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The Impact of Environmental Regulation on the Upgrading of Urban Industrial Structure: A Quasi-Natural Experiment Based on the Two Control Zones Policy

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Abstract: This paper considers the two control zones policy implemented in 1998 in China as a quasi-natural experiment, examines the impact of environmental regulation on the upgrading of urban industrial structure by constructing a DID model, and tests the heterogeneity of its role at the regional and urban levels. Results have found that: (1) From a national perspective, the two control zones policy has significantly promoted the upgrading of urban industrial structure. In addition, from the perspective of different control zones, the two control zones policy has a positive promoting effect on the upgrading of industrial structure. (2) The two control zones policy has significant long-term effects in promoting industrial structure upgrading, and its impact on industrial structure upgrading shows dynamic effects. (3) The industrial structure upgrading effect of the two control zones policy exhibits significant heterogeneity across different city scales. (4) In terms of regions, the two control zones policy has significant spatial heterogeneity.

Keywords: environmental regulation; upgrading of industrial structure; two control zones policy

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1. Introduction

The early extensive development model in China laid an important foundation for rapid economic growth, but the attendant cost was severe environmental pollution. Severe environmental pollution has affected the normal social lives of residents and even endangered their physical health. According to the 2015 China Environmental Status Bulletin released by the Ministry of Environmental Protection of China, of the country's 338 cities above the prefecture level, only 73 cities' air quality meets the standard, and 265 cities' air quality fails to meet the standard, and air pollution has gradually become an important factor threatening the healthy survival of residents and the sustainable development of cities. Due to the fact that sulfur dioxide and acid rain are the main sources of atmospheric pollution, the State Council approved the two control zones policy in 1998 to prevent and control acid rain and sulfur dioxide pollution, and improve air quality. With the rapid development of the economy, the industrial structure characteristics of extensive development are difficult to sustain. The government has taken the opportunity to propose a strategy for optimizing and upgrading the industrial structure. Therefore, this paper studies whether environmental regulation has a significant impact on the upgrading of urban industrial structure from the perspective of the two control zones policy.

According to data, in 1995, the GDP of the two control zones accounted for 62.4% of the national GDP, the population accounted for 40.6% of the national GDP, and the sulfur dioxide emissions accounted for 60% of the national GDP. Among them, acid rain control areas are mainly concentrated in the southern region. The sulfur dioxide control areas are mainly located in northern cities. With the rapid development of China's economy, air quality has been severely damaged, with sulfur dioxide and acid rain being the main sources of air pollution. Therefore, the State Council approved the implementation of the two control zones policy in 1998 to achieve the goal of improving air quality. The impact mechanism of the two control zones policy on improving air quality is mainly reflected in two ways, namely, the production cost mechanism and the inefficient elimination mechanism. For the production cost mechanism, the two control zones policy requires enterprises to use clean energy with higher costs or upgrade and transform high pollution production lines, thereby increasing production costs and reducing profits. On the one hand, the two zones policy has a negative impact on the increase in enterprise costs, but on the other hand, the two zones policy can encourage enterprises to improve productivity by developing new technologies to obtain profits, thus promoting the upgrading of industrial structure and improving air quality. For the inefficient elimination mechanism, the two control zones policy will accelerate the elimination speed of low tech and high-pollution industries, leading to the exit of industries using inefficient production technologies from the market, thereby improving and adjusting the industrial structure of society and promoting the improvement of the social ecological environment.

There are three different viewpoints in the academic community regarding whether environmental regulations promote the upgrading of urban industrial structure [1]. The first type of theoretical viewpoint is the pollution haven or sanctuary hypothesis, whose core viewpoint is that under open economic conditions, free trade will cause highly polluting industries in developed countries to migrate to developing countries. This situation arises because developed countries have stronger environmental awareness, resulting in stricter environmental management systems and stricter environmental standards, which can lead to an increase in production costs in developed countries. Compared to other countries, countries with lower environmental standards have a low-cost advantage, leading to the transfer of high-pollution industries from developed countries to developing countries, which become pollution havens for developed countries [2–6]. Cole (2004) used the North–South trade flow data of pollution intensive products to evaluate the evidence of the pollution haven hypothesis, and the research conclusions support the pollution haven hypothesis [7]. Akbostanci et al. (2007) used Turkish panel data from 1994 to 1997 to test the pollution haven hypothesis, and found that trade exports increased with the increase in industrial pollution, providing a basis for the pollution haven hypothesis [8]. Bu et al. (2013) utilized investment data from multinational corporations in China and found that loose environmental regulatory policies can attract multinational corporations to invest in China [9]. Bakirtas and Cetin (2017) used panel data as the research object to test the pollution haven hypothesis. The analysis results showed that FDI was not conducive to the improvement of environmental quality, and the pollution haven hypothesis was confirmed [10].

The second representative viewpoint is the Porter hypothesis, which contrary to the first viewpoint, holds that environmental protection and improvement in corporate competitiveness can coexist. Appropriate environmental regulations can compensate for the increase in pollution control costs by stimulating corporate innovation capabilities, thus enhancing the international competitiveness of enterprises [11–17]. The research results of Wells et al. (2013) found that increasing environmental standards can shift the product structure of enterprises towards the mid to high end [18]. Lin and Guan (2020) constructed spatial weight matrices from the perspectives of geographical and economic characteristics, and used the spatial Durbin model to analyze the impact of environmental regulation intensity on regional manufacturing upgrading in 30 provinces and cities in China. The study found that environmental regulation can serve as a new driving force for manufacturing upgrading [19]. Ren et al. (2019) used China's first large-scale market-oriented environmental regulation as a quasi-natural experiment to study the impact of emission trading system on total factor productivity of enterprises, and the results showed that the Porter hypothesis was valid [20].

