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Original Research

Research on the Policy Effect and Mechanism of Central Environmental Protection Supervision System on Industrial Structure Upgrading – Empirical Evidence from 283 Prefecture-Level Cities in China

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Abstract

The industrial structure upgrading (ISU) plays an important role not only as an important issue in China's economic structure transformation, but also as a key factor in terms of implementing a "win-win" situation between economic growth and environmental protection. The full implementation of the central environmental protection supervision system's (CEPSS) function in fostering the modernization of China's industrial structure is crucial for the country's economic restructuring and the development of eco-civilization. By applying the double difference (DID) model, this paper has analyzed the policy effect and impact mechanism of the CEPSS on the ISU, in order to explore the effectiveness of the CEPSS on ISU. The research results based on the panel data integrated from 283 prefecture-level cities in China from 2006 to 2019 reveal that: (1) the CEPSS has significantly improved the ISU; (2) the CEPSS was able to act on the ISU through three paths: local government environmental governance motivation, innovation level, and foreign direct investment; (3) The heterogeneity analysis reveals that the promotion function of the CEPSS on the ISU chiefly exists in large cities, super cities, non-resource-based cities and cities in eastern and central China. The research results shall provide theoretical support and policy suggestions for rationally optimizing the CEPSS and promoting the ISU.

Keywords: central environmental protection supervision system, environmental regulation, industrial structure upgrading, double difference

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Introduction

The process of economic development has inevitably produced environmental pollution while environmental pollution and unreasonable industrial structure have been restricting the sustainable growth of the economy in turn. Since the reform and opening up, China's economy has achieved drastic growth, however, the economic structure has not experienced an effective improvement, some industries still adopt the "extensive" development model characterized by high energy consumption and high emissions, and the environmental pollution problem continues to worsen. How to balance economic growth and ecological protection become a severe challenge for the Chinese government. At the legislative level, in order to harness environmental pollution, China has enacted a series of laws and regulations related to environmental issues over the past 20 years, totaling more than 500 articles. Unfortunately, owing to the weak endogenous driving force of the political system (and the inadequate implementation of local government policies, etc.), China's environmental pollution problem has not been fundamentally improved [1]. In response to the above-mentioned failure of local government environmental governance mechanisms, the Chinese central government launched a specialized campaign for central environmental protection inspections in 2016 to achieve vertical environmental supervision over the party committees and governments of provinces, autonomous regions and municipalities and their related departments. As a model of environmental regulation, the special action of the central environmental protection inspector will inevitably affect the local government's environmental governance motivation and the business decision-making of enterprises, and the local industrial structure will also be affected. Neoclassical economics believes that strict environmental supervision shall inevitably decrease the profit rate of enterprises, besides improvement of environmental quality must be at the expense of reducing economic growth. According to the "Porter Hypothesis", which takes the opposing position, well-designed environmental restrictions help encourage businesses to innovate in technology and advance the industrial structure [2]. So, what effect will the Central Environmental Protection Supervision System (CEPSS) have on the modernization of the industrial structure under China's institutional framework? Investigating how the ISU is affected by the CEPSS can therefore encourage environmental regulation to be more in line with China's industrial development. The realization of the economic and environmental "win-win" has significant practical implications.

This paper takes 283 prefecture-level cities in China from 2006 to 2019 as samples, based on the theory of environmental decentralization, innovative compensation theory and the hypothesis of pollution shelter, and uses the method of logical reasoning to analyze the impact of the central environmental protection inspection system on the ISU, and discussed its impact mechanism. The following are the primary contributions of this paper: first, the novel research methodology. Researchers have frequently used techniques like the single index approach and the comprehensive index method in past research to measure environmental regulation. Because the upgrading and optimizing of the industrial structure may also resolve environmental issues, it is challenging for these methodologies to accurately capture the net effect of environmental legislation. The quasi-natural experiment of inspector action creates a double-difference model for testing, thus alleviating the endogeneity problem of reverse causality in OLS empirical evidence, on which the paper is based. Second, the research viewpoint is original. researchers currently focus on the government and businesses as study topics. However, one of China's biggest environmental governance challenges is the failure of environmental control under the decentralized system. The central environmental protection inspector may act in a "supervisory" capacity for local governments as a significant institutional arrangement. In order to achieve this, the article examines current environmental policy and advances prior research. Third, the paper re-examines the consequences of the Porter Hypothesis and the Pollution Halo Hypothesis of the impact of environmental regulation on industrial structure based on the most recent research findings. Additionally, the motive for local government environmental governance is discussed in relation to environmental regulation and transmission system for the modernizing industrial structure. This paper offers a theoretical foundation and a clear path for clarifying the ISU against the backdrop of a centralized CEPSS. It also offers policy recommendations for fostering coordinated regional industrial structure development, logical environmental policy optimization, and promoting high-quality economic development.

Literature Review

Existing research on the influence of environmental legislation on the modernization of industrial structure has not come to a uniform result. According to the "Cost Hypothesis", under the static game assumption, businesses make production decisions based on the supposition that consumer income, demand and technology level would not change. Once environmental regulation is put into place, industrial enterprises will inevitably increase investment in environmental governance, which will have a "crowding-out effect" on productive and R&D investment, which will have a negative impact on regional productivity and ISU [3-4]. However, the "Porter Hypothesis" on the basis of the "Cost Hypothesis" gives a positive evaluation of the environmental regulation. According to M. Porter, environmental protection and economic growth are not mutually exclusive. Effective environmental regulation can encourage businesses to innovate and improve their production processes, cut costs, increase input-

output efficiency and ultimately achieve a "win-win" situation for both [5]. Huang, Zhao and Cao examine the relationship between environmental regulations and innovation activities and find that environmental regulations have led to a 0.145% increase in firms' R&D investment as a percentage of total assets, indicating a significant positive effect of environmental regulations on enterprises' R&D expenditures [6]. Research by Hascic and Popp supports this view from the perspective of innovation output. Their findings show that the stronger the regional environmental regulation, the higher the number of patent applications [7].

The "pollution paradise hypothesis" believes that environmental regulation promotes the evolution of industrial structure by affecting industrial migration. Copeland and Taylor believe that under the background of free flow of production factors, the environmental regulation in developed countries is generally more intensive, and environmental regulation increases the production cost of heavily polluting enterprises, resulting in the transfer of pollution-intensive enterprises from developed countries to less developed countries or regions with looser environmental standards, lower production costs and factor prices, the transfer of, eventually making less developed countries and regions with loose environmental regulations into "pollution paradise" [8]. However, the "Pollution Halo Hypothesis" holds a diametrically opposite view. The “Pollution Halo Hypothesis” believes that although the inflow of pollution-intensive industries will cause certain pollution to the ecological environment of the host country, with the improvement of the local economic level and the awakening of residents’ awareness of environmental protection, the intensity of environmental regulation will also increase accordingly, forcing cleaner production technology and technological innovation of polluting enterprises [9-10]. In addition, the influx of talents and technology diffusion with foreign capital will have a local technology spillover effect, thereby promoting the process of local ISU [11].

