects the steel industry as the sample for the study.

The Chinese steel industry currently suffers from high levels of polluting waste, high total emissions, low energy efficiency and comprehensive product performance that needs further improvement. This paper quantifies corporate environmental responsibility based on environmental panel data established by 56 large steel enterprises of the China Iron and Steel Industry Association from 2008-2017, applying the SBM super-efficiency model that includes non-desired outputs.

Measurement Methods

The data envelopment analysis (DEA) CCR evaluation model was first proposed by Chames et al. in 1978 [55]. Since the introduction of the CCR model, DEA theory has continued to evolve, with new DEA models emerging and expanding in cross-cutting research areas. Because of this, the DEA family of models has become more and more popular among researchers. DEA models are divided into radial DEA models and non-radial DEA models. The radial DEA models include the CCR model and the BCC model. The non-radial DEA models include Additive model, Multiplication model, Range-adjusted measure model, Slacks-based measure model, Super-efficiency model, and other extended models.

The DEA method, which takes the traditional sense of single-input and single-output engineering science efficiency ideas and evaluates them for the more complex homogeneous Decision-Making-Unit (DMU) with multiple inputs and multiple outputs, combines the linear programming techniques of operations research to perform operations. As a non-parametric method, the DEA method can meet the practical application of the production function theory in economics, and has certain advantages in terms of relative objectivity, algorithmic simplification and error reduction. The standard DEA model gives a maximum efficiency value of 1, which does not allow for further differentiation of the efficiency of an effective DMU. To solve this problem, the 'super-efficiency' model was developed. For further research purposes, the Super-SBM model (super-efficiency SBM model) is constructed by combining the SBM model, which contains undesired outputs, with the super-efficiency model. The planning equation of the model is as follows:

$$\min \rho = \frac{1+\frac{1}{M}\sum_{i=1}^{M} S_i^- / x_{ik}}{1-\frac{1}{Q+Z}\left(\sum_{r=1}^{Q} S_r^+ / y_{rk} + \sum_{t=1}^{Z} S_t^{b-} / b_{tk}\right)} \tag{1}$$

$$\text{S. t.} \quad \sum_{j=1, j\neq k}^{n} x_{ij}\lambda_j \leq x_{ik} + S_i^- \tag{2}$$

$$\sum_{j=1, j\neq k}^{n} y_{ij}\lambda_j \geq y_{rk} + S_r^+ \tag{3}$$

$$\sum_{j=1, j\neq k}^{n} b_{tj}\lambda_j \leq b_{tk} + S_t^{b-} \tag{4}$$

$$1 > \frac{1}{Q+Z}\left(\sum_{r=1}^{Q} S_r^+ / y_{rk} + \sum_{t=1}^{Z} S_t^{b^-} / b_{tk}\right) \tag{5}$$

$$\lambda_j, S_i^-, S_r^+ \geq 0 \tag{6}$$

$$i = 1,2,\ldots,M; r = 1,2,\ldots,Q; t = 1,2,\ldots,Z; j = 1,2,\ldots,n; (j \neq k). \tag{7}$$

In the above model, it is assumed that there are n decision-making units (DMU), each of which has input

vector, expected output vector and non-expected output vector. The number of input variables is *M*, the number of desired output variables is *Q* and the number of non-desired output variables is *Z*. S^-, S^+ and S^{b-} are the input, desired output and non-desired output slack variables respectively. λ_j is the weight of the jth DMU and ρ represents the efficiency score of the evaluated decision making unit.

Variable Description

Table 1 provides a description of the input-output variables. The input variables include the number of employees, energy consumption, fixed assets and new water usage. The variables were selected based on the Cobb Douglas production function, with labour, resources and capital selected as input factors and the level of economic development and environmental pollutant emissions as desired and undesired output variables. This paper focuses on the environmental responsibility of steel companies, so the input variables include new water use to make the indicators more comprehensive. The non-desired output variables include waste residue, waste gas, waste water and pollution discharge fees. The selection of indicators for wastewater, waste gas and waste residue is more in line with the Chinese government's campaign to control multiple pollutants in a coordinated manner, including blue water, blue sky, clean soil and clean waste. The pollution discharge fees reflects the government's adoption of charging the emitters to internalize the cost of environmental pollution to enterprises, reflecting the government's environmental monitoring role. The desired output variable, selected as the value of output from the use of three wastes, indicates the extent to which enterprises reuse pollutants and realize the value of the products of three wastes, reflecting the degree to which enterprises attach importance to actively fulfillling their environmental responsibilities. The SBM super-efficiency model can better combine data on energy consumption, water consumption and material consumption of enterprises. In this paper, the SBM super-efficiency model is used to construct an environmental responsibility evaluation system for the collaborative management of pollutants, the efficient use of energy and the reuse of waste.

Measurement Results of Corporate Environmental Responsibility

This paper calculates the environmental inputs and outputs of steel companies using the SBM super-efficiency model and expresses the results in terms of corporate environmental responsibility (CER). The results reflect the extent to which the environmental management decisions and daily business practices of enterprises have an impact on the environment. It provides data to support the subsequent examination of the relationship between corporate environmental responsibility and corporate economic performance and the mechanisms of influence. Due to space constraints, Fig. 1 and Fig. 2 respectively show the measurement results of environmental responsibility of Chinese iron and steel enterprises in 2008 and 2017.

As can be seen from Fig. 1 and Fig. 2, there are significant differences in the calculation results of CER of different enterprises. We found the same pattern in other years. This shows that the level of environmental responsibility of Chinese steel enterprises is uneven, and the level of environmental responsibility of most enterprises is still at a low position. Next, we will delve into the effects and mechanisms of environmental responsibility on corporate economic performance.

Research Design

In China, gross industrial output has traditionally been an important component of GDP. China's total industrial output as a percentage of GDP remains above 30%, significantly higher than that of developed countries in Europe and the US. Industry is vital to

Table 1. Descriptive statistics of enterprise input-output variables (2008-2017).

Variable	Units	Mean	SD	Min	Max
Fixed Assets	Billion Yuan	19.91	19.07	1.73	117.79
Number of Employees	Ten Thousand People	19.33	18.54	1.31	139.74
Energy Consumption	Hundred Thousand Tons Standard Coal	43.26	32.64	2.23	206.22
New Water Usage	Million Tons	27.30	20.23	2.29	114.95
Output Value of Three Wastes Utilization	Billion Yuan	574.58	811.47	2.75	5956.52
Pollution Discharge Fees	Billion Yuan	23.91	22.39	1.79	146.90
Waste Residue	Hundred Thousand Tons	44.24	42.01	0.16	268.25
Waste Gas	Billion Cubic Meters	147.54	126.33	0.01	797.60
Waste Water	Hundred Million Tons	4.95	5.31	0.01	37.61

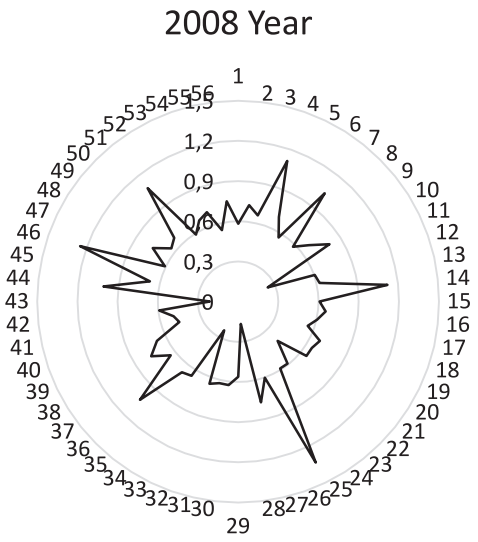

Fig. 1. Measurement results in 2008.

