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Analysis of the Influence Mechanisms of Environmental Management System Certification on the Green Innovation of Enterprises: The Exogenous Shock Effect of Environmental Protection Tax

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Abstract

Promoting the green transformation of enterprises is key to achieving the goal of "double carbon" and promoting sustainable economic development. Based on 2012-2021 panel data of Chinese listed companies in Shanghai and Shenzhen, this study explores how various factors interacting with environmental management system certification (ISO14001 certification) indirectly impact enterprises' green innovation. The mechanism analysis indicates that enterprises' management system certification promotes green innovation by improving investment efficiency and alleviating financing constraints. Heterogeneity analysis demonstrates that this promotion effect of environmental management system certification on enterprise green innovation is primarily reflected in private and large-scale enterprises. Further analysis demonstrates that the implementation of the Environmental Protection Tax Law of the People's Republic of China in 2018 strengthened the system even further. Compared with state-owned enterprises, this positive effect is primarily concentrated in non-state-owned enterprises. This study provides empirical evidence to confirm the beneficial impact of environmental management system certification and environmental protection tax on corporate green innovation and provides inspiration for the promotion of this practice.

Keywords

ISO14001, Enterprise Green Innovation, Investment Efficiency, Environmental Tax Implementation, China

1. Introduction

Compared with command-based and market-based environmental regulations, environmental management system certification, as a voluntary environmental regulation, plays an important role in environmental protection and economic development. Since China issued the "Environmental Management System Specification and User Guide" in 1996, the number of ISO14001 certification applications for Chinese enterprises has been increasing annually. According to data from China's National Certification and Accreditation Supervision and Administration Commission, the number of environmental management system certification organizations was 123,851 in 2015. As of 2021, China's environmental management system certification organizations are 353,758. In just seven years, environmental management system certification has increased by 1.8 times; however, there is still a clear gap with the United States, Britain, Germany, and other developed countries. Of late, numerous countries have advocated for more market players and public participation to improve the environment. Voluntary environmental regulation policies can allow full play to the governance role of third-party institutions, industry associations, and the public (Lim & Prakash, 2014). However, whether the environmental management certification system has real advantages in China does not appear to have been verified. ISO14001 certification has been running in China for 27 years and can provide sufficient historical data for the verification of this problem.

The theme of World Environment Day 2022 is "Only One Earth". Earth is the only home for human survival. It is the common responsibility of all mankind to build a clean and beautiful world in which humans and nature coexist harmoniously. Rapid economic growth under the high-speed investment growth model has led to a significant increase in environmental pollution, burdening the environment. Thus, improvements are vital. High-level green innovation is an essential driving force behind sustainable development (Dai & Xue, 2022; Li & Xiao, 2020). According to the "China Green Patent Statistics Report (2014-2017)" issued by the Planning and Development Division of the State Intellectual Property Office of China, their current green innovation activities are active, and green patent applications are gradually increasing. In 2014-2017, these applications accounted for 6.2% of invention patent applications. Because of the active guidance of the Chinese government, more and more enterprises realize the importance of green development. Environmental management system certification includes implementation, operation, inspection, and corrective measures, which require enterprises to consume a certain amount of resources. How should micro-enterprises respond to this? Will green innovation be executed? Based on the analysis of the mechanism of corporate investment efficiency and financing constraints, this paper discusses the impact of environmental management system certification on corporate green innovation and considers the exogenous impact of an environmental tax on it.

The rapid development of environmental management system certification

has gradually become a focus of the government and academia. Scholars at home and abroad have studied environmental management system certification from different perspectives, primarily based on the micro-level perspective of enterprises, to examine the impact of environmental management system certification on technological innovation (Ren, Xiang, & He, 2018; Bu & Zhao, 2022), financing constraints (Wu, An, Wu, Tsai, & Yang, 2020), audit fees (Dogui, Boiral, & Heras-Saizarbitoria, 2014), financial performance (Lee, Noh, Choi, & Rha, 2017), stock performance (Paulraj & De Jong, 2011), suppliers, and other aspects of enterprises (González, Sarkis, & Adenso-Díaz, 2008). Some scholars have also explored the internal and external driving factors for enterprises to implement environmental management system certification and found that ISO14001 certification is affected by stakeholders (Simpson & Sroufe, 2014), government penalties (Blackman & Guerrero, 2012), institutional pressure (Daddi, Testa, Frey, & Iraldo, 2016), and other factors. Based on research content, the existing literature appears to only discuss the direct relationship between environmental management certification and enterprise green innovation (Ren, Xiang, & He, 2018) and does not explore the mechanism through which environmental management system certification affects enterprise green innovation. This study aimed to explore the mechanism by which ISO14001 certification affects green innovation and provide inspiration for the practice of environmental management system certification.