Whether environmental regulation can exert its governance effect depends on whether the central government and local governments can perform their respective functions. The theory of environmental decentralization holds that the central government should assume responsibility for environmental supervision and support research and development activities in pollution control. Since local governments have a better understanding of local information and public products of environmental protection policies are more effectively provided by local governments, the central government should give the power to allocate resources to local governments, and local governments should manage environmental affairs within their jurisdiction [12]. Subsequently, the impact of decentralization on environmental policies and outcomes began to be documented in the empirical literature. Zhang et al. investigate the empirical impact of environmental decentralization on water quality in Chinese counties near the border of cities using data from local monitoring stations. The results support Oates’ contention that local governments can more effectively address regional pollution issues by delegating environmental governance to them [13]. Hatfield and Kosec contend that environmental de-centralization has no effect on environmental governance [14]. However, environmental decentralization may lead to a so-called "race to the bottom" between local governments. The "race to the bottom" refers to local governments competing for capital at the expense of lowering environmental standards. The research of some scholars supports the theory of "race to the bottom", and further points out that the centralized environmental governance model can better provide environmental products and restrain vicious competition among local governments [15].

The theory of the relationship between environmental regulation and industrial structure also serves as the theoretical foundation for this study. Academics have conducted a very systematic investigation into the relationship between environmental regulation and industrial structure. However, the following issues with the current research still warrant further discussion: (1) Two effect pathways – technological innovation and foreign direct investment – have been offered for how environmental regulation will affect the ISU. Few literary works, meanwhile, consider the local government's environmental governance motivation as a possible influence. (2) There is no unified conclusion on the merits of environmental decentralization. This paper argues that the impact of environmental decentralization should be analyzed in conjunction with the regional institutional environment. (3) There hasn't been enough focus on the spatial and scale heterogeneity of cities in existing studies, which go beyond a general discussion of the stimulating influence of environmental legislation on industrial structure. This study examines the effects of the CEPSS on the modernization of the industrial structure in an effort to mitigate and improve the aforementioned issues as well as China's unique national circumstances. Additionally, the relationship between the CEPSS and the ISU is examined from the three perspectives of local government environmental governance motive, technical innovation and foreign direct investment. The path of the CEPSS affecting the ISU in this paper is shown in Fig. 1. On this foundation, a thorough examination of how the CEPSS affects the modernization of industrial structure in the context of urban.

Institutional Background and Research Hypothesis

Central Environmental Protection Inspector, Local Government Environmental Governance Motivation and Industrial Structure Upgrading

At present, the institutional framework of China's environmental regulation has formed a de facto

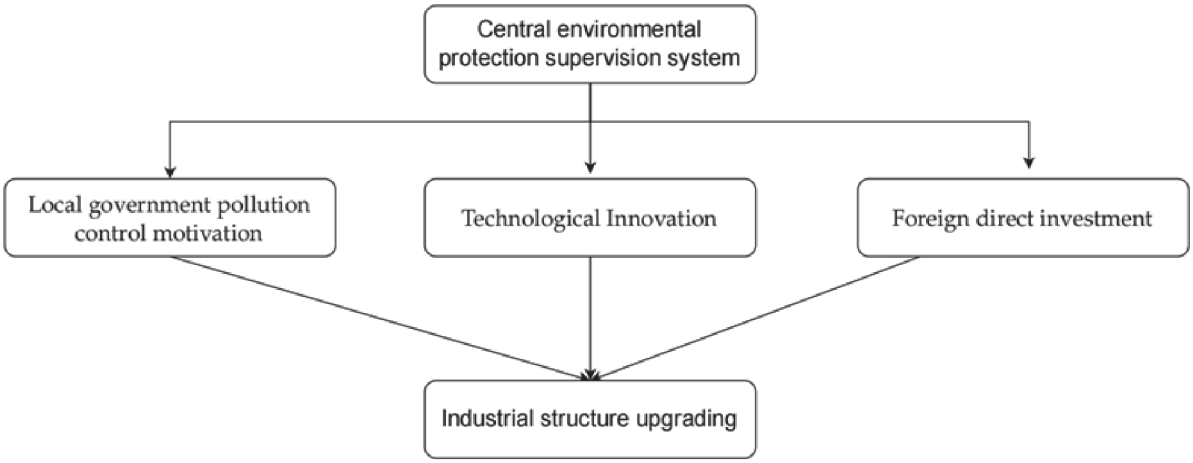

Fig. 1. The path of the CEPSS affecting the ISU.

feature of environmental decentralization. The central government is responsible for planning and designing the environmental policy system, and local governments are responsible for implementation. China has established a relatively complete environmental legal system, laying a solid foundation for clarifying environmental governance responsibilities. According to Wu et al., local governments in China have not successfully implemented environmental policies, despite the fact that the central government has done a good job of top-level design [16]. This is because the environmental governance system of the central government does not effectively encourage and restrain local governments. In terms of incentives, local government representatives are juggling a trade-off between environmental pollution and economic development. Early on in China's development, the central government's performance review of local governments made economic growth its top priority [17]. According to Li et al., local government officials will actively develop the economy at the expense of the environment as a means of advancing their careers. They may even serve as an "umbrella" for local businesses to violate environmental protection laws [18]. The Chinese central government has incorporated an environmental governance indicator, but this does little to restrain local governments. According to Li and Hu et al., some local governments even change the air pollution index [19]. In the end, the environmental evaluation has not successfully controlled local governments' actions.

The "Environmental Protection Supervision Program (Trial)" was evaluated and authorized at the 14th meeting of the Central Leading Group for Deep Reform in July 2015 in order to effectively encourage local governments to adopt environmental protection measures. The central environmental protection inspector grants environmental protection inspectors greater authority on behalf of the Central Committee of the Communist Party of China and the State Council, with a focus on supervising the fulfillment of environmental protection obligations of the party committees and governments of the provinces (municipalities and autonomous regions). The Hebei Province was chosen as the pilot inspection province by the central environmental protection inspection team in January 2016, and the remaining provinces were subsequently inspected by the team in three batches. More than 6,000 top-ranking cadres, including over 20 province and ministerial-level cadres, more than 900 departmental and bu-reau-level cadres and more than 2,800 division-level cadres were held accountable during this round of central environmental protection inspectors. Additionally, 2,264 individuals were administratively and criminally detained, 2,303 cases were filed and probed, over 40,000 businesses received penalties and 2.46 billion yuan in fines. It can be seen that the central environmental protection inspector has increased the accountability of local governments, and the strong intervention of the "central" authority has brought strong political pressure and deterrence to local officials, and local governments will pay more attention to environmental issues [20] and increase the intensity of environmental regulation [21]. The inspection results of the central environmental protection inspectors are closely related to the assessment and punishment of local officials, which increases the political cost of "collusion" between local government officials and local enterprises, and local heavy-polluting enterprises will lose the "blessing" of the local government. For the existing pollution-intensive enterprises in the region, the local government will implement higher technical standards for the enterprise and put forward higher requirements for the enterprise's pollution control equipment, which will increase the environmental treatment cost and technological transformation cost of this type of industry, consequently speeding up the exit and elimination of pollution-intensive enterprises. What's more, in order to quickly meet the requirements of the rectification plan after the inspection, some local governments will use extremely strict measures such as suspension and restriction of production to restrict the production of heavily polluting enterprises. In short, the Central Environmental Protection Inspectorate has

reduced the proportion of pollution-intensive industries as a whole, increased the elimination of outdated production capacity, and finally promoted the continuous ISU. On the other hand, the "barriers to entry" of pollution-intensive industries have been raised. For dye-intensive enterprises that want to invest in this area, the increase in the intensity of environmental regulation will increase the entry cost of pollution-intensive enterprises and limit the further expansion of their scale. Even if it is successfully entered by an enterprise, there must be a large amount of capital to support the introduction of advanced production technology, the introduction of high-level technical personnel and the installation of pollution control equipment with higher technical standards, which also improves the industrial structure to a certain extent. Accordingly, this paper proposes Hypothesis 1 and Hypothesis 2:

Hypothesis H1: The CEPSS can optimize the regional industrial structure.