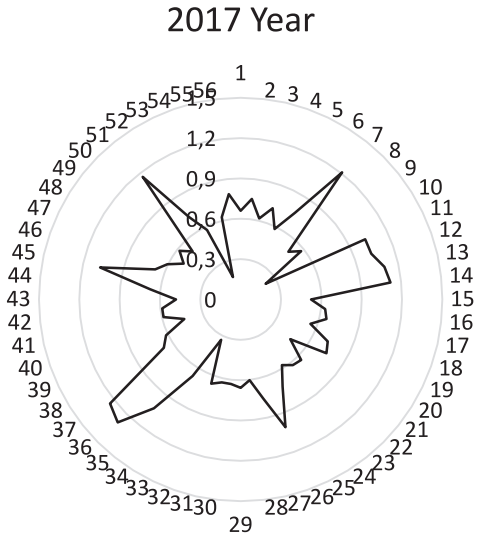

Fig. 2. Measurement results in 2017

China's economic structure. However, due to the sheer size of China's industrial economy, the environmental pollution caused by an irrational production structure cannot achieve the clean production encouraged by the government. Therefore, as the main bearer of economic development, improving the environmental and economic efficiency of enterprises has become an important objective of environmental management. In the face of increasingly serious environmental problems and pressure from stakeholders such as the government and the public, enterprises need to take a proactive approach to environmental responsibility and environmental management.

However, as enterprises aim to make profits, the key to the problem is whether the fulfillment of environmental responsibility can bring economic benefits. Therefore, in order to make enterprises actively fulfill their environmental responsibility, this paper links corporate environmental responsibility with corporate profitability and explores the impact of corporate fulfillment of environmental responsibility on corporate economic performance and the mechanism of research to provide a new path for solving corporate environmental problems.

Model Building

Basic Model

The focus of this paper is on the impact of corporate environmental responsibility (CER) on the economic performance of enterprises. Based on the measurement of this indicator of corporate environmental responsibility, the relationship between corporate environmental responsibility and economic performance is empirically tested according to the previous hypothesis. The empirical econometric model is as follows:

$$IVA_{j,t} = l_0 + l_1 CER_{j,t\text{-}1} + l_2 \ln SCALE_{j,t} + l_3 KLR_{j,t} + l_4 \ln MBI_{j,t} + l_5 \ln TC_{j,t} + l_6 LEV_{j,t} + e_{j,t} \quad (8)$$

In the above model, j represents the firm and t represents time (2008-2017). λ_0~λ_6 are parameters to be estimated, $\varepsilon_{j,t}$ are error terms. Corporate environmental responsibility is the independent variable, using the measurements in Section 3 of this paper. SCALE, KLR, TC, MBI, LEV are the control variables.

Mediation Effect Model

To further test whether corporate environmental responsibility can indirectly influence corporate economic performance through green reputation. This paper constructs a mediating effect model to further clarify the mechanism of the effect of environmental responsibility on firms' economic performance. Based on theoretical and hypothesis analyses, this paper draws on Baron and Kenny's model setting to test green reputation as a mediating variable of corporate environmental responsibility affecting economic performance [56]. A mediating effect test model is constructed as follows:

$$IVA_{i,t} = a_0 + a_1 CER_{i,t\text{-}1} + a_2 \ln SCALE_{i,t} + a_3 KLR_{i,t} + a_4 \ln MBI_{i,t} + a_5 \ln TC_{i,t} + a_6 LEV_{i,t} + b_{i,t} \quad (9)$$

$$\ln GR_{i,t} = s_0 + s_1 CER_{i,t\text{-}1} + s_2 \ln SCALE_{i,t} + s_3 KLR_{i,t} + s_4 \ln MBI_{i,t} + s_5 \ln TC_{i,t} + s_6 LEV_{i,t} + m_{i,t} \quad (10)$$

$$IVA_{i,t} = g_0 + g_1 \ln GR_{i,t} + g_2 CER_{i,t\text{-}1} + g_3 \ln SCALE_{i,t} + g_4 KLR_{i,t} + g_5 \ln MBI_{i,t} + g_6 \ln TC_{i,t} + g_7 LEV_{i,t} + t_{i,t} \quad (11)$$

where i and t denote the ith iron and steel enterprise and year t respectively, $\beta_{i,t}$, $u_{i,t}$ and $\tau_{i,t}$ are random disturbance terms. Each of these models is first tested using a fixed effects model. If α_1 is significant in model (9), it indicates the total effect of corporate environmental responsibility on economic performance, while if α_1 is not significant, it indicates that there is no mediating effect. The significance of the coefficients σ_1, γ_1 and γ_2 of models (10) and (11) are then examined. If both σ_1 and γ_2 are significant, but B is not, then a full mediation effect is present. If the coefficients σ_1, γ_1 and γ_2 are all significant, then a partial mediation effect is present. However, if at least one of the coefficients σ_1 and γ_2 is insignificant, a further Sobel test is required.

Variable Description

Industrial value added (IVA) is the dependent variable. Industrial value added is mainly a count of the new value added in the production process of an enterprise. The object of this paper is that steel enterprises are industrial enterprises and the choice of IVA as a reflection of the economic performance of iron and steel enterprises is more in line with the purpose of the study.

Corporate Environmental Responsibility (CER) is the independent variable. This paper measures the level of environmental responsibility of iron and steel enterprises using an SBM super-efficiency model that includes non-desired outputs. As there are often lagged effects in corporate environmental management decisions and behaviour. Therefore, this paper will use a one-period lag of the dependent variable for empirical testing.

Green reputation (GR) is the mediating variable. Green Reputation is the public's comprehensive evaluation of a company based on its ability to meet stakeholders' environmental needs and its commitment to environmental responsibility. In this paper, green reputation refers to the attractiveness to stakeholders of a company's environmental management practices in the course of its production and operation. Environmental penalties imposed by the government can reflect the ecological pollution and environmental damage caused to the surrounding environment by the enterprise in its daily operations. The greater the environmental penalty, the greater the negative impact on the environment caused by the enterprise. Under regulations and laws, companies are required to disclose information to the public in a timely manner when they are subject to environmental penalties, thus adversely affecting their green reputation. The more severe the environmental penalties an enterprise receives, the more detrimental it is to the green reputation of the enterprise. Therefore, combined with the availability of data, the green reputation indicator in this paper is measured by the inverse of the per capita environmental penalties of iron and steel enterprises.

