The impact of the coordinated development of Beijing-Tianjin-Hebei urban agglomeration on green total factor productivity--an empirical analysis based on the synthetic control method

Kuang Fei[1,a*], Yu Qian[1,b], and Qin Yidong[1,c]

[1] School of Economics, Wuhan University of Technology, 430070 Hubei Wuhan, China

Abstract. Based on the panel data of 92 prefecture-level cities in five major urban agglomerations from 2010 to 2019, and taking the 2015 Beijing-Tianjin-Hebei Coordinated Development Planning Outline as the quasi-natural experiment, evaluating the impact of the coordinated development of Beijing-Tianjin-Hebei on green total factor productivity by using synthetic control method. The study found that the coordinated development of Beijing-Tianjin-Hebei has a significant promoting effect on green total factor productivity; The policy effect of Beijing-Tianjin-Hebei coordinated development has regional differences in the time dimension. The coordinated development has a greater role in promoting non-core cities in the short term and a stronger role in promoting core cities in the long term; The mechanism test results show that the coordinated development of Beijing-Tianjin-Hebei mainly affects green total factor productivity through industrial structure upgrading and ecological environment protection.

1.Introduction

The Beijing-Tianjin-Hebei urban agglomeration is the longest developing urban agglomeration with the largest economic volume in northern China. In 2021, the total regional GDP of the Beijing-Tianjin-Hebei urban agglomeration reached 9.6 trillion yuan, creating 8.4% of the country's GDP. At the same time of rapid development, the accompanying environmental pollution and "big city disease" in Beijing have gradually become increasingly serious problems in the green development process of Beijing-Tianjin-Hebei urban agglomeration. The environmental pollution of urban agglomeration has the characteristics of complexity, continuity and integrity, and it is difficult for cities to deal with it alone. This requires joint action by local governments and coordinated governance based on effective interregional cooperation mechanism. Therefore, on April 30, 2015, the Political Bureau of the Central Committee of the Communist Party of China deliberated and adopted the Outline of the Beijing-Tianjin-Hebei Coordinated Development Plan, hoping to achieve the overall green development of the region, which also represents that the coordinated planning and governance of the Beijing-Tianjin-Hebei urban agglomeration has officially entered the substantive development stage.

As one of China's three major national strategies at present, the coordinated development of Beijing-Tianjin-Hebei urban agglomeration takes relaxing Beijing's non-capital functions as its strategic core, hoping to achieve the overall green development of the region and improve the quality of the ecological environment. The promulgation of the Beijing-Tianjin-Hebei Coordinated Development Planning Outline indicates that the coordinated development of the Beijing-Tianjin-Hebei urban agglomeration has been officially implemented. The policy has established a variety of coordinated development paths including "regional transportation integration", "ecological environment protection" and "industrial transformation and upgrading", and hopes to create a new driving force for the green development of urban agglomeration through "coordinated development" So, has the Beijing-Tianjin-Hebei coordinated development strategy improved the level of regional green development? Has it alleviated Beijing's "big city disease" in the process of relieving Beijing's non-capital functions, and will the green development level of surrounding cities be affected after accepting the economic and public sectors transferred from Beijing? Is the coordinated development path in the "Outline of the Beijing-Tianjin-Hebei Coordinated Development Plan" effective? The answers to these questions are of great significance for exploring replicable and promotable urban agglomeration collaborative development model.

2.Literature review

At present, domestic and foreign literatures mainly focus on the impact of urban agglomeration coordinated development on economic benefits, ecological environment and its action path. In terms of economic benefits, some scholars, from the perspective of government cooperation[1], transportation infrastructure[2], market integration[3] and industrial synergy[4], have studied and found that urban agglomeration synergy

* Corresponding author: kuangfei@whut.edu.cn
[b]yuqian@whut.edu.cn
[c]qyd02304212@163.com

promotes the level of economic development, thereby enhancing the spillover effect of interregional economic growth[5]; In terms of ecological environment, Parikh J.[6], York R.[7] and other scholars have studied and found that in the process of urban development and economic growth, pollution emissions will also increase, resulting in deterioration of the ecological environment[8]. Buehn[9], Li Qian[10] and other scholars believe that urban development will improve the government's governance capacity and strengthen environmental regulation, and at the same time lead to a reasonable distribution of population and industry, which is conducive to achieving the scale effect of pollution control. In addition, some scholars have found that there is an "inverted U-shaped" relationship between urbanization and ecological environment[11-12] or no correlation[13]. To sum up, the academic community has reached a consensus on the promotion of economic effects by the coordinated development of urban agglomeration, but there are still disputes on the ecological environment and green development.