Research on voluntary environmental regulation and green innovation has not reached an agreement in academia. Some scholars believe that voluntary environmental regulation is effective. For example, Ni et al. utilized panel data from foreign-funded enterprises in Vietnam and discovered that foreign-funded enterprises are inclined to perform environmental management system certification and effectively improve their environmental performance (Ni, Tamechika, Otsuki, & Honda, 2019). The release of environmental management system certification will help reduce solid waste generation and wastewater discharge and improve regional environmental quality (Arimura, Hibiki, & Katayama, 2008). Based on the resource-based view, He and Shen used Chinese-listed companies as samples and discovered that ISO14001 certification promoted corporate green innovation through internal resource management. Some scholars believe that voluntary environmental regulation is invalid. Considering China's low-carbon pilot city plan as an example (He & Shen, 2019), Di et al. evaluated the impact of voluntary environmental regulation on urban innovation and discovered that the implementation of low-carbon pilot cities significantly inhibited urban innovation (Zhou, Yuan, & Xie, 2022). Highly polluting enterprises are affected by government sanctions and external investors. Although they have environmental management system certification, their environmental performance remains low (Maxwell, Lyon, & Hackett, 2000). As an important voluntary environmental regulation, how do mechanisms of environmental management system certification affect enterprise green innovation? For example, the implementation of en-

vironmental protection tax policy is an exogenous shock event. Will it indirectly affect the internal relationship between environmental management certification and green innovation?

The remainder of this paper is organized as follows: Section 2 presents the theoretical analysis and hypothesis construction; Section 3 discusses the data and technique; Section 4 presents the empirical findings; Section 5 contains further analysis; Section 6 contains the conclusion, recommendations, future research, and contribution.

2. Theoretical Analysis and Research Hypothesis

2.1. Analysis of the Impact of Environmental Management Certification System on Enterprise Green Innovation

Based on Porter's hypothesis, reasonable environmental regulation will produce "innovation compensation" (Lanoie, Laurent-Lucchetti, Johnstone, & Ambec, 2011; Porter & Van Der Linde, 1995); that is, environmental regulation can promote green innovation in enterprises, and the economic benefits it brings can make up for environmental investment. As a voluntary environmental regulation, environmental management system certification also has this "innovation compensation" (Li, Tang, & Zhang, 2020). In recent years, carbon peak and carbon neutralization have become hot topics in society, and people's awareness of environmental protection has continuously strengthened. Enterprise's environmental management system certification can send signals to stakeholders to actively fulfill their green responsibilities, establish a good social image, and obtain sufficient resources for green innovation (Graafland, 2018).

Environmental management system certification has the characteristics of a club benefit. Managers often think that the long-term benefits of environmental management certification are far greater than the short-term costs (Lyon & Maxwell, 2003). For example, institutional investors are more willing to invest in enterprises that have passed the environmental management certification and government funding becomes easier to obtain. Enterprises that have passed environmental management certification will inevitably prioritize as partners those who have done the same. Subsequently, externality theory provides a powerful explanation for environmental problems (Papandreou, 1998). Externality can be divided into external economies and diseconomies. External diseconomy is a phenomenon in which some people's production or consumption damages others, while the former cannot compensate for the latter. Environmental problems comprise manufacturing consumption behaviors, resulting in environmental pollution, (e.g. of water and air), which impairs public interests without enterprises facing penalties. Enterprises' environmental management system certification internalizes this negative externality, so that they are compelled to pay for environmental pollution, increase their environmental contribution, and are forced to perform green innovation (Shao, Hu, Cao, Yang, & Guan, 2020). Based on this, this study proposes the following hypothesis:

H1: Environmental management system certification can promote green innovation when other factors remain unchanged.

2.2. Analysis of the Mechanism of Enterprise Investment Efficiency and Financing Constraints

Inefficient investment and financing constraints in enterprises are often caused by information asymmetry and agency problems (Fazzari, Hubbard, & Petersen, 1987; Modigliani & Miller, 1958). First, information asymmetry causes adverse selection and moral hazard. Adverse selection occurs when one side of the market benefits from information at the expense of the others in the market. Adverse selection makes the market unable to identify the true quality of the enterprise, which will cause financing difficulties for enterprises with good investment projects, forcing them to abandon high-quality investment and underinvestment projects. When external stakeholders face higher information asymmetry, external stakeholders often choose to wait and see, while enterprises will not obtain sufficient resources, and incur higher financing costs. Second, the principal-agent theory believes that the relationship between shareholders and managers is a contractual relationship. Over time, managers have more "private information" than shareholders and may use this advantage to harm the interests of shareholders (Huang, 2019). Therefore, when there is a difference of benefit between managers and shareholders in a decision, managers often have moral problems and pursue the maximization of enterprise scale. If the cash flow of enterprises is sufficient, managers will abuse funds, causing excessive investment. Finally, the agency problem is generated by separating the company's management rights and ownership, and the interests of shareholders and managers differ. Shareholders are concerned about how to maximize the company's profits, and thus, benefit themselves. Managers' limited rationality may damage the interests of shareholders while pursuing their own interests, causing agency conflicts that in turn lead to ineffective investment.

Owing to the problem of information asymmetry in the market, compared with external followers, the internal personnel of the enterprise often have more information, which will produce information asymmetry. According to signal transmission theory, the environmental management certification will disclose the enterprise's environmental management system, environmental audit, environmental label, and other contents to the outside world, so that internal and external investors can clearly know whether the enterprise environmental management, reduce the problem of adverse selection, and make high-quality investment projects receive sufficient resource support. For example, the government provides subsidies to enterprises that contribute to carbon neutrality and the "green premium" that external investors are willing to pay (Cox & Wicks, 2011). This resource effect can effectively stimulate enterprises' investment behavior and restrain the phenomenon of insufficient investment. Environmental management system certification provides transparent environmental informa-

tion to external stakeholders, reduces the information asymmetry of external stakeholders, and reduces the financing costs of enterprises. Subsequently, certification of the environmental management system must be supervised by a third-party institution recognized by the State Certification and Accreditation Supervision and Administration Commission. Third-party institutions can supervise the environmental behavior of enterprises through regular re-evaluations. Environmental supervision can effectively restrain the investment behavior of enterprises and reduce their excessive investment behavior (Zhang, Zhang, & Pei, 2020). Based on this, this study proposes the following hypothesis:

H2: Environmental management system certification can promote green innovation by improving enterprise investment efficiency.