Control variables include firm size, factor endowment structure, total operating cost, main business income and asset-liability ratio. The size of the firm (SCALE) is expressed using the average annual total assets. Factor endowment structure (AER) is the ratio of net fixed assets to the average annual number of employees of a firm, the higher the ratio the more favourable it is for the firm to improve its production technology. Total cost of operations (TC) is the total cost consumed by a firm's production and operation activities. Main Business Income (MBI) refers to the income generated by the enterprise's most core production and operation activities. Gearing ratio (LEV) reflects the solvency and capital utilisation of the enterprise. Table 2 shows the descriptive statistics of the variables.

The enterprise Environmental responsibility (CER) measurements in Table 2 represent the enterprise's environmental management capability and reflect the level of fulfilllment of the enterprise's environmental responsibility. The highest CER measure is 1.342 and the mean value is 0.507. This means that there is a wide gap between the high and low levels of environmental responsibility among Chinese steel companies, with uneven development and an overall low level of environmental responsibility.

Table 2. Descriptive statistics of variables.

Variable	Units	Symbol	Mean	SD	Min	Max
Industrial Value Added	Billion Yuan	IVA	5.210	25.394	-4.361	33.412
Corporate Environmental Responsibility	Efficiency Value	CER	0.507	0.321	0.020	1.342
Green Reputation	Ten Thousand Yuan Per Thousand People	lnGR	3.157	5.518	0.895	4.297
Enterprise Scale	Ten Thousand Yuan	lnSCALE	15.774	1.038	10.458	17.006
Total Operating Cost	Ten Thousand Yuan	lnTC	13.849	0.972	11.253	17.009
Main Business Income	Ten Thousand Yuan	lnMBI	15.374	1.156	11.769	17.022
Factor Endowment Structure	Percentage	AER	10.945	8.687	0.412	49.563
Asset Liability Ratio	Percentage	LEV	66.258	12.716	32.207	98.370

Empirical results

Benchmark Regression Analysis

Based on the panel data used in this study, the model was selected by considering a combination of three models: fixed effects model, random effects model and mixed model. By comparing the regression results of the three models, the fixed effects model was finally identified as the optimal model. Based on the previous model construction, the relationship between corporate environmental responsibility and economic performance was tested empirically and the results are shown in Table 3. model (1) did not include control variables in order to examine whether the regression results were robust. Model (2) does not lag the independent variables by one period, in order to examine whether there is a lagged effect in the regression results. Model (3) is the baseline regression result. It examines how the economic performance of firms within the iron and steel industry changes in response to their environmental responsibility by controlling for corporate fixed effects. The results show that corporate environmental responsibility (CER_{t-1}) has a significant positive correlation with industrial added value (IVA). Specifically, Model (3) in Table 3 shows that the influence coefficient of corporate environmental responsibility (CER_{t-1}) on industrial added value is 11.273, which is significant at 1%. It indicates that there is a significant positive relationship between corporate environmental responsibility and industrial added value, which verifies the theoretical hypothesis H1: corporate environmental responsibility has a positive impact on corporate economic performance.

Table 3. Results of baseline regression test.

Variable	Model (1)	Model (2)	Model (3)
	IVA	IVA	IVA
CER_{t-1}	12.496***		11.273***
	(3.04)		(3.43)
CER_t		9.934	
		(1.22)	
lnSCALE		2.014**	2.366**
		(2.03)	(2.19)
lnTC		-3.035***	-3.249***
		(-2.88)	(-3.57)
lnMBI		2.941***	3.652***
		(4.33)	(4.84)
AER		0.117**	0.129**
		(2.14)	(2.51)
LEV		-0.204**	-0.278**
		(-1.97)	(-2.24)
Constant	8.375**	7.564*	6.959**
	(2.11)	(1.92)	(2.47)
N	504	560	504
R^2	0.098	0.205	0.221

Note: T statistics in parentheses. *, ** and *** indicate significant at the levels of 10%, 5%, and 1%, respectively.

According to the detailed analysis of the results in Table 2 and Table 3, the environmental responsibility level of China's iron and steel enterprises is quite different at present, and the level of environmental responsibility of most enterprises is low. However, with China's environmental problems becoming increasingly prominent and attracting increasing attention from various stakeholders, it is urgent for enterprises to solve the problems of development and environmental protection. The central and local governments have successively issued laws and regulations regulating corporate emissions and encouraging environmental protection. Consumers and the media pay more attention to the environmental behavior of enterprises. Employees and investors also pay more attention to the green image of enterprises. Finally promote the improvement of enterprise economic performance. The empirical results show that corporate environmental responsibility has a lag effect on economic performance. This shows that the environmental behavior of enterprises has a long-term impact on enterprises. In the process of daily environmental management, more attention should be paid to establishing the image of enterprises actively fulfillling environmental responsibilities and promoting the sustainable development of enterprises.

The regression results of the control variables show that both the main business income and size of enterprises have a significant positive relationship on industrial value added. The factor endowment structure of an enterprise has a significant contribution to industrial value added. This indicates that the higher the factor endowment structure, the more capital-intensive the enterprise tends to be and the more advanced the production technology of the enterprise is, the more conducive to improving the economic performance of the enterprise. There is a significant negative relationship between the total cost of doing business and industrial value added. The asset-liability ratio of enterprises has a significant inhibitory effect on industrial added value.

Robustness Tests

To test the robustness of the above regression results, this paper uses a dynamic system GMM model and the replacement variable method for robustness testing. In order to address the endogeneity issues caused by omitted variables and reverse causality, a dynamic system GMM panel model is selected as the robustness test and the results are shown in model (4) in Table 4. Also, this paper uses replacement of dependent variables for robustness testing, and the return on assets (ROA) and net profit margin (NPR) are chosen to represent economic performance for verification, and the results are shown in models (5) and (6) in Table 4.

Table 4. Results of robustness tests.

Variable	Model (4)	Model (5)	Model (6)
	IVA	ROA	NPR
$CER1_{t-1}$	19.312***	29.149***	21.251***
	(4.32)	(4.07)	(3.82)
IVA_{t-1}	-0.012		
	(-0.83)		
IVA_{t-2}	-0.108***		
	(-2.86)		
lnSCALE	2.452*	-2.314	2.864*
	(1.72)	(-1.35)	(1.77)
lnTC	-3.574**	-8.545***	-9.024***
	(-2.26)	(-3.24)	(-3.79)
lnMBI	5.245***	10.426***	13.388***
	(3.67)	(3.22)	(5.34)
AER	0.034	0.108	0.758***
	(1.24)	(1.38)	(4.25)
LEV	-0.242***	-0.346***	-0.257**
	(-4.91)	(-3.45)	(-2.37)
Constant	-22.258*	67.257***	-81.568***
	(-1.92)	(2.86)	(-3.81)
N	448	504	504
AR(1)test (p-value)	0.0003	-	-
AR(2)test (p-value)	0.221	-	-
Hansen test (p-value)	0.295	-	-
R^2	-	0.218	0.242

Note: T statistics in parentheses. *, ** and *** indicate significant at the levels of 10%, 5%, and 1%, respectively.