The existing literature mainly discusses the relationship between the coordinated development of urban agglomeration and economic benefits or ecological environment, but it lacks the theoretical analysis and empirical test of the channel mechanism of the two, and it is also difficult to fully reflect the environmental effects of the coordinated development of urban agglomeration. In addition, the existing literature on the benefits of the coordinated development of urban agglomeration is mainly based on the analysis of the economic benefits or the single indicator of the ecological environment, and does not establish a comprehensive indicator system that integrates economic development and environmental pollution, which leads to the limited use of policy recommendations for government decision-making, sometimes even counterproductive. Therefore, this paper takes the Outline of the Beijing-Tianjin-Hebei Coordinated Development Plan as a quasi-natural experiment, evaluates the impact of the Beijing-Tianjin-Hebei coordinated development on green total factor productivity using the synthetic control method, further uses the mediating effect model to empirically test the channel mechanism of the coordinated development of urban agglomeration affecting green total factor productivity, and explores a replicable and promotable urban agglomeration coordinated development model.

3.Design of empirical research

3.1.Estimation method

At present, most scholars use breakpoint regression method, double difference method, composite control method and other methods to conduct empirical research on policy effects. By comparison, composite control method can alleviate subjective errors and endogenous problems of traditional measurement methods. In this paper, the synthetic control method is adopted, and the Beijing-Tianjin-Hebei Coordinated Development Planning Outline released in February 2015 is used as a quasi-natural experiment, define Y^0_{2019} represents the "counterfactual" of the Beijing-Tianjin-Hebei urban agglomeration in 2019, assuming that the policy is not implemented, Y^1_{2019} represents the observed value of Beijing-Tianjin-Hebei urban agglomeration in 2019 after the implementation of the policy[14]. The difference between the two (θ) represents the treatment effect of the policy on the Beijing-Tianjin-Hebei urban agglomeration:

$$\theta = Y^1_{2019} - Y^0_{2019} \tag{1}$$

Y^1_{2019} can be calculated by actual data, while Y^0_{2019} needs to be obtained by using synthetic control method:

$$Y_{it} = A_t + \alpha_t Z_i + \beta_t \mu_i + \varepsilon_{it} \tag{2}$$

Y_{it} is the observed value of the t period of city i, A_t is time fixed effect; α_t and β_t is the parameter vector to be estimated, Z_i is a covariate vector, representing the observable variable of city i ; μ_i is an unobservable variable; $\varepsilon_{i,t}$ is a random perturbation term. Assuming that there is a matrix w_i^*, so that the virtual cities fitted in each phase are equal to the Beijing-Tianjin-Hebei urban agglomeration, we can get:

$$\sum_{j=2}^{N+1} w_j^* Y_{j1} = Y_{11}, \sum_{j=2}^{N+1} w_j^* Y_{j2} = Y_{12}, \dots, \sum_{j=2}^{N+1} w_j^* Y_{jt} = Y_{1t} \tag{3}$$

Then the treatment effect is as follows[14]:

$$Y_{1t}^N - \sum_{j=2}^{N+1} w_j^* Y_{j1} = \frac{\beta_t}{\sum_{s=1}^{T_0} \beta_s / T_0} \sum_{j=2}^{N+1} w_j^* \frac{1}{T_0} \sum_{s=1}^{T_0} (\varepsilon_{js} - \varepsilon_{1s}) - \sum_{j=2}^{N+1} w_j^* (\varepsilon_{jt} - \varepsilon_{1t}) \tag{4}$$

3.2.Variable description and data source

3.2.1.Explained variable

The SBM-GML index is used to measure green total factor productivity, and the relevant input-output measurement indicators are shown in Table 1.