The third kind of view is the Kuznets curve theory, whose core view is that environmental quality deterioration is an inevitable stage of industrial development, and when the economic development reaches a certain level, environmental quality will gradually improve [21–26]. Selden and Song (1994) used panel data to study the relationship between per capita pollution emissions and per capita GDP, and found that there was an inverted U curve relationship between the two [27]. Andreoni and Vesterlund (2001) found that the environmental Kuznets curve depended on technological progress and had nothing to do with political system and externality [28]. Harbaugh et al. (2002) used global ambient air panel data to test the relationship between national income and pollution emissions, and did not draw an inverted U curve between air pollution and national income [29]. Stern (2004) found that some developing countries adopt developed country standards to solve environmental problems, with a short time lag and even perform better than some wealthy countries [30]. Zhu et al. (2010) conducted an EKC empirical analysis of seven industrial pollution emissions based on China's provincial panel data from 1989 to 2007, and found that industrial pollution emissions in China had a strong spatial dependence [31]. Chen (2015) used the inter provincial panel data from 1997 to 2011 to empirically analyze the changes in EKC in China over the past decade. The results showed that there was an environmental Kuznets curve between China's economic growth and environmental pollution [32].

To sum up, the existing studies have richly analyzed the relationship between environmental regulation and industrial structure, but there are relatively few quantitative studies on the effect of the two control zones policy implemented by the Chinese government. Therefore, this paper analyzes the correlation mechanism between environmental rules and urban industrial upgrading under the perspective of the two control zones policy, so as to realize the quantitative portrayal of the economic impacts that may be generated by the two control zones policy, and thus provide solid empirical evidences for the government's formulation of environmental and industrial policies, which is an important novelty in the present article.

2. The Policy Concept of Two Control Zones

2.1. Background of the Two Control Zones Policy

Since the reform and opening up, industrial development in various regions has made significant contributions to sustained and rapid economic development, but it has also caused serious environmental pollution. Air pollution, as one of the main forms of environmental pollution, is mainly due to the excessive consumption of coal resources, leading to an increase in sulfur dioxide emissions and serious acid rain pollution. However, the basic characteristics of China's natural resources are that they are rich in coal and poor in oil and gas, which determine the important position of coal in primary energy. Since the founding of the People's Republic of China, the production and consumption of coal have accounted for over 70% of the country's one-time energy production and consumption, forming an energy consumption structure dominated by coal. From Figure 1, it can be seen that from 1990 to 2022, China's coal consumption increased from 75,211.69 million tons to 304,042 million tons, exceeded 100,000 million tons in 2000, and exceeded 200,000 million tons in 2006. The coal consumption shows a gradually increasing trend.

The significant increase in coal consumption is bound to increase the degree of air pollution, especially when emission reduction technology is at a low level, and coal combustion is not treated with reasonable emission reduction technology. The direct discharge of pollutants into the air will have a serious impact on air quality. Based on the characteristics of China's natural resources, the government's dependence on coal will gradually increase in order to promote rapid economic development. At the same time, it is difficult to find alternatives to coal in a short period of time. In order to achieve the goal of controlling air quality, environmental regulations have played a positive role in this stage. The government sets reasonable environmental regulations to encourage enterprises to reduce pollutant emissions through technological innovation, while also encouraging enterprises to increase innovation investment and stimulate a new round of productivity growth.

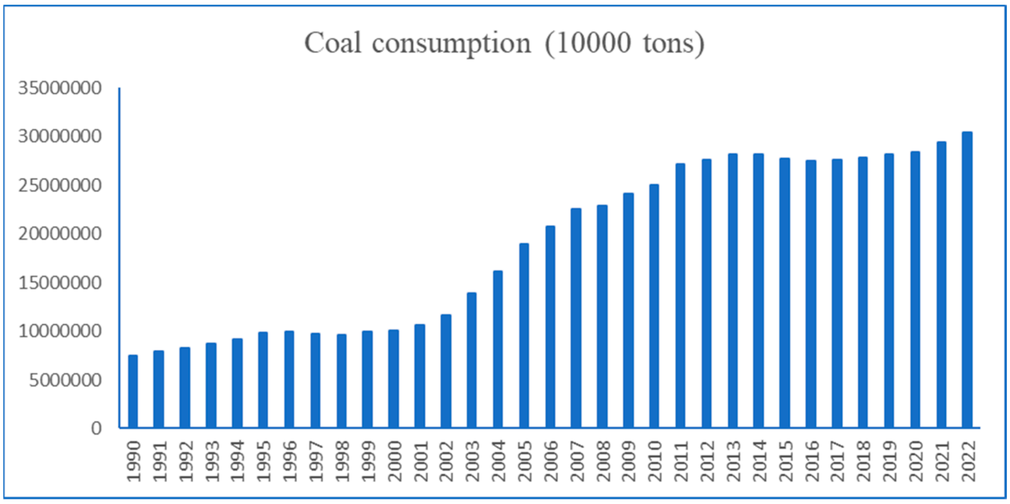

Figure 1. Coal Consumption from 1990 to 2022.

Due to the lack of fundamental changes in China's coal-based energy structure, atmospheric pollution, mainly caused by sulfur dioxide pollution, will persist for a long time. Moreover, due to the high sulfur content in coal in some regions and the fact that most enterprises have not installed desulfurization equipment, China's sulfur dioxide emissions have increased sharply year by year, leading to serious acid rain pollution. Figure 2 depicts the changes in sulfur dioxide emissions in China from 1990 to 2021. As shown in the figure, from 1900 to 1995, China's sulfur dioxide emissions rapidly increased, from 14.95 million tons to 23.7 million tons. Subsequently, China's sulfur dioxide emissions began to decline, reaching 18.57 million tons in 1999. With the continuous development of the economy and the increasing demand for coal consumption, sulfur dioxide emissions have been increasing year by year, reaching a peak of 24.68 million tons in 2006, followed by an overall downward trend. However, the total amount of sulfur dioxide emissions still ranks among the top in the world.