The estimation results based on the GMM dynamic panel model show that the AR(2) test for the absence of second-order serial correlation has a p-value greater than 0.01, indicating that the original hypothesis cannot be rejected. Also the p-value of the Hansen test for over-identification restriction is greater than 0.01, indicating that the original hypothesis of instrumental validity cannot be rejected. The test results indicate that the positive relationship between corporate environmental responsibility and industrial value added is robust. Hypothesis H1 is further supported.

To further validate the robustness of the benchmark regression results, this section continues to use the replacement variable method to conduct the test. Therefore, return on assets (ROA) and net profit margin (NPR) are chosen to represent corporate economic performance for verification. Table 4 models (5) and (6) report in detail the test results for replacing the dependent variable. The results indicate that there is a significant positive effect of corporate environmental responsibility on return on assets and net profit margin, and the robustness of hypothesis H1 results is further supported.

Influence Mechanism Test

In this section, we empirically examine how corporate environmental responsibility indirectly affects the economic performance of iron and steel enterprises through green reputation through a mediating effects model. Based on the analysis of the direct effect of corporate environmental responsibility on economic performance, this paper selects green reputation as a mediating variable, constructs a mediating effect model of corporate environmental responsibility affecting corporate economic performance, and empirically tests the transmission mechanism between corporate environmental responsibility and economic performance.

This section estimates the mediating effect Equations (9)-(11) from Section 4. The results of the mediating effect estimates are reported in detail in Table 5. The estimation results of Equation (9) have been presented in detail in Table 3. In Table 5, models (7) and (9) are estimated using Equation (10), and models (8) and (10) are estimated using Equation (11). In particular, models (7) and (8) do not include control variables in order to examine the robustness of the regression results.

From the results in Table 5, it is observed that the estimated coefficients of both corporate environmental responsibility and green reputation for model (7)-model (10) are significant, indicating that the estimation results are robust. This section further determines whether green reputation has a mediating effect based on the process of testing for mediating effects. According to the regression results in Table 3, the coefficient of the effect of corporate environmental responsibility on industrial value added is significantly positive, indicating that the effect of corporate environmental responsibility on economic performance is significant and the conditions for the test of mediating effect have been met. As can be seen from model (9), the estimation coefficient of σ_1 is significantly positive, which indicates that corporate environmental responsibility can significantly promote corporate green reputation. From model (10), it can be found that the estimated coefficients of both γ_1 and γ_2 are significantly positive. Overall, the coefficients of the mediating effect model α, γ and σ are all significant, indicating that the mediating effect of green reputation affecting corporate economic performance is significant.

According to the empirical results of model (10) in Table 5, the influence coefficient of corporate environmental responsibility on corporate economic performance is significantly positive. Meanwhile,

Table 5. Results of the green reputation mediating effect test.

Variable	Model (7)	Model (8)	Model (9)	Model (10)
	lnGR	IVA	lnGR	IVA
lnGR		0.105*		0.942**
		(1.90)		(2.13)
CER_{t-1}	0.081**	12.487***	0.097**	11.182**
	(2.01)	(4.54)	(2.21)	(2.52)
lnSCALE			-0.852*	-1.831
			(-1.82)	(-0.74)
lnTC			0.360	-4.843***
			(0.93)	(-3.81)
lnMBI			-0.296	4.542***
			(-0.77)	(4.56)
AER			0.104***	0.272***
			(3.34)	(2.91)
LEV			0.021	-0.375***
			(1.08)	(-4.36)
Constant	-4.147***	-10.598***	-1.672*	4.706
	(-8.25)	(-4.02)	(-1.86)	(1.22)
N	504	504	504	504
R^2	0.002	0.194	0.181	0.325
Sobel Test	-	-	-	-
Mediation Effect Test	-	-	Significant	

Note: T statistics in parentheses. *, ** and *** indicate significant at the levels of 10%, 5%, and 1%, respectively.

in model (10), the influence coefficient of green reputation on enterprise economic performance is also significantly positive. It shows that corporate environmental responsibility can effectively promote the green reputation of iron and steel enterprises, and the green reputation will affect the attitude and behavior of enterprise stakeholders. Green reputation can help enterprises establish a better image in front of the public, attract consumers to buy products, and obtain tax breaks and environmental protection subsidies from the government, thus producing a positive effect on the economic performance of enterprises. This result indicates that hypothesis H2 in this paper is verified, that is, corporate environmental responsibility has a positive incentive effect on corporate economic performance through green reputation.

Whether the influence mechanism of corporate environmental responsibility on economic performance varies greatly among different regions and ownership forms. Next, this paper discusses the regional heterogeneity and ownership heterogeneity.

Heterogeneity Test

The differences in the mediating effects of corporate environmental responsibility on economic performance are explored in depth by considering the regional heterogeneity and ownership heterogeneity of enterprises.

Regional Heterogeneity

China is a vast country with large regional differences in levels of economic development and laws and regulations. This paper therefore explores in more depth the mediating effect of corporate environmental responsibility on corporate economic performance through green reputation in a spatial dimension. The mediating effect of green reputation in different regions of eastern and central-western China is tested and compared. The estimated results are shown in Table 6.

Table 6 presents the results of the grouped regressions of the mediation model on green reputation based on regional heterogeneity. According to the regression results of model (11) in Table 6, the estimated

Table 6. Regional heterogeneity test results of green reputation mediating effect.

Variable	Eastern			Central-Western		
	Model (11)	Model (12)	Model (13)	Model (14)	Model (15)	Model (16)
	IVA	lnGR	IVA	IVA	lnGR	IVA
lnGR			1.284**			0.765
			(2.45)			(1.58)
CER_{t-1}	9.587***	1.014**	8.285***	13.347***	0.059*	13.302***
	(3.27)	(2.11)	(4.67)	(4.45)	(1.79)	(5.26)
lnSCALE	-2.376	-0.981	-2.314	3.041	0.062	3.167
	(-0.46)	(-1.51)	(-0.73)	(0.31)	(0.57)	(0.41)
lnTC	-3.085***	0.408	-3.852***	-9.248***	-0.253	-9.586***
	(-3.95)	(1.28)	(-3.72)	(-5.52)	(-0.96)	(-5.50)
lnMBI	3.412***	-0.249	3.227***	8.483***	0.128	8.641***
	(2.64)	(-0.88)	(2.58)	(6.34)	(0.51)	(6.35)
AER	0.029	0.037***	0.041	0.234***	0.122**	0.281***
	(0.36)	(4.71)	(1.41)	(3.12)	(2.52)	(3.18)
LEV	-0.341***	0.024**	-0.381***	-0.092***	-0.004	-0.095***
	(-4.43)	(2.53)	(-4.37)	(-3.45)	(-1.24)	(-3.48)
Constant	5.754	-1.185*	4.128	14.357	-1.896	14.024
	(0.94)	(-1.77)	(0.76)	(1.54)	(-1.08)	(1.46)
N	288	288	288	216	216	216
R^2	0.197	0.205	0.215	0.286	0.106	0.349
Sobel Test	-	-	-	Significant		
Mediation Effect Test	Significant			Significant		

