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Assessing the Policy Effects of China's Environmental Governance from the Perspective of Technological Innovation

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Abstract— In the context of addressing global climate change and achieving sustainable development, understanding the mechanisms, conducting comprehensive assessments, and making specific policy improvements in environmental policies have become important research topics. By constructing a Schumpeterian growth framework that incorporates negative environmental externalities, this paper provides a theoretical analysis of how environmental policies impact the level of technological innovation and industrial structural transformation among industries by adjusting the interactions and resource allocations of different sectors. Using the Action Plan for Air Pollution Prevention and Control as a natural experiment, we empirically test the conclusions drawn from the theoretical model. The empirical study reveals that the implementation of the Action Plan has yielded positive results in promoting technological innovation and reducing haze pollution. There is a significant negative correlation between the increase in technological innovation and the decrease in haze pollution levels. Further research indicates that although technological innovation is constrained by the existing industrial structure, an improvement in the level of technological innovation has a positive impact on the rationalization of the industrial structure after the implementation of the Action Plan. Furthermore, the improvement in technological innovation level is significantly and negatively correlated with the decline in haze pollution levels, regardless of whether it is in resource-based cities, non-resource-based cities, key regions, or non-key regions, which further verifies the effectiveness of the Action Plan. This study evaluates the policy effects of environmental governance in China from the perspective of technological innovation and provides specific policy implications. These findings and policy recommendations offer valuable insights for understanding and enhancing environmental governance policies in China.

Index Terms—Difference-in-Differences Method, Endogenous Growth Model, Environmental Governance, Technological Innovation.

I. INTRODUCTION

Environmental issues, including air, water, and soil pollution, have gained global prominence. Among them, the frequent incidence of haze has significantly affected people's health and well-being. To address this challenge, the Chinese government has actively implemented a series of environmental policies aimed at controlling environmental pollution and achieving sustainable development.

The "Action Plan for Air Pollution Prevention and Control" is a pivotal initiative launched by the Chinese government to combat air pollution. The plan was initially introduced in 2013 as the "Ten Measures for Air Pollution Control" and has since undergone multiple revisions and updates. The most recent version, the "Action Plan for Air Pollution Prevention and Control (2018-2020)," was released in 2018 and was scheduled for completion by the end of 2020. The "Action Plan for Air Pollution Prevention and Control" primarily focuses on implementing stringent emission standards and reduction measures, promoting pollution mitigation in high-emission industries, advancing the development of clean energy and low-carbon industries, strengthening coal consumption management and control, endorsing enhanced vehicle emission standards, establishing regional joint prevention and control mechanisms to address cross-boundary pollution, and establishing robust monitoring and evaluation systems to enhance inspection and accountability measures. By implementing the "Action Plan for Air Pollution Prevention and Control," the Chinese government aims to enhance air quality, mitigate the adverse impact of air pollution on public health and the environment, and achieve sustainable development objectives. However, limited research has been conducted thus far to evaluate the plan's effectiveness and its implications for technological innovation and industrial restructuring.