Table 1. GTFP Measurement Indicators

Index type	Factor	Meaning of Indicators
Input indicators	Labor	Working population of the city at the end of the year
	Energy	Energy consumption converted by standard coal conversion method
	Capital	Replace with fixed capital stock *K*[15]
Output indicators	Expected output	Real GDP
	Unexpected output	Calculated by entropy method, including industrial sulfur dioxide emissions, industrial smoke emissions and industrial wastewater emissions

3.2.2.Prediction variables

In this paper, eight prediction variables are selected: traffic integration (tra), which is calculated by entropy method. The indicators include road area, number of buses, number of taxis, length of rail transit route and number of vehicles. The industrialization level (ind) is the proportion of the secondary industry in GDP. Environmental protection (evo) is calculated by entropy method, and the indicators include industrial pollution discharge and urban sewage discharge. Foreign investment (fdi) is measured by the ratio of the amount of foreign capital actually utilized to GDP. Capital endowment (str) is the per capita fixed capital stock. Human capital (edu) is expressed by the proportion of college students in the total population; The urban population size (pop) is the total urban population at the end of the year. The level of economic development (eco) is expressed as the logarithm of the real per capita GDP. The descriptive statistics of each variable are shown in Table 2.

Table 2. Descriptive statistics of variables

Variable	Standard deviation	Maximum	Minimum	Average
lnGTFP	0.247	0.912	-1.068	-0.013
evo	0.062	0.558	0.007	0.149
tra	0.083	0.666	0.008	0.074
ind	0.081	0.747	0162	0.494
fdi	0.021	0.338	0.000	0.024
str	0.787	4.639	0.238	1.522
edu	0.027	0.127	0.000	0.024
pop	0.405	3.416	0.073	0.543
eco	0.747	12.953	9.275	10.736

3.2.3.Data source description

This paper selects five national urban agglomerations: Beijing-Tianjin-Hebei urban agglomerations, Chengdu-Chongqing urban agglomerations, urban agglomerations in the middle reaches of the Yangtze River, urban agglomerations in the Yangtze River Delta and urban agglomerations in the Pearl River Delta as the research objects. The panel data of 92 prefecture-level cities in the urban agglomeration from 2010 to 2019 are used for empirical analysis. The data comes from the statistical yearbooks of provinces in the Statistical Yearbook of China's Cities and the Statistical Yearbook of China's Urban Construction from 2011 to 2020.

4.Analysis of empirical test result

4.1.The impact of coordinated development of Beijing-Tianjin-Hebei urban agglomeration on green total factor productivity

This paper uses the Synthetic Control Method to empirically test the impact of Beijing-Tianjin-Hebei coordinated development on green total factor productivity. First, construct the "synthetic Beijing-Tianjin-Hebei" as a control group, and compare it with the green total factor productivity of the actual Beijing-Tianjin-Hebei urban agglomeration.

Using the synthetic control method and referring to the treatment methods of Liu Naiquan and Wu You[16], the average of all indicators of all prefecture-level cities in the Beijing-Tianjin-Hebei urban agglomeration is regarded as the experimental group, and the prefecture-level cities in the remaining four urban agglomerations are regarded as the cities to be fitted, and the synthetic control method is used to construct a control group weighted in the cities to be fitted. The synthetic control method assigns weights to the control group based on data driven. The weights of each city are non-negative and the cumulative sum of the weights of all cities is 1. According to the synthetic control method, the weights of cities in "synthetic Beijing-Tianjin-Hebei" are shown in Table 3.

Table 3. City weight of control group

City	Huan ggan g	Xiny u	Chan g-sha	Chon gqin g	Tai-zhou	Shen -zhen	Sha ng-hai
Wei-ght	0.38 7	0.21 4	0.09 7	0.06 8	0.06 7	0.05 5	0.03 4

Table 4 shows the comparison of the mean value of prediction variables between the experimental group and the control group before the policy. The difference between the variables is small, indicating that the control group constructed by the composite control method can well fit the economic characteristics of the Beijing-Tianjin-Hebei urban agglomeration.