H3: Environmental management system certification can promote green innovation by alleviating corporate financing constraints.

3. Research Design

3.1. Data Sample

This study selected China's Shanghai and Shenzhen A-share listed companies from 2012 to 2021 as the initial samples. Additionally, this study excludes the sample companies of ST and * ST, and excludes research companies with a serious lack of financial insurance and sample data. Finally, 994 enterprises were included with a total of 9940 observations. The data source for this study is as follows: the enterprise green innovation data come from the China Research Data Service Platform (CNRDS), the environmental management system certification (ISO) is obtained from the environmental research database of the CSMAR database, and the other data is obtained from the China Stock Market & Accounting Database (CSMAR). To avoid the influence of extreme values, all continuous variables were tailed at the upper and lower 1% levels. In this study, data processing and analysis were completed using Stata 16.

3.2. Variable Design

The empirical study involves four categories of variables: 1) Dependent Variable: Green innovation (Gi); 2) Independent Variable: Environmental Management Certification (Iso); 3) Mediator Variable: Inefficient Investment (Absinv) and Financing Constraints (Kz); and 4) Control Variables.

3.2.1. Dependent Variable

Enterprise green innovation (Gi): Based on the research of Li, Zhao, Zhang, Chen, and Cao (2018) and He and Shen (2019), this study employs the natural logarithm of the number of green patent applications +1 to measure enterprises' green innovation. The green patent data employed in this study was obtained from the CNRDS green patent research database. Compared to other data, patent data are objective, open, and more accurate.

3.2.2. Independent Variable

Environmental Management System Certification (ISO): Based on the practices of Zhang, Zhang, and Cao (2021) and Bu, Qiao, and Liu (2020), this study takes the value of enterprises that passed ISO14001 certification in that year as 1; otherwise, it is 0.

3.2.3. Mediator Variable

This study focuses on whether environmental managementsystem certification can affect corporate green innovation through investment efficiency and financing constraint mechanisms. The mediating variables are inefficient corporate investment (Absinv) and financing constraints (Kz). Efficiency investment draws on Richardson's research (Richardson, 2006), with new investment expenditure, asset size, asset-liability ratio, growth opportunities, stock returns, cash flow status, and company age as variables in Model (1). The regression residual is employed as the non-efficiency investment of the enterprise. We consider the absolute value of the residual as the investment efficiency of the enterprise. The greater the absolute value, the lower the investment efficiency of the enterprise. Financing constraints (Kz): refers to the practice of Kaplan and Zingales (1997) and classifies the entire sample according to the operating net cash flow/total assets at the beginning of the year, cash dividends/total assets at the beginning of the year, cash holdings/total assets at the beginning of the year, asset-liability ratio, and Tobin's Q. According to the corresponding screening conditions, the KZ index is added to obtain the KZ index, and the KZ index is used as the dependent variable to rank Model (2). Using the estimated results of the above regression model, we calculate the KZ index of the degree of financing constraints for each listed company. The larger the KZ index, the higher the degree of financing constraints faced by listed companies.

$$\begin{aligned} Inv_{i,t} = {} & \alpha_0 + \alpha_1 Inv_{i,t-1} + \alpha_2 Size_{i,t-1} + \alpha_3 Lev_{i,t-1} + \alpha_4 Growth_{i,t-1} \\ & + \alpha_5 Return_{i,t-1} + Cash_{i,t-1} + \alpha_6 Age_{i,t-1} + \sum Year + \sum Ind + \varepsilon \end{aligned} \tag{1}$$

$$KZ_{i,t} = \alpha \frac{CF_{i,t}}{ASSET_{i,t-1}} + \alpha_1 \frac{DIV_{i,t}}{ASSET_{i,t}} + \alpha_2 \frac{cash_{i,t}}{ASSET_{i,t}} + \alpha_3 LEV_{i,t} + \alpha_4 Q_{i,t} \tag{2}$$

3.2.4. Control Variables

Considering that the research subjects are listed companies, their characteristics will have a potential impact on the regression results. This study selected a series of enterprise characteristics as the control variables, including: 1) business growth rate (Growth): operating income of this year/operating income of the previous year-1; 2) asset-liability ratio (Lev): total liabilities/total assets at the end of the period; 3) return on total assets (Roa): net interest rate/total assets; 4) book-to-market ratio (Bm): book value/total market value; 5) whether the chairman and the general manager are concurrently (Dual): 1, otherwise 0; 6) ownership concentration (Top1): the proportion of the largest shareholder; 7) board size: the natural logarithm of the number of board members; 8) proportion of independent directors (Indep): independent directors divided by the number of

directors.

