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Environmental Effects of City–County Mergers in China: Strengthening Governance or Aggravating Pollution?

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Abstract: Green and high-quality development is the focus of China's urban development strategy in the new era. The city–county merger policy has been one of several powerful tools used by the Chinese government to promote urbanization in recent decades, but whether and how it influences the environment has been rarely discussed. Using the multi-period difference-in-differences method and urban panel datasets, we investigated the environmental effects of the city–county merger policy in China from 2000–2016 and obtained the following results. First, the city–county mergers significantly reduce the environmental pollution of merged cities. The robustness tests support this conclusion. Second, the effects of city–county mergers on environmental pollution control decrease with the increase in geographical distance between the merged cities and counties; the smaller the differences in economic strength of merged cities and counties, the better the coordinated control of environmental pollution; the environmental governance effects of merged cities in the eastern region are lower than those in the central and western regions. Third, by intensifying the vertical management of urban environmental protection agencies, unified urban planning and fiscal centralization, the city–county mergers can strengthen the overall environmental governance capabilities of merged cities, reduce the negative effects of urbanization, and ultimately improve the environmental quality.

Keywords: city–county merger; multi-period difference-in-differences method; environmental pollution

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1. Introduction

Over the past 40 years of the opening up and reform of China, environmental pollution has become increasingly serious with the rapid development of urbanization and industrialization. The 2020 Global Environmental Performance Index evaluation results show that China ranks 120th out of 180 cities and regions. Although many indicators have been improved, there is still great pressure on environmental governance. Environmental pollution not only seriously endangers the health of residents, but it also affects the sustainable development of cities. According to the estimates of the World Bank, the Chinese Academy of Sciences, and the State Environmental Protection Administration, China's annual losses due to environmental pollution account for about 10% of GDP. How to achieve a win–win solution for both economic development and ecological environment protection is the key challenge in achieving green and high-quality development of Chinese cities. Therefore, clarifying the relationship between urban development and environmental pollution and exploring the effective treatment of urban environmental pollution are not only important topics of environmental research, but they are also key to the government's formulation of environmental policies.

China's environmental issues are inseparable from the development of urbanization. According to the China Bureau of Statistics, China's urbanization rate has increased from 17.9% in 1978 to 60.6% in 2019. Rapid urbanization is accompanied by increasing

environmental pollution; however, research conclusions on the relationship between urbanization and environmental pollution are inconsistent. There are three main viewpoints: (1) Urbanization has exacerbated environmental pollution. Zhao and Xu [1] believe that transportation, industry, and energy production may have negative effects on the environment in the process of urbanization. Wang et al. [2] found that urbanization not only increases haze concentrations in the region, but it also has a spillover effect on neighbouring areas. (2) Urbanization helps to reduce environmental pollution. Satterthwaite's research on developing countries found that environmental pollution is alleviated as cities expand [3]. Shao et al. [4] argue that with the promotion of urbanization and the improvement of living standards, people's requirements for environmental quality increase and influence the government's environmental regulations and enterprises' production and emission behaviors through consumption preferences and public opinion pressures, thereby mitigating damage to the environment. (3) There is a non-linear relationship between urbanization and environmental pollution. Martínez-Zarzoso and Maruotti [5] used dynamic panel data to conduct research that found an inverted U-shaped relationship between urbanization and carbon dioxide emissions. Jiao [6] studied emerging economies and found that the urbanization rate of countries with low populations has a positive linear relationship with environmental pollution, that medium-sized countries have a U-shaped relationship, and that populous countries have an inverted U-shaped relationship. Although the existing literature has analyzed the environmental effects of urbanization from different perspectives, they have mostly been based on market-led urbanization research, with less attention having been paid to the impact of government-led urbanization on the environment. In fact, different urbanization development paths may have a great impact on the urban environment and urban environmental governance.

Unlike many countries that mainly promote urbanization through industrialization and marketization, China's urbanization is dominated by the government, and the adjustment of administrative divisions is the main way by which they promote urbanization. Since the 1990s, city–county mergers have been the most representative way of adjusting administrative divisions in China. The city–county merger policy transforms these counties which give priority to agriculture development into municipal districts with a focus on urban management through the administrative force of the government (more details in Section 2).This adjustment has led to rapid expansion of the urban population and land area, which is in line with the urbanization development strategy. At the same time, after the county became a municipal district, administrative power was shifted to the prefecture-level city government, which undoubtedly helped to enhance its administrative jurisdiction. As a result, the city–county mergers have become the main means for the expansion of large cities in China [7]. A large number of cities have promoted urbanization through the city–county merger policy, the impact of which has become the focus of research, mainly concentrating on the economic growth effects of the policy [8–10], the impact on urbanization [11,12], the adjustment of government functions [13], and the reconstruction of urban space [14,15], etc. However, few studies have examined the impact of the city–county merger policy on environment. Li et al. [16] found that the city–county merger policy is conducive to reducing energy use intensity through regional integration and agglomeration effects [16]. Chen and Jin [17] empirically analyzed the impact of the city–county merger policy on the pollutant discharge behavior of enterprises and believed that the stricter the urban environmental regulation, the better the effect of policy on the emission reduction of enterprises. Cai [18] believed that the city–county merger promoted market integration between districts and counties, and the agglomeration economy formed after the merger was conducive to realizing the scale effect of emission reduction. In addition, from the perspective of administrative division adjustment, Zhang [19] analyzed the environmental effects of Province-managing-county reform and concluded that the reform reduced haze pollution by reducing the scale effect, optimizing the structure effect and enhancing the technology effect. Xu et al. [20] explored the impact of government resident relocation on enterprise pollution emissions and found that the relocation pro-

cess has a pollution concomitant effect, but this effect decreases gradually with distance. Compared with the indirect environmental effects of research policies, researchers have paid more attention to the direct effects of various environmental governance measures. For example, these include the governance effects of environmental regulatory tools, such as energy trading policies [21], environmental protection legislation [22], and the central environmental inspection system [23], as well as the environmental governance effects of different urban development concepts, such as low-carbon city construction [24], smart city construction [25], and collaborative regional development [26]. With the increased emphasis on air quality in China, air pollution control has attracted attention. Gao et al. [27] analyzed the effects of air pollution control policies in the Chengdu-Chongqing region in China. Tan et al. [28] explored the effect of agglomeration externalities on air pollution, arguing that promoting industrial agglomeration to a mature stage can reduce air pollution. Wang and Lee [29] found that flexible and reginal-targeted strategies adapted to local situations are more conducive to air pollution control compared with unified actions. These studies have extended our research ideas from different perspectives. As an important way for the Chinese government to lead urbanization, the city–county merger policy has a significant impact on the green and high-quality development of cities. Whether the policy has increased environmental pollution or improved environmental quality, what the mechanisms of influence are, and whether there are differences between cities remain to be tested empirically, which is the core motivation of this paper. The exploration of these questions will provide empirical evidence for the Chinese government to optimize the city–county policy and improve the efficiency of environmental governance.