Table 4. Comparison Table of Forecast Variables

Variable	Real Beijing-Tianjin-Hebei	Synthetic Beijing-Tianjin-Hebei	Absolute value of difference	Error rate
evo	0.147	0.155	0.009	6%
tra	0.089	0.088	0.001	0.9%
ind	0.445	0.458	0.013	3%
fdi	0.022	0.020	0.002	11%
str	1.881	1.654	0.226	12.1%
edu	0.022	0.022	0.000	1.4%
pop	0.762	0.759	0.003	0.4%
eco	4.691	4.905	0.214	4.6%

Figure 1 shows the change trend of green total factor productivity in the experimental group and the control group, in which the gray vertical line in 2015 represents the policy implementation node of the Beijing-Tianjin-Hebei Cooperation Development Plan. It can be seen from Figure 1 that before the implementation node of the policy, the change trend of the green total factor productivity of the real Beijing-Tianjin-Hebei and the synthetic Beijing-Tianjin-Hebei is almost the same, indicating that the synthetic Beijing-Tianjin-Hebei can well fit the real green total factor productivity level before the implementation of the Beijing-Tianjin-Hebei policy. In other words, if there is no policy impact in Beijing-Tianjin-Hebei, its development level after 2015 should be consistent with the synthetic Beijing-Tianjin-Hebei. According to the change of the solid line and the dotted line in Figure 1, after the policy impact of the Beijing-Tianjin-Hebei urban agglomeration in 2015, the green total factor productivity of the real Beijing-Tianjin-Hebei is gradually higher than that of the synthetic Beijing-Tianjin-Hebei. This gap decreased in 2016, and gradually increased after 2017, indicating that the policy impact has indeed improved the level of green total factor productivity of Beijing-Tianjin-Hebei, and this impact has existed for a long time.

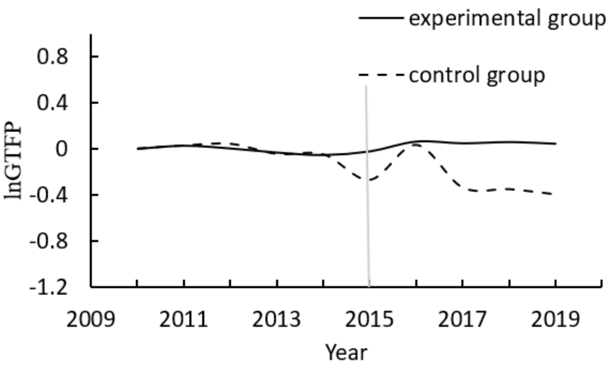


Fig. 1. Green total factor productivity of real Beijing-Tianjin-Hebei and synthetic Beijing-Tianjin-Hebei.

Table 5 shows the green total factor productivity difference between the real Beijing-Tianjin-Hebei region and the synthetic Beijing-Tianjin-Hebei region. The difference between the two groups of data before 2015 was not large. The difference between the two groups was 0.25, 0.031, 0.386 and 0.411 in the four years after the implementation of the policy. By 2019, the difference between the experimental group and the control group was expanded to 0.441. It can be concluded that the coordinated development of Beijing, Tianjin and Hebei has significantly improved green total factor productivity.

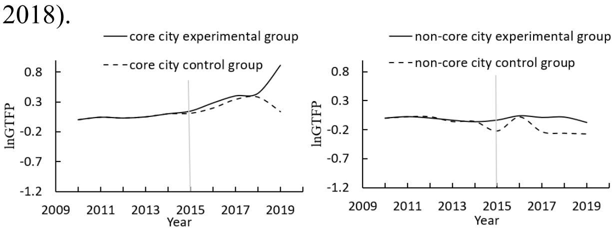
Table 5. Difference of green total factor productivity between experimental group and control group

Year	Difference (Overall)	Difference (Core cities)	Difference (Non-core cities)
2010	0.000	0.000	0.000
2011	0.000	0.000	0.000
2012	-0.037	0.000	-0.025
2013	0.016	0.000	0.019
2014	0.000	0.000	-0.011
2015	0.250	0.037	0.183
2016	0.031	0.087	0.020
2017	0.386	0.061	0.245
2018	0.411	0.063	0.276
2019	0.441	0.778	0.191

This paper further tests the regional heterogeneity of the impact of the coordinated development of Beijing-Tianjin-Hebei urban agglomeration on green total factor productivity. The core cities (Beijing) and non-core cities (cities other than Beijing) of the Beijing-Tianjin-Hebei urban agglomeration are taken as the experimental groups, and the Synthetic control method is used to test the regional heterogeneity of policy effects.

Figure 2 (a) shows the empirical test results of the core city composite control method. See the fifth column of Table 5 for the inter-group difference data between the experimental group and the control group; Figure 2 (b) shows the empirical test results of the composite control method of non-core cities. The data of the differences between the experimental group and the control group are shown in the sixth column of Table 5.