Research in this field has primarily focused on several aspects. Firstly, research has explored the relationship between environmental policies and economic growth. Studies by Acemoglu et al. [1] have focused on the link between environmental policies and technological innovation, proposing a theoretical framework to explain the impact of environmental policies on economic growth. Furthermore, Wang Jun [2] introduced the variable of carbon emission trading system, while Wang Linhui, et al. [3] expanded the scope of environmental technological progress models. Additionally, Zhang Yu and Qian Shuitu [4] incorporated green finance into the theoretical framework of technological innovation bias, providing a more comprehensive understanding of the relationship between environmental policies and technological innovation. Secondly, research has investigated the impact of environmental policies on green innovation. Specifically, studies have shown that policies such as emission trading schemes (Qi Shaozhou, et al.[5]), green credit guidelines (Wang Xin and Wang Ying[6]), new urbanization(Song, et al.[7]), new energy demonstration cities (Li Yuxin, et al.[8]), and low-carbon city pilot policies (Zhang Hailing and Li Manxi [9]) have had a positive impact on green innovation in enterprises. These research findings provide important insights into the relationship between environmental policies and green innovation, serving as a strong reference and empirical support for the formulation of more effective environmental policies. Thirdly, research has focused on the impact of environmental policies on industrial structural transformation. Existing studies have examined the influence on industrial upgrading from perspectives such as environmental regulations (Tong Jian, et al. [10]), local government target constraints (Yu Yongze, et al. [11]), new urbanization (Fan Decheng [12]), carbon emission trading (Liu Manfeng and Cheng Sijia [13]), environmental taxes (Zhan Lei, et al. [14]), and new urbanization (Deng Xiang, et al. [15]). Through these previous studies, we can gain a better understanding of the mechanisms behind environmental policy and provide important references and empirical support for the formulation of more effective environmental policies.

In previous studies, although the relationship between the effects of China's environmental governance policies and technological innovation has been extensively studied, there are still some shortcomings. Most studies focus on the isolated impact of environmental policies on economic growth, green innovation, and industrial structural transformation, without comprehensively analyzing the interrelationships and combined effects among these factors. This study makes significant contributions in several aspects. Firstly, by constructing a Schumpeterian growth framework based on innovation-driven theory, we provide a theoretical analysis of the impact of environmental policies on technological innovation and industrial structural transformation, thus offering essential theoretical support for empirical research. Secondly, we empirically test the policy effects of the Air Pollution Prevention and Control Action Plan from the perspective of technological innovation, providing robust evidence to evaluate the actual effects of China's environmental policies. Finally, this study also explores the impact of environmental policy on technological innovation, presenting a novel perspective for a deeper understanding of the relationship between environmental policy and economic development.

II. THEORETICAL MODEL

The Schumpeterian endogenous growth model (Philippe Aghion and Peter Howitt [16]) emphasizes the influence of institutions and market environment on economic growth and innovation. This model posits that economic growth depends on institutional environment, market structure, and economic organization. It highlights the incentivizing and constraining role of institutional environment on innovation activities, as well as the competitive and innovative dynamics of the market. This aligns with the study's exploration of the impact of environmental policy implementation on technological innovation and the effects of technological innovation changes on environmental quality. Therefore, this study constructs a multi-sector Schumpeterian endogenous growth model incorporating environmental externalities to examine the influence of environmental policy on technological innovation and industrial structural transformation. It also investigates the interaction and resource allocation mechanisms among different sectors affecting technological innovation. Simultaneously, the study explores optimal environmental policy settings to achieve the dual objectives of economic growth and environmental protection.

A. Basic Model Framework

In this study, a comprehensive Schumpeterian growth framework was constructed, including household sector, intermediate goods sector, final goods sector, research and development (R&D) sector, and environmental sector. To ensure logical consistency, the following assumptions and references were employed:

Firstly, for the production function of the goods sectors, we adopted the Dixit-Stiglitz production function as the foundational model. This production function takes into account the impact of market competition and product differentiation on production efficiency. Secondly, we referred to the work of Aghion and Howitt (2009) to establish the R&D sector. This setup involves crucial elements such as R&D inputs and innovation outputs to reflect the contribution of the R&D sector to economic growth. The production functions for the household sector and the environmental sector were based on conventional economic literature. These assumptions encompass factors such as household consumption, labor supply, resource utilization, and environmental impacts within the environmental sector.

By integrating these production functions across sectors, we were able to simulate and analyze the interactions and influences among different sectors, as well as the effects of policy measures on economic growth and sustainable development. This comprehensive framework provides a more complete and accurate perspective, facilitating in-depth exploration of the relationship between economic growth and environmental impacts.