Note: T statistics in parentheses. *, ** and *** indicate significant at the levels of 10%, 5%, and 1%, respectively.

coefficient of corporate environmental responsibility (CER_{t-1}) on industrial value added (IVA) in the eastern region is significantly positive, indicating that the direct effect of environmental responsibility of iron and steel enterprises in the eastern region on economic performance is significant. The estimated coefficient of corporate environmental responsibility in model (12) is significantly positive, which indicates that the fulfillment of environmental responsibility by iron and steel enterprises in the eastern region is conducive to the enhancement of corporate green reputation. The estimated coefficients of both corporate environmental responsibility and green reputation in model (13) are significantly positive, indicating that the mediating effect of corporate environmental responsibility affecting economic performance through green reputation in the eastern region is significant. This indicates that the active fulfilllment of environmental responsibility by enterprises in the eastern region can effectively promote the green reputation of iron and steel enterprises, while the environmental protection behaviour of enterprises improves the production process, enhances efficiency and helps enterprises to achieve environmental cost advantages in their production process, which ultimately has a positive effect on the economic performance of enterprises.

The results of model (14) in Table 6 indicate that the direct effect of environmental responsibility on economic performance of iron and steel enterprises in the central-western region is significantly positive. The estimated coefficient of corporate environmental responsibility in model (15) is significantly positive, which indicates that corporate environmental responsibility in the central-western region significantly contributes to corporate green reputation. From model (16), the estimated coefficient of corporate environmental responsibility is significant, while the estimated coefficient of green reputation is not significant. Therefore, in order to test the mediating effect, a further Sobel test is required, which yields a Z-statistic of -1.675 for the Sobel test, which is greater than the MacKinnon critical value of 0.97 at the 5% significance level of the table, indicating that the mediating effect of green reputation in the central-western region is significant. This suggests

Table 7. Ownership heterogeneity test results of green reputation mediating effect.

Variable	State-owned			Private		
	Model (17)	Model(18)	Model(19)	Model(20)	Model(21)	Model(22)
	IVA	lnGR	IVA	IVA	lnGR	IVA
lnGR			1.311***			0.876
			(3.52)			(1.41)
CER_{t-1}	15.284***	1.147***	13.780***	4.345*	0.038	4.312
	(4.22)	(3.02)	(4.65)	(1.71)	(0.84)	(0.74)
lnSCALE	2.741*	-0.212	2.486	-4.045***	-0.075	-4.016***
	(1.92)	(-1.49)	(1.63)	(-3.75)	(-0.54)	(-3.74)
lnTC	-8.452***	0.434	-8.145***	-2.149*	0.207	-2.342*
	(-5.21)	(0.96)	(-5.15)	(-1.76)	(1.44)	(-1.94)
lnMBI	9.524***	-0.148	9.286***	2.756	-0.562*	2.924
	(5.23)	(-0.37)	(5.23)	(1.31)	(-1.82)	(1.62)
AER	0.134***	0.116***	0.293***	0.051	0.086***	0.091
	(2.76)	(4.43)	(3.88)	(1.24)	(3.75)	(0.58)
LEV	-0.351***	0.011	-0.424***	-0.143	0.029**	-0.185
	(-5.29)	(0.63)	(-5.33)	(-1.53)	(2.11)	(-1.55)
Constant	1.278	-1.968**	-4.478	48.159***	-0.831	50.207***
	(0.21)	(-2.32)	(-0.82)	(3.99)	(-0.53)	(4.04)
N	378	378	378	126	126	126
R^2	0.304	0.176	0.341	0.195	0.214	0.313
Sobel Test	-	-	-	Not Significant		
Mediation Effect Test	Significant			Significant		

Note: T statistics in parentheses. *, ** and *** indicate significant at the levels of 10%, 5%, and 1%, respectively.

that corporate environmental responsibility in the central-western region can effectively promote the green reputation of iron and steel enterprises, which ultimately has a positive effect on corporate economic performance.

From the regional heterogeneity analysis, it is concluded that there is a positive incentive effect of corporate environmental responsibility through green reputation on the economic performance of iron and steel enterprises in both the eastern and central-western regions. Comparing the estimated coefficients of models (13) and (16), it can be seen that the impact of corporate environmental responsibility through green reputation on economic performance is greater in the eastern region than in the central-western regions. This indicates that the environmental awareness of enterprises in the eastern region is still stronger than that of enterprises in the central-western regions. This also reflects the difference in economic development between Eastern, Central and Western China, and the greater difference in stakeholders' environmental awareness, so that companies in the East will pay more attention to environmental protection out of market demand.

Ownership Heterogeneity

Chinese enterprises exist under a variety of forms of ownership and fall into two main categories: state-owned enterprises and private enterprises. State-owned enterprises are required to take on more social responsibility from government agencies in addition to their economic responsibility. This section therefore discusses the ownership heterogeneity of the impact of corporate environmental responsibility on corporate economic performance through green reputation.

Table 7 shows the grouping regression results of the mediation model of green reputation. According to the regression results of model (17) in Table 7, the direct effect of environmental responsibility on economic performance of state-owned iron and steel enterprises is significant. The estimated coefficients of corporate environmental responsibility and green reputation in Model (18) and Model (19) are significantly positive.

The results show that the environmental responsibility of state-owned enterprises has a significant mediating effect on economic performance through green reputation.

According to the regression results of model (20) in Table 7, the estimation coefficient of private enterprise environmental responsibility (CER_{t-1}) on industrial added value is significantly positive. However, the estimated coefficients of corporate environmental responsibility in model (21) are not significant, while the estimated coefficients of corporate environmental responsibility and green reputation in model (22) are not significant. Therefore, it is necessary to further conduct Sobel test and obtain the Z-statistic of Sobel test as 0.312, which is less than 0.97 of the 5% significance level of the MacKinnon critical value table, indicating that the mediating effect of private enterprises' green reputation on enterprise economic performance is not significant. It shows that the environmental responsibility of private iron and steel enterprises has no intermediary effect on economic performance through green reputation.

Taken together, the above analysis shows that in China, state-owned enterprises are subject to more government intervention and control than private enterprises, and that state-owned enterprises are more aware of their environmental responsibilities. In addition, state-owned enterprises with a good green reputation will be encouraged and supported by the government, such as tax relief, environmental protection subsidies, interest-free or low-interest loans and publicity praise, while enterprises with a bad reputation will suffer potential financial losses caused by government environmental control penalties and environmental responsibility disputes. Therefore the active implementation of environmental responsibility by state-owned enterprises can effectively promote the green reputation of iron and steel enterprises, which can also gain additional profits through various compensations and enhance their competitiveness, ultimately contributing to their economic performance.