Before the implementation of the policy, the experimental group and the control group in the two regions (core cities and non-core cities) were well matched, indicating that the control group could reflect the "counterfactual" situation that the experimental group assumed that there was no policy impact. After the policy impact in 2015, the experimental group and the control group were significantly separated. By comparing the differences between the experimental group and the control group of the core and non-core cities in Figure 2 in the time dimension, we can find that the coordinated development of the Beijing-Tianjin-Hebei urban agglomeration has a greater role in promoting the green total factor productivity of the non-core cities in the short term (2015-2018), and a stronger role in promoting the core cities in the long term (after 2018).



(a) (b)

Fig. 2. Regional heterogeneity test results

4.2.Robustness test

The previous results show that the level of green total factor productivity between the real Beijing-Tianjin-Hebei and the synthetic Beijing-Tianjin-Hebei is significantly different before and after the policy. This may also be due to other exogenous factors, so this paper will conduct a robustness test to ensure the reliability of the empirical test results.

4.2.1.Data source description

The permutation test is similar to the quasi-rank test method of the rank test in statistics. The cities that are not in the Beijing-Tianjin-Hebei urban agglomeration are randomly selected and assumed to be impacted by the policies of the Beijing-Tianjin-Hebei Coordinated Development Plan, and then a series of prediction error curve distributions are obtained using the Synthetic Control Method. If the error curve of the Beijing-Tianjin-Hebei urban agglomeration processing group is closer to the upper and lower ends, the empirical test results of this paper are reliable. If the average prediction standard deviation of a city's policy implementation node before is large, it means that the city's fitting effect is poor, and the change of the city's green development level after the policy impact may come from the error, not the policy impact. Based on the above principles and referring to the processing method of Liu Youjin et al.[17], delete the urban samples with the square root of the mean square prediction error greater than 1.5 times of the real Beijing-Tianjin-Hebei.

The results of substitution test are shown in Figure 3. The solid line in Figure 3 is the difference between the real Beijing-Tianjin-Hebei and the control group constructed by the synthetic control method, and the dotted line is the difference between the experimental group and the control group selected from other cities in turn for the synthetic control method analysis. Before the policy shock, the error of each group was close to 0, indicating that the fitting effect was generally good.

From a statistical point of view, the probability of a significant difference in the Beijing-Tianjin-Hebei urban agglomeration in 2015 is 1/64 (1.56%), which indicates that the promulgation of the Beijing-Tianjin-Hebei Collaborative Development Planning Outline improves the level of green total factor productivity in Beijing-Tianjin-Hebei, and the result can pass the 5% significant level test. And as of 2019, the probability value is 5/64 (7.81%), which still has good robustness.

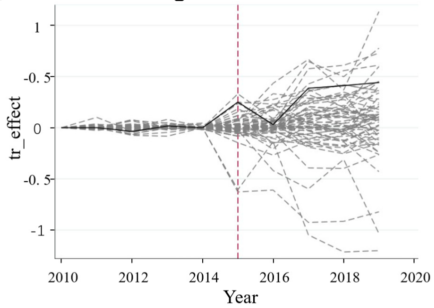


Fig. 3. Permutation test results

4.2.2.Placebo test

Next, use the placebo test to eliminate the impact of missing variables. The specific operation is as follows: In the control group, select the cities most similar to the Beijing-Tianjin-Hebei urban agglomeration, and use the Synthetic Control Method to test the samples of such cities. Since this kind of urban sample is not affected by any policy, the change trend of the green total factor productivity level of the experimental group and the control group should be different from that of the Beijing-Tianjin-Hebei urban agglomeration, which shows that the empirical test results of this paper are reliable.

The similarity between each city and Beijing-Tianjin-Hebei can be expressed by the city weight used to construct the control group (Table 3). The greater the weight, the higher the similarity between the city and Beijing-Tianjin-Hebei, and the more reliable the placebo test results. Huanggang and Xinyu with the largest weight were selected for the placebo test, and the results are as follows. The development tracks of Huanggang, Xinyu and Beijing-Tianjin-Hebei are completely different, which shows that the empirical test results of this paper are robust.