Based on these factors, this study collected urban panel data from 263 Chinese cities from 2000–2016 to empirically analyze the environmental effects of city–county mergers. The marginal contribution of this study may be reflected in the following three ways. First, although much of the recent research has explored the relationship between urbanization and environment, few studies have focused on the environmental effects of government-led urbanization. As a representative policy of Chinese government-led urbanization, city–county mergers provide an ideal quasi-natural experiment for studying the environmental effects of government-led urbanization. Therefore, this study is a useful supplement and expansion of the literature in this field. Second, most studies focused on the impact of the city–county merger policy on economic growth, with less attention paid to the impact on the environment. We provide empirical evidence for evaluating the environmental effects of city–county mergers, which is conducive to expand the existing research results. Third, the evaluation of the policy effect often faces problems of endogeneity and non-random sample allocation. This paper adopts the difference-in-differences (DID) method to evaluate the environmental effects of the city–county merger policy, using a variety of methods to conduct tests of robustness, effectively solving the endogenous problems of empirical research and ensuring the reliability of the estimated results.

The remainder of this paper is organized as follows: Section 2 introduces the background and theoretical mechanisms of city–county mergers on the environment; Section 3 presents the econometric methods and a description of the relevant data; Section 4 gives the main empirical results and robustness tests; Section 5 discusses the heterogeneity of the data; Section 6 analyzes the mechanism of city–county mergers to strengthen environmental governance; finally, Section 7 draws conclusions and policy implications.

2. Institutional Background and Theoretical Analysis

2.1. Institutional Background

After the reform and opening up, China has gradually promoted its urbanization development strategy. Increasing the number of cities and expanding the scale of cities through the adjustment of administrative divisions are the main ways for the government to promote urbanization. In the 1980s, China's urbanization development strategy focused on increasing the number of cities. Under the guidance of the policy of "strictly controlling the scale of large cities, reasonably developing medium-sized cities, and actively developing

small cities", county-to-city upgrading became the main way of adjusting administrative divisions at that time, as this could increase the number of small cities. Although many small cities were newly established, the policy did not bring about rapid urban development [30], and furthermore, pseudo-urbanization and inefficient urban sprawl occurred, which prompted the central government to urgently stop the county-to-city upgrading policy in 1997. In the late 1990s, China's urbanization development strategy shifted from increasing the number of cities to expanding the scale of cities, giving full play to the agglomeration and scale effects of large and medium cities. The city–county merger policy has replaced the county-to-city upgrading policy as the main way of government-led urbanization. City–county mergers can expand the scale of the city, increase the influence of central cities, and create the possibility of back-feeding the surrounding areas based on the diffusion effect. Therefore, it quickly became the first choice for the urban expansion of prefecture-level cities [31]. From 1978 to 2018, 271 counties and 162 prefecture-level cities in China participated in city–county mergers, accounting for 55.29% of prefecture-level cities, with many cities still awaiting approval. Figure 1 shows the changes in the number of city–county mergers, counties, and municipal districts in China. From 1978 to 2018, with the adjustment of county-to-city upgrading and city–county mergers, the number of counties in China decreased by 698, while the number of districts increased by 565. There were two peaks in the process of city–county merger adjustment. During the first peak of 2000–2004, many cities expanded their urban areas through city–county mergers. In 2002 alone, 22 prefecture-level cities and 27 counties participated in this adjustment. In order to control the unchecked growth in the number of municipal districts and prevent the spread of false urbanization, central government suspended approval of city–county mergers. In the following years, the growth rate of city–county mergers slowed down. In order to promote the development of urbanization, central government liberalized approval in 2011, leading to the second peak period for mergers. Some cities even merged several times during a single year. For example, in 2016, Zhangjiakou City in Hebei Province merged Xuanhua County, Wanquan County, and Chongli County. Through city–county mergers, prefecture-level cities have greatly improved in terms of urbanization, urban development space, and administrative power.

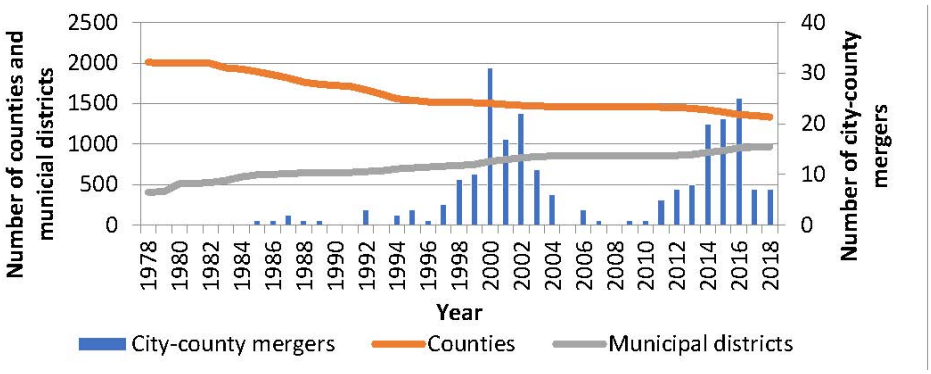

Figure 1. Number of counties, municipal districts, and city–county mergers from 1978 to 2018.

China's urban governance has distinct administrative hierarchical characteristics. The higher the administrative hierarchy, the more administrative power and resources it obtains. China's administrative regions are divided vertically into province, prefecture-level city, county, and township. Municipal districts can be established in large prefecture-level cities, according to the "Standards for the Establishment of Municipal Districts." Although both counties and municipal districts are subordinate to prefecture-level cities, they have significant differences in functional authority and urban development functions. It can be seen from Table 1 that the county has relatively independent socio-economic management authority, financial power, institutions and can make independent arrangements for county development planning. Since the county focuses on agricultural development and has a

large proportion of the rural population, its level of urbanization is relatively low. With independent administrative and financial power, the county government can make decisions on industrial structure, attracting investment and environmental management. In comparison, the financial and administrative powers of the municipal district government are coordinated and managed by the prefecture-level city government. The municipal district focuses on urban planning and construction, with a predominantly urban population and a high level of urbanization. Therefore, with the transformation of counties into municipal districts of prefecture-level cities after merger, the administrative powers of prefecture-level cities have been expanded, which not only helps to reduce the administrative coordination costs of the cities, but also facilitates the unified implementation of public policies.