3.3. Model Construction

To verify Hypothesis 1, this study constructs the following model:

$$Gi_{i,t} = \alpha_0 + \beta_1 ISO_{i,t} + \beta_2 Cv + \mu_t + \delta_p + \vartheta_j + \varepsilon \quad (3)$$

where $Gi_{i,t}$ represents the annual green innovation of the enterprise; $ISO_{i,t}$ is the dummy variable that passes the environmental management system certification in the year, and the value is 1; otherwise, it is 0. Cv represents the control variable, μ_t is the fixed effect of the year; δ_p is the industry fixed effect; ϑ_j is the provincial fixed effect; ε is a random disturbance term. For Hypothesis 1, we expect the coefficient β_1 of ISO to be significantly positive.

To verify Hypothesis 2, this study draws on Baron and Kenny (1986) to construct the following model:

$$Mv_{i,t} = \alpha_0 + \beta_3 ISO_{i,t} + \beta_4 Cv + \mu_t + \delta_p + \vartheta_j + \varepsilon \quad (4)$$

$$Gi_{i,t} = \alpha_0 + \beta_5 ISO_{i,t} + \beta_6 Mv_{i,t} + \beta_7 Cv + \mu_t + \delta_p + \vartheta_j + \varepsilon \quad (5)$$

where $Mv_{i,t}$ represents the mechanism variable, which is inefficient investment (Absinv) and financing constraints (Kz) mentioned above. For Hypothesis 2, we expect that the coefficient of ISO β_3 is significantly negative, β_5 is significantly positive, and the coefficient of inefficient investment and financing constraints β_6 is significantly negative.

4. Empirical Analysis

4.1. Descriptive Statistical Analysis

Table 1 presents the descriptive statistical results of the main variables. The maximum value of enterprise green innovation (Gi) is 5.476, and the minimum value is 0, indicating that there is a large gap between enterprises in green innovation. The average value of ISO is 0.247, and the proportion of certified enterprises is 24.7%, indicating that China's listed companies have less environmental management certification, and there is still a big gap between this proportion and that of developed countries such as the United States and Europe. The average value of inefficient investment (Absinv) is 0.039, the maximum value is 0.304, and the minimum value is 0.000, indicating that there are significant differences in investment quality between enterprises. The maximum value of financing constraints (Kz) is 33.250, and the minimum value is −12.853, indicating that there are significant differences in financing constraints among enterprises. The statistical results of other variables are basically consistent with the existing research.

4.2. Basic Regression Results

To explore the impact of environmental management system certification on corporate green innovation, this study compiles Table 2 based on the regression

Table 1. Descriptive statistics results.

Variables	Sample Size	Mean	SD	Min	Max	Median
Gi	9940	1.110	1.356	0.000	5.476	0.000
ISO	9940	0.247	0.431	0.000	1.000	0.000
Absinv	9940	0.039	0.050	0.000	0.304	0.002
Kz	9940	1.153	2.503	−12.853	33.250	−3.147
Bm	9940	1.314	1.479	0.093	8.624	0.187
Top1	9940	0.344	0.147	0.091	0.743	0.134
Dual	9940	0.223	0.416	0.000	1.000	0.000
Indep	9940	0.376	0.055	0.333	0.571	0.333
Board	9940	2.149	0.201	1.609	2.708	1.792
Growth	9940	0.157	0.416	−0.542	2.789	−0.281
Roa	9940	0.039	0.062	−0.232	0.226	−0.058
Lev	9940	0.456	0.208	0.064	0.934	0.125

Table 2. Regression results.

Variable	(1)	(2)	(3)	(4)
ISO	0.117***	0.115***	0.351***	0.108***
	(4.087)	(4.165)	(11.960)	(3.946)
Bm		0.193***	0.135***	0.185***
		(18.770)	(12.561)	(17.949)
Top1		0.643***	0.186**	0.560***
		(7.701)	(2.078)	(6.683)
Dual		0.070**	0.138***	0.036
		(2.461)	(4.445)	(1.280)
Indep		1.241***	1.434***	1.222***
		(5.023)	(5.308)	(4.948)
Board		0.490***	0.494***	0.522***
		(6.995)	(6.552)	(7.487)
Growth		−0.005	0.032	0.0001
		(−0.157)	(1.018)	(0.003)
Roa		3.215***	2.213***	2.961***
		(15.418)	(9.759)	(14.274)
Lev		1.025***	0.982***	1.082***
		(14.072)	(12.699)	(14.972)
_cons	1.075***	−1.520***	−1.388***	−1.549***
	(76.341)	(−7.154)	(−6.026)	(−7.301)
Year Fixed Effect	Yes	Yes	Yes	Yes
Industry Fixed Effect	Yes	Yes	No	Yes
Province Fixed Effect	Yes	No	Yes	Yes
Observations	9940	9940	9940	9940
R^2	0.232	0.296	0.167	0.321

Note: *, ** and *** represent the significance levels of 10%, 5% and 1%, respectively, and the t value is in parentheses. The following table is the same.

results of Model (3). As shown in Table 2, Column 1 summarizes the regression result without control variables, and Columns 2 - 4 summarize the results of controlling for different fixed effects. The regression coefficient of the single variable is 0.117, which passes the significance level of 1%, indicating that the environmental management certification will promote green innovation in enterprises. The coefficient remains significantly positive after adding the control variables and different fixed effects. Column 4 presents the regression results under the fixed effects of controlling for year, industry, and province simultaneously. The regression coefficient of ISO is 0.108, which is significantly positive at the 1% significance level, and R^2 increases, further supporting H1.