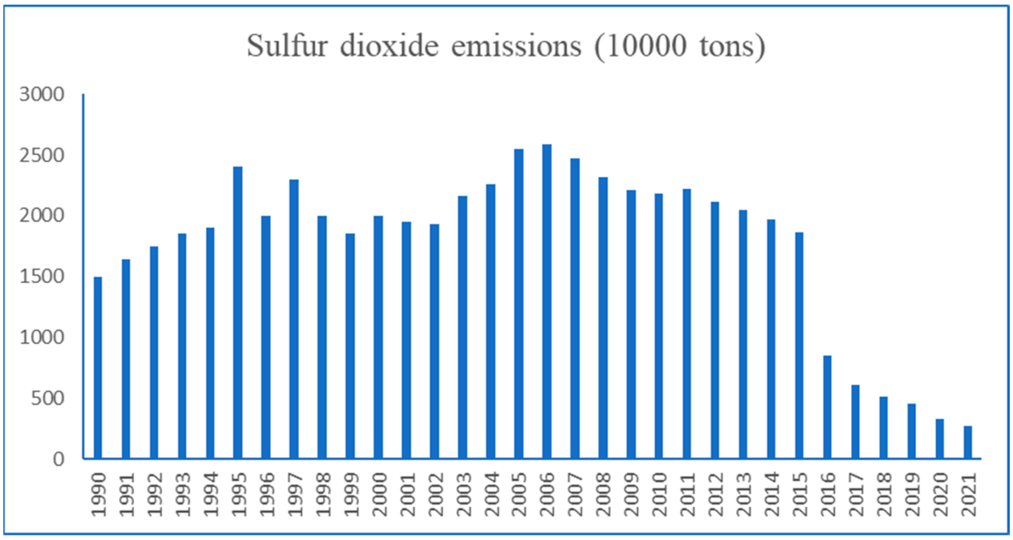

Figure 2. Sulfur dioxide emissions from 1990 to 2021.

According to data from 2177 environmental monitoring stations across the country detected by the National Environmental Protection Administration from 1981 to 1993, the number of cities with excessive sulfur dioxide concentrations in the atmosphere is increasing. In 1993, 62.3% of the urban sulfur dioxide annual average concentration exceeded the national level II standard, and the daily average concentration exceeded the national level III standard. High level of sulfur dioxide pollution and smoke pollution increased the probability of humans suffering from respiratory disease, increased the mortality rate of residents, and brought major threats and challenges to the health and social lives of residents.

With the continuous development of industry, a large amount of sulfur dioxide is emitted from coal combustion that not only exacerbates air pollution but also leads to the rapid development of acid rain pollution. Since the 1990s, the acid rain-contaminated area has spread widely compared with that of the 1980s, from a few areas, such as Southwest China, to most of Southwest China, South China, Central China, and East China, spreading over an area of up to more than 1 million square kilometers. By 1995, the average annual precipitation PH value was less than 5.6, accounting for 40% of the national area. Severe acid rain pollution changed the soil structure, resulting in soil impoverishment, forest death, corrosion of building materials, and extremely serious economic losses. Faced with the serious problem of sulfur dioxide and acid rain pollution, the State Council officially approved the Division Plan for Acid Rain Control Zone and Sulfur Dioxide Pollution Control Zone in 1998 and began its formal implementation. This policy is abbreviated as the two control zones policy by the academic community.

2.2. Content of the Two Control Zones Policy

In 1998, China divided acid rain control areas and sulfur dioxide pollution control areas based on natural conditions such as meteorological conditions, soil, and terrain, abbreviated as two control zones. The two controlled zones include 175 cities and regions at or above the prefecture level in 27 provinces, covering an area of 1.09 million square kilometers, accounting for 11.4% of the national area. Among them, the acid rain control zone covers an area of approximately 800,000 square kilometers, accounting for 8.4% of the national area. The area of sulfur dioxide control zone is approximately 290,000 square kilometers, accounting for 3% of the national area. Cities included in the two control zones will be subject to stricter environmental policy controls, in order to curb the trend of increasing acid rain and sulfur dioxide pollution. Environmental policies mainly include restricting the mining and use of high-sulfur coal, controlling sulfur dioxide emissions from thermal power plants, strictly controlling high-pollution industries, strengthening research and development of desulfurization technologies, and strengthening the collection and management of pollution discharge fees.

(1) Restrict the mining and use of high-sulfur coal

Control the emission of sulfur dioxide from the source, restrict the mining, production, transportation, and use of high-sulfur coal, and promote the construction of washing equipment for high-sulfur coal mines, prioritizing the supply of low-sulfur coal to the two control zones. Various regions are prohibited from approving the construction of new coal mines with sulfur content greater than 3%, and gradually limit production or close existing high sulfur mines. The coal fuel in the two controlled zones should comply with the local government's regulations on prosperous environmental protection indicators and restrict the import of fuels with high sulfur content.

(2) Control of sulfur dioxide emissions from thermal power plants

The sulfur dioxide emissions from thermal power plants account for a large proportion of the total national emissions, so it is important to focus on monitoring the sulfur dioxide emissions from thermal power plants. In the two controlled zones, it is prohibited to build new coal-fired power plants, and at the same time, the construction of power plants for desulfurization is accelerated.

(3) Strict control on high-pollution industries

The production processes in the metallurgical, chemical, non-ferrous, and building materials industries are accompanied by a large amount of sulfur dioxide emissions, accounting for about 20% of the total emissions. The control of the entire production process in high-pollution industries should be strengthened, and clean production should be implemented. Processes and equipment that pollute the environment should be eliminated within a specified period of time, and the use of highly polluting processes and equipment in new and renovated projects should be prohibited. Over-standard emission sources in the two controlled zones should be treated within a specified period of time, and those that fail to meet the standards should be shut down.

(4) Strengthening of the research and development of desulfurization technology

The research, development, promotion, and application of desulfurization technology should be accelerated, the construction of rotary spray drying flue gas desulfurization, calcium injection desulfurization in furnace, wet dust removal desulfurization, circulating fluidized bed desulfurization, industrial briquette sulfur fixation and other equipment should be focused on, and the introduction of foreign advanced treatment technology and equipment should be accelerated.

(5) Strengthening of the collection and management of pollution discharge fees

In accordance with the requirements of the Reply of the State Council on the Pilot Work of Expanding Sulfur Dioxide Pollutant Discharge Fees, all regions have conscientiously implemented policies for the collection, management, and use of sulfur dioxide pollutant discharge fees.