Table 1. Comparison between the county and municipal district.

Major Differences	County	Municipal District
Function focus	Agriculture development	Urban planning and construction
Functional institutions Independence	Independent	Prefecture-level city government vertical management
Socio-economic management authority	Independent	Unified management of prefecture-level city government
Financial authority	Independent	Unified management of prefecture-level city government
Urbanization level	low	high

2.2. Theoretical Analysis

To date, although many cities have undergone city–county mergers, it is not yet clear what impact this policy will have on the environment. The city–county merger policy has two distinctive features: the promotion of urbanization and the concentration of power, both of which have an impact on the urban environment. Urbanization is the only way for China to move towards modernization. As an important means for China to promote the development of urbanization, the city–county merger policy does play a significant role in promoting urban economic development, upgrading urbanization, and improving people's livelihoods [32,33], Urbanization generates knowledge spillover through the agglomeration of production factors [34], which is conducive to the improvement of both production and emission reduction technologies, thereby reducing the generation and emission of pollutants [35]. Through the city–county mergers, the prefecture-level cities have expanded their urban scale, promoted market integration and economic agglomeration, and helped to promote the agglomeration of the urban population [36], which has a scale effect on urban pollution discharge, thus reducing per capita discharge [37]. However, at the same time, a series of negative effects brought about by urbanization are also inevitable. Urbanization threatens the urban ecological environment through population agglomeration, industrial production, and transportation [38–40]. Through the analysis of 74 cities in China, Wang et al. found that the rapid advancement of industrialization and urbanization led to the continuous development of heavy industry and the increase of population density, resulting in a significant decline in urban ambient air quality [41]. Chen et al. [42] found that the urban sprawl has significantly increased urban industrial and domestic pollution. The population, total industrial output value, and sulfur dioxide emissions brought about by urban development will increase the concentration of $PM_{2.5}$ [43].

Based on the above analysis, as an important means of promoting urbanization, the city–county merger policy has both positive and negative impacts on the environment. However, unlike market-led urbanization, the city–county merger is led by the government, so its advantages and disadvantages to the urban environment depend more on the government's urban governance capabilities. A problem that cannot be ignored in China's environmental governance is the difficulty of coordinated regional environmental governance. China's urban management takes administrative divisions as the boundary, which means different cities in different administrative regions focus on their own affairs, and it is difficult to manage regional environmental problems together. As a public good, the environment has externalities. When coordination is insufficient, decentralization will

aggravate the problem of environmental pollution [44,45]. Only by increasing environmental jurisdiction can the environmental regulatory measures of prefecture-level cities be fully effective. The process of the city–county merger is also a process of power reorganization. Under China's administrative system, the county has a certain independent right to independently develop the county economy and conduct urban planning and environmental governance. However, under the GDP-oriented performance evaluation system, the local government's emphasis on the economy at the expense of environmental protection has made the enforcement of environmental laws and regulations the weakest link in environmental protection [46]. Through city–county mergers, county-level power is shifted to prefecture-level city governments; the concentration of power is more conducive to prefecture-level city governments' vertical management of the environment and the implementation of environmental protection policies. Through general urban planning, urban and rural areas will be further integrated, and rural production, lifestyle changes, and residents' awareness of environmental protection all will increase. Fiscal centralization is conducive to increasing investment in infrastructure construction and governance expenditure for the environment, reducing pollution emissions, promoting coordinated governance of environmental pollution, reducing the negative impact of urbanization, and finally, improving the urban environment.

From the above analysis, it can be seen that the environmental effects of the city–county mergers are due to two factors (Figure 2). On the one hand, the development of urbanization will have an impact on the environment, and on the other hand, the increase in power will produce an effect on environmental governance. The effect that city–county mergers will have on the environment ultimately depends on the contest between these two forces. If the governance capacity of the prefecture-level city is enhanced after the merger, it will have a positive impact on the environment; if not, environmental pollution will continue to increase. Based on the above analysis, the empirical part of this paper will further study the environmental effects of the city–county merger policy, analyzing the heterogeneity of different cities and how to strengthen urban environmental governance through centralization.

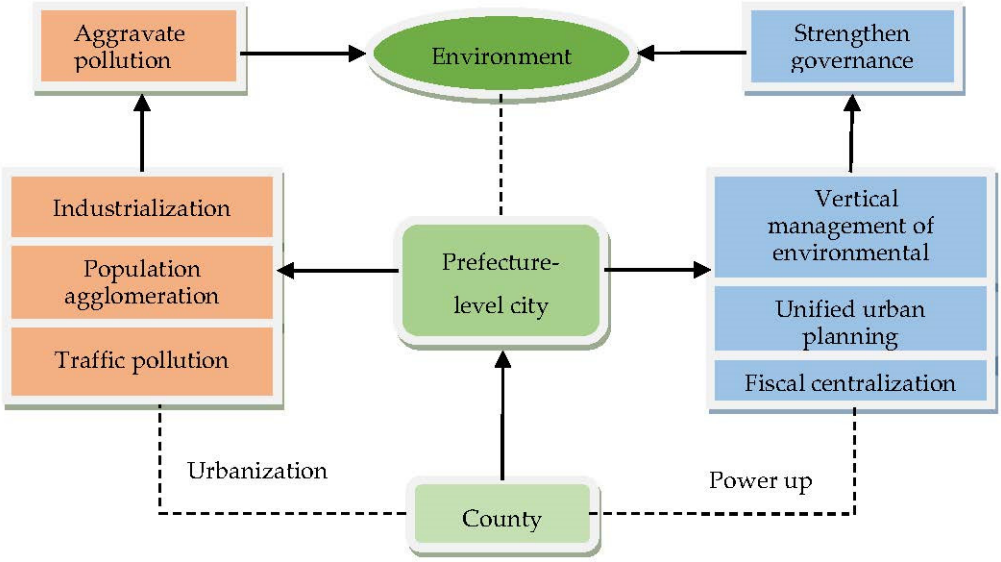

Figure 2. Mechanism for the city–county merger to affect the environment.