Discussion

This paper mainly discusses the impact of corporate environmental responsibility on economic performance from the following three aspects.

Firstly, corporate environmental responsibility is measured to provide a basis for subsequent empirical research. Based on statistical data from the China Iron and Steel Industry Association, this paper collects and constructs an environmental panel dataset of 56 large enterprises in the Chinese iron and steel industry from 2008 to 2017. On the basis of summarizing, comparing and evaluating methods for measuring corporate environmental responsibility, the SBM super-efficiency model is selected to measure and analyze the environmental responsibility of Chinese iron and steel enterprises. It is concluded that the level of environmental responsibility of Chinese steel enterprises is uneven, and most of them have more room for improvement. This indicates that Chinese enterprises are still passive in their approach to environmental responsibility, both in terms of perception and in terms of practical action. They often consider the issue of environmental responsibility only when they are under pressure from the government and society, and from their partners in the industry chain, and they do not see the benefits and competitiveness that environmental responsibility can bring to them. With the continuous improvement of China's economic development level, the problem of environmental pollution is becoming more and more prominent. Enterprises should transform passively meeting the requirements of environmental management into actively undertaking environmental responsibility in daily management activities, and then make corresponding countermeasures. The integration of environmental responsibility and enterprise economic development goals will become the goal of enterprises to create competitive advantages for enterprises and increase enterprise value.

Secondly, the impact of corporate environmental responsibility on economic performance is empirically tested. In the context of emerging economy, Chinese enterprises are increasingly challenged by stakeholders to fulfilll their environmental responsibilities in terms of environmental management. Most corporate decision makers agree that the sustainable development of enterprises needs to invest environmental resources, but in the actual operation, they worry about the impact of environmental resources investment on the economic performance of enterprises. Facing the current increasingly severe environmental problems and the pressure of the government, the public and other stakeholders. This paper links corporate environmental responsibility with corporate financial objectives and probes into the impact of corporate environmental responsibility fulfilllment on corporate economic performance. The research shows that there is a positive relationship between the environmental responsibility of Chinese iron and steel enterprises and their economic performance, which verifies the hypothesis H1. At the same time, the empirical analysis results show that the impact of corporate environmental responsibility on economic performance has a lag effect. This means that an enterprise's environmental protection behavior can improve its core competitiveness and ultimately promote its economic performance. This is why it is important for enterprises to take the initiative to transform their development approach to green development, establish long-term environmental strategies and plans and develop sustainable production methods.

Finally, the paper examines the transmission mechanisms through which corporate environmental responsibility affects corporate economic performance from the perspective of corporate green reputation. Further, the paper delves into the differences in

the mediating effects of corporate environmental responsibility on economic performance from the perspective of the region to which the firm belongs and the form of ownership. The empirical results show that corporate environmental responsibility has a significant contribution to economic performance through green reputation, testing hypothesis H2. The results of heterogeneity test on the mediating effect of green reputation show that the environmental responsibility of iron and steel enterprises in eastern and central and western regions has a positive incentive effect on economic performance through green reputation. Moreover, the environmental responsibility of iron and steel enterprises in eastern China has a greater impact on economic performance through green reputation than that in central and western China. The ownership heterogeneity test shows that the environmental responsibility of state-owned iron and steel enterprises has a positive incentive effect on economic performance through green reputation, while the impact of environmental responsibility on economic performance of private iron and steel enterprises does not play an effective role through the intermediary variable of green reputation.

The green behavior and attitude of an enterprise will generate emotional attraction to stakeholders and build a green reputation for the enterprise. A good green reputation will attract investors, be welcomed by consumers, and be trusted by upstream and downstream enterprises in the supply chain, which is conducive to the improvement of long-term value of the enterprise. Therefore, enterprises actively fulfilll their environmental responsibilities and ultimately generate economic benefits through the transmission of green reputation. At present, China's iron and steel enterprises are increasingly fulfillling their environmental responsibilities. Their environmental protection concepts and actions make sustainable development reports and environmental disclosures available to the public, thus helping enterprises maintain a good reputation. Consumers are more likely to consume products produced by enterprises with a green reputation, companies in the upstream and downstream of the supply chain are more likely to believe in the credit of enterprises with a green reputation, professionals have a higher degree of trust in enterprises with a green reputation, and the government and social organizations are more likely to give support or give preferential policies to enterprises with a green reputation. All these create benefits for enterprises virtually. Corporate environmental responsibility means not only improving its reputation, but also improving its production process, increasing efficiency, and ultimately improving corporate economic performance. Enterprises should attach importance to the establishment and maintenance of green reputation, and strengthen the risk management of green reputation. Enterprises should accumulate the strategic resources of green reputation from a long-term perspective, establish sustainable competitive advantages, and realize the sustainable development of iron and steel enterprises.

Conclusions and Recommendations

Conclusion

As environmental issues continue to increase, governments, regulators and investors from all walks of life are gradually paying more attention to the issues of sustainable development and combating climate change, and strengthening environmental management is becoming a global consensus.

The purpose of this paper is to explore the effect of corporate environmental responsibility on economic performance and its transmission mechanism. Firstly, it constructs a theoretical analysis framework on the impact of corporate environmental responsibility on the economic performance of enterprises, taking into account the existing research results at home and abroad. Secondly, we measure and comprehensively evaluate corporate environmental responsibility and empirically test the effect of corporate environmental responsibility on economic performance. Finally, green reputation is selected as a mediating variable to further explore the transmission mechanism of corporate environmental responsibility on corporate economic performance. The heterogeneity of the impact mechanism is also explored in two dimensions: the region to which the enterprise belongs and the type of ownership. The empirical results show that there is a positive incentive effect of corporate environmental responsibility on the economic performance of iron and steel enterprise. In addition, green reputation has a positive mediating effect in the effect of corporate environmental responsibility on economic performance.

The contradictions between environmental pollution, resource wastage, environmental protection, green transformation and upgrading caused by China’s iron and steel industry are becoming increasingly acute and continue to constrain the path to sustainable development. The empirical results of this paper encourage companies to fulfill their responsibilities in terms of ecological and environmental protection. This paper argues that when reliable information about the environmental responsibility of companies is communicated to external stakeholders, it helps companies to build a good green reputation, and through this transmission path, it helps companies to generate competitive advantage and build trust, thus improving their economic performance. By actively addressing the challenges of environmental responsibility, companies help to enhance their environmental management strategies and green image, thus improving their ability to cope with the complex economic environment and contributing to their competitiveness.

The findings of this paper contribute to the proactive implementation of corporate environmental

responsibility in emerging economies and provide theoretical support and countermeasure suggestions to enhance the green development of the iron and steel industry, corporate environmental responsibility practices as well as government environmental regulation and policies.

Recommendations

This paper expects to provide practical assistance and guidance for the sustainability of enterprises and proposes the following policy recommendations based on theoretical analysis and empirical research findings.