3. Empirical Design

3.1. Model Settings

Through the research on the existing literature, it has been found that there are currently three main methods for evaluating policy effects, namely, the Regression Discontinuity (RD), Synthetic Control Method (SCM), and Difference-in-Difference Method (DID). Among them, the main idea of the RD method is that when a certain variable in the sample is greater than the critical value, policy intervention is accepted, and when it is less than the critical value, policy intervention is not accepted, and it is considered as the control group. The RD method can effectively reveal causal relationships in random experiments, but it also has certain limitations. When using the RD method, it is necessary to ensure that there are no interruptions in other covariates. Then, the RD method assumes that the research object is homogeneous or approximately homogeneous, but in reality, it is difficult to control the homogeneity of the sample, so the estimation results are biased. Finally, the RD method measures the policy effects near the critical value, not the overall average effect. Due to the inability to find suitable indicators as critical values for policy implementation, this method is not suitable for policy evaluation in the two control areas.

The basic principle of the SCM method is to construct a composite control group with similar characteristics to the experimental group by linearly combining multiple existing control groups. The policy effect is evaluated by comparing the differences between the control group and the experimental group before and after policy implementation. The SCM method simulates the pre-policy situation of the target object policy by weighting multiple objects, clearly reflecting the contribution of each object in the counter factual event. However, the composite control method needs to provide corresponding composite control objects for each experimental group implementing the new policy. In this article, the two control zone policies cover 175 cities and regions above the prefecture level in China, making it difficult to find matching city samples. Therefore, the composite control method is not applicable to the research in this paper.

The DID model, also known as the double difference method, has gradually emerged in academic circles since the 1980s. As a research method of policy effect evaluation, it can regard institutional change and new policies as a natural laboratory born out of the economic system, and objectively measure the impact of new policy implementation on the economy [33,34]. Due to its simple and easy-to-use econometric model with clear logic, it has been widely applied in the field of social sciences. In terms of principle, the DID model divides the samples into two groups: one is the experimental group that underwent experimental treatment, and the other is the control group that did not implement the experimental project. In the study of policy effectiveness evaluation, the samples affected by the policy are the experimental group, otherwise they are the control group, and individual dummy variables are used to distinguish between the experimental group and the control group. The policy implementation time is divided into two periods, namely, before and after policy implementation, using time dummy variables to distinguish. Then, individual dummy variables, time dummy variables, and their cross products are included in the regression equation. Unlike the static evaluation method of directly comparing the mean changes in samples before and after the implementation of the new policy, the DID model determines whether the impact of implementing the new policy has significant statistical significance by regressing individual data.

The DID model effectively avoids the endogeneity problem of policies as the dependent variable, which controls the mutual influence between the dependent variable and the explanatory variable. For panel data, the DID model can not only use the exogenous nature of explanatory variables but also control the impact of unobservable individual heterogeneity on the explanatory variables. Based on this, the DID model can control both unobservable individual heterogeneity and the impact of unobservable population factors, thus obtaining unbiased estimates of policies. In summary, the three methods are applicable to different types of policy evaluations. Based on the actual situation of this article, it is more reasonable to use the DID model.

In order to evaluate the impact of the implementation of the two control zones policy on the upgrading of the urban industrial structure, the two control zones policy is regarded as a quasi-natural experiment, and a DID model is used to evaluate the effect of policy implementation. The model contains two main dummy variables, namely, the policy dummy variable TCZ (with a value of 1 for two controlled zones cities and 0 for non-two controlled zones cities) and the time dummy variable (with a value of 1 for the year of policy implementation and subsequent years, and 0 before implementation). Therefore, based on the timeline of the implementation of the two control zones policy and whether it is affected by the two control zones policy, the sample is divided into four groups: cities in the "two control areas" before the policy implementation, cities in the two control zones after the policy implementation, non-two control zones cities before the policy implementation, and cities in the two control zones after the policy implementation. By calculating the average changes between the experimental group and the control group during different periods, and differentiating the changes, the difference obtained is used to measure the policy impact of the two control zones.

This article constructs a DID model as follows:

$$y_{it} = \alpha_0 + \gamma TCZ_i \cdot post_t + \beta X + \mu_i + \delta_t + \varepsilon_{it} \tag{1}$$

Among them, y_{it} is the upgrading index of the industrial structure of each city, and μ_i is an individual fixed effect that controls factors that do not change over time at the city level; δ_t is a fixed time effect, controlling for time trend factors; X is the control variable, and ε_{it} is the error term. This article focuses on estimating parameter γ, which is the net effect of policy intervention in the two control zones. If the dual control zone policy has indeed promoted the upgrading of urban industrial structure, then the coefficient of γ is significantly positive.

3.2. Variable Description

Explained variable: In order to evaluate the role of environmental regulation in the upgrading of industrial structure, the ratio of the output value of tertiary sector of the economy and secondary sector of the economy of each city is used to measure the upgrading of urban industrial structure (*es*). This indicator reflects the evolution trend of industrial structure from industry to service industry, and better explains the upgrading connotation of industrial structure from low added value to high added value and from extensive to intensive transformation.

Core explanatory variables: Based on the research purpose of this article, the main explanatory variables are the urban dummy variable (TCZ) and policy implementation dummy variable ($post$) in the two control zones. The experimental group and control group are divided to analyze the role of environmental regulations in the upgrading of urban industrial structure. Among them, the product term ($TCZ \cdot post$) of the policy dummy variable in the two control areas and the policy implementation time dummy variable is the core explanatory variable, and the industrial structure upgrading effect of the policies in the two control areas is obtained by calculating its estimation coefficient.

Control variable:

(1) Investment scale (*inv*). Fixed assets investment of the whole society in each city is used for measurement. Investment, as one of the three carriages, plays a significant role in driving economic growth. Based on modern economic growth theory, knowledge, technology, capital, and institutions are all important factors driving economic growth, and the important source of capital formation is investment. At the current stage of development, industrial transformation, technological innovation, elimination of outdated production capacity, urbanization construction, and improvement of people's livelihoods all require significant financial support, expanding and optimizing investment, and fully leveraging the key role of investment in industrial structure upgrading.

(2) Economic development level ($pgdp$). It is measured using actual per capita GDP. With the continuous development of the economy, the industrial structure of a country or region will also shift from a low level to a high level.