Hypothesis H2: The CEPSS can promote the ISU by stimulating the local government's local environmental governance motivation.

Central Environmental Protection Inspector, Technological Innovation and Industrial Structure Optimization

The "Porter Hypothesis" main argument is that as environmental regulations get more stringent, the cost of pollution control in industries with high pollution levels will grow. As a result, businesses will be forced to invest more in R&D and production efficiency. From the perspective of the "innovative compensation effect", after the implementation of the CEPSS, local governments will transmit pressure on polluting enterprises within their jurisdictions. In the short term, the cost of pollution control in pollution-intensive industries will rise, compressing the profit margins of enterprises. Enterprises will actively adjust production and operation strategies, increase R&D innovation, and improve the technical content and environmental quality of products. In the long run, with the support of technological innovation and production efficiency, the optimization of the industrial structure has been promoted. The central environmental protection inspection system can not only produce an "innovative compensation effect", but also a "first-mover advantage effect" [22]. With the nationwide promotion of the CEPSS, people's awareness of environmental protection will gradually increase, and consumer preferences will shift to low-carbon, non-polluting, clean and recyclable products and services, and more environmentally friendly products and services. Enterprises that give priority to mastering environmental protection production technology and putting it into production and use in the market will suffer less impact, and can gradually occupy a higher market share, gaining the "first-mover advantage" that others do not have. Enterprises that fail to respond in time will gradually be eliminated by the market in the later stage of their operations. Finally, the CEPSS can motivate local governments to increase their support for environmental technology innovation. Among them, the most direct and rapid measure of the local government is to use the financial funds at its disposal to vigorously support the technological innovation of enterprises. Specifically, local governments can support enterprise innovation by giving innovation subsidies or reducing tax rates on clean products, reducing the R&D cost of technological innovation of enterprises, and then promote the transformation and upgrading of the manufacturing industry. Accordingly, this paper proposes Hypothesis 3:

Hypothesis H3: The CEPSS can optimize the industrial structure through technological innovation paths.

Central Environmental Supervision, Foreign Direct Investment and Industrial Structure Optimization

The "pollution shelter hypothesis" believes that the intensity of environmental regulation will affect the location or country choice of foreign direct investment, resulting in the creation of areas or nations with less environmental regulation and creating "pollution paradises" not favorable to raising the standard of economic growth.

According to the "pollution shelter effect" theory, businesses that produce a lot of pollution may congregate in areas with laxer environmental regulations in order to avoid more stringent regulations in their home country. The "pollution shelter effect" claims that businesses that produce a lot of pollution would move to areas or nations with laxer environmental regulations in an effort to get around their own stricter environmental regulations. In the early days of reform and opening up, China became a "pollution shelter" for many pollution-intensive foreign-funded enterprises. The reason is that in order to achieve the core goal of economic growth, China has vigorously introduced foreign capital through various means. At that time, China's environmental regulation was still in the exploratory stage, and it failed to effectively restrain polluting enterprises. Some local governments invited foreign-funded firms with potential pollution to invest and develop factories locally, ignoring the preservation of the ecological environment and adopting the paradigm of polluting first and later control in order to achieve short-term quick economic growth. As a result, diverse areas' industrial structures continued to be characterized by high energy consumption, high emissions and high pollution [23]. This paper argues that the Central Environmental Protection Inspectorate will have a "structure-oriented effect", "innovation spillover effect" and "crowding-out effect" on foreign direct investment, which will then affect the regional industrial structure.

The CEPSS may have a "crowding-out effect" on foreign direct investment, which would subsequently

have an impact on the industrial structure. Countries with laxer environmental regulation benefit from competitive advantages in industries that produce pollution [24]. When the CEPSS increases the intensity of regional environmental regulation, the competitive advantage of China's lax environmental rules will be lost, increasing the cost of environmental governance for foreign-invested businesses, which would result in a loss of foreign direct investment and a shift to other areas or countries with laxer environmental regulations. Therefore, the CEPSS has a "crowding-out effect" on foreign direct investment, which will weaken the development of the regional industrial scale to a certain extent and is not conducive to the optimization of industrial structure.

The CEPSS has a "structure-oriented effect" on foreign direct investment, which in turn influences the local industrial structure. The investment structure of businesses may clearly be guided by environmental laws [25]. Local governments' views on green development have changed as a result of the country's slow growth of centralized environmental protection inspection work, and the government will modify its selection of industry sectors for attracting foreign investment. The restriction and oversight of foreign-invested businesses with high energy consumption, high pollution and poor added value is the most obvious effect of the CEPSS on FDI. Minimal energy use, low pollution and high added value are preferred, relatively speaking. Value-added technology-intensive and environmentally friendly and clean enterprises invest and build factories locally, thereby changing the ISU. Therefore, the central environmental protection inspector can optimize the regional industrial structure through the "structure-oriented effect" of foreign direct investment.

The CEPSS will have an "innovation spillover effect" on foreign direct investment, which will affect the regional industrial structure. First, foreign-funded enterprises generally have a higher technological "first-mover advantage" than Chinese domestic enterprises. After the CEPSS was put into place, under stricter environmental regulation standards, foreign-funded enterprises with technological "first-mover advantages" can make up for the technical deficiencies of Chinese domestic enterprises. There are advantages in innovation, and higher economic benefits can be obtained, which will stimulate the increase of foreign direct investment. Secondly, the entry of foreign direct investment will increase competition in China's domestic market, forcing local enterprises to improve financial support for innovation, speed up technological innovation and improve their own competitive advantages, ultimately promoting the ISU [26]. Finally, foreign direct investment brings advanced technology and management experience, which can significantly improve the knowledge and skills of local personnel. In addition, the host country of the domestic enterprise can imitate and learn from the high-tech foreign-funded enterprises, digest and absorb the technology, improve the efficiency of resource utilization in the region, and then promote the adjustment and upgrading of the regional industrial structure [27].

Considering the previous analysis, this paper proposes Hypothesis 4:

Hypothesis H4a: The CEPSS will reduce foreign direct investment and is not conducive to optimizing the industrial structure.

Hypothesis H4b: The CEPSS will optimize the industrial structure by promoting foreign direct investment.