3. Measurement Model and Index Description

3.1. Measurement Model Setting

This paper examines the effects of the city–county merger policy on the environment. A direct comparison of the differences between the merged cities and the unmerged cities may lead to inaccurate conclusions. Other policies issued during the same period may also have an impact on the environment, so we use the difference-in-differences (DID)

model, which is commonly used in policy evaluation for estimation. The DID method is a quasi-natural experimental method, the basic idea of which is that in order to assess the net effect of a policy implementation, the entire sample is divided into a "treatment group" (which is affected by the policy) and "control group" (which is not affected by the policy). The first difference is performed according to the policy implementation time (before and after) to eliminate the differences of individuals that do not change with time, and the two groups of changes are obtained, and then, the second difference is performed on the changes of the two groups to eliminate the increment of changes with time, and finally, the net effect of the policy is obtained. Since policies are exogenous relative to micro-subjects, there is no reverse causality, which can avoid endogeneity problems caused by omitted variables and can effectively improve the accuracy of policy evaluation. The baseline DID model setting is as follows:

$$Y_{it} = \alpha_0 + \alpha_1 D + \alpha_2 T + \alpha_3 D \times T + \varepsilon_{it} \quad (1)$$

In Equation (1), D is the policy grouping dummy variable. If individual i belongs to the treatment group affected by the policy, then $D = 1$, and if individual i belongs to the control group not affected by the policy, then $D = 0$. T is the policy implementation time dummy variable. Before the policy implementation, $T = 0$, and after the policy implementation, $T = 1$. $D \times T$ is the interaction term between the policy grouping dummy variable and the policy implementation time dummy variable, and its estimated coefficient α_3 is the policy implementation net effect. Table 2 presents the basic idea of the DID method more visually.

Table 2. Basic ideas for he DID method.

	$T = 0$	$T = 1$	Difference
$D = 1$	$\alpha_0 + \alpha_1$	$\alpha_0 + \alpha_1 + \alpha_2 + \alpha_3$	$\alpha_2 + \alpha_3$
$D = 0$	α_0	$\alpha_0 + \alpha_2$	α_2
Difference	α_1	$\alpha_1 + \alpha_3$	α_3

In order to examine the net effect of the city–county merger policy on the environment, according to the basic principle of the DID method, we set the cities participating in city–county mergers as the "treatment group", while the other cities not participating in the city–county mergers were the "control group"; other relevant factors were also controlled. The standard DID model assumes that individuals are affected by the policy at the same time but that the timing of the city–county merger adjustments is not consistent across cities. Therefore, the standard DID model was no longer applicable, and we used a multi-period DID model for empirical analysis. In the multi-period DID model, since the policy occurrence time was inconsistent, a variable that changes with time and individuals was used to replace the interaction term in the standard DID to estimate the net effect of the policy. Referring to Beck et al. (2010) [47], the econometric model was set up as follows:

$$Y_{it} = \alpha + \beta Merger_{it} + \delta X_{it} + \gamma_i + \sigma_t + \varepsilon_{it} \quad (2)$$

In Equation (1), Y_{it} measures the environmental pollution in city i in year t (i = 1, 2, 3, . . . , 263; t = 2000, 2001, 2003, . . . , 2016). $Merger_{it}$ is a dummy variable. When city i participates in the city–county merger (treatment group) in year t, $Merger_{it}$ is set to 1 from this year, set to 0 before year t, and other cities that have not participated in the merger (control group) are set to 0. X_{it} represents the relevant control variables. γ_i and σ_t represent the city fixed effects and year fixed effects, respectively, and ε_{it} is the error term. The coefficient β, indicates the effects of the city–county merger policy on the environment. A positive and significant β suggests that the city–county merger policy has aggravated pollution, while a negative and significant β indicates that the policy has reduced pollution and improved environmental quality.

3.2. Variable Selection and Data Source

3.2.1. Explanatory Variable: $PM_{2.5}$ (PM)

Air pollution is one of the key environmental problems in China. Haze pollution with $PM_{2.5}$ as the main pollutant occurs frequently, has a wide range of influence, and is difficult to control, which has seriously affected China's ecological civilization construction [48]. This study uses the grid data on the annual average global $PM_{2.5}$ concentration, which are jointly released by the Application Center and Social Economic Data of Columbia University based on satellite monitoring [49] to characterize environmental pollution. Satellite monitoring data are more objective and accurate and can avoid measurement errors caused by human factors [50]. These grid data were further transformed into the annual average concentration of $PM_{2.5}$ data of 263 prefecture-level cities in China from 2000–2016 by ArcGIS software.

3.2.2. Core Explanatory Variable: City–County Merger Policy (Merger)

A dummy variable was constructed for the city–county merger policy and the effect of the policy examined by comparing the merged prefecture-level cities (treatment group) and non-merged prefecture-level cities (treatment group). To ensure the accuracy and effectiveness of the study, this paper excluded the cities that have been merged multiple times from 2000 to 2016. The final number of sample cities was 263, including 114 merged and 149 non-merged cities, covering the eastern, central, and western regions. The list of merged prefecture-level cities was derived from the administrative division website and the official website of the Ministry of Civil Affairs of the People's Republic of China.

3.2.3. Control Variables

Since $PM_{2.5}$ is closely related to climate, urban economic development level, industrial production, and residents' lives, this study controlled a series of variables described below: (1) Ventilation coefficient (VC)—in the case of a certain amount of air pollutant emissions, the smaller the ventilation coefficient, the greater the concentration of air pollutants [51]. The ERA-Interim database of the European Center for Medium-Range Weather Forecasts provides data on wind speed at a 10-m height and boundary layer height for a global grid of $0.75^\circ \times 0.75^\circ$ (about 83 km^2). We first calculated the ventilation coefficient of each grid corresponding to the year; each grid was then matched with the sample city according to its latitude and longitude to obtain the ventilation coefficients of the 263 cities from 2000 to 2016; (2) Population agglomeration (Pop) measured by the number of people per unit area; (3) Industrial structure (Ind) measured by the proportion of the added value of the secondary industry to the regional GDP; (4) Economic development level (Pgdp) measured by the per-capita GDP; (5) Financial dependence (Fis) expressed by the proportion of fiscal revenue in GDP. The higher the degree of financial dependence, the more abundant the city's financial resources; (6) Urbanization level (Urb) measured by the ratio of the urban non-agricultural population to the total population. To control the effect of nominal prices, all currency variables were deflated with the GDP of each province based on the year 2000. Table 3 shows the descriptions and data sources for each variable.

Table 3. Variable description and data sources.