B. Steady-State Analysis and Optimization

1 Growth rate of technological progress in the industry:

$$g_{it} = \sigma^{\frac{\sigma}{1-\sigma}} (1-\alpha)^{\frac{\sigma}{1-\sigma}} \alpha^{\frac{(1+\alpha)\alpha}{(1-\alpha)(1-\sigma)}} (1-\tau_{it})^{\frac{\sigma}{(1-\alpha)(1-\sigma)}} \lambda_i^{\frac{1}{1-\sigma}} (\gamma_i - 1) \quad (2.1)$$

2 Output structure of any two industries:

$$\frac{Y_{it}}{Y_{kt}}=\left(\frac{1-\tau_{it}}{1-\tau_{kt}}\right)^{\frac{\alpha}{1-\alpha}}\frac{L_{it}A_{it}}{L_{kt}A_{kt}} \tag{2.2}$$

3 Product prices and labor changes in any two industries:

$$\frac{\dot{P}_{it}}{P_{it}}-\frac{\dot{P}_{kt}}{P_{kt}}=\Delta+\frac{\dot{A}_{kt}}{A_{kt}}-\frac{\dot{A}_{it}}{A_{it}}=\left(\frac{\dot{\tau}_{it}}{1-\tau_{it}}-\frac{\dot{\tau}_{kt}}{1-\tau_{kt}}\right)^{\frac{\alpha}{1-\alpha}}+g_{kt}-g_{it} \tag{2.3}$$

$$\frac{\dot{L}_{it}}{L_{it}}-\frac{\dot{L}_{kt}}{L_{kt}}=(\varepsilon-1)\left(\frac{\dot{\tau}_{it}}{1-\tau_{it}}-\frac{\dot{\tau}_{kt}}{1-\tau_{kt}}\right)^{\frac{\alpha}{1-\alpha}}+(\varepsilon-1)(g_{it}-g_{kt}) \tag{2.4}$$

4 Output shares of any two industries:

$$\frac{P_{it}Y_{it}}{\sum_{i=1}^{n}P_{it}Y_{it}}=d_{it}=\frac{L_{it}}{L_t}=\frac{A_{it}^{\varepsilon-1}\phi_i^{\varepsilon}(1-\tau_{kt})^{\frac{\alpha(\varepsilon-1)}{1-\alpha}}}{\sum_{i=1}^{n}A_{it}^{\varepsilon-1}\phi_i^{\varepsilon}(1-\tau_{it})^{\frac{\alpha(\varepsilon-1)}{1-\alpha}}} \tag{2.5}$$

Based on the analysis above, it can be understood that the intensity of environmental governance within industries can influence the rate of technological progress within those industries. The relative prices of products in the industry are determined by the relationship between the growth rate of technological progress among industries and the government's varying intensity of environmental governance across different industries. The rate of labor change and output shares among industries depend on the changes in the government's environmental governance intensity across industries and the growth rate of technological progress among industries. *Therefore, the government can promote technological innovation and facilitate the rationalization of industrial structure by implementing appropriate environmental governance policies.*

5 Shadow Prices of Optimal Environmental Tax and Research and Development (R&D) Subsidies:

$$\tau_{it}=\frac{\xi_i}{\widehat{p}_{it}}\sum_{v=t+i}^{\infty}\frac{(1+\delta)^{v-t-1}}{(1+\rho)^{v-2t}}\frac{\partial u(C_v,S_v)/\partial S_v}{\partial u(C_t,S_t)/\partial C_t} \tag{2.6}$$

$$\widehat{S}_{it}=\frac{(\gamma_i-1)\mu_{it}^{*}+1}{1+\rho}\frac{\zeta_{it+1}}{\lambda_{it}} \tag{2.7}$$

Taking into account the analysis above, the following conclusions can be drawn: *The government can promote environmental quality improvement, maximize social welfare, and achieve sustainable development by implementing appropriate environmental policies.* The specific mathematical symbols can be found in Table 1.