Methodology and Data

Model Establishment

Since the central environmental protection inspection system is piloted in batches and gradually implemented in China, this feature makes the central environmental protection inspection system have the nature of the "quasi-natural experiment". This paper makes full use of the differences in pilot policies at both time and region levels and adopts the method of difference-in-differences to identify the impact of central environmental protection inspectors on the ISU. The specific empirical model is constructed as follows:

$$ISU_{it} = \alpha_0 + \alpha_1 DID_{it} + \alpha_2 Control_{it} + \gamma_i + \mu_t + \varepsilon_{it} \quad (1)$$

Among them, the subscript i represents the prefecture-level city, t is the year, and DID is the measurement of the central environmental protection inspector. When the central environmental protection inspection team is stationed in the i prefecture-level city in the t year, the value is assigned as 1, otherwise it is assigned a value of 0, and Control represents a set of control variables. Considering that there will be differences in the corporate tax burden of different individuals and years, this paper further control individual fixed effects and year fixed effects, γ_i and μ_t, respectively. The coefficient α_1 measures the effect of the implementation of the central environmental protection supervision. If α_1 is greater than 0, it means that the CEPSS has promoted the ISU.

This paper constructs the following intermediary effect model to examine whether local government governance motivation, technological innovation and foreign direct investment play an intermediary role in the influence of central environmental protection inspectors on the improvement of local industrial structure:

$$M_{it} = \alpha_0 + \alpha_1 DID_{it} + \alpha_2 Control_{it} + \gamma_i + \mu_t + \varepsilon_{it} \quad (2)$$

$$ISU_{it} = \alpha_0 + \alpha_1 DID_{it} + \alpha_2 M_{it} + \alpha_3 Control_{it} + \gamma_i + \mu_t + \varepsilon_{it} \quad (3)$$

The mediation effect model is Equation (2) to Equation (3). The explanatory variable M_{it} of Equation (2) can be replaced by the intermediary variables of local government governance motivation (Lgm), technological innovation (Ti) and foreign direct investment (Fdi). If the coefficient of α_1 in formula (2) is significant and the coefficient of α_1 and α_2 in formula (3) is significant, it means that the mediation mechanism test has passed.

Variable Definition and Interpretation

Explained Variables

Industrial structure upgrading (ISU). The ISU can also be called a high-level or advanced industrial structure. According to Clark's law, the heightening of the industrial structure can be defined as the increase in the proportion of non-agricultural industries, and the industrial share may be used to assess how the three main industrial structures have changed through time. Consequently, the following is the precise calculation method for the ISU:

$$ais_{i,t} = \sum_{m-1}^{3} y_{i,m,t} \times m, m = 1,2,3 \tag{4}$$

In formula (4), the industrial structure is highly transformed into $ais_{i,t}$, and $y_{i,m,t}$ represents the proportion of the m industry in the i region to the regional GDP in the t period, reflecting the evolution of the proportional relationship between the secondary industry and the tertiary industry. However, such a measurement method ignores the essence of the evolution of the industrial structure, which is likely to result in a "virtual height" in quantity. The development of the proportional connection and the rise in labour productivity are two factors that contribute to the high-level industrial quality of the structure [28]. Only when a nation or region has a greater proportion of industries with better worker productivity does this suggest that the area has a more sophisticated industrial structure [29]. Combined with the above analysis and the calculation methods of other scholars on the ISU [30], the calculation model for the heightened industrial structure is as follows:

$$ais2_{i,t} = \sum_{m-1}^{3} y_{i,m,t} \times lp_{i,m,t}, m = 1,2,3 \tag{5}$$

In formula (5), $lp_{i,m,t}$ represents the labor productivity of the m industry in region i in period t, and the calculation formula is:

$$lp_{i,m,t} = Y_{i,m,t} / L_{i,m,t} \tag{6}$$

Among them, $Y_{i,m,t}$ represents the added value of the m industry in the i region in the period t, and $L_{i,m,t}$ represents the employed persons in the m industry in the i region in the period t. In formula (6), the proportion of output value $y_{i,m,t}$ has no dimension, while the labor productivity $lp_{i,m,t}$ has a dimension. In this regard, this paper adopts the averaging method to eliminate the dimension, so that the quality of the industrial structure has no dimension.

Mechanism Variables

Local government pollution control motivation (LGM). The government work report, a programmatic document that directs government activity, is a summary of the decisions and resolutions made by the administrative and executive authority organs in compliance with the legislation. As a result, the government work report's frequency and proportion of terms relating to the environment may more fully represent the government's management of the environment. Referring to Chen Shiyi's study [31], the following are the precise processes used in this paper's production of the government's environmental governance indicators: first, manually compile the 31 provinces' government work reports from 2004 to 2013; The frequency of terms relevant to the environment is determined, as well as how frequently those words appear overall in the whole text of the government report. Environmentally-related terms include: environmental protection, pollution, energy consumption, emission reduction, ecology, green, low carbon, air, chemical oxygen demand, sulfur dioxide, carbon dioxide, PM10 and PM2.5, etc. The ratio between the total number of words in the lexicon and the total number of words in the entire text is the final proxy variable for government environmental governance. Fig. 2 plots the kernel density curve of the proportion of environment-related words in the government work report. It is evident that the percentage of words in the government work report relevant to the environment is rising, which is highly consistent with the government's growing attention to environmental concerns.

Technological Innovation (TI). This study measures regional TI using the yearly number of permitted patents and the number of authorised green patents in each prefecture-level city.

Foreign direct investment (FDI). This article uses "the ratio of actual utilization of foreign direct investment to GDP" as a measure of FDI.

Control Variables

This article relies on the elements that may affect the ISU discussed in the literature and chooses the following variables as control variables to lessen the estimated bias brought on by omitted variables: Gross domestic product (GDP), Tax burden (Tax), Population (Pop), Wage (Pop). The specific definition of each variable is shown in Table 1.

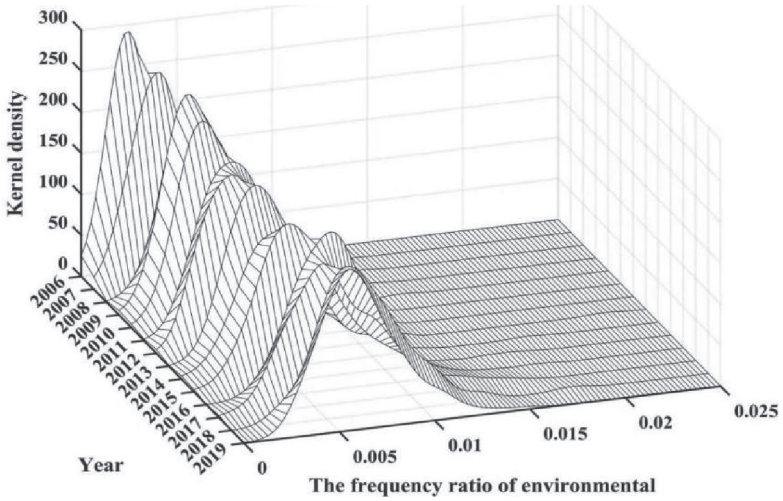

Fig. 2. Kernel density distribution of environmental word frequency.

Table 1. Definition of each variable.

