Impact of Regional Integration Policy on Carbon Emission

Based on Beijing-Tianjin-Hebei Urban Agglomeration

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Abstract. As the area of concern for national regional economic development, the pace of Beijing-Tianjin-Hebei synergistic development has always been at the forefront of regional integration in China. At the critical period of achieving the carbon targets, the environmental effects generated by the integration policy have also raised concerns. Based on provincial carbon emission panel data released by the *National Bureau of Statistics* from 2001–2019, this paper explores the carbon emission effects of the Beijing-Tianjin-Hebei Coordinated Development Initiative, taking 2013 as the year when the integration policy was thought to have an impact as a quasi-natural experiment. The results show that the implementation of the policy can have a significant effect on carbon emission reduction, and it still holds after taking the robustness tests. Accordingly, this paper suggests that the Beijing-Tianjin-Hebei area should accelerate industrial upgrading and technological transformation, and develop better environment-oriented policies to promote green economy development.

Keywords: Beijing, Tianjin and Hebei Coordinated Development · Peak Carbon Dioxide Emissions · Carbon Neutrality

1 Introduction

Carbon emissions and their likely consequent climate issues have been the most widely concerned global environmental matters. As the largest country in carbon emissions, China proposed to achieve "Peak Carbon Dioxide Emissions" by 2030 and "Carbon Neutrality" by 2060. As one of our country's three major regional economic development strategies, the coordinated development of the Beijing-Tianjin-Hebei area is bound to keep up with the trend of the time and carry out industrial innovation in the context of sustainable development.

At present, scholars' research on regional economic integration and environmental effects mainly includes the following two main points of view.

First, from the perspective of functional integration, which includes the linkage of specific projects such as markets, transportation, infrastructure, etc. Among them, market integration is specifically emphasized. In research considering foreign markets, most

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scholars have the similar conclusion that market integration effectively reduced environmental pollution. [1] Krugman (1991) confirmed that market consolidation promotes industrial clustering and contributes to the efficiency of green growth. [2] Rodríguez-Sarasty J A.et al. (2021) examined electricity market transactions in North America and found that the collaboration of the electricity sectors in each region can significantly reduce carbon emissions. [3] Interiorly, some scholars have reached similar conclusions that market integration can reduce CO_2 emissions through industrial innovation, labor transfer, and other technological transmission routes. [4–6]

Second, from the perspective of policy integration, scholars studied the environmental effects of regional economic integration policies on domestic scales such as the Yangtze River Delta [7, 8], and the Pearl River Delta [9], and on international scales such as the European Union [10]. The results of the studies are controversial due to the different choices of indicators. Lu et al. (2020) found that the carbon emission reduction effect of the integration of the Yangtze River Delta was mainly manifested in the central cities, which was achieved through the outward shift of highly polluting industries. [11]

In summary, the existing research on the carbon effect of regional integration in China mainly concentrated on the Yangtze River Delta region. In contrast, the research on the Beijing-Tianjin-Hebei region is more common in subdivided fields, lacking the exploration of the comprehensive impact on the environment. Since the Chinese market is inexorably influenced by policy orientation, this paper will take provincial administrative divisions as the basic unit to study the Beijing-Tianjin-Hebei integration policy and its carbon effect. The possible innovations of this paper are as follows: (1) For the first time, the Beijing-Tianjin-Hebei integration policy and urban carbon emissions are included in the same analytical system. (2) Under the background of transformation from administrative regions to an integrated economy in China, taking the regions with unbalanced development but an outstanding economic role as the research object can help explore the practical integration process with sustainable development.

2 Policy Background

Because of the close geographical connection, Beijing, Tianjin, and Hebei have had a long-lasting history of commercial and political exchanges. To promote integration in many fields such as economy and politics, President Xi Jinping has visited the region several times since 2013 and made important instructions on the Beijing-Tianjin-Hebei Integration Initiative. Subsequently, in 2014, the symposium on coordinated development was carried out, bringing the resolution of economic integration into focus. In April 2015, the *Outline of Coordinated Development of the Beijing-Tianjin-Hebei Region* was officially adopted and elevated to a major national strategy. Since then, a new situation has been formed:

The establishment of an institutional system is basically completed. The decommissioning of non-capital functions in Beijing shows its effectiveness. [12] The level of comprehensive economic and social development gets improved continuously. Breakthroughs are made in key areas like transportation, industry, and ecology where 57 relevant cooperation agreements are subsequently reached.