(3) Infrastructure construction level (*inr*). It is measured using per capita urban road area. Infrastructure provides important material engineering facilities for social production and residents' lives in a country or region, and plays a fundamental role in the survival and development of society. With the continuous improvement of infrastructure, frequent factor flows between regions, and increasingly close development connections between cities, large-scale infrastructure construction will not only have an impact on the upgrading of local urban industrial structure but also have an impact on the upgrading of surrounding urban industrial structure.

(4) Government expenditure (*gov*). It is measured by the ratio of fiscal expenditure within the general government budget to gross regional product. In modern economic development, the government has a significant impact on the changes and upgrades of regional economic development and industrial structure. Government fiscal expenditure, as an important component of industrial policy, plays an important role in upgrading industrial structure.

3.3. Data Sources

The data used in this paper are mainly from China Statistical Yearbook, China Urban Statistical Yearbook, Division Plan of Acid Rain Control Area and Sulfur Dioxide Pollution Control Area, and the Statistical Yearbooks of Cities. The data samples are panel data of 257 prefecture level cities in China from 1994 to 2010. The data was collected from 1994 to avoid estimation errors caused by the implementation of the tax-sharing reform policy. The deadline was 2010 because the long-term goal of the two control zones policy was set for 2010. During the data processing process, regions and cities with significant missing data were excluded. In the sample, there were 127 cities belonging to the two control areas (79 acid rain control areas and 48 sulfur dioxide control areas), and 100 cities outside the area. All value variables in the article are uniformly accounted for as constant prices based on 1994, and some missing data is supplemented by the moving average method. Descriptive statistics of variables are shown in Table 1.

Table 1. Descriptive statistics of variables.

Variable	Mean	Standard Deviation	Minimum	Maximum
es	0.834	0.360	0.084	3.3062
lninv	13.644	1.424	8.434	17.688
lnpgdp	8.472	0.687	4.079	11.529
inr	6.884	5.158	0.100	64
gov	0.227	0.277	0.005	6.797
TCZ	0.559	0.496	0	1

4. Empirical Result Analysis

4.1. The Impact of the TCZ Policy on the Upgrading of Urban Industrial Structure

In order to evaluate the impact of the two control zones policy on the upgrading of urban industrial structure, a bidirectional fixed effect model was used to regress Equation (1), and the specific results are shown in Table 2. The columns (1) and (2) in Table 2 show the full sample estimation results. Column (1) does not include control variables, while column (2) shows the regression results after adding control variables. From the results in the table, it can be seen that the estimated coefficient of $TCZ \cdot post$ is significantly positive across the entire sample. On average, the two control zones policy has a significant promoting effect on industrial structure upgrading under strict environmental regulations. Although the implementation of the two control zones policy has increased the pollution discharge fees and equipment investment of enterprises in the two control zones, it can promote the transformation and upgrading of urban industries. Highly polluting enterprises have reduced profits due to strict environmental regulations, and the service industry, which is less affected by environmental policies, has developed smoothly, driving the upgrading of urban industries. From the perspective of the long-term development of enterprises in the two control zones, in order to enhance their competitive advantage, enterprises have increased research and development investment to promote technological improvement and production innovation and improve production efficiency and profit margin to offset the increase in production costs, thereby driving the overall industrial structure upgrade.

Table 2. The impact of the two control zones policy on the upgrading of industrial structure.

Variable	Full Sample		Acid Rain Control Zone		Sulfur Dioxide Control Zone	
	(1)	(2)	(3)	(4)	(5)	(6)
$TCZ \cdot post$	0.0504 *** (6.87)	0.0364 *** (4.97)	0.0701 *** (4.20)	0.0662 *** (7.55)	0.0512 *** (4.98)	0.0324 ** (2.26)
lninv		0.0137 * (1.88)		0.0410 *** (10.38)		0.0206 ** (2.11)
lnpgdp		0.0395 ** (2.18)		0.0692 *** (4.40)		0.0301 ** (2.19)
inr		−0.0053 *** (−4.98)		−0.0024 * (−1.88)		−0.0121 *** (−6.35)
gov		0.2767 ** (2.06)		0.2337 *** (2.93)		0.2406 ** (2.03)
Urban fixed effects	YES	YES	YES	YES	YES	YES
Time fixed effect	YES	YES	YES	YES	YES	YES
Constant	0.8412 *** (25.15)	1.3141 *** (11.42)	0.8413 *** (13.01)	1.9187 (17.66)	0.8512 *** (12.75)	1.3800 *** (11.77)
F	22.78	32.32	17.60	70.80	24.84	88.61
R^2	0.3378	0.4485	0.3080	0.3480	0.4013	0.3243

Note: The values in parentheses are *t*-values, and ***, **, and *, respectively represent significant values at 1%, 5%, and 10% confidence levels.

In addition, from the results in column (2), it can be seen that the estimated coefficients of control variables such as the whole society's fixed assets investment, economic development level, and government size in each city are also significantly positive, that is, each city can promote the industrial level through increasing investment, policy factors, and economic development. At the same time, in order to examine the effects of and differences in environmental policies in different control zones on industrial structure upgrading, the two control zones were divided into acid rain control area and sulfur dioxide control area based on the division standards of acid rain control area and sulfur dioxide control area. From a regional perspective, the heterogeneity of industrial upgrading effects of environmental regulation policies was examined. The specific results are shown in columns (3)–(6) of Table 2. The results show that environmental regulation has a significant role in promoting urban industrial upgrading in the acid rain control area and sulfur dioxide control area. Even if control variables are gradually added, the positive effect of the policies in the two control areas on the upgrading of local industrial structure is still significant.

4.2. Dynamic Testing

The above analysis strongly indicates the promoting effect of the two control zones policy on the upgrading of urban industrial structure. However, this only evaluates the average effect of the two control zones policy on the upgrading of urban industrial structure, and cannot deeply analyze the sustained effect of environmental regulation policies. In fact, the impact of any policy implementation may not necessarily be effective in the current period, so it is necessary to examine the dynamic effects of the two control zones policy on industrial upgrading. Starting from 1998, the time dummy variable of implementing the two control zones policy was split into time dummy variables for each year, and then multiplied with the urban dummy variable of implementing the two control zones policy to obtain the long-term dynamic effect of the two control zones policy on industrial structure upgrading (estimated results are shown in Table 3).