Index	Description	Source
Merger	Dummy variables of the city–county merger policy	http://www.xzqh.org/html/ (accessed on 8 June 2021) http://www.mca.gov.cn/ (accessed on 8 June 2021)
PM	Annual average concentration of $PM_{2.5}$ ($\mu g/m^3$)	https://beta.sedac.ciesin.columbia.edu/ (accessed on 1 March 2021)

Table 3. *Cont.*

Index	Description	Source
VC	Ventilation coefficient	https://www.ecmwf.int/en/forecasts/datasets/reanalysis-datasets/era-interim (accessed on 8 March 2021)
Pop	Population/regional administrative area	China City Statistical Yearbook (2001–2017)
Ind	Added value of the secondary industry/GDP	
Pgdp	GDP/population	
Fis	Fiscal revenue/GDP	
Urb	Non-agricultural population/total population	
SO_2	Industrial sulfur dioxide emissions per unit of GDP (t /10^4 yuan)	
Sci	Amount of scientific research and number of technical personnel (person)	
Fauto	Financial revenue/financial expenditure	
Gas	Natural gas penetration rate	China Urban Construction Statistical Yearbook (2001–2017)

4. Empirical Results

4.1. Baseline Regression Results

We used a multi-period DID method to assess the effects of the city–county merger policy on the environment. Table 4 shows the baseline regression results. Columns (1)–(3) are all control city fixed effects and year fixed effects. Column (1) is the basic regression result without adding other control variables. It can be seen that the regression coefficient was −1.229 at 1% significance, which suggests that the air pollution level in the city will be significantly reduced after the city–county merger adjustment. Column (2) added city-level control variables, and the regression coefficient was −1.424, which was still significant at the 1% level. Due to the impact of air circulation speed on the diffusion of $PM_{2.5}$, the ventilation coefficient was added in column (3). After controlling the ventilation coefficient, the regression coefficient was −1.389, which was still significant at the 1% level. The regression showed that the city–county merger adjustment can indeed significantly reduce the air pollution of the merged cities and improve environmental quality. The existing literature suggests that population agglomeration and urbanization may have both positive and negative effects on environmental pollution. This paper concludes that a higher degree of population agglomeration and urbanization both lead to a significant increase in urban air pollution. In terms of industrial structure, China is still at the stage of industrialization, and the associated coal-based energy consumption has a serious negative impact on the environment. Empirical results show that air pollution in cities with a higher proportion of secondary industry has increased significantly. Economic development and fiscal dependence have a significant negative effect on air pollution, possibly because the more developed the economy and the stronger the financial strength of the city, the more it invests in environmental infrastructure construction and environmental governance expenditure, which improve the environment.

Table 4. Baseline regressions.

Variables	(1)	(2)	(3)
Merger	−1.229 ***	−1.424 ***	−1.389 ***
	(0.39)	(0.397)	(0.391)
lnPop		1.039 **	2.294 **
		(0.022)	(1.036)
Ind		0.098 ***	0.098 ***

Table 4. *Cont.*

Variables	(1)	(2)	(3)
		(0.023)	(0.023)
lnPgdp		−4.449 ***	−4.791 ***
		(0.792)	(0.791)
Fis		−23.476 ***	−23.328 ***
		(5.254)	(5.254)
Urb		6.376 ***	6.463 ***
		(2.170)	(2.167)
lnVC			−7.083 ***
			(1.125)
City fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES
Observations	4436	4436	4436
R-squared	0.951	0.91	0.952

Note: The values in brackets are the robust standard errors, with *** and ** representing the significance level of 1% and 5%, respectively.

4.2. Parallel Trend Hypothesis Testing and Dynamic Analysis

An important requirement of the DID method is that the parallel trend assumption must be met; that is, before the implementation of the city–county merger adjustment, there should be no significant difference in air pollution trends of the merged and non-merged cities. To test whether the empirical model in this paper meets the parallel trend hypothesis and whether the city–county merger policy has long-term dynamic effects, we expanded the model (2) as follows:

$$Y_{it} = \alpha + \sum_{k=-3}^{k=6} \beta \, Merger_{it}^{k} + \gamma_i + \sigma_t + \varepsilon_{it} \quad (3)$$

In Equation (2), $Merger_{it}^{k}$ is a dummy variable representing the "k" year of the city–county mergers (i = 1, 2, 3, . . . , 263; t = 2000, 2001, 2003, . . . , 2016). For example, $k = 1$ indicates the first year of the implementation of the city–county merger in city i, and $k = -1$ indicates the year before the implementation of the policy. The year of implementation of the merger was used as the base year and excluded from the regression to avoid multicollinearity ($k \neq 0$). This paper examines the policy effects in the three years prior to and six years after its implementation. The coefficient "β" indicates the differences in air pollution between the merged and non-merged cities in the "k" year of the policy. If "β" is not significant in the period $k < 0$, then the differences in air pollution between the merged and non-merged cities are caused by the merger policy. On the contrary, if "β" is significant in the period $k < 0$, then the differences in air pollution between the merged and non-merged cities are not caused by the policy, which does not conform to the parallel trend hypothesis. It can be seen from Figure 3 that before the implementation of the merger policy, "β" was not significant, but it became significant after the merger, indicating that the parallel trend test was passed. Through a dynamic analysis, it was found that in the first year after the implementation of the merger policy, the regression coefficient was negative but not significant, indicating that there was a lag in the policy effect. The reason may be that it takes time to adjust government agencies and coordinate environmental policies after the merger, which makes the environmental effects of the city–county merger policy not appear immediately. From the second year after the implementation of the policy, the air pollution of merged cities decreased significantly, particularly in the fourth to fifth years, but it was followed by an increasing trend thereafter, indicating that the medium-term effects of city–county mergers on improving air pollution were better, while the long-term effects were weakened. The reason may be that in the first few years after the mergers, with the deepening of urban–rural integration and county–city integration, the synergistic effect of regional air pollution control increases, which reduces environmental pollution. At the

same time, population density gradually increased, and the promotion of urbanization and industrialization made governance more difficult, resulting in fluctuations in the effects of the merger policy.