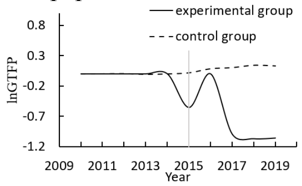


Fig. 4. Results of Huanggang synthetic control method

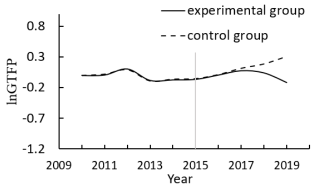


Fig. 5. Results of Xinyu synthetic control method

4.2.3.Differences-in-Differences(DID) method

Finally, the DID model is used to verify the robustness of the results. The model is as follows:

$$lnGTFP_{i,t} = a_0 + a_1 * treat_i * post_t + a_2 * control_{it} + \lambda_t + \mu_i + \varepsilon_{i,t}$$

Where *i* represents the city; *t* represents the year; $lnGTFP_{i,t}$ is the green total factor productivity of the i city in the t year; $treat_i$ is the policy dummy variable, $post_t$ is the time dummy variable, $control_{i,t}$ is the control variable.

Table 6 shows the estimated results of DID, and the control variables are added in column (2). The results show that the Beijing-Tianjin-Hebei coordinated development policy can significantly improve green total factor productivity, which is the same as the conclusion of the Synthetic control method, and further verifies the robustness of the conclusion. Figure 6 shows the parallel trend test results of model (5). There is no significant difference between the experimental group and the control group before the implementation of the policy, but after the implementation of the policy, the green total factor productivity of the experimental group is significantly higher than the control group, meeting the parallel trend hypothesis.

Table 6. Robustness test: Differences-in-Differences

	(1)	(2)
treat*post	0.066**(0.031)	0.086***(0.030)
fdi		-0.889**(0.377)
str		0.002***(0.001)
edu		1.418(1.481)
pop		0.015***(0.003)
lneco		0.352***(0.114)
lngdp		-0.333**(0.135)
Year fixed effect	Yes	Yes
Subclass fixed effect	Yes	Yes
cons	-0.036*(0.021)	-12.488***(1.461)

Robust standard errors in parentheses
***p<0.01,**p<0.05,*p<0.1, the same below

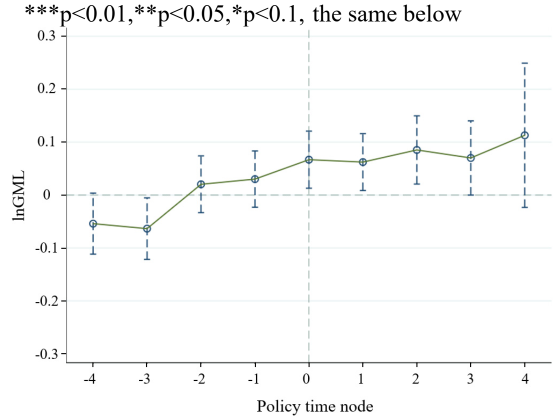


Fig. 6. Parallel Trend Test

5.Further analysis

The above analysis results show that the coordinated development of Beijing-Tianjin-Hebei urban agglomeration can improve green total factor productivity. Another question worth further discussion is how to improve the green total productivity through the coordinated development of Beijing-Tianjin-Hebei urban agglomeration? What is its mechanism?. According to the requirements of the Plan for the Coordinated Development of Beijing-Tianjin-Hebei

Region, industrial upgrading, transportation and environmental protection are the three key areas of the coordinated development of Beijing-Tianjin-Hebei Region. Therefore, this part verifies whether there is a transmission mechanism of mediating effect from these three aspects.

5.1.Models and variables

Using the method of Wen Zhonglin et al.[18] for reference, construct the mediating effect model as follows:

$$lnGTFP_{i,t} = \varphi_0 + \varphi_1(time * treat) + \lambda Control + \gamma_t + \mu_i + \varepsilon_{i,t} \quad (5)$$

$$MV_{i,t} = \eta_0 + \eta_1(time * treat) + \omega Control + \gamma_t + \mu_i + \varepsilon_{i,t} \quad (6)$$

$$lnGTFP_{i,t} = b_0 + b_1(time * treat) + \rho MV_{i,t} + \beta Control + \gamma_t + \mu_i + \varepsilon_{i,t} \quad (7)$$

$lnGTFP$ represents the logarithm of green total factor productivity; *treat* is the policy dummy variable, *time* is the time dummy variable. $MV_{i,t}$ represents intermediary variables, including industrial structure upgrading (UPG), transportation integration (TRA) and ecological environment protection (EVO).