III. RESEARCH DESIGN

Based on the analysis of the theoretical model, this study concludes that the output shares among industries are influenced by changes in the government's environmental governance intensity across industries and the growth rate of technological progress among industries. Additionally, the intensity of environmental governance within industries can impact the rate of technological progress within those industries. Consequently, the government can promote technological innovation, facilitate the rationalization of industrial structure, and improve environmental quality by implementing appropriate environmental governance measures. Next, this study will empirically examine the specific effects and underlying mechanisms of the implementation of the "Action Plan for Air Pollution Prevention and Control" on haze pollution.

A. Sample Selection and Data Sources

This study selects a sample of 280 cities in China from 2003 to 2020. The PM2.5 data is compiled and calculated based on the global annual average concentration data of PM2.5 provided by the Center for International Earth Science Information Network (CIESIN) at Columbia University. The patent data at the city level is sourced from the State Intellectual Property Office. The remaining data for other variables are obtained from the China Research Network and the China City Statistical Yearbook.

B. Model and Variable Explanation

1. Technological Innovation Level (TI)

This study considers the number of patent applications as a proxy variable for technological innovation. The number of patent applications reflects the quantity of new inventions filed by enterprises or individuals within a specific period. A higher number of patent applications generally indicates more active technological innovation activities and achievements. Model (3.1) examines the impact of the implementation of the "Action Plan for Air Pollution Prevention and Control" on technological innovation (TI). Since the "Action Plan" was implemented starting from September 10, 2013, considering policy lags, the year 2014 is taken as the policy shock point. Thus, a binary variable, post, is set to 1 for the years 2014 and onwards, and 0 otherwise.

Table.1 Mathematical Symbols Explanation

Symbol	Explanation
C_t	Resident's final product consumption
S_t	Environmental quality
ρ	Discount rate
Y_t	Quantity of production in the general product sector
Y_{it}	Quantity of production in the industry's final product sector
P_t	Price of general products sector
P_{it}	Price of industry's final products
ε	Substitution elasticity between industry's final products
L_{it}	Labor force quantity
A_{it}	Technological innovation level
A_{it}^{*}	Technological innovation goals
x_{it}	Quantity of intermediate inputs
μ_{it}	Success rate of technological research and development
R_{it}	Investment in research and development
λ_i	Efficiency of research and development investment
δ	Environmental self-purification rate
ξ_i	Pollution emission coefficient
γ_i	Degree of technological level improvement
τ_{it}	Intensity of environmental governance
λ_t	Shadow price of consumption
λ_{it}	Shadow price of final product sector
$\widehat{P}_{it}$	Relative price of industry's final product sector
ζ_{it}	Shadow price of technological innovation
$\widehat{s}_{it}$	Subsidy intensity

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Additionally, control variables such as per capita GDP, FDI, human capital, population size, financial development, and industrial structure are selected.

$$TI_{it} = \alpha_0 + \alpha_1 post + \alpha_2 gdp + \alpha_3 fdi + \alpha_4 hc + \alpha_5 pop + \alpha_6 fin + \alpha_7 indu + \varepsilon_{it} \quad (3.1)$$

2. Air Pollution (PM2.5)

The empirical section of this study focuses on examining the impact of the "Action Plan" on haze pollution from the perspective of technological innovation. Model (3.2) is employed to empirically analyze the effect of the "Action Plan" on haze pollution, taking into account the factors of technological innovation. In the model, in addition to controlling for variables such as the first order and second-order terms of per capita GDP, human capital, population size, and financial development, it also includes city fixed effects and time fixed effects.

$$PM2.5_{it} = \alpha_0 + \alpha_1 \Delta TI + \alpha_2 \Delta TI * post + control + u_i + \lambda_t + \varepsilon_{it} \quad (3.2)$$

3. Industrial Structure Rationalization (theil_indu)

In order to investigate the mechanism through which the "Action Plan" affects haze pollution from the perspective of technological innovation, we select the rationalization of industrial structure as an empirical indicator. The aim is to delve into the impact mechanism of the "Action Plan" on promoting technological innovation and haze pollution control. Firstly, following the approach of Gan et al. [17], we use Model (3.3) to calculate the Theil index of industrial structure, which is used to assess the rationality of regional industrial structure. The Theil index of industrial structure reflects the distribution of the proportion of each industry in the overall industrial structure, ranging from 0 to 1. A value closer to 1 indicates a more imbalanced industrial structure, while a value closer to 0 indicates a more balanced industrial structure.