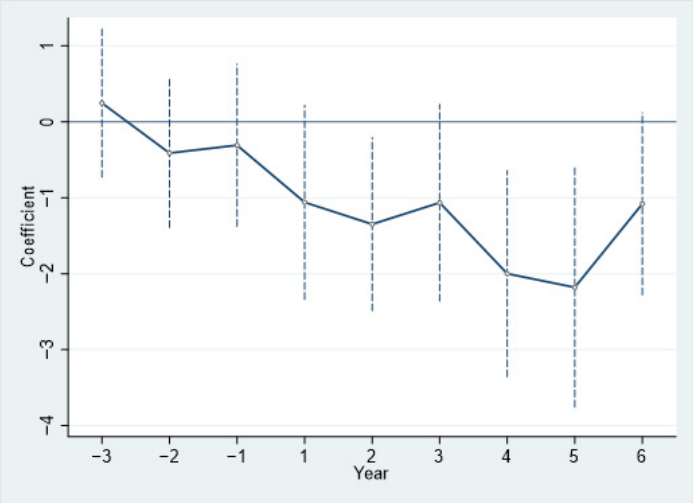

Figure 3. Parallel trend hypothesis testing and dynamic analysis. The figure plots the impact of the city–county merger policy on the environment. We consider a nine-year window, spanning from three years before until six years after mergers. The dashed lines represent 95% confidence intervals.

4.3. Robustness Checks

4.3.1. Excluding Other Policy Influences

To improve environmental quality, China has adopted a variety of policies, such as the central environmental protection inspection and the Three-year Action Plan in defense of blue sky. However, most of the policies were implemented after 2014, so this paper uses the emission trading system implemented in the sample period as the interference factor of the merger policy. China initiated the emission trading project in 2001, and in 2007, it approved the pilot emission trading system in 11 provinces, including Tianjin, Hebei, Shanxi, Inner Mongolia, Jiangsu, Zhejiang, Henan, Hubei, Hunan, Chongqing, and Shaanxi. Under the condition that the total amount control index is determined, the market mechanism is used to conduct market transactions on pollution emission rights to reduce pollutant emissions and improve environmental quality. We deleted the samples of prefecture-level cities under the authority of these 11 provinces to eliminate their impact on air pollution. The estimated results are shown in column (1) of Table 4. The city–county mergers still significantly reduced the annual average concentration of $PM_{2.5}$ (−1.789), which means that the conclusion that the merger policy has a significant negative effect on air pollution is robust.

4.3.2. Excluding the Impact of Administration Hierarchy

China's urban administrative hierarchy has a significant impact on urban development. Provincial capital cities are the economic and political centers of the province, and compared with other prefecture-level cities, they have greater advantages for resource allocation and urban agglomeration. At the same time, their environmental governance standards are higher than other prefecture-level cities. In addition, urban management of sub-provincial cities and municipalities directly under the central government has certain distinct features. Therefore, we deleted all the provincial capital cities, sub-provincial cities, and municipalities, and re-regressed the model (1). Column (2) of Table 4 reports these results. We found that after excluding the impact of administrative hierarchy, the merger policy can significantly reduce the average annual $PM_{2.5}$ concentration (−1.316), and the research conclusions remain robust.

4.3.3. PSM-DID Test

Since the city–county merger policy is a quasi-natural experiment, cities to be merged are not selected randomly, but they are determined after evaluation based on a series of indicators, such as population, economy, and urbanization. As the samples in this paper include most of the prefecture-level cities in the country, there may be major differences in the development of different cities, which may lead to a "selective bias". To further control for this systematic bias, this paper adopted the Propensity Score Matching Difference-in-Differences (PSM–DID) model as a robustness test. First, we selected a series of city-level variables, including population concentration, industry structure, urban economic level, fiscal dependence, and urbanization as the matching criteria. We then used the nearest-neighbor matching method and bootstrap technology to repeat the sampling calculations, running the test 500 times to obtain the standard error. The scores were determined to match the control groups of the treatment groups, and then, the matched results were further used for regression of the DID method. The regression results of the PSM-DID model in column (3) of Table 5 show that the merger policy significantly reduces $PM_{2.5}$ (−1.276), indicating that the conclusions obtained in this paper are still robust.

Table 5. Robustness test.

Variables	(1)	(2)	(3)
Merger	−1.789 ***	−1.316 ***	−1.276 ***
	(0.507)	(0.406)	(0.399)
Control variables	YES	YES	YES
City fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES
Observations	2816	4079	4346
R-squared	0.945	0.942	0.951

Note: The values in brackets are the robust standard errors, with *** representing the significance level of 1%.

5. Heterogeneity Analysis

5.1. Differences in the Influence by Geographical Distance on the Environment

Geographical distance has been considered to play an important role in government decision-making [52]. Campante and Do [53] found that the farther a city is from the state center, the weaker the government's ability to supervise and account for it. Cao et al. [54] pointed out that the closer a city is to the environmental supervision center, the stricter its environmental inspection and the stronger its deterrence ability for local governments. Theoretically, prefecture-level cities should first consider cities at a close geographical distance and with better integration when choosing merging counties. However, in practice, some cities merge blindly for political purposes and competitive pressure. The geographical distance between counties and cities not only determines the development of regional integration and the integration of cities after the merger, but also, the further the distance, the higher the travel costs and the greater the impact on environmental pollution. We calculated the geographic distance between the merged cities and counties based on latitude and longitude, dividing the merged cities into four groups to examine the environmental impact of this. It can be seen from Table 6 that when the distance between the merged counties and cities is less than 10 km, air pollution is significantly reduced. When the distance is expanded to 10–30 km, the air pollution is still significantly reduced, but the effect is weakened. When the distance between the counties and cities reaches 30–50 km, the impact of the merger policy on air pollution is no longer significant, and when the distance is more than 50 km, the impact of city–county mergers on air pollution becomes significantly positive, which means that air pollution has increased. A possible explanation for this is that the closer the geographical distance between the counties and cities, the smoother the urban integration after the merger, the lower the supervision costs of the prefecture-level cities on the newly established districts, and the better the coordinated governance of environmental issues. With the expansion of distance between counties

and cities, it is more difficult for prefecture-level cities to supervise new districts, and the construction of infrastructure such as roads increases due to the long distances, and the number and frequency of use of transportation vehicles increases, factors which are not conducive to the improvement of environmental quality.

Table 6. Influence differences of geographical distance on $PM_{2.5}$.

Variables	0–10 km	10–30 km	30–50 km	Over 50 km
Merger	−2.581 ***	−1.300 **	−1.433	3.652 **
	(0.654)	(0.543)	(0.888)	(1.608)
Control variables	YES	YES	YES	YES
Ctiy fixed effects	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES
Observations	3450	3790	3297	3229
R-squared	0.950	0.951	0.949	0.948

Note: The values in brackets are the robust standard errors, with *** and ** representing the significance level of 1% and 5%, respectively.