Mediation variables are as follows : (1) *UPG* is calculated by $\sum_{i=1}^{3} i * v_{i,t}$, indicating the ratio of industry *i* to GDP in the *t* year. (2) *TRA* is calculated by entropy method, and the indicators include paved road area, number of buses, number of taxis, length of rail transit route and number of vehicles. (3) *EVO* measurement method is: 1 minus industrial pollution emissions, and industrial pollution emissions are calculated by entropy method.

5.2.Result analysis

Table 7 shows the results of the intermediary mechanism test. The treat*post coefficient in column (1) is significantly positive, indicating that the coordinated development of Beijing-Tianjin-Hebei urban agglomeration can promote the upgrading of industrial structure. The coefficient of treat*post and the intermediary variable Upgrading in column (2) are significantly positive, indicating that the coordinated development of Beijing-Tianjin-Hebei urban agglomeration has an impact on green total factor productivity by changing the level of industrial structure. The treat*post coefficient in column (3) is positive, but it does not pass the significance test. The treat*post coefficient in column (5) is significant, which indicates that the coordinated development of Beijing-Tianjin-Hebei urban agglomeration has improved the ecological environment quality. The treat*post and the intermediary variable Evo coefficient in column (6) are significantly positive, which indicates that the coordinated development of Beijing-Tianjin-Hebei urban agglomeration has improved the green total factor productivity by improving the ecological environment quality.

Table 7. Impact path inspection

Variable	Upgrading		Traffic		Evo	
	(1)	(2)	(3)	(4)	(5)	(6)
	Upgrading	lnGML	Traffic	lnGML	Evo	lnGML
treat*post	0.023** (0.010)	0.098*** (0.030)	0.005 (0.004)	0.085*** (0.030)	0.009* (0.005)	0.083*** (0.030)
UPG		0.515*** (0.100)				
TRA				0.154*** (0.115)		
EVO						0.396** (0.171)
Control variable	controlled					
Year fixed effect	Yes					
Subclass fixed effect	Yes					
cons	3.171*** (0.505)	-10.856*** (1.473)	0.654*** (0.228)	-12.388** (1.469)	1.074*** (0.299)	-12.914*** (1.469)

6.Conclusions and policy recommendations

China's urbanization has entered the era of metropolitan area and urban agglomeration, and the coordinated development of urban agglomeration has become an important driver for achieving green economic development. The results of this study show that :① the coordinated development of Beijing-Tianjin-Hebei urban agglomeration has a significant role in promoting green total factor productivity, and the conclusion is still valid after a series of robustness tests; ② The analysis of regional heterogeneity shows that the coordinated development of Beijing-Tianjin-Hebei urban agglomeration has improved the level of green total factor productivity of core cities and non-core cities, but there are regional differences in the policy effect in the time dimension. The coordinated development has a greater role in promoting non-core cities in the short term and a stronger role in promoting core cities in the long term; ③ The coordinated development of Beijing-Tianjin-Hebei urban agglomeration mainly affects green total factor productivity through industrial structure upgrading and ecological environment protection..

According to the conclusion, the following policy recommendations are put forward:① Timely expand the pilot area of coordinated development of urban agglomeration, and take coordinated development as an important driving force to promote the green development of urban agglomeration economy. Regional green development needs effective inter-governmental cooperation mechanism, and urban agglomeration should actively promote regional coordination and cooperation, eliminate administrative barriers, and establish a sound inter-governmental cooperation mechanism; ② Plan urban agglomeration scientifically and reasonably to alleviate the "big city disease" in the process of urbanization. The concentration of population and industrial activities in the core cities of each urban agglomeration is relatively high, and the accompanying environmental pollution problem will be more serious. Therefore, we should continue to promote the construction of urban agglomeration and copy the successful experience of coordinated development of Beijing-Tianjin-Hebei urban agglomeration. ③ Broaden the multi-dimensional approach of "coordinated development of urban agglomeration to promote green total factor productivity". In the process of implementing the coordinated development strategy, other urban agglomerations should actively promote industrial transfer and docking, optimize the overall industrial structure of urban agglomerations, strengthen joint prevention and control of environmental pollution, avoid governance failures such as the dispersion of responsibilities between cities and the free-rider effect, and improve the green all-factor production rate.

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