4.3. Robust Test

4.3.1. Variable Substitution Test

To alleviate the impact of the explained variable measurement bias on the empirical results, we draw on the practice of Kong, Xu, and Kong (2017) to utilize the natural logarithm of the number of green patents obtained +1 (Gi1) as a replacement indicator. The results are presented in Column 1 in Table 3.

Table 3. Robustness test.

	Replace Dependent Variables	Instrumental Variable Method		PSM	Outlier Detection	Negative Binomial Regression
Variable	Gi1	The First Stage	The Second Stage	Gi	Gi	Gi
ISO	0.103***		0.198***	0.117***	0.120***	0.109***
	(4.219)		(4.251)	(3.593)	(4.238)	(4.894)
L.ISO		0.619***				
		(73.238)				
ISOMean		0.777***				
		(8.847)				
F statistics	152.04	99.20	61.57	84.99	131.31	
Wald F		2741.774				4604.26
Sargan			0.748			
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
_cons	−1.482***	−0.1061	−1.758***	−1.550***	−1.499***	−3.075***
	(−7.833)	(−1.390)	(−6.810)	(−5.340)	(−6.671)	(−11.990)
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Province Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	9940	8946	8946	5783	8946	9940
R^2	0.340	0.439	0.326	0.311	0.301	

The coefficient of ISO is 0.103 and significant at the 1% level. Supporting this article is H1.

4.3.2. Endogenous Issues Test

Considering that there is a two-way causal relationship between green innovation and environmental management system certification and that the results may be biased owing to missing variables, the endogeneity of the model is further processed to ensure the reliability of the results. The environmental management system certification may be related to the relevant characteristics of the enterprise itself (such as financial status and governance of the enterprise), so there may be endogeneity problems caused by selection bias.

First, we employed instrumental variable (IV). In this study, the lag of the environmental system certification management (L.ISO) and the average value of the industry (ISOMean) were selected as instrumental variables for two-stage least squares regression. In theory, the lag phase of environmental management system certification and the industry average are effective instrumental variables. First, the validity period of environmental management system certification is three years, and supervision and audits are conducted every year. Therefore, the environmental management system certification lagging by one period and the average value of the industry are closely related to the current environmental management system certification, which meets the correlation hypothesis. Second, the lagged environmental management system certification (L.ISO) is not related to the random disturbance term, which satisfies the exogenous hypothesis. According to the over-identification test, the Sargan line in **Table 3** presents that the P value is 0.748 (more than 0.05), which supports the assumption that all instrumental variables are exogenous. Therefore, the instrumental variables selected in this study meet the assumptions of exogeneity and endogeneity, which are reasonable.

The regression results of the instrumental variable method are demonstrated in the instrumental variable method column in **Table 3**. Column 3 in **Table 3** presents the regression results for the first stage. The coefficients of the environmental management system certification (L.ISO) and the industry mean (ISOMean) are 0.619 and 0.777, respectively, and both are significant at the 1% level, indicating that the selected instrumental variables are related to the environmental management system certification. Column 4 in **Table 3** presents the regression results for the second stage. The regression coefficient of the environmental management system certification is 0.198, which is significant at the 1% level. This indicates that environmental management system certification can significantly promote green innovation in enterprises. Evidently, after using the instrumental variable method, H1 still holds.

Second, we employed propensity score matching (PSM). In this study, control variables were utilized as matching covariates to establish a logit model. The 1:2 nearest neighbor matching method was used to perform PSM, and the matched samples were used for benchmark regression. Column 5 in **Table 3** summarizes

the samples with non-empty weights. The regression coefficient of environmental management system certification is 0.117, which is significant at the level of 1%, indicating that environmental management certification can significantly promote corporate green innovation. H1 continues to support this article.

4.3.3. Outlier Detection

In 2018, China implemented the "Environmental Protection Tax Law of the People's Republic of China" (hereinafter replaced by the environmental protection tax), known as the strictest environmental regulation in history. Previous studies found that the implementation of the law has a positive impact on corporate green investment (Fang, Kong, Sensoy, Cui, & Cheng, 2021; Huang, Lin, Zhou, Ji, & Zhu, 2022). To reduce the external impact of the environmental tax policy, this study excludes the 2018 data and regresses only the remaining nine years. The results are presented in Column 6 in **Table 3**. After eliminating outliers, it still supports H1, indicating that the results of this study are robust.

4.3.4. Negative Binomial Regression Test

Considering that the enterprise green patent data are non-negative integers, numerous zero values exist. The data distribution is relatively scattered and does not follow a normal distribution. This study refers to the practice of Allison and Waterman (2002) and utilizes negative binomial regression to retest H1. As presented in Column 7 in **Table 3**, the regression coefficient of ISO is 0.109, which is significant at the level of 1%, and the results still support H1.

4.4. Intermediary Test

As mentioned in the theoretical analysis, environmental management system certification primarily affects the green innovation of enterprises through investment efficiency and financing constraint mechanisms. The investment efficiency mechanism implies that environmental management system certification can improve the investment efficiency of enterprises and promote green innovation by playing an incentive role. The financing constraint mechanism refers to the fact that environmental management system certification can alleviate financing constraints and enhance enterprises' green innovation ability by exerting inhibitory effects.