Table. 2 Variable Explanations

Variable		Explanation
Dependent Variable	PM2.5	Degree of Air Pollution: Logarithm of annual average PM2.5 concentration.
	TI	Technological Innovation: Logarithm of the number of patent applications plus one.
	theil_indu	Industrial Structure Rationalization: Calculated based on formula (3.3).
Explanatory Variable	ΔTI	Degree of Technological Innovation Improvement: Difference in technological innovation level before and after 2014 for each region.
	post	Before and After Implementation of "Action Plan": Assigned a value of 1 for the period after implementation and 0 otherwise.
Control Variables	gdp	Level of Economic Development: Logarithm of regional GDP divided by total population at the end of the year.
	hc	Human Capital: Number of students in regular higher education institutions divided by total population at the end of the year.
	pop	Population Size: Logarithm of total population at the end of the year.
	fin	Financial Development: Ratio of year-end financial institution loans and deposits to regional GDP.
	indu	Industrial Structure Upgrading: Ratio of value added in the tertiary sector to value added in the secondary sector.
Grouping Variables	area	Regional Classification: Eastern region assigned a value of 1, central region assigned a value of 2, and western region assigned a value of 3.
	res	Resource-based City: Assigned a value of 1 for resource-based cities and 0 for non-resource-based cities.
	unit	Key Areas for Air Pollution Control: Indicator variable taking the value 1 for key control areas and 0 for non-key areas.

Based on the computed Theil index of industrial structure, we then employ Model (3.4) to study the impact mechanism of the "Action Plan" on haze pollution from the perspective of technological innovation. In the model, we take into account other control variables such as the first order and second-order terms of per capita GDP, human capital, population size, financial development, as well as city fixed effects and year fixed effects, to ensure the accuracy and reliability of the research results.

$$theil\_indu_{it} = \sum_{m=1}^{3}\left(\frac{Y_{imt}}{Y_{it}}\right)\ln\left(\frac{Y_{imt}}{L_{imt}} / \frac{Y_{it}}{L_{it}}\right) \quad (3.3)$$

$$theil\_indu_{it} = \alpha_0 + \alpha_1 \Delta TI + \alpha_2 \Delta TI * post + control + u_i + \lambda_t + \varepsilon_{it} \quad (3.4)$$

4. Other Variables

The meanings and descriptive statistics of the other variables are presented in Table. 2.

IV. EMPIRICAL RESULTS

A. The "Action Plan" and Technological Innovation

Based on Fig. 1, it can be observed that after 2014, there was a significant decrease in haze pollution levels, accompanied by a steady increase in the level of technological innovation. This preliminary observation suggests that the implementation of the "Action Plan" has played a positive role in promoting technological innovation and improving haze pollution.

B. "Action Plan" and Haze Pollution

Table. 3 reports the impact of the increase in regional technological innovation on haze pollution after the implementation of the "Action Plan." The study findings indicate that, regardless of whether it is the entire sample, the eastern, central, or western regions, the regression coefficients of the main explanatory variable ΔTI*post are all significantly negative. This indicates that regions with a higher level of technological innovation experience a greater reduction in haze pollution after the implementation of the "Action Plan." Furthermore, the regression coefficient of the explanatory variable ΔTI is also significantly negative, where ΔTI represents the degree of improvement in regional technological innovation after the implementation of the "Action Plan." It can be inferred that regions with relatively low levels of technological innovation before the implementation of the "Action Plan" may have higher levels of haze pollution. Therefore, after the implementation of the "Action Plan," regions with a higher degree of improvement in technological innovation also experience a greater reduction in haze pollution. The subsequent analysis of mechanisms, robustness tests, and heterogeneity analysis all control for control variables, city fixed effects, and year fixed effects. To save space, only the regression results for the core explanatory variables are reported.