At the governmental level. The government plays an important role in the fulfillment of corporate environmental responsibility, guiding enterprises to take the initiative to fulfill their corporate environmental responsibility through the formulation of environmental protection policies. The government should support enterprises support them to establish management systems that use environmental protection as a value leader and growth driver, and to develop green and sustainable production methods, so as to achieve a 'win-win' situation for both economic and environmental benefits. In order to promote the active implementation of environmental responsibility by enterprises, it is necessary to play the role of policy supervision and guidance, as well as the role of market incentives and regulation. Firstly, the government should make use of the market's regulatory role and use the laws of the market to incentivise enterprises to fulfill their environmental responsibilities. The economic benefits of market-based mechanisms can provide a more sustainable and effective incentive for companies to actively engage in environmental responsibility than top-down administrative orders. Secondly, the government should take into account the heterogeneity of enterprises in formulating environmental policies. According to the characteristics of enterprises, laws and regulations should be formulated in a more targeted manner. Finally, the government can influence the reputation of enterprises through media exposure and administrative penalties, so as to implement environmental monitoring and positive incentives, and more efficiently play the role of the government in environmental protection.

At the enterprise level. Chinese enterprises are still passive in their commitment to environmental responsibility, both in concept and in practical action, often under pressure from the government and society, and from partners in the industry chain, ignoring the benefits and competitiveness that environmental responsibility brings to the enterprise. Enterprises must update their concepts and take the initiative to assume environmental responsibility. Firstly, enterprises must establish the correct concept of environmental protection and ensure the quality of their products while at the same time penetrating the concept of environmental protection into every link of the industrial chain. Secondly, establish a system of corporate environmental information disclosure. Consciously place the production of enterprises under the supervision of the public and guarantee the public's right to know about the environment, thus shaping the good green reputation of enterprises. At the same time, enterprises should strengthen their advertising efforts to improve the transparency of their environmental responsibility, attract the attention of more stakeholders and bring into play the reputational effect of environmental responsibility [57]. Finally, as the leading enterprise in the industry, large iron and steel enterprises should include the sustainable development practice of environmental protection, energy conservation and emission reduction as an important part of their corporate strategy, better fulfilll their corporate environmental responsibility, actively respond to the government's call for green production, and establish management policies and systems from energy saving, water saving, pollution reduction and other aspects to reduce their negative impact on the environment.

Research Shortcomings and Outlook

There are a number of issues in this study that deserve further exploration. In terms of the influence mechanism of environmental responsibility on the economic performance of enterprises, there are some mediating factors that need further research in addition to the green reputation factors discussed in this paper. In terms of heterogeneity analysis, subsequent efforts should be made to increase data collection and further segmentation of the study, and the findings will be more practically meaningful to governments and enterprises in implementing refined environmental management.

Acknowledgments

We are grateful for the support of the National Social Science Foundation of China (Project No. 22BGL093).

Conflict of Interest

The authors declare no conflict of interest.

References

1. HART S.L., AHUJA G. Does it pay to be green? An empirical examination of the reletionship between pollution prevention and firm performance. Business Strategy & the Environment, **5** (1), 30, **1996**.
2. MONTIEL I. Corporate Social Responsibility and Corporate Sustainability: Separate Pasts, Common Futures. Organ Environ, **21** (3), 245, **2008**.
3. KATHY, BABIAK, SYLVIA, TRENDAFILOVA. CSR and environmental responsibility: motives and pressures

to adopt green management practices. Corp Soc Resp Env Ma, **18** (1), 11, **2011**.
4. BOWEN H.R. Social Responsibilities of the Businessman. New York: Harper, **1953**.
5. KLASSEN R.D., McLaughlin C.P. The Impact of Environmental Management on Firm Performance. Manage Sci, **42** (8), 1199, **1996**.
6. BRUMMER J.J. Corporate Responsibility and Legitimacy. Greenwood Press, 212, **1991**.
7. BUNNIN N., TSUI-JAMES E.P. The Blackwell Companion to Philosophy. Blackwell Publishers, **2003**.
8. LÖÖF H, SAHAMKHADAM M, STEPHAN A. Is Corporate Social Responsibility investing a free lunch? The relationship between ESG, tail risk, and upside potential of stocks before and during the COVID-19 crisis. Financ Res Lett, **46**, 102499, **2022**.
9. HERATH H., HERATH T.C., DUNN P. Profit-Driven Corporate Social Responsibility as a Bayesian Real Option in Green Computing. J Bus Ethics, **158** (2), 387, **2019**.
10. BOHIDAR N. Strategy and society: The link between competitive advantage and corporate social responsibility. Harvard Bus Rev, **85** (6), 136, **2007**.
11. ALEXOPOULOS I., KOUNETAS K., TZELEPIS D. Environmental and Financial Performance. Is there a win-win or a win-loss situation? Evidence from the Greek manufacturing. J Clean Prod, **197** (1), 1275, **2018**.
12. SIANO A., VOLLERO A., CONTE F., AMABILE S. "More than words": Expanding the taxonomy of greenwashing after the Volkswagen scandal. J Bus Res, **71**, 27,**2017**.
13. IOANNOU I., KASSINIS G., PAPAGIANNAKIS G. The Impact of Perceived Greenwashing on Customer Satisfaction and the Contingent Role of Capability Reputation. J Bus Ethics, 1, **2022**.
14. CHOI W., CHUNG C.Y., RABARISON M.K., WANG K. Related party transactions and corporate environmental responsibility. Financ Res Lett, **46**, 102490, **2022**.
15. PENG B., CHEN S., ELAHI E., WAN A. Can corporate environmental responsibility improve environmental performance? An inter-temporal analysis of Chinese chemical companies. Environ Sci Pollut R, **28** (10), 12190, **2021**.
16. LI W., LI W., SEPPÄNEN V., KOIVUMÄKI T. Effects of greenwashing on financial performance: Moderation through local environmental regulation and media coverage. Bus Strateg Environ, **32** (1), 820, **2023**.
17. ZHOU Y., LUO L., SHEN H. Community pressure, regulatory pressure and corporate environmental performance. Aust J Manage, **47** (2), 368, **2022**.
18. FREUDENREICH B., LÜDEKE-FREUND F., SCHALTEGGER S. A Stakeholder Theory Perspective on Business Models: Value Creation for Sustainability. J Bus Ethics, **166** (1), 3, **2020**.
19. TESTA F., BOIRAL O., IRALDO F. Internalization of Environmental Practices and Institutional Complexity: Can Stakeholders Pressures Encourage Greenwashing? J Bus Ethics, **147** (2), 287, **2018**.
20. SINHA A., SENGUPTA T. A Stakeholder Theory Perspective on Business Models: Value Creation for Sustainability. Resources Policy, **63**, 101413, **2019**.
21. CAROLINE F. Corporate social responsibility and shareholder reaction, the environmental awareness of investors. Acad Manage J, **3**, 758, **2013**.
22. HART, STUART L., DOWELL, GLEN. Invited Editorial: A Natural-Resource-Based View of the Firm: Fifteen Years After. J Manage, **37** (5), 1464, **2011**.
23. SERAFEIM G., YOON A. Stock price reactions to ESG news: the role of ESG ratings and disagreement. Rev Account Stud, 1, **2022**.
24. ZHANG D. Environmental regulation, green innovation, and export product quality: What is the role of greenwashing? Int Rev Financ Anal, **83**, 102311, **2022**.
25. JIANG Y., XUE X., XUE W. Proactive Corporate Environmental Responsibility and Financial Performance: Evidence from Chinese Energy Enterprises. Sustainability-Basel, **10** (4), 964, **2018**.
26. BAI G., MENG D. Assessing Influence Mechanism of Management Overconfidence, Corporate Environmental Responsibility and Corporate Value: The Moderating Effect of Government Environmental Governance and Media Attention. Int J Env Res Pub He, **20** (1), 577, **2023**.
27. WONG C.W.Y., MIAO X., CUI S., TANG Y. Impact of Corporate Environmental Responsibility on Operating Income: Moderating Role of Regional Disparities in China. J Bus Ethics, **149** (2), 363, **2018**.
28. WEI Z., SHEN H., ZHOU K.Z., LI J.J. How Does Environmental Corporate Social Responsibility Matter in a Dysfunctional Institutional Environment? Evidence from China. J Bus Ethics, **140** (2), 209, **2017**.
29. LUNDGREN T., ZHOU W. Firm performance and the role of environmental management. J Environ Manage, **203** (1), 330, **2017**.
30. TANG M., WALSH G., LERNER D., FITZA M.A., LI Q. Green Innovation, Managerial Concern and Firm Performance: An Empirical Study. Bus Strateg Environ, **27** (1), 39, **2018**.
31. MAY A.Y.C., HAO G.S., CARTER S. Intertwining Corporate Social Responsibility, Employee Green Behavior and Environmental Sustainability: The Mediation Effect of Organizational Trust and Organizational Identity. Economics Management and Financial Markets, **16** (2), 32, **2021**.
32. DE M., DE B., MARTA. Impact of environmental performance and policy on firm environmental reputation. Manage Decis, **59** (2), 190, **2020**.
33. BENHONG P., YU T., GUO W. Can Environmental Regulations Promote Corporate Environmental Responsibility? Evidence from the Moderated Mediating Effect Model and an Empirical Study in China. Sustainability-Basel, **10** (3), 641, **2018**.
34. BHATTACHARYYA A., RAHMAN M.L. Mandatory CSR expenditure and firm performance. Journal of Contemporary Accounting and Economics, **15** (3), 100163, **2019**.
35. DENG J., ZHANG Y., XING X., LIU C. Can Carbon Neutrality Commitment Contribute to the Sustainable Development of China's New Energy Companies? Sustainability-Basel, **14** (18), 1, **2022**.
36. XU P., XU X., BAI G. Corporate environmental responsibility, CEO's tenure and innovation legitimacy: Evidence from Chinese listed companies. Technology in Society, **70**, 102056, **2022**.
37. LONG F., CHEN Q., XU L., WANG J., VASA L. Sustainable corporate environmental information disclosure: Evidence for green recovery from polluting firms of China. Frontiers in Environmental Science, **10**, 1, **2022**.
38. AFUM E., AGYABENG-MENSAH Y., BAAH C., ASAMOAH G., YAW KUSI L. Green market orientation, green value-based innovation, green reputation and enterprise social performance of Ghanaian SMEs: the role