Variable Symbol	Variable Name	Variable Description
ISU	Industrial structural upgrade	Explained Variables Defined
LGM	Local government's motivation for pollution control	Mechanism Variables Defined
TI	Technological innovation	Mechanism Variables Defined
FDI	Foreign direct investment	Mechanism Variables Defined
Gdp	Gross domestic product	Annual gross domestic product
Tax	Tax burden	The ratio of fiscal revenue in the regional general budget to the regional GDP
Pop	Population	Regional resident population
Wage	Wage	Average wage of employees in the region

Selection of Samples and Data Sources

First, the paper chooses 283 prefecture-level cities from 30 provinces and cities in China between the years 2006 and 2019 as the research object in order to test the aforementioned hypothesis. These cities will be used to examine the effects of the CEPSS on the optimization of industrial structures. First of all, the main basis for selecting 2006 as the starting point for the study is that before 2006, local governments in China did not need to bear environmental responsibility. Until December 2005, the Chinese central government made it clear in the decision on putting the scientific outlook on development into practice and strengthening environmental protection that "environmental protection should be included in the important content of the assessment of leading bodies and leading cadres, and the assessment results should be taken as one of the bases for the selection, appointment, rewards and punishments of cadres." For the first time, environmental indicators were added to the official incentive system, and local government officials' responsibilities for environmental preservation have been made clearer. Therefore, it is reasonable to take 2006 as the research starting point. Second, all the information in the article comes from the EPS database, the regional statistical yearbook and the urban statistical yearbook. Some missing information is filled in the local city yearly reports. Third, in order to ensure the accuracy and validity of the empirical results, and to prevent the impact of extreme value data on the empirical results, the paper has conducted 1% and 99% tailing treatment on the data year groups. Finally, in order to prevent the influence of heteroscedasticity caused by the large fluctuation of the data, the absolute number of data is logarithmic processed. The empirical results were processed with stata15.

Results and Discussion

Descriptive Statistics

The descriptive statistical findings for the key variables are displayed in Table 2. The average value

Table 2. Descriptive Statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
ISU	2978	6.398	0.343	5.517	7.6
LGM	2914	0.005	0.002	0	0.023
LnIT	2907	3.995	1.815	0	9.827
LnFDI	2978	13.355	2.081	4.605	18.834
Tax	2978	0.071	0.029	0.021	0.238
Lnpop	2978	5.89	0.67	2.896	8.129
Lngdp	2978	16.202	0.964	13.528	19.457
Lnwage	2967	10.426	0.443	8.906	13.169

of the industrial structural upgrade (ISU) is 6.398, the minimum value is 5.517, the maximum value is 7.6, and the standard deviation is 0.343, demonstrating that the ISU varies substantially overall and that the data are highly dispersed. Among the variables of the intermediary mechanism, the data on the LGM generally fluctuates little, while the data on TI and FDI are quite different.

Table 3. Analysis of Regression Results.

Variable	ISU	
	(1)	(2)
DID	0.049***	0.037***
	(-6.3)	(-4.709)
LnFDI		0.01***
		(-3.636)
Tax		0.111
		(-1.013)
Lnpop		-0.017
		(-0.542)
Lngdp		-0.11***
		(-9.192)
lnpwage		-0.003
		(-0.213)
_cons	-38.913***	-63.469***
	(-46.186)	(-19.251)
Year fixed effects	Control	Control
Individual fixed effects	Control	Control
Observations	2978	2964
R-squared	0.559	0.578

Note: *, **, *** indicate significance at the 10%, 5%, and 1% levels, respectively (the same as in the following table).

Analysis of Regression Results

The null hypothesis is disproved by the Hausman test. In order to investigate the influence of the central environmental protection inspector system on the ISU, this research employs a fixed-effect DID model.

The regression findings in Table 3's column (1) demonstrate that the coefficient of DID is notably favorable at the 1% level, indicating that the central environmental protection supervision promotes the ISU. The contribution margin of action is 0.049. In column (2), the control variable is added, the regression coefficient of DID is still significant, and R2 has increased, demonstrating that the study finding is more reliable and the model fits well once the control variable is included.

Robustness Test

Parallel Trend Test

The DID model must ensure that the ISU within the therapeutic group and the control group have the same trend before the policy is put into effect. Therefore, the test model is as follows:

$$ISU_{it} = \alpha_0 + \alpha_1 DID_{it} + \alpha_2 pre4_{it} + \alpha_3 pre3_{it} + \alpha_4 pre2_{it} + \alpha_5 pre1_{it} + \alpha_6 current_{it} + \alpha_7 After1 + \alpha_8 After2 + \alpha_9 Control_{it} + \varepsilon_{it} \quad (7)$$

Pre4 indicates that if the enterprise is in that year, the variable takes the value 1; otherwise, the variable takes the value 0 in the fourth year before the prefecture-level city is impacted by the policy. After1 refers to the first year after a prefecture-level city is affected by the policy. The results of the parallel trend test regression are shown in the first column of Table 4. Regression results show that the parallel trend test is passed.

Parallel trends are further examined through the "counterfactual approach". Drawing on the method of Yang et al. [32], this paper examines whether parallel

Table 4. Robustness check.

Variable	ISU		
	(1) Parallel Trend Test	(2) Test 2012	(3) Test 2011
Pre3	0.004		
	(-0.422)		
Pre2	0.011		
	(-1.116)		
Pre1	-0.014		
	(-1.332)		
Current	0.102***		
	(-16.373)		
After1	0.032***		
	(-3.329)		
After2	0.05***		
	(-4.904)		
Placebox2014		0.0003	
		(-0.03)	
Placebox2015			0.003
			(-0.304)
LnFDI	0.016***	0.013***	0.013**
	(-3.806)	(-2.594)	(-2.585)
Tax	0.044	0.28	0.279
	(-0.397)	(-1.032)	(-1.029)
Lnpop	-0.113***	-0.035	-0.035
	(-4.035)	(-0.476)	(-0.475)
Lngdp	-0.025**	-0.011	-0.011
	(-2.356)	(-0.365)	(-0.364)
Lnpwage	0.024**	0.019	0.019
	(-2.117)	(-0.875)	(-0.876)
_Cons	-39.148***	6.321***	6.32***
	(-11.583)	(-10.055)	(-10.034)
Year fixed effects	Control	Control	Control
Individual fixed effects	Control	Control	Control
R-squared	0.715	0.614	0.614

trends pass through a "counterfactual approach" that changes the timing of policy implementation. Specifically, this paper presupposes the time of the central environmental protection inspectors in each region is set to be 2015 and 2014 respectively. If the corresponding interaction items Placebox2014 and Placebox2015 are no longer significant, it indicates that the parallel trend test is passed. Columns (2) and (3) of Table 4 report the "counterfactual" regression results. The coefficients of the interactive terms Placebox2014 and Placebox2015 are not significant. This largely proves that the parallel trend test passes.

Table 5. Propensity Score Matching.