C. Rationalization of Industrial Structure

Table. 4 depicts the impact of the increase in regional technological innovation on the rationalization of the industrial structure after the implementation of the "Action Plan." The research findings show that in the entire sample, as well as in the central and western regions, the regression coefficients of the main explanatory variable ΔTI*post exhibit a significant positive relationship, while the relationship in the eastern region is not significant. This indicates that regions with a higher level of technological innovation tend to have a more rationalized industrial structure after the implementation of the "Action Plan." The regression coefficient of the explanatory variable ΔTI is significantly negative. This may be due to the protection and maintenance of existing industrial structures as technological levels improves, which limits the development of emerging industries.

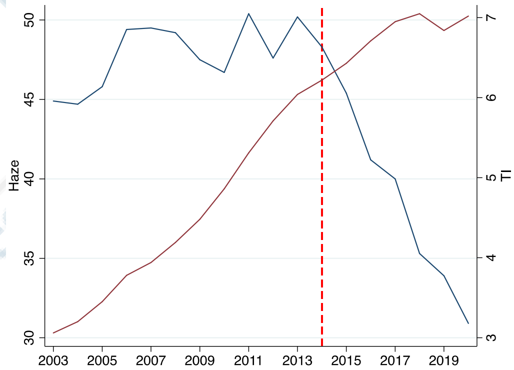

Fig. 1 Trend of PM2.5 Pollution and Technological Innovation

Table. 3 The regression results for haze pollution

VARIABLES	Haze pollution			
	Overall	Eastern region	Central region	Western region
ΔTI	-0.0156***	-0.0156***	-0.00971**	-0.0207***
	(0.00219)	(0.00219)	(0.00392)	(0.00360)
ΔTI*post	-0.0130***	-0.0130***	-0.0320***	-0.0158**
	(0.00429)	(0.00429)	(0.00853)	(0.00711)
Control Variables	YES			
City Fixed Effects	YES			
Year Fixed Effects	YES			
Constant	4.462***	4.765***	4.975***	3.587***
	(0.206)	(0.409)	(0.519)	(0.348)
Observations	5,030	1,800	1,780	1,450
R-squared	0.775	0.839	0.770	0.792

Note: ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively. They will not be reiterated in the following text.

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Table. 4 Mechanism

	Rationalization of Industrial Structure			
VARIABLES	Overall	Eastern region	Central region	Western region
△TI	-0.00758***	-0.000853	-0.00184	-0.0138***
	(0.00260)	(0.00479)	(0.00392)	(0.00531)
△TI*post	0.0126**	0.0160	0.0352***	0.0214**
	(0.00509)	(0.0105)	(0.00776)	(0.00945)

Table. 5 Robustness test

	Haze pollution			
VARIABLES	scientific investment	did1	did2	did1 and did2
△TI	-0.00982***	-0.0175***	-0.0170***	-0.0176***
	(0.00299)	(0.00220)	(0.00218)	(0.00219)
△TI*post	-0.00925**	-0.0103**	-0.00806*	-0.00756*
	(0.00420)	(0.00429)	(0.00428)	(0.00429)
did1		-0.0291***		-0.0127**
		(0.00441)		(0.00494)
did2			-0.0628***	-0.0540***
			(0.00663)	(0.00746)

Table. 6 Heterogeneity analysis

	Haze pollution			
VARIABLES	resource-based	non-resource-based	key regions	non-key regions
△TI	-0.0117***	-0.0180***	-0.0218***	-0.0111***
	(0.00327)	(0.00296)	(0.00385)	(0.00269)
△TI*post	-0.00746	-0.0148***	-0.0169**	-0.0121**
	(0.00649)	(0.00568)	(0.00767)	(0.00512)

However, based on the regression coefficients of ΔTI*post and ΔTI, it can be observed that regions with a greater increase in technological innovation levels exhibit a significantly higher level of promotion in industrial structure rationalization compared to the adverse effects of technological innovation on industrial structure rationalization.