Table 3. The impact of the TCZ policy on the upgrading of industrial structure: dynamic test.

Time	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
coefficient	0.0093	0.0249	0.0047	0.0080	0.0018 *	0.0361 ***	0.0441 ***
standard error	0.006	0.0056	0.0054	0.0057	0.0061	0.0075	0.0077
Time	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	
coefficient	0.0204 **	0.0321 ***	0.0325 *	0.0542 ***	0.0980 ***	0.1297 ***	
standard error	0.0105	0.0085	0.0100	0.0097	0.1013	0.0216	

Note: The above regression controls for urban and temporal fixed effects, and the coefficients of the control variables are not shown. ***, **, and *, respectively represent significant values at 1%, 5%, and 10% confidence levels.

The results of Table 3 indicate that the two control zones policy has a significant long-term promoting effect on the upgrading of industrial structure. At the beginning of policy implementation, the impact on industrial structure upgrading was relatively small and not significant. Since 2002, the impact of the two control zones policy on the upgrading of industrial structure has gradually become apparent, and since then, it has shown an inverted U pattern of first increasing and then decreasing. The industrial structure upgrading effect of the two control zones policy in 2002 was 0.0018, which increased to 0.0441 in 2004. By 2005, there was a correction, and the effect was decreased to 0.0204. Due to the second phase of the two control zones policy in 2010, the industrial upgrading effect from 2008 to 2010 showed an upward trend. From this, it can be seen that the impact of the two control zones policy on the upgrading of regional industrial structure is not a one-time impact. In the process of continuous impact, the marginal effect of the policy shows fluctuating changes [35]. In addition, the above results prove that the promotion effect of the two control zones policy on the upgrading of industrial structure is stable.

4.3. Heterogeneity Test of Urban Scale

There are significant differences in factor endowments among various cities in China, and in China's political and economic system, and these differences are closely related to administrative levels [36]. Administrative levels and larger cities have significant advantages in factor possession and economic development. Therefore, the same policy incentives have different promoting effects on industrial upgrading in cities of different scales. In order to prove that factors such as factor endowment and institutional regulation make the promotion effect of the two control zones policy on industrial structure upgrading different among cities of different scales, this article divides the sample cities into categories 1, 2, and 3 based on the national urban scale classification standards. Among them, cities with a permanent population of over 5 million in urban areas are classified as class I cities, cities with a permanent population of over 3 million but less than 5 million in urban areas are classified as class II cities, and cities with a permanent population of less than 3 million in urban areas are classified as class III cities. The scale of class III cities is gradually decreasing. The results are shown in Table 4.

Table 4. Results of city size heterogeneity test.

Variable	(1)	(2)	(3)	(4)	(5)	(6)
Class I cities	0.2152 *** (3.14)			0.1200 * (1.78)		
Class II cities		0.0867 *** (4.68)			0.0636 *** (2.86)	
Class III cities			0.0569 *** (10.25)			0.0351 *** (5.06)
Control variable	NO	NO	NO	YES	YES	YES
Urban fixed effects	YES	YES	YES	YES	YES	YES
Time fixed effect	YES	YES	YES	YES	YES	YES
Constant	0.8682 *** (11.21)	0.8010 *** (13.35)	0.8429 *** (15.16)	0.5508 *** (13.93)	2.4118 *** (22.06)	2.0815 *** (10.45)
F	16.00	21.89	15.16	16.00	19.23	11.67
R^2	0.4906	0.4167	0.4445	0.4906	0.4661	0.3158

Note: The values in parentheses are *t*-values, and ***, and *, respectively represent significant values at 1%, and 10% confidence levels.

The (1)–(3) columns in Table 4 mainly examine the promoting effect of the two control zones policy on the upgrading of industrial structure under different city sizes. It can be seen that the promoting effect of environmental regulation policies on the upgrading of industrial structure under different city sizes is still significant. However, as the city size increases, the impact of the two control zones policy on the upgrading of industrial structure gradually increases. The columns (4)–(6) report the impact of the two control zones policy on industrial structure upgrading under different city sizes after adding control variables. It can be seen that the estimated coefficient of the impact of the two control zones environmental regulation policy on industrial structure upgrading is the highest in the class I cities, followed by the estimated coefficient of the class II cities, and the estimated coefficient of the class III cities is the lowest, that is, as the city size continues to expand.

The promoting effect of the two control zones policy on the upgrading of industrial structure is gradually increasing. A possible explanation for this is that larger cities are more attractive to industrial agglomeration. At the same time, due to the characteristics of economies of scale in pollution discharge technology, pollution control capacity, and the environmental supervision costs of the public and the government, measures such as pollution prevention and reduction can become the centripetal force of enterprise agglomeration [37,38]. The unit pollution control costs in the agglomeration area are low, and the environmental supervision benefits are high. The factor agglomeration generated by industrial agglomeration promotes technological innovation and industrial structure upgrading. Therefore, cities with high population and economic activities have a more significant industrial upgrading effect due to environmental regulations.

4.4. Regional Heterogeneity Testing

China has a vast territory, and there are significant differences in factor endowments, geographical locations, and economic systems among different regions. Therefore, the impact of the two control zones policy on the upgrading of industrial structure will vary depending on the region. Therefore, this section further examines the regional heterogeneity of the impact of the two control zones policy on industrial structure upgrading. According to the regional division standards of the National Bureau of Statistics, 227 sample cities were divided into eastern, central, western, and northeastern regions according to their respective regions. Among them, 79 cities were in the eastern region, 68 cities were in the central region, 46 cities were in the western region, and 34 cities were in the northeastern region. Regression was conducted on urban sub-samples, and the specific results are shown in Table 5.

Table 5. Regional heterogeneity test.