5.2. Differences in the Influence of Economic Strength on the Environment

The economic development level of a city will have an impact on the urban environment, and the differences in economic strength between merged cities and counties is related to the coordinated governance of the environment. From the perspective of merger motivation, in order to expand the scale of urban development, promote the development of urbanization, and obtain more production factors, prefecture-level cities are more motivated to merge than counties. In particular, after a merger, the power of the county government is transferred to the prefecture-level city government, which carries out overall planning. The advantage of this upward shift in power is that it is easier for prefecture-level cities to implement unified public policies in the region. However, in reality, it was found that cities and counties of different economic strengths play games when they are merged, especially when the economic development gap between cities and counties is large, making the obstacles to integration greater. To examine the differences in influence of economic strength on urban environmental governance, we divided the merged cities and counties into four combinations of strong and weak, based on their economic strength. A calculation was made of the ratio of the city (county) per capita GDP to the national city (county) per capita GDP in the year before the merger. If it was greater than 1, it was a strong city (county), and if it was less than 1, it was a weak city (county). This resulted in four groups of combined city and county combinations: strong cities and strong counties (SS), strong cities and weak counties (SW), weak cities and strong counties (WS), and weak cities and weak counties (WW).

Table 7 presents the regression results. The impact of the combination of cities and counties with different economic strength on air pollution was clear. The combination of strong cities and counties had the most significant effect (−1.590), followed by the combination of weak cities and counties (−1.523). However, the coefficient of the combination of strong cities and weak counties (−1.311) and the combination of weak cities and strong counties (−0.677) was negative but not significant. These results show that the combination of cities and counties with equivalent economic strength is more conducive to coordinated pollution control, while the combination of cities and counties with large differences in economic strength does not significantly improve environmental quality. Prefecture-level cities with strong economic power pay more attention to environmental protection, while weak counties hope to increase local taxation and financial strength through economic development. Although the combination of weak cities and strong counties broke the urban administrative boundaries through administrative power, prefecture-level cities are in a weak position in terms of city and county interests, and it is difficult to promote the integration of environmental policies.

Table 7. Influence differences of economic strength on $PM_{2.5}$.

Variables	SS	SW	WS	WW
Merger	−1.590 **	−1.311	−0.677	−1.523 **
	(0.675)	(1.073)	(0.735)	(0.724)
Control variables	YES	YES	YES	YES
Ctiy fixed effects	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES
Observations	2922	2477	3017	2686
R-squared	0.953	0.948	0.945	0.951

Note: The values in brackets are the robust standard errors, with ** representing the significance level of 5%.

5.3. Differences in Influence of Regional Heterogeneity on the Environment

There are significant regional differences in China's urban development process and mode. The economic development level and urbanization process in the eastern region are significantly higher than those in the central and western regions. The question then is whether there are regional differences in the environmental effects of city–county mergers. Table 8 shows that the cities in the eastern, central, and western regions significantly reduced the annual average $PM_{2.5}$ concentration after the merger, but differences between regions are clear. The regression coefficient of the eastern region was −0.807, which is significantly smaller than that in the central region (−2.501) and the western region (−2.862). The reason may be that the eastern region's own economic development and urbanization levels are higher than the other two regions, with large population density and high levels of industrialization, which makes its air pollution situation more serious than other regions. Despite the implementation of environmental regulation measures, the optimization and upgrading of industrial structure, and the expansion of urban space scale after the merger, environmental pressure on the city was alleviated. However, due to the greater environmental pressure accumulated by its rapid urbanization, the improvement of its environmental quality was slower than that of the central and western regions. The central and western regions, especially the western, have relatively light air pollution due to their advantages in terms of resources and climate, so the pressure on air pollution control was relatively small.

Table 8. Influence differences of regional heterogeneity on $PM_{2.5}$.

Variables	Eastern	Central	Western
Merger	−0.807 *	−2.501 **	−2.862 ***
	(0.472)	(1.136)	(0.657)
Control variables	YES	YES	YES
Ctiy fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES
Observations	1496	1645	1295
R-squared	0.965	0.935	0.909

Note: The values in brackets are the robust standard errors, with ***, ** and * representing the significance level of 1%, 5%, and 10%, respectively.

6. Analysis of Impact Mechanisms

The basic regression results and robustness test of this paper confirm that the city–county mergers can significantly reduce air pollution, which means that the policy has greater environmental governance effects than emissions effects. How do the city–county mergers strengthen environmental governance and reduce environment pollution? After the merger, power was moved upward, which enhanced the ability of prefecture-level city governments in terms of overall and coordinated environmental management. In addition, the main obstacle in regional environmental governance is the coordinated governance of cross-regional environmental pollution; however, the city–county mergers break the

administrative boundaries of merged cities and counties, which is conducive to the cross-regional implementation of the environmental governance policies of prefecture-level city governments. Therefore, we believe that the city–county merger policy has strengthened environmental pollution control in the following three ways:

First is the vertical management of environmental protection institutions. After the merger, the county environmental protection department is transformed into a branch of the prefecture-level city environmental protection department, which is vertically managed by the prefecture-level city. On the one hand, it is conducive to breaking the administrative boundary and promoting the coordinated governance of the regional environment. On the other hand, the vertical management of environmental protection institutions is conducive to strengthening environmental supervision and the implementation of environmental regulation policies. Compared with counties, prefecture-level cities have higher environmental protection standards and stronger driving forces for environmental pollution control due to the pressures of environmental protection and performance evaluation. To develop the economy and attract investment, the county government is more likely to accept high-consumption and high-polluting industries and enterprises. The county's environmental protection department is weak in the local government's development model of emphasizing the economy and neglecting environmental protection, and it is difficult for them to play a supervisory role. After the merger, the vertical management of environmental protection agencies further enhanced the environmental supervision power of prefecture-level cities, which urged enterprises to implement clean production and technological innovation, thereby reducing pollutant emissions. Based on the analysis above, we used industrial sulfur dioxide emissions per unit of GDP (SO2) and the amount of urban scientific research and number technical personnel (Sci) as proxy variables of cleaner production and technological innovation.

Second is the overall planning of the city. One important motivation for city–county mergers is to promote the development of regional integration [55]. In contrast to market-led urbanization, as government-led urbanization, the city–county mergers pay more attention to the coordinated development of regions. The county governs a large number of villages. After the county was transformed into a district, the prefecture-level city implemented unified urban planning, and the integration of urban and rural areas was advanced. Through the transformation of the public transport network and water and electricity provision, the government rapidly promoted the integration of urban and rural areas. With the promotion of urbanization, concepts of rural production, lifestyle, and environmental protection gradually changed. For example, the practice of burning coal, firewood, straw, and garbage in rural areas has changed to the use of clean energy, such as electricity, natural gas, and the harmless treatment of garbage, which serve to reduce air pollutant emissions [56]. We used natural gas penetration rate (Gas) as a proxy variable for the upgrading of environmental protection standards under the unified urban planning.