Variable	ISU		
	(1)	(2)	(3)
DID	0.017***	0.038***	0.038***
	(-3.024)	(-4.786)	(-4.789)
LnFDI	-0.003	0.01***	0.01***
	(-0.591)	(-3.608)	(-3.626)
Tax	0.192	0.117	0.115
	(-1.046)	(-1.054)	(-1.04)
Lnpop	-0.05	-0.017	-0.016
	(-1.45)	(-0.521)	(-0.485)
Lngdp	-0.183***	-0.103***	-0.103***
	(-7.71)	(-8.33)	(-8.381)
Lnwage	0.02	-0.016	-0.015
	(-0.63)	(-1.173)	(-1.079)
_Cons	-89.062***	-64.755***	-64.579***
	(-16.383)	(-19.132)	(-19.112)
Year fixed effects	Control	Control	Control
Individual fixed effects	Control	Control	Control
Observations	710	2949	2952
R-squared	0.788	0.575	0.576

Propensity Score Matching

To prevent bias caused by failure to control for the effects of potential unobservable variables, this paper uses the PSM-DID method to test the robustness of the regression results. In this study, the samples are subjected to neighbour matching, radius matching and kernel matching operations, and the matched samples are then replaced into the benchmark regression model, if appropriate. Table 5 displays the results of the regression. The results of the preceding benchmark regression are supported by the calculated coefficients of the interaction term DID, which are all positive and significant at the 1% level. This confirms the results of the benchmark regression, demonstrating that the improvement of local industrial infrastructure may be encouraged by the central environmental protection inspection system.

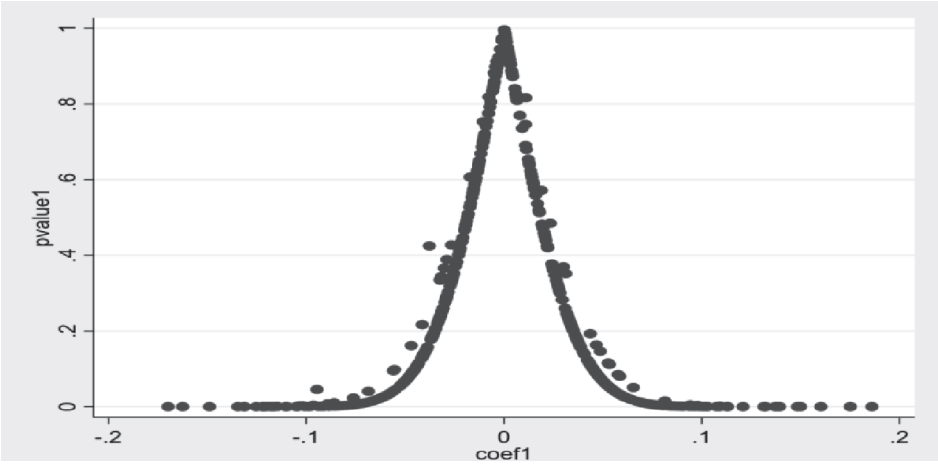

Fig. 3. Exclude randomness.

Exclude Randomness

This paper also needs to rule out the possibility that the conclusion of the paper is a random result without any substantive meaning. For example, with the passage of time, China's market rules have been gradually improved, the overall social awareness of environmental protection has generally increased, and other factors have finally led to the ISU. The results at this time are related to the implementation of the central environmental protection inspection system. There is no connection whatsoever. In order to exclude this effect, refer to Salinas et al. [33], randomly arranging the year and region where the central environmental protection inspector was stationed, and repeat this process 500 times to conduct a placebo test. The test result excluding randomness is shown in Fig. 3. The results show that the regression coefficients derived from the random simulation are distributed around 0, while the coefficients of the benchmark regression are completely independent of this coefficient distribution. This shows that the empirical results of the article are not caused by random and chance factors.

Mechanism Inspection

Mechanism Inspection of Local Government's Motivation for Pollution Control Path

This paper will test the mediation mechanism of the hypothesis H2. The effects of the CEPSS on local government's environmental governance motivation are listed in Column (1) of Table 6. The CEPSS considerably increases the LGM, according to the positive and significant regression coefficient of DID at the 1% level. Column (2) of Table 6 summarizes the influence of the LGM and CEPSS on the improvement of the ISU. Both the DID and LGM regression coefficients are positive and significant at the level of 5%, while the DID regression coefficient is significant at the level of 10%. Based on the benchmark regression in Table 3 and the regression findings in Table 6, it can be shown that local government's motivation for pollution control is a connection between the CEPSS and the ISU. Therefore, H2 is certified.

Table 6. Mechanism inspection of local government's motivation for pollution control path.

Variable	LGM	ISU
	(1)	(2)
LGM		0.014*
		(-1.8)
DID	0.174***	0.047**
	(-4.329)	(-2.44)
LnFDI	0.018	0.008***
	(-1.261)	(2.867)-
Tax	-0.003	1.03***
	(-0.005)	(-6.886)
Lnpop	0.017	-0.251***
	(-0.106)	(-32.962)
Lngdp	0.319***	0.266***
	(-5.124)	(-28.463)
Lnwage	0.058	0.095***
	(-0.884)	(-4.57)
_Cons	-36.74**	70.68***
	(-2.162)	(-16.027)
Year fixed effects	Control	Control
Individual fixed effects	Control	Control
Observations	2902	2902
R-squared	0.288	0.742

Table 7. Mechanism inspection of technological innovation path.

Variable	TI	ISU
	(1)	(2)
TI		0.001*
		(-1.74)
DID	179.68**	0.038***
	(-2.557)	(-4.752)
LnFDI	-37.076*	0.01***
	(-1.781)	(-3.664)
Tax	2574.236***	0.103
	(-2.871)	(-0.93)
Lnpop	32.662	-0.029
	(-0.423)	(-0.887)
Lngdp	545.016***	-0.108***
	(-7.473)	(-8.889)
Lnwage	-627.53***	0.001
Year	(-5.845)	(-0.094)
	71.838***	0.035***
_Cons	(-5.725)	(-19.443)
	-146297.18***	-61.504***
Year fixed effects	(-6.042)	(-17.957)
	Control	Control
Individual fixed effects	Control	Control
Observations	2919	2919
R-squared	0.145	0.574

Mechanism Inspection of Technological Innovation Path

In order to test the hypothesis H3, that is, the CEPSS promotes the ISU by improving regional technological innovation, this paper will test the intermediary mechanism of this hypothesis. Column (1) of Table 7 lists the impact of the CEPSS on the TI. The CEPSS has considerably promoted the TI, leading to the "Porter effect" according to the positive and significant regression coefficient of DID at the 1% level. Column (2) of Table 7 lists the effects of the TI and the CEPSS on the modernization of regional industrial structure. The regression coefficient of DID is positive and significant at the 1% level, and the regression coefficient of the TI is positive and at the 10% level. The level is significant. Based on the benchmark regression in Table 3 and the regression results in Table 7, it shows that the TI has played an intermediary role in the promotion of the ISU by the CEPSS. Therefore, H3 is certified.

Table 8. Mechanism inspection of foreign direct investment path.

Variable	LnFDI	ISU
	(1)	(2)
LnFDI		0.01***
		(-3.636)
DID	0.129*	0.037***
	(-1.751)	(-4.709)
Tax	2.366***	0.111
	(-3.126)	(-1.013)
Lnpop	-0.853***	-0.017
	(-4.037)	(-0.542)
Lngdp	1.258***	-0.11***
	(-15.805)	(-9.192)
Lnwage	-0.146***	-0.003
	(-2.929)	(-0.213)
_Cons	-36.74**	-63.469***
	(-2.162)	(-19.251)
Year fixed effects	Control	Control
Individual fixed effects	Control	Control
Observations	2964	2964
R-squared	0.666	0.578

Mechanism Inspection of Foreign Direct Investment Path

In order to test the hypothesis H4, that is, the CEPSS affects the ISU by affecting foreign direct investment, this paper will test the hypothesis of the intermediary mechanism. Column (1) of Table 8 details the effects of the CEPSS on the FDI. The regression coefficient of DID is positive and significant at the 10% level, indicating that the CEPSS promotes the FDI. Column (2) of Table 8 details the effects of the DID and LnFDI on the ISU. The regression coefficient of DID is positive and significant at the level of 1%, and the regression coefficient of LnFDI is positive and at 1%. In this paper, the benchmark regression in Table 3 and the regression results in Table 8 show that FDI has played an intermediary role in the promotion of the ISU by the CEPSS. Therefore, H4 is certified.