D. Robustness test

We have further explored the robustness of the benchmark regression results by replacing the core explanatory variable with research and development (R&D) expenditure as a proxy for technological innovation. From the regression results in the first column of Table 5, we can observe that the signs and significance of the core explanatory variable and control variables remain largely consistent, thereby strengthening our confidence in the reliability of the benchmark regression results. To control for the influence of other policies, we include controls for the "Low-carbon City Pilot" policy (did1) and the "Carbon Emission Trading" (did2) policy on haze pollution. From the reported results in Table 5, it can be observed that ΔTI*post is consistently significant and negative, further confirming the robustness of the findings in this study. Additionally, the coefficients for the "Low-carbon City Pilot" policy (did1) and the "Carbon Emission Trading" policy (did2) are also significant and negative, indicating that these policies have significantly reduced the level of haze pollution in cities.

E. Analysis of heterogeneity

By further categorizing cities into resource-based and non-resource-based cities, as well as distinguishing between the designated key regions (coordinated prevention and control areas) and non-key regions in the Action Plan, we observed the following results.

From Table. 6, it can be observed that, except for resource-based cities, both non-resource-based cities and designated key regions show significantly negative coefficients for the regression of ΔTI*post. This indicates that after the implementation of the Action Plan, the increase in regional technological innovation is significantly negatively correlated with the level of local haze pollution. However, for resource-based cities, the correlation between technological innovation and haze pollution is not significant. There could be two possible reasons for this: Firstly, resource-based cities often rely on traditional industrial structures that have a higher association with air pollution. Even with an improvement in technological innovation, the influence of the traditional industrial structure remains, leading to a lack of significant reduction in haze pollution levels. Secondly, resource-based cities may lag in technological innovation and its application, particularly in environmental protection and air pollution control. Despite some technological innovation, the slow adoption and application of these technologies result in a lack of significant short-term reduction in haze pollution levels. Additionally, for both resource-based and non-resource-based cities, as well as key and non-key regions, the regression coefficients of the explanatory variable ΔTI are significantly negative, further confirming the effectiveness of the Action Plan.

V. CONCLUSION AND POLICY IMPLICATIONS

Environmental issues have become a global focus. Severe environmental pollution, especially air pollution and haze, have had a significant impact on people's health and quality of life. To address this problem, the Chinese government has taken active environmental governance measures and implemented a series of environmental policies, including the Action Plan for Air Pollution Prevention and Control. Based on the theoretical analysis and empirical research results of this study, we propose the following policy insights:

First, the government should emphasize coordinating cooperation and resource allocation among different departments to promote the development of technological innovation and the transformation of industrial structure. Interdepartmental collaboration is a key factor in driving environmentally friendly technological innovation. Second, the government can provide more research and development subsidies and support to incentivize enterprises and research institutions to increase investment in environmentally friendly technology research and development. Third, the government should strengthen the construction of monitoring and evaluation systems and establish effective inspection and accountability mechanisms. Fourth, the government should further promote the development of clean energy and low-carbon industries, accelerating the transformation and upgrading of the industrial structure.

In summary, the results of this study demonstrate that through policy measures such as coordinating resource allocation, providing research and development support, strengthening monitoring and evaluation, and promoting the transformation of the industrial structure, the Chinese government can effectively address environmental issues, promote technological innovation, and achieve the dual goals of economic growth and environmental protection. These policy insights provide important references and guidance for China's future environmental governance.

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