The first is an investment efficiency mechanism. Columns 2 - 3 in **Table 4** present the regression results of the investment efficiency mechanism. The results demonstrate that the regression coefficient of environmental management system certification on corporate green innovation is 0.108, which is significant at the level of 1%, indicating that environmental management certification can promote corporate green innovation. The regression coefficient of environmental management system certification on enterprise investment efficiency is −0.003, and it is significant at the level of 1%, indicating that environmental management certification can improve the investment efficiency of enterprises; the regression coefficient between inefficient investment and green innovation is

Table 4. Mechanism test.

Variable	Gi	Absinv	Gi	Kz	Gtp
ISO	0.108***	−0.003***	0.104***	−0.184***	0.100***
	(3.946)	(−2.624)	(3.822)	(−4.573)	(3.657)
Absinv			−1.153***		
			(−4.780)		
Kz					−0.043***
					(−6.360)
Control Variables	Yes	Yes	Yes	Yes	Yes
_cons	−1.549***	0.064***	−1.475***	1.386***	−1.489***
	(−7.301)	(7.263)	(−6.942)	(4.438)	(−7.025)
Year/Ind/Province	Yes	Yes	Yes	Yes	Yes
Observations	9940	9940	9940	9940	9940
R^2	0.321	0.116	0.323	0.568	0.324

−1.153, and it is significant at the level of 1%, indicating that the inefficient investment of enterprises will inhibit their green innovation. Simultaneously, the regression coefficient of environmental management system certification on enterprise green innovation remains significantly positive and the coefficient becomes smaller. This demonstrates that enterprises' investment efficiency mechanisms are established and H2 is thus verified.

Second, we consider a financing constraint mechanism. Columns 4 - 5 in Table 4 present the regression results for the financing constraint mechanism. The results demonstrates that the regression coefficient of environmental management system certification to financing constraints is −0.184, which is significant at the level of 1%, indicating that environmental management system certification can inhibit the financing constraints of enterprises. The regression coefficient between financing constraints and green innovation is −0.043, which is significant at the level of 1%, indicating that the financing constraints of enterprises will inhibit their green innovation. Simultaneously, the regression coefficient of environmental management system certification on enterprises' green innovation remains significantly positive and the coefficient becomes smaller. This demonstrates that the financing constraint mechanism for enterprises has been established and H3 is thus verified.

4.5. Heterogeneity Analysis

First, property heterogeneity exists. Considering that the environmental management system certification of enterprises with different property rights is uneven, the impact of environmental management system certification on enterprise green innovation under different property rights will differ. This study divides enterprises into two groups, state-owned enterprises and private enterprises, according to the nature of enterprise property rights, and examines whether

the role of environmental management system certification in promoting enterprise green innovation has heterogeneous effects on enterprises of different natures. As shown in Table 5, Columns 1 - 2 present the regression results between environmental management system certification and enterprise green innovation under different property rights. In the group regression of state-owned enterprises, although environmental management system certification can promote green innovation, the coefficient is not significant. In the group of private enterprises, the coefficient of environmental management certification is 0.185 and it is significant at the level of 1%. This indicates that compared with state-owned enterprises, environmental management system certification plays a more significant role in promoting green innovation in non-state-owned enterprises.

Second, enterprise-scale heterogeneity exists. Considering that enterprises of different sizes often have many differences, theoretically, large-scale enterprises pay more attention to environmental management system certification, while small-scale enterprises are often limited by resources without certification. This study divides enterprises into two groups: large-scale enterprises and small-scale enterprises, according to the median size of enterprises, and examines whether the role of environmental management system certification in promoting green innovation in enterprises has heterogeneous effects on enterprises of different sizes. As shown in Table 5, Columns 3 - 4 present the regression results between environmental management system certification and enterprise green innovation under different enterprise scales. In the group regression of small-scale enterprises, although environmental management system certification can promote green innovation, the coefficient is not significant. In the group of large-scale enterprises, the coefficient of environmental management system certification was 0.131 and significant at the level of 1%. This demonstrates that compared with small-scale enterprises, environmental management system certification plays a more significant role in promoting green innovation in small-scale enterprises.

Table 5. Heterogeneous regression results.

Variable	State-Owned Enterprises	Private Enterprise	Macro-scale	Small-scale
ISO	0.019	0.185***	0.131***	0.040
	(0.474)	(5.080)	(3.189)	(1.293)
_cons	−2.183***	0.003	−1.877***	1.226***
	(−7.510)	(0.009)	(−6.243)	(4.360)
Control Variables	Yes	Yes	Yes	Yes
Year/Ind/Province	Yes	Yes	Yes	Yes
Observations	4966	4974	4970	4970
R^2	0.400	0.264	0.427	0.161

5. Further Analysis

5.1. Impact of Environmental Management System Certification on Enterprise Green Innovation after the Implementation of Environmental Protection Tax

The previous robustness test verified H1, which adopts the method of eliminating the 2018 data. Subsequently, we explore the impact of the implementation of the Environmental Protection Tax Law of the People's Republic of China in 2018 on the relationship between environmental management system certification and corporate green innovation. Based on the above exogenous shock events and the sample of Shanghai and Shenzhen listed companies from 2012 to 2021, this study establishes a DID model to further test the impact of environmental protection tax on corporate green innovation and designs the following econometric regression Model (6):

$$Gi_{i,t} = \alpha_0 + \rho_1 ISO_{i,t} \times Post_{i,t} + \rho_2 Cv + \mu_t + \delta_p + \varepsilon \tag{6}$$