Variable	Eastern Region		Central Region		Western Region		Northeast Region	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$TCZ{\cdot}post$	0.0961 ***	0.1159 ***	0.1019 ***	0.2236 ***	−0.0819	−0.0771	−0.1353 ***	−0.607 ***
	(6.42)	(6.11)	(13.91)	(8.79)	(−1.08)	(−1.33)	(−8.22)	(−4.79)
Control variable	NO	YES	NO	YES	NO	YES	NO	YES
Urban fixed effects	YES	YES	YES	YES	YES	YES	YES	YES
Time fixed effect	YES	YES	YES	YES	YES	YES	YES	YES
Constant	0.8517 ***	0.1728 ***	0.7532 ***	2.6737 ***	0.8547 ***	1.5573 ***	0.9595 ***	3.6158 ***
	(10.83)	(2.99)	(19.50)	(8.09)	(31.52)	(7.32)	(16.11)	(22.42)
F	41.16	23.56	33.59	23.47	36.91	18.08	17.65	23.87
R^2	0.3688	0.3753	0.3529	0.4205	0.5654	0.4741	0.4854	0.3379

Note: The values in parentheses are *t*-values, and *** represents significant value at 1% confidence level.

From the results of urban grouping, the estimated coefficient of $TCZ{\cdot}post$ for eastern and central cities is positive at a significance level of 1%, indicating that the two control zones policy has a significant promoting effect on the industrial upgrading of eastern and central cities, and the central region is most affected by the environmental policies of the two control zones. The estimated coefficient of $TCZ{\cdot}post$ in the western and northeastern regions is negative, indicating that the two control zones policy has failed to promote the upgrading of the industrial structure of cities in the western and northeastern regions. The possible explanation for this is that cities in the eastern and central regions can quickly adjust their industries and transform towards technology intensive or service industries in the face of strict two control zone policies. Environmental regulations can force technological innovation to guide industrial structure upgrading.

Strict environmental regulation policies have a more effective promoting effect on the upgrading of industrial structure in central cities, because the service-oriented trend of industrial structure in central cities is weaker than that in developed cities in the east. When facing tight environmental regulations, the innovation compensation effect of environmental regulations should have more space to act, and it can promote higher upgrading of industrial structure. The western and northeastern regions are mostly resource-based cities, making it difficult to adjust their industrial structure in the short term in the face of strict environmental regulatory policies. At the same time, the economic development in the western and northeastern regions is relatively backward. Under strict environmental control pressure, enterprises find it difficult to continuously invest in innovation to promote technological upgrading, and the innovation compensation effect has not had a significant effect. Therefore, the policy of the two control zones has not shown a significant impact on promoting industrial structure upgrading.

The impact of environmental regulations on industrial structure upgrading shows significant heterogeneity in different sample regions, and the underlying factors behind this phenomenon may be closely related to technological progress, population structure, and demand structure. Firstly, in terms of technological progress factors, enterprises in the central and eastern regions of China are more engaged in high-tech industries. Faced with strict environmental regulations proposed by the government, high-tech enterprises are more likely to avoid the constraints of environmental regulations through technological upgrading, thereby achieving increased profits and development space, and correspondingly promoting the upgrading of industrial structure. However, enterprises in the western and northeastern regions are more engaged in resource-based enterprises, which face constraints from environmental regulations and find it difficult to improve their technological level in a short period of time. Therefore, environmental regulations have not had a significant impact on the upgrading of the industrial structure in the region in the short term. Secondly, in terms of demographic factors, the central and eastern regions are more likely to attract more young talent due to their economic developmental advantages, while the western and northeastern regions face the problem of talent loss year-round. This factor exacerbates the gap in technological levels between regions, and indirectly leads to significant heterogeneity in environmental regulations for upgrading industrial structures in different regions. Finally, for the demand structure factor, the demand structure has an indirect effect on the upgrading of industrial institutions by influencing the technological progress of enterprises. The demand for high-quality and high-level products in the central and eastern regions has increased due to higher income levels, which has motivated enterprises in the region to improve technological changes and promote the upgrading of industrial structure.

4.5. Counterfactual Testing

In order to test the robustness of the above regression results, it is necessary to conduct a counterfactual test on the net effect of the two control zones policy on industrial structure upgrading, that is, to examine the impact of the two control zones policy on industrial structure upgrading by changing the policy implementation time. If the test results of changing the implementation time of the policy are similar to the regression results of the benchmark model, it indicates that the same conclusion is still obtained in the year or region where the policy was not implemented, indicating that there is no conclusion that the two control zones policy affects the upgrading of industrial structure. Here, the implementation time of the two control zones policy in this article is verified one year, two years, and three years in advance. The specific results are shown in Table 6.

Table 6. Counterfactual test results.

Variable	1995	1996	1997
$TCZ \cdot post$	0.0026 (1.42)	0.0024 (1.51)	0.0166 (0.43)
Control variable	YES	YES	YES
Urban fixed effects	YES	YES	YES
Time fixed effect	YES	YES	YES
Constant	1.1849 *** (9.73)	1.1978 *** (9.52)	1.2116 *** (9.62)
F	8.92	8.61	10.21
R^2	0.4213	0.3756	0.384

Note: The values in parentheses are *t*-values, and *** represents significant value at 1% confidence level.

This paper analyzes the dynamic impact of environmental regulation on the upgrading of urban industrial structure from the perspective of the two control zones policy and through the construction of a DID model. The research results show that the two control zones policy plays a positive role in promoting the upgrading of urban industrial structure. This research conclusion provides empirical evidence for the design of reasonable environmental regulations. However, it is worth noting that the research in this paper is an empirical analysis based on empirical perspectives and does not focus on exploring the mechanism of interaction between variables in theoretical models, which is one of the limitations of this article. In addition, for the industrial upgrading indicator, this article chooses to measure it using the proportion of the service industry, without expanding the indicator to multiple dimensions such as rationalization and upgrading the industrial structure, in order to conduct empirical analysis and provide richer policy insights for policy authorities, which constitutes another limitation of this article. Finally, in terms of empirical methods, our empirical analysis was conducted in a linear econometric model and did not introduce the nonlinear characteristics of the model into the empirical research. In fact, in the economic system, various variables have universal nonlinear characteristics. Although linear econometric models can capture the essential correlation mechanism, they will ignore the nonlinear characteristics between variables, especially the lack of universality in policy recommendations provided by policy authorities. Therefore, we will explore the above issues in future research.