Further Discussion

Grouping by Region

Due to China's vast territory and uneven regional development, the CEPSS may have different impacts. This research examines the CEPSS's effects on the eastern region, the central region and the western

region, respectively. The regression coefficient of DID is positive and has passed the 1% significance level test, as can be seen in column (1) and column (2) of Table 9, demonstrating that the CEPSS has a significant positive impact on the ISU in the eastern region and central region. The possible reason is that due to its geographical advantages, the eastern region and central region have achieved industrialization earlier and have a relatively high level of economic development. Facing the strict CEPSS, it can quickly make inter-industry adjustments and transform into technology-intensive or service industries. Increasing environmental regulation will force technological innovation to guide the ISU. From column (3) of Table 9, it can be seen that the regression coefficient of DID has not passed the 10% significance level test, indicating that the central environmental protection inspection system has no significant impact in the western region. The poor foundation of the western region may be the cause. To be specific, the economic development started late, and there are low-end industries that sacrifice the environment in exchange for economic growth. In the face of the CEPSS, on the one hand, it is difficult to adjust the industrial structure in the short term; on the other hand, the western region has weak basic innovation ability and high innovation cost. Looking for a way to control pollution in the end, the rising cost of pollution control means "crowding out" investment in technological innovation, the creative compensatory effect of environmental legislation has not had a substantial impact, and it is challenging to raise the technological level. As a result, the western region's industrial structure has not been upgraded significantly.

Table 9. Heterogeneity analysis: region.

Variable	ISU		
	(1)	(2)	(3)
DID	0.05***	0.056***	0.008
	(-3.421)	(-4.033)	(-0.622)
LnFDI	0.018**	0.023***	0.003
	(-2.396)	(-4.376)	(-0.783)
Tax	0.526**	-0.26	0.422*
	(-2.326)	(-1.556)	(-1.961)
Lnpop	0.2**	-0.042	-0.078
	(-2.456)	(-0.979)	(-1.042)
Lngdp	-0.075***	-0.14***	-0.151***
	(-2.836)	(-6.274)	(-6.99)
Lnwage	0.039	-0.029	0.001
	(-1.092)	(-1.296)	(-0.072)
_Cons	-43.561***	-68.569***	-76.682***
	(-6.237)	(-10.945)	(-12.856)
Year fixed effects	Control	Control	Control
Individual fixed effects	Control	Control	Control
Observations	809	1068	768
R-squared	0.647	0.474	0.649

Grouping by City Size

The differences in urban scale are generally reflected in the differences in urban economic scale, urban population scale and urban infrastructure level differences, while regional city scale, population size and infrastructure level can affect the regional industrial structure. In this paper, the sample is divided according to the size of the city, and regressions are carried out to explore the moderating effect of city size. This article separates the scale of cities into four categories: mega cities, super cities, large cities, and small and medium-sized cities. This paper is based on China's criteria for an urban scale. Small and medium-sized cities are those with less than one million inhabitants, big cities are those with one to five million inhabitants. Super cities are those with five to ten million inhabitants, and mega cities are those with more than ten million inhabitants. The regression results are shown in Table 10. Column (1) is the regression result of the sample of small and medium-sized cities. The regression coefficient of DID has not passed the 10% significance level test. Column (2) is the regression result of the large city sample. The regression coefficient of DID is 0.018 and it passes the 10% significance level test. Column (3) is the regression result of the super city sample. The regression coefficient of DID is 0.055 and it passes the 1% significance level test. Column (4) is the regression result of the sample of mega city. The regression coefficient of DID has not passed the 10% significance level test. To sum up, with the increase of the city scale, the promotion effect of the supervisory system on the ISU is as follows: insignificant impact → positive impact → greater positive impact → less obvious impact.

The reason is that: the research of Chen and Du shows that the net agglomeration effect of cities first increases sharply with the increase in city size, and then decreases slowly after reaching the peak. Therefore, the relationship with city size shows an inverted U-shaped change [34]. Small and medium-sized cities are in the early stage of industrialization, and their industrial models are embodied in traditional industrial models. Due to their own economic strength and lack of human resources, they do not have the advantages of economies of scale and technology diffusion effects like large cities. Large cities and super cities are in the middle and late stages of industrialization. They can quickly adjust their industrial structure by relying on their own economic advantages. On the one hand, the transition and transfer from pollution-intensive industries to

Table 10. Heterogeneity analysis: city size.

Variable	ISU			
	(1)	(2)	(3)	(4)
DID	0.036	0.018*	0.055***	0.013
	(-0.058)	(-0.011)	(-0.012)	(-0.021)
LnFDI	-0.001	0.011***	0.006	0.041*
	(-0.014)	(-0.003)	(-0.006)	(-0.022)
Tax	4.887***	-0.476***	0.135	-1.176*
	(-0.722)	(-0.147)	(-0.158)	(-0.636)
Lnpop	0.206	0.001	-0.019	-0.451**
	(-0.276)	(-0.039)	(-0.093)	(-0.205)
Lngdp	-0.026	-0.111***	-0.103***	-0.302***
	(-0.074)	(-0.014)	(-0.025)	(-0.065)
Lnwage	-0.157	-0.001	-0.022	-0.015
	(-0.122)	(-0.015)	(-0.023)	(-0.06)
_Cons	-44.403	-62.168***	-74.024***	-133.034***
	(-32.321)	(-3.83)	(-6.373)	(-16.913)
Year fixed effects	Control	Control	Control	Control
Individual fixed effects	Control	Control	Control	Control
Observations	106	1813	930	115
R-squared	0.543	0.531	0.696	0.871

technology-intensive and service-oriented industries. Mega cities not only have "urban diseases" such as over-population and environmental pollution, but also have problems such as limited regional resource sharing and technology diffusion effects due to weak links with surrounding cities [35]. In the end, the efficiency of resource allocation in mega cities will decline and external costs will rise. The CEPSS cannot effectively exert its policy effect.

Grouping by Resource Type

The leading industries of resource-based cities are generally dominated by resource-based industries with significant pollutants and emissions. However, with the increase of resource consumption year by year, the resource endowment advantage of resource-based cities has gradually declined. Table 11 (1) lists the resource-based city sample's regression outcomes. The regression coefficient of DID is negative and passes the 10% significance level test, indicating that the CEPSS is not conducive to the ISU of resource-based cities. Column (2) displays the regression outcome of the sample of non-resource-based cities. The regression coefficient of DID is 0.019 and it has passed the 10% significance level test, indicating that the CEPSS has a significant positive effect on the ISU of non-resource-based cities.