ISO is a group dummy variable, and the enterprise that has passed the environmental management system certification is assigned a value of 1; otherwise, it is 0; post is the time dummy variable. This study takes the policy implementation year 2018 as the boundary and assigns zero before 2018 and one after 2018. The regression coefficient of the interaction term ISO × Post measures the net impact of the voluntary environmental regulation of ISO14001 certification and the market-based environmental regulation of environmental protection tax on the green innovation of enterprises that have passed the environmental management system certification compared with those that have not.

The parallel trend test is a prerequisite for using the DID model; that is, before the implementation of the policy, there is no difference in the change trend between the control group and the experimental group; that is, the two groups have the same trend. This study used the event study method to test the parallel trend hypothesis for the control and experimental group (Lechner, 2011). Specifically, the previous period of policy implementation is taken as the base period, and the interaction term between each independent year, excluding the first year and ISO, is taken as the independent variable to replace the interaction term in Model (6). Using 2017 as the base period, the effects of each year before and after the policy were compared. The regression model was as follows:

$$Gi_{i,k} = \alpha + \sum_{k=2012, k\neq 2017}^{2021} \beta_1 ISO_i \times year_k + \beta_2 Cv + \mu_t + \delta_p + \varepsilon \tag{7}$$

Among them, year is a dummy variable, taking 1 when the policy is implemented, otherwise 0, **Figure 1** shows the value of the coefficient β_1 of the annual interaction term, and its 95% confidence interval boundary.

As shown in **Figure 1**, there was no significant difference in investment efficiency between the experimental and control groups before the implementation of the environmental protection "fee-to-tax" policy in 2012-2018; however, in the year after the reform in 2018, there was a significant difference in the trend

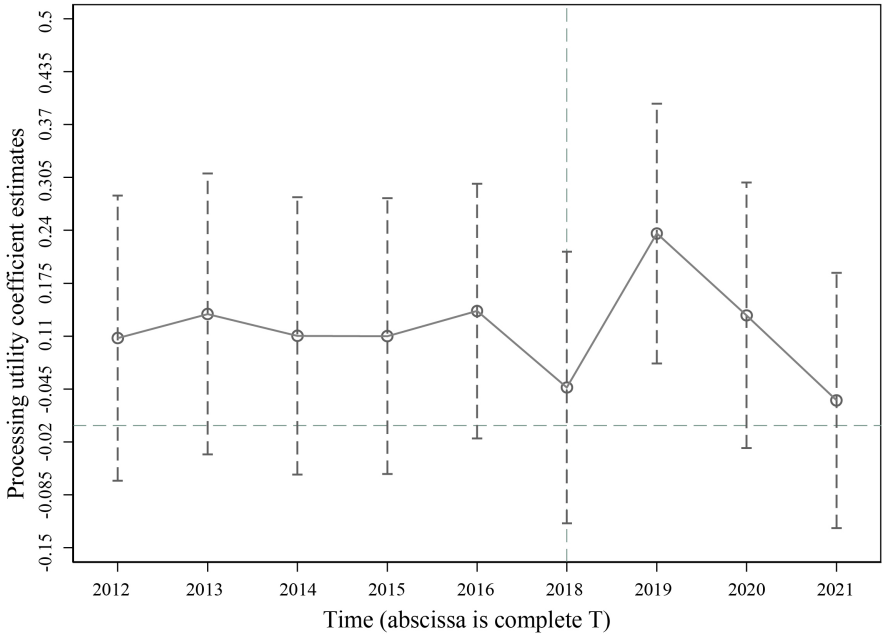

Figure 1. Parallel trend test.

of green innovation between the experimental and control groups. Therefore, it can be considered that the parallel trend test was passed, which guarantees the use of the difference-in-difference model in this study.

Table 6 presents the regression results for DID. The coefficient of the interaction term in Column 1 is 0.109, which is significant at the level of 1%, indicating that the incentive effect of environmental management system certification on corporate green innovation is significantly enhanced after the implementation of an environmental protection tax. Column 2 presents the results of the regression using the PSM + DID method. Consistent with the steps of the robust PSM above, the weight is not empty data regression, the coefficient of the interaction term (ISO × Post) is 0.122, and it is significant at the 5% level, which supports the regression results of the difference-in-difference.

5.2. Nature of Property Rights in Exploring the Role of Environmental Protection Tax

Enterprises with different ownership attributes play different roles in economic activities, assume different responsibilities, and perform different roles (Tian, 2000). This study explores whether the implementation of an environmental tax has different effects on enterprises with different property rights. According to the nature of enterprise property rights, this study divides enterprises into two groups: state-owned and private enterprises. The specific regression results are presented in Columns 3 - 4 in **Table 6**. In the group regression of state-owned enterprises, although the implementation of the environmental protection tax can promote the green innovation of state-owned enterprises that have passed environmental management certification, the coefficient is not significant. In the private group, the coefficient of the interaction term (ISO × Post) is 0.140, and it

Table 6. DID regression results.