3 Method

3.1 Research Technique

To assess the impact brought by the implementation of the integration policy, this paper adopts the method of DID to make a comparative analysis of results before, after, and without the implementation of the policy. The promulgation of the *Outline of Coordinated Development of the Beijing-Tianjin-Hebei Region* in 2015 is considered a quasi-natural experiment in this study. Due to the time lag of policy promulgation, this paper sets the policy impact time in 2013 and regards it as the beginning of the Beijing-Tianjin-Hebei Synergistic Development Directive. So, the model set is as follows:

$$\begin{aligned} ln\_emission = \beta_0 + \beta_1\, did + \delta_1\, gdp + \delta_2\, population + \delta_3\, road \\ + \delta_4\, indst + \mu_i + \nu_t + \varepsilon_{it} \\ did = treated_{it} \times time_{it} \end{aligned}$$

In the model, *ln_emission* is the explained variable. It is the result obtained after taking the natural logarithm of carbon emission, reflecting the change in carbon emission in the studied region. $Treated_{it}$ is the regional dummy variable, and its value is 1 if the region is the policy-implemented region and 0 for others. $Time_{it}$ is the dummy variable of time. Time after 2013 takes the value of 1, and that before 2013 takes 0. *Did,* as the product of both, is regarded as the explanatory variable. β_0 is a constant and β_1 is the coefficient to be estimated, which is this paper's core parameter of interest. If the coefficient is significantly negative, it demonstrates the policy has reduced carbon emissions in the region.

Some relative factors are taken as control variables in this paper. *gdp* represents the regional GDP per capita, measuring an area's economic development. *road* stands for the urban road area per capita, which indicates the level of infrastructure and traffic condition. *indst* shows the ratio of added value in the secondary industry to regional GDP, being a rough estimate of the regional industrial structure. In addition, μ_i and ν_t display respectively the area fixed effects and time fixed effects, and ε_{it} is the residual.

3.2 Data Description

THis paper selects carbon emission data from 30 Chinese provinces and cities from 2001 to 2019. Since the Yangtze River Delta region is in a highly integrated state, which may weaken the effect of the Beijing-Tianjin-Hebei coordinated development policy, the data of corresponding regions are removed from the control group selected in this paper. The data are selected from the *China statistical yearbook* published by the *National Bureau of Statistics*. The final data are 492 in total.

4 Results

4.1 Benchmark Regression Results

Table 1 reports the results of the benchmark regressions. According to Model 2, the result of the regression using multidimensional panel fixed effects is significantly negative at

Table 1. Benchmark Regression Results

VARIABLES	Model 1	Model 2	Model 3
did	−0.421***	−0.220***	
	(−5.594)	(−3.363)	
_diff			−0.235**
			(−2.057)
time			0.181*
			(1.790)
treated			−0.050
			(−0.592)
gdp		−0.000***	0.000**
		(−3.040)	(2.162)
population		0.000	0.000***
		(0.321)	(11.806)
road		0.018***	0.046***
		(2.667)	(4.892)
indst		0.044	1.839***
		(0.136)	(4.379)
Constant			3.187***
			(17.260)
Observations	492	416	416
R-squared	0.936	0.958	0.464

t-values in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

the level of 1%, which initially indicates that the regional economic integration policy has a significant negative effect on the total carbon emissions. Model 3 is the regression result under DID model, and it can be seen that the results remain largely consistent with the previous two regressions, which show a negative effect at the 5% significance level.