Third is fiscal centralization. Environmental infrastructure construction and pollution control are inseparable from financial capital guarantee. Counties have independent fiscal power. After the merger, the fiscal power of the county government shifted upward, which means that the proportion of county-level fiscal revenues turned over to prefecture-level cities greatly increased, so that prefecture-level city governments had greater financial autonomy. This means that local governments had stronger urban governance capability, which was conducive to increasing investment in environmental protection and strengthening urban environmental governance [57]. Based on the research of Chen [58], we used the ratio of fiscal revenue to expenditure in the local general budget as a proxy variable for fiscal autonomy, measuring fiscal centralization.

Based on the above analysis, we conducted an empirical test on the environmental governance mechanism of the city–county mergers. It can be seen from Table 9 that the city–county mergers significantly reduced the industrial sulfur dioxide emissions per unit of GDP (−0.015), and the number of technical personnel increased significantly (0.092), indicating that after the mergers, through the vertical management of environmental

protection departments, the environmental supervision capabilities of prefecture-level cities were enhanced. In addition, the regression coefficient of the natural gas penetration rate was significantly positive (2.419), indicating that the mergers were conducive to the unified planning of the city and that they improved the environmental coordination capacity of prefecture-level cities. After the merger, as the county-level government's fiscal power shifted upward, the fiscal autonomy (0.017) of the prefecture-level city government significantly increased, providing financial guarantees for the construction of urban environmental infrastructure, pollution control, and environmental quality improvement. The regression results confirmed the analysis of the city–county mergers to strengthen the environmental governance mechanism, indicating that through the mergers, along with the concentration of power to prefecture-level cities and regional integration, the city's environmental coordination and governance capabilities have indeed improved, which is conducive to reducing environmental pollution.

Table 9. Analysis of impact mechanisms.

Variables	SO_2	lnSci	Gas	Fauto
Merger	−0.015 **	0.092 ***	2.419 **	0.017 ***
	(0.007)	(0.032)	(0.945)	(0.005)
Control variables	YES	YES	YES	YES
Ctiy fixed effects	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES
Observations	4436	4436	4436	4436
R-squared	0.592	0.928	0.807	0.933

Note: The values in brackets are the robust standard errors, with *** and ** representing the significance level of 1% and 5%, respectively.

7. Conclusions and Policy Implications

Most existing studies have focused on the economic growth and urbanization effects of the city–county mergers; however, the environmental effects of the merger policy have rarely been studied. Taking the panel data for 263 prefecture-level cities in China from 2000 to 2016 as samples, this study systematically investigated the relationship between the city–county merger policy and environmental pollution, adopting the multi-period DID model. Based on our analysis, we reached the following conclusions:

(1) China's city–county merger policy can significantly reduce environmental pollution while promoting the development of urbanization, indicating that the policy can strengthen environmental governance and improve urban environmental quality. The robustness test supports this conclusion, but there is a one-year lag in the policy effect.
(2) The heterogeneity analysis showed that the closer the geographical distance of the merged cities and counties and the smaller the difference in economic strength between them, the better the coordinated governance of environmental pollution. The eastern cities are under intense pressure for pollution control due to their faster economic development and urbanization, and the environmental control effects after mergers are not as good as those in the central and western regions.
(3) In addition, we further tested the environmental governance mechanism of city–county mergers and found that the policy promotes regional integration by breaking the administrative boundaries between merged cities and counties and that it strengthens the administrative power of prefecture-level cities, thereby enhancing the environmental governance capacity of prefecture-level cities, specifically by intensifying the vertical management of urban environmental protection agencies, unified urban planning, and fiscal centralization, thereby reducing the negative effects of urbanization and improving the environmental quality of the city.

On the basis of our findings, we propose the following policy recommendations for environmental governance and city–county mergers reform:

(1) On the issue of environmental governance, centralization is more effective than decentralization. It is conducive to improving the overall environmental governance capacity of prefecture-level governments and avoiding the coordination difficulties caused by differences in objectives and information asymmetry between different local governments under decentralization. This provides an empirical basis for vertical management reform of central environmental protection Institutions.

(2) The sustainable development of the ecological environment should become one of the goals of urbanization development. Therefore, China should raise the threshold of city–county mergers and add the preconditions of environmental protection to the conditions of application. Most cities applied for merger adjustments in accordance with the 2003 "Criteria for the Establishment of Municipal Districts", which set conditions for mergers in terms of economic development level, population size, population density, urbanization level, and public services. Although more content was added in 2014, environmental protection has yet to be included. Therefore, in order to improve the environmental quality of the merged cities, existing merger standards should be adjusted with the addition of the environmental protection requirements.

(3) Promoting regional integration is the key to realizing coordinated environmental governance, and the effective integration of merged cities and counties is the guarantee to promoting regional integration. The city–county mergers involve the reorganization of power and the reconstruction of interests. The complexity of mergers leads to a certain degree of lag in the effect of the policy. Therefore, it is necessary to strictly examine and approve the merger application and supervise the merger process to reduce the integration costs and prevent the adverse impact of false urbanization on the environment.

(4) Cities should choose the urbanization path to suit local conditions to prevent the disorderly expansion. In the past two decades, many prefecture-level cities in China hoped to rapidly advance urbanization through city–county mergers. However, the results of this paper show that not all cities are suitable for the merger policy. For example, when the geographical distance between merging cities and counties is great or the difference in economic strength is large, the effect of environmental governance is not ideal. Blind expansion does not necessarily bring about the green development of the city but constrains sustainable urban development. Careful consideration should be given as to which counties the prefecture-level city chooses to merge and to whether those at a distance from the central city should choose a city–county mergers adjustment, county to city upgrading, or expanding towns and villages through industrial development.

In short, environmental issues are a reflection of urban development methods and governance efficiency. At present, most developing countries are in the stage of accelerated urbanization. The government should take the coordinated development of urbanization and the environment as an important goal of sustainable urban development and explore effective paths for urban governance. In promoting the development of urbanization, the government should give full play to its macro-regulatory role, maximize the positive effects of urbanization on the environment, reduce its adverse impacts, and achieve a mutually beneficial win–win situation for urban development and environmental protection. Only through the synergistic development of the population, economy, society, and environment can sustainable urban development be truly achieved.

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