The above results show that the CEPSS is not favorable to the ISU of resource-based cities, and the possible reason is that resource-based cities have a "resource curse" and are more likely to suffer from the "Dutch disease" than non-resource-based cities [36-37]. This means that, on the one hand, the over-dependence of resource-based cities on resource-based industries and the crowding out of production factors such as capital and labor by the resource sectors have inhibited the growth and development of manufacturing and service industries in resource-based cities, and have not formed an industrial structure pattern supported by multiple industries. On the other hand, resource-based cities have long adopted an extensive approach to resource extraction, which has caused serious damage to the urban environment, the ecological environment is generally poor, and sustainable development is not strong enough. In the face of the CEPSS, the single industrial structure of resource-based cities makes it difficult not only to cultivate alternative industries with sustainable growth potential, but also to facilitate the transfer of high-tech and emerging industries to such cities, making it difficult for resource-based cities to achieve industrial structure upgrading. Therefore, CEPSS is not conducive to promoting ISU in resource-based cities.

Table 11. Heterogeneity analysis: resource type.

Variable	ISU	
	(1)	(2)
DID	-0.028*	0.019*
	(-0.016)	(-0.01)
LnFDI	0.016***	0.008**
	(-0.004)	(-0.004)
Tax	0.119	0.298**
	(-0.205)	(-0.12)
Lnpop	0.112*	-0.132***
	(-0.059)	(-0.034)
Lngdp	0.014	-0.032*
	(-0.021)	(-0.017)
Lnwage	0.023	0.024
	(-0.021)	(-0.015)
_Cons	4.994***	7.268***
	(-0.429)	(-0.309)
Year fixed effects	Control	Control
Individual fixed effects	Control	Control
Observations	964	2000
R-squared	0.531	0.675

Conclusions and Policy Suggestions

Conclusions

The CEPSS is an important institutional innovation to stimulate the motivation of local governments and enterprises to fulfill environmental responsibility. This research empirically investigated the influence of the CEPSS on the ISU. The following are the primary conclusions:

(1) The improvement of the regional industrial structure has been greatly aided by the CEPSS.

(2) The influence of the central environmental supervisory system on the improvement of regional industrial structure is mediated by local government environmental governance motivation, technical innovation and foreign direct investment.

(3) The heterogeneity analysis reveals that the promotive function of the CEPSS on the escalation of regional industrial structure chiefly exists in large cities, super cities, non-resource-based cities and cities in eastern and central China.

Limitations. First, the crucial antecedent variables of the CEPSS's influence on the modernization of regional industrial structure need to be further investigated. In addition to the motivations of local government control, technical innovation and foreign direct investment in this research, it may be examined from the perspectives of societal demand and human capital. However, due to the availability of data on indicators such as social needs and human capital, this paper did not empirically test them. The influence of the CEPSS on the ISU will be furthered by further research. Second, because the ISU is a complicated notion, the mathematical approach utilized in this work cannot accurately capture it. Some important sub-indicators may not be taken into account, which is the direction to be further explored in the future. Finally, 283 prefecture-level cities were chosen as samples for this study due to the constraints of data gathering channels and the unavailability of statistical data for some prefecture-level cities, and some prefecture-level cities had openings in some years. Therefore, the empirical study using comprehensive statistical data from prefecture-level cities in the future may result in more reliable research findings.

Policy Suggestions

Based on the above demonstration, the following recommendations can be made in light of the foregoing findings:

(1) First of all, promote the CEPSS's normality and legality. On the one hand, the mechanism of "looking back" from time to time should be established to restrain the strategic behavior of local governments in response to the central environmental protection inspection, so that some local governments do not set up a set of policies in front of each other, and the regional pollution emission will increase rapidly after the inspection is finished. On the other hand, special administrative regulations should be formulated for the CEPSS. The direct basis for regulating the behavior of central environmental protection inspectors in China is the "Provisions on the Work of Central Ecological Environmental Protection Supervision", which is an intraparty regulation jointly issued. In practice, it may be difficult to define the legal nature of the law. We can refer to the Supervision Regulations of Public Security Organs to improve the rule of law of the CEPSS by means of administrative rules.

(2) Further stimulate the motivation of local governments for environmental governance. First of all, the promotion assessment mechanism should be improved, and factors such as local ecological environment, economic development level and industrial structure should be incorporated into the performance assessment system, so as to change the mode that local governments seek local economic growth at the expense of the environment and thus benefit promotion. Secondly, the current scope of the central environmental protection supervision is the administrative units at the prefecture level and above, so we can consider promoting the comprehensive scope of the central environmental protection supervision, and extending the objects of the central environmental protection supervision to the county level, etc., so as to build a comprehensive

CEPSS. Finally, big data technology can be used to build a full-coverage environmental data monitoring system, in order to construct a complete environmental information chain between central government, local government and enterprises, reduce the information asymmetry among the three, and restrain the "collusion" between local government and local enterprises.

(3) The orientation of environmental technology innovation should be strengthened. At the government level, the government may think about using environmental tax revenue to support businesses' efforts to innovate in the field of environmental technology, encourage businesses to invest more in this area of research and development, support the growth of high-tech, energy-efficient and environmentally friendly industries, and finally support the optimization and modernization of local industrial structures. Enterprises should focus on "source management" rather than relying on "end management" to merely react passively to environmental regulating rules. Boost technology innovation to encourage company change and improvement, improve industrial production efficiency, lower costs associated with pollution emissions, and achieve the innovation compensating benefit of environmental legislation through fostering technical innovation.

(4) The empirical findings of this article demonstrate that the central environmental supervisory system raises the amount of foreign direct investment, offering empirical support for raising the standard of foreign direct investment even higher. On the one hand, we should keep going on strengthening environmental control, limiting and outright banning foreign direct investment that has high energy consumption, high pollution, poor added value and not supportive of advancing industrial structure as a measure. On the other hand, we should actively introduce foreign direct investment with low energy consumption, low pollution and high added value in order to foster an environment favorable for investment and to fully encourage the technical spillover effect of foreign direct investment, superior management and a high capacity for R&D and innovation are required.

(5) The implementation of environmental protection policies should be developed in accordance with local conditions, according to the heterogeneity study which demonstrates that the central environmental surveillance system's insignificant policy impact in some cities. For the small and medium-sized cities and the less developed western part of the country, whose economic development started relatively late and industrialization level in the pro-phase, the central government should gradually implement environmental regulations. In the early stage, the intensity of environmental regulation can be appropriately reduced to avoid large-scale work and production stoppages due to the intensity of environmental regulations that exceed the affordability of enterprises in such cities. For super-large cities, in order to better realize regional resource sharing and form an environmental governance network with an appropriate division of labor among large, medium and small cities, super-large cities should be advised to strengthen their connections with neighboring cities, establish regional environmental pollution coordination and treatment mechanisms, and increase their connections with surrounding cities. For resource-based cities, through macro-control and administrative involvement, the government should encourage resource-based cities to transition from a single resource-based economy to a diversified one. On the basis of ensuring that resource-based cities provide a stable supply of resources and energy for the whole country, we will transform and upgrade traditional resource-based industries, cultivate and expand their replacement industries.

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Conflict of Interest

The authors declare no conflict of interest.

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