4.2 Robustness Test Results

4.2.1 Parallel Trend Test Results

DID model requires the data to satisfy the parallel trend test, so this paper divides the data by 2013, sets the interaction terms before and after the experiment, respectively, and re-runs the regressions. The results are shown in Fig. 1. From the year before the policy occurred, the total carbon emissions in Beijing, Tianjin, and Hebei showed a general trend of increasing. The trend slows down two years before the policy implementation, which to some extent indicates that there is a time lag in the actual release of the policy,

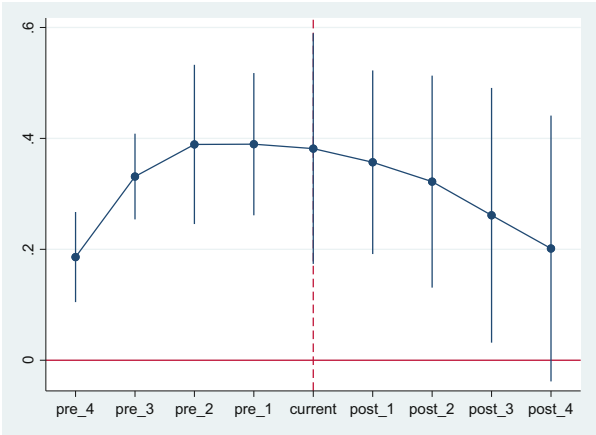

Fig. 1. Parallel Trend Test Results

while in reality, the layout of the Beijing-Tianjin-Hebei Coordinated Development may have started from an earlier time, and the emission reduction effect has already appeared in a small scale. From 2013 onwards, the trend of the test changes from an increase to a decrease.

In the following years, the total carbon emissions steadily decreased. The integration in transportation, ecology, and markets became more perfect, which further consolidated the carbon emission reduction effect of the integration.

4.2.2 Placebo Test Results

To exclude other factors from confounding the experimental results, a placebo test is set up in this paper. Assuming that the policy implementation time is one year ahead of schedule, a counterfactual assumption is made. The results are shown in Table 2. As can be seen from the table, the effect between the newly set explanatory variable did_2 and the explained variable *ln_emission* is not significant, indicating that the carbon emission reduction effect is caused by the implementation of the Beijing-Tianjin-Hebei co-development policy.

Table 2. Placebo Test Results

VARIABLES	ln_emission
did_2	−0.195
	(−1.346)
gdp	7.19e−06*

(*continued*)

Table 2. (*continued*)

VARIABLES	ln_emission
	(1.950)
population	−0.000139
	(−0.618)
road	0.0654***
	(5.001)
indst	0.800
	(1.169)
Constant	3.468***
	(13.27)
Observations	416
Number of regions	26
R^2	0.572

Robust z-statistics in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

5 Conclusions

From the quasi-natural experiment results based on the coordinated development of Beijing-Tianjin-Hebei in 2013, the following conclusions can be drawn:

(1) According to the results of DID model, the proposal of the Beijing-Tianjin-Hebei Coordinated Development policy has a significant role in promoting carbon emission reduction.
(2) The result still holds after robustness tests such as the parallel trend test and placebo test, proving that the result is reliable.
(3) Since policy formulation requires certain procedures, there is a time deviation between the implementation of the policy and its impact. The impact is more likely to occur before the specific policy is implemented.

Based on the results of the empirical research and related literature, this paper draws the following inspirations and suggestions:

(1) Beijing-Tianjin-Hebei has achieved carbon emission reduction results, but not in each place separately. Judging from the data, the total carbon emissions in Hebei Province are still high. In Beijing, there is a marked decline. [13] Combining the actual measures, it can be seen that the existing carbon effect is still mainly realized by the relocation of industries with high pollution and high carbon emission. Some cities in Hebei are the target areas for the transfer of industries in Beijing and Tianjin. To continue to maintain the effect of carbon emission reduction in the Beijing-Tianjin-Hebei area, it is still necessary to accelerate industrial transformation and

technological innovation to solve the problem of high carbon emissions from the source.

(2) Since China's regional integration policy is more market-oriented than environment-oriented, regional economic integration is not the primary measure to improve the carbon emission pattern. To consolidate the existing achievements and promote the realization of the goals, more complete environmental protection-oriented policies are still in need.

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