5. Conclusions

After the reform and opening up of China's economy, it has developed rapidly, but the extensive development mode of high consumption, high emissions, and high pollution has led to serious environmental pollution. Environmental governance has become an important issue related to national development. Will the implementation of strict environmental regulations affect economic growth, and more accurately, will it affect China's industrial structure adjustment? The answer to this question not only helps us understand the impact of environmental regulations on economic development, but also provides theoretical support and policy guidance for the implementation of environmental regulation policies and the transformation and upgrading of industrial structure. On the one hand, the improvement of environmental regulations has increased the production costs of enterprises, squeezed out the profit space of enterprises, and is not conducive to their development; on the other hand, the improvement of environmental standards can help stimulate some enterprises' innovative production activities, promote technological upgrading, generate innovation compensation effects, and achieve a win–win situation of environmental improvement and industrial structure upgrading. Based on this, this paper considers the two control zones environmental regulation policy implemented in 1998 as a quasi-natural experiment, builds a DID model by constructing panel data of 227 prefecture-level cities from 1994 to 2010, examines the impact of environmental regulation on the upgrading of urban industrial structure, and tests the heterogeneity of its role at the regional and urban levels.

The main research conclusions of this article:

(1) From a national perspective, the two control zones policy has significantly promoted the upgrading of urban industrial structure. In addition, from the perspective of different control zones, environmental regulatory policies have a positive promoting effect on the upgrading of industrial structure. This means that strict environmental regulations can not only improve the environment, but also help promote the transformation and development of industrial structure, thereby achieving a win–win situation between environmental protection and industrial structure upgrading. This will provide strong evidence for the government to seek a balance between environmental governance and economic development.

(2) The two control zones policy has significant long-term effects in promoting industrial structure upgrading, and their impact on industrial structure upgrading shows fluctuating changes. Therefore, when implementing environmental governance policies, policies should focus on the long-term development interests of the region, handle the contradiction between short-term and long-term benefits, and cannot only focus on immediate interests and ignore sustainable development. Frequent changes in environmental

governance policies will not only contribute to the upgrading effect of industrial structure brought about by the implementation of environmental regulations, but also will cause fluctuations in environmental governance effects and ineffective changes in industrial structure, resulting in the government's policies not achieving the expected results.

(3) The industrial structure upgrading effect of two control zones policy shows significant heterogeneity in different city scales, indicating that in promoting industrial structure adjustment, attention should be paid to the uneven development of different regions. Regional development imbalance is one of the important features of China's economic development structure. Considering the differentiated effects of environmental rules on the regulation of industrial structure in different city sizes, policy authorities should adopt city-specific policies when formulating appropriate environmental policies, so as to ensure that environmental rules play a maximum role in the process of upgrading the industrial structure of each city.

(4) In terms of regions, the two control zones policy has significant spatial heterogeneity. Environmental regulatory policies have significantly promoted the upgrading of industrial structure in cities in the eastern and central regions, but have a restraining effect on the upgrading of industrial structure in cities in the western and northeastern regions. The fundamental reason lies in the uneven development of regions and the varying effects of environmental regulation policies. Therefore, when formulating policies, the country should start from the overall strategy, and when implementing environmental regulation policies, it should be tailored to local conditions. It is not advisable to adopt a comprehensive approach to environmental governance to avoid efficiency losses and resource waste, and it should cooperate with other relevant policies. While committed to economic development, it should also pay attention to balanced development between regions.

The research conclusion of this article supports the applicability of the Porter hypothesis in China. In other words, environmental regulations have a significant reverse effect on the upgrading of China's industrial structure. Strict environmental regulation policies incentivize enterprises to achieve the goal of reducing pollution emissions by encouraging them to increase innovation investment and technology research and development, and thus achieve a national-level industrial structure upgrading strategy. The research results of this article coincide with the current strategy of the Chinese government's high emphasis on green development. The government places more emphasis on environmental protection in the process of economic development, and by designing appropriate environmental regulations to manage enterprise pollution issues, it can also promote the transformation and upgrading of economic structure.

Based on the research findings, we can propose the following policy implications:

(1) From an overall perspective, the two control zones policy has a significant promoting effect on urban industrial upgrading, which also means that the government can achieve the dual policy goals of industrial upgrading and optimizing the environment by designing reasonable environmental regulation policies. Especially as China enters the stage of high-quality development, economic development and environmental protection need to be coordinated and coordinated. A new trend of environmentally friendly and healthy economic development needs to be reconstructed, and the old path of damaging the environment in exchange for economic growth cannot be repeated. Therefore, the two control zones policy is an effective environmental regulation. Although acid rain and sulfur dioxide have been effectively controlled, we can still add new detection targets to the dual control zone policy to further play its positive role.

(2) At the regional level, there is a significant heterogeneity in the impact of the two control zones policy on industrial upgrading. The underlying meaning behind this is that environmental regulation cannot adopt a one size fits all model nationwide, as there are natural differences in natural endowments, economic development levels, and geographical locations among regions. The one size fits all policy will promote the upgrading of industrial structures in some regions while harming the upgrading of industrial structures

in other cities. Therefore, based on the research conclusion, the following measures can be taken: in the central and eastern regions, stricter environmental regulations can be adopted to force their industrial structure to upgrade, while in the western and northeastern regions, relatively mild environmental regulations should be adopted to slowly urge them to adjust their own industrial structure, ultimately achieving nationwide industrial structure upgrading.

(3) From the perspective of long-term and short-term policies, the two control zones policy has a long-term impact on the upgrading of industrial structure, which means that policy authorities need to balance the interests of policies in the long and short term. Specifically, environmental regulatory policies may not have shown a strong promoting effect in the short term, and policy departments should not abandon them outright due to the short-term weak effectiveness of environmental regulatory policies, thereby disrupting market participants' expectations of policies. On the contrary, policy departments should pay attention to the potential long-term effects of environmental regulations, enabling them to play a positive role in an orderly manner, in order to overcome policy myopia.

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