of lean management. The Journal of business & industrial marketing, 1, **2023**.
39. CHENG L.T.W., SHARMA P., BROADSTOCK D.C. Interactive effects of brand reputation and ESG on green bond issues: A sustainable development perspective. Bus Strateg Environ, **32** (1), 570, **2023**.
40. KONG G., KONG D., WANG M. Dose media attention affect firms' environmental protection efforts? Evidence from China. The Singapore Economic Review, **65** (3), 577, **2020**.
41. DANGELICO R.M. Improving Firm Environmental Performance and Reputation: The Role of Employee Green Teams. Business Strategy & the Environment, **24** (8), 735, **2015**.
42. C H., K M. Segmenting stakeholders in terms of corporate responsibility: Implications for reputation management. Australasian Marketing Journal, **17** (2), 99, **2009**.
43. HSU K.T. The Advertising Effects of Corporate Social Responsibility on Corporate Reputation and Brand Equity: Evidence from the Life Insurance Industry in Taiwan. J Bus Ethics, **109** (2), 189, **2012**.
44. SURROCA, TRIBO, WADDOCK. Corporate Responsibility and Financial Performance: The Role of Intangible Resources. Strategic Manage J, **31** (5), 463, **2010**.
45. CHEN Z., HAO X., CHEN F. Green innovation and enterprise reputation value. Bus Strateg Environ, 1, **2022**.
46. SZABO S., WEBSTER J. Perceived Greenwashing: The Effects of Green Marketing on Environmental and Product Perceptions. J Bus Ethics, **171**, 719, **2021**.
47. PANG K., LU C., SHANG K., WENG H. An empirical investigation of green shipping practices, corporate reputation and organisational performance in container shipping. Int J Ship Trans Log, **13** (3), 422, **2021**.
48. SALAMA A. A note on the impact of environmental performance on financial performance. Structural Change & Economic Dynamics, **16** (3), 413, **2005**.
49. XI B., WANG Y., YANG M. Green credit, green reputation, and corporate financial performance: evidence from China. Environ Sci Pollut R, **29** (2), 2401, **2022**.
50. BAAH C., JIN Z., TANG L. Organizational and regulatory stakeholder pressures friends or foes to green logistics practices and financial performance: Investigating corporate reputation as a missing link. J Clean Prod, **247**, 119125, **2020**.
51. BRAMMER S., PAVELIN S. Building a Good Reputation. Eur Manag J, **22** (6), 704, **2004**.
52. SADOK E.G., OMRANE G., HAKKON K., KWANGWOO P. Corporate Environmental Responsibility and the Cost of Capital: International Evidence. J Bus Ethics, **149** (2), 1, **2018**.
53. GANGI F., DANIELE L.M., VARRONE N. How do corporate environmental policy and corporate reputation affect risk-adjusted financial performance? Bus Strateg Environ, **29** (5), 1975, **2020**.
54. PENG W., XIN B., XIE L. Optimal strategies for product price, customer environmental volunteering, and corporate environmental responsibility. J Clean Prod, **364**, 132635, **2022**.
55. CHARNES A., COOPER W.W., RHODES E. Measuring the efficiency of decision making units. Eur J Oper Res, **2** (6), 429, **1978**.
56. BARON R.M., KENNY D.A. The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. J Pers Soc Psychol, **51** (6), 1173, **1986**.
57. KHOSROSHAHI H., DIMITROV S., HEJAZI S.R. Pricing, greening, and transparency decisions considering the impact of government subsidies and CSR behavior in supply chain decisions. J Retail Consum Serv, **60**, 102485, **2021**.