	DID	PSM + DID	State-Owned Enterprises	Private Enterprises
ISO × Post	0.109***	0.122**	0.086	0.140**
	(2.612)	(2.458)	(1.364)	(2.543)
Control Variable	Yes	Yes	Yes	Yes
_cons	−1.514***	−1.541***	−2.056***	−0.105
	(−7.123)	(−5.299)	(−7.013)	(−0.323)
Year/Ind/Province	Yes	Yes	Yes	Yes
Observations	9940	5783	4966	4974
R^2	0.296	0.285	0.350	0.239

is significant at the level of 5%, indicating that the implementation of environmental protection tax can significantly promote the green innovation of private enterprises that have passed environmental management certification. This demonstrates that compared with state-owned enterprises, the implementation of environmental protection taxes has a more significant incentive effect on the green innovation of private enterprises with environmental management certification.

6. Conclusion and Recommendations

6.1. Conclusion

Based on Porter's and externality theories, this study proposes a theoretical model of the impact of environmental management system certification on corporate green innovation. It also explores the relationship between ISO1400 standard certification and green innovation and examines the mechanism effect of corporate investment efficiency and financing constraints on the relationship between environmental management system certification and green innovation. It further determines whether the implementation of an environmental protection tax in 2018 significantly enhances the impact of environmental management system certification on corporate green innovation. It employs the data of China's Shanghai and Shenzhen listed companies from 2012 to 2021 for empirical analysis. The main conclusions of this study are as follows: First, environmental management system certification can significantly promote green innovation in enterprises. This research conclusion remains valid after a series of robustness tests, such as the instrumental variable method, PSM method, replacement variable, and negative binomial regression. Second, environmental management system certification can promote green innovation by improving enterprise investment efficiency and alleviating financing constraints. It can be seen that environmental management system certification can convey green information to society, enable enterprises to establish a good social image, and promote their green transformation. Third, the nature and scale of property rights differ in the role of environmental

management system certification in promoting enterprises' green innovation, resulting in a comparative benefit in green innovation for private and large-scale enterprises. Fourth, after the implementation of the environmental protection tax, the incentive effect of environmental management system certification on enterprise green innovation is significantly enhanced.

6.2. Recommendations

The research findings have important management and policy implications for environmental management system certification. First, they imply that listed companies could focus on environmental management system certification to reduce the cost of enterprises' over-investment, transmit green signals to external stakeholders, obtain sufficient resources, perform green innovation, and create new competitiveness. Second, environmental management system certification is a voluntary environmental regulation. The government's regulatory costs are low compared with other types of environmental regulation. The government could provide government subsidies, tax relief, and other measures for enterprises performing environmental management system certification; guide enterprises to perform environmental management system certification; and give full play to the incentive role of environmental management system certification. Third, according to the heterogeneity results, the government could formulate reasonable guidance measures to enable enterprises to actively perform environmental management system certification. For state-owned enterprises, the government can link environmental management certification with the leadership promotion system, promote enterprises to carry out environmental management certification, and force green transformation and upgrading. For large-scale enterprises, the government should take them as the focus of environmental supervision and audit, encourage large-scale enterprises to actively participate in certification, transmit environmental information, and make practical changes. Additionally, for large-scale enterprises, Even if the certification is successful, it cannot relax the supervision, and give full play to the green innovation role of environmental management system certification. Fourth, as a market-based environmental regulation, the implementation of an environmental protection tax has a short-term promotion effect on the incentive effect of environmental management system certification. The government could pay attention to the synergy of the two different environmental regulations on green innovation and continue to improve environmental protection policies.

6.3. Future Research Directions and Limitations

Although this study has certain research significance, there are also some research deficiencies. First, heavy-polluting enterprises are an important subject to solve environmental problems. However, heavy-polluting enterprises may be reluctant to environmental management certification, so all of the listed companies in Shanghai and Shenzhen are selected as samples. In the future, we will choose heavy-polluting enterprises as research samples. Second, different regions have

different economic environments. This paper only explores the heterogeneity of enterprises. In the future, we will further explore whether there is regional heterogeneity. Third, the mechanism analysis of this study only discusses the impact of environmental management certification on green innovation through financing constraints and investment efficiency, and lacks the verification of other mechanisms.

6.4. Contribution of the Article

The possible contributions of this study are as follows: 1) Taking the mechanism of corporate investment efficiency and financing constraints as the starting point, it uniquely analyzes how factors in environmental management system certification have an indirect impact on corporate green innovation. 2) Since January 1, 2018, the "Environmental Protection Tax Law of the People's Republic of China" has been implemented nationwide, which means that the change in sewage charges to environmental protection tax has significantly changed the original environmental governance motivation of enterprises, thus providing an ideal exogenous shock for this study. Based on this, this study considers China's Shanghai and Shenzhen listed companies from 2012 to 2021 as the research object and employs difference-in-differences (DIDs) to explore whether the implementation of environmental protection tax affects the promotion of environmental management system certification in enterprise green innovation. 3) This study further refines the differences in property rights and scale of enterprises and explores whether environmental management certification has heterogeneity in corporate green innovation. It provides data support for improving enterprises' green innovation and environmental management system certification.

Authors' Contributions

Conceptualization: G.L.; data curation: S.Y.; writing—original draft: S.Y.; writing—review and revision of the manuscript: G.L. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

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