ISSN: 2692-7608 DOI: 10.6981/FEM.202309_4(9).0009

Big Data Comprehensive Pilot Zone Construction and Urban Green Technology Innovation

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Abstract

The establishment of National Big Data Comprehensive Pilot Zone is an important driver for promoting green technology innovation.Therefore, based on the panel data of 282 prefecture-level cities in China from 2013 to 2020, this paper utilizes the National Big Data Comprehensive Pilot Zone as a quasi-natural experiment, and uses the double-difference method to explore how it affects green technological innovation.The study outcomes show that the establishment of the pilot zone can effectively improve the level of green technology innovation, which still holds after the robustness test;Mechanism tests have shown that the construction of pilot zones improves green technological innovation mainly by promoting the development of the digital economy;The findings of the heterogeneity analysis show that the construction of the pilot area exhibits significant differences for cities in different zones.This paper reveals the role of comprehensive pilot zones of big data in promoting green technological innovation, enriches the research literature in related fields, and sheds light on the subsequent implementation of comprehensive pilot zones of big data, especially on the realization of green and low-carbon development in various regions.

Keywords

National-level Big Data Comprehensive Pilot Zone; Green Technology Innovation; Location Heterogeneity.

1. Introduction

In the report of the 20th Party Congress, General Secretary Xi Jinping emphasized, "Deeply implement the strategy of revitalizing the country through science and education, the strategy of strengthening the country through talents, and the strategy of innovation-driven development, open up new fields and new tracks of development, and continuously shape new dynamics and new advantages in development."At the same time, The 14th Five-Year Plan calls for green development to be reflected in all areas and aspects of economic and social development and for accelerating the promotion of green and low-carbon development.Green development is an important part of China's high-quality economic development, and the improvement of green technology innovation is indispensable for realizing the transformation of the economy to green development. Green technological innovation is becoming an important game field of global scientific and technological competition and a new round of industrial revolution. Under the background of carbon peak and carbon neutrality, the development of traditional industries and emerging industries can not be separated from the improvement of the development level of green technological innovation.

With the rapid development of big data, the Internet of Things, artificial intelligence and other digital technologies, digital general technology based on a new generation of information technology has increasingly become an important driving force for promoting green economic development, and the all-round integration of big data with all fields of the economy and society has shown an irresistible trend.To this end, in September 2015, the State Council on the

ISSN: 2692-7608 DOI: 10.6981/FEM.202309_4(9).0009

issuance of the Circular on the Outline of Action for Promoting the Development of Big Data proposed to "promote the construction of comprehensive pilot zones for big data in Guizhou and other areas". The following year, in February 2016, Guizhou was approved to build the first national-level comprehensive pilot zone for big data, and in October of the same year, Beijing, Tianjin, Hebei, Inner Mongolia, Shenyang, Henan, Shanghai, Chongqing, and Guangdong were awarded the second batch of pilot construction of pilot zones. The implementation of the big data comprehensive pilot zone policy provides a unique "quasi-natural experiment" for the study of green technological innovation. Existing studies have mainly focused on the digital economy [1], industrial structure [2], and theoretical assessment [3], but there is very little literature on the green innovation effect of the policy. How do pilot zones affect green technological innovation? Does the impact of pilot zones on green technological innovation vary across cities? In the critical period of China's vigorously practicing scientific and technological innovation, green and low carbon, how to scientifically answer the above questions is of great significance to comprehensively understand the impact of the construction and development of pilot zones on green technological innovation, and to reveal the environmental effects of green innovation.

2. Theoretical Analysis and Research Hypothesis

The boosting effect of big data development on green technology innovation is mainly reflected in the following three aspects: at the micro level, the establishment of a comprehensive pilot zone for big data promotes the transformation of enterprises from the traditional factor-driven and investment-driven to innovation-driven, and the "information silo" and "data barriers " is gradually broken, and the increasingly accelerated iterative upgrading of technology as well as the requirements for sustainable development jointly push enterprises to continuously improve their green R&D capabilities to cope with external competition [4]. At the Medium level, the establishment of a comprehensive pilot zone for big data has led to the emergence of new models and new business models, and the convergence and fusion of data resources and industries has led to a new leap in social productivity, and traditional industrial production and manufacturing has been given a new impetus, which further revolutionizes the development mode of traditional industries and improves the level of green technological innovation [5]. At the macro level, big data promote the economy to realize green development through resource integration, scientific decision-making, environmental monitoring and other means, and promote the level of green technological innovation [6]. Based on the above analysis, this paper proposes the following research hypotheses:

Hypothesis 1: Comprehensive big data pilot zones can influence the level of green technology innovation.

3. Research Design

3.1. Model Setting

This paper focuses on the impact of national-level big data comprehensive pilot zones on green technology innovation. To this end, this paper takes the "national-level big data comprehensive pilot zone" as an exogenous policy shock, and constructs a double-difference model to compare the differences in green technology innovation levels between pilot zone cities and non-test zone cities before and after the implementation of the policy. The specific measurement model is as follows:

$$Gti_{it} = \alpha_0 + \beta DID_{it} + \gamma \mathbf{Controls_{it}} + \eta_t + \mu_i + \varepsilon_{it}$$

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Where i and t represent city and year respectively, the explanatory variable is Gti, the core explanatory variable is DID, which is set to 1 if city i is a pilot city of "national-level big data comprehensive pilot zone" in year t, and 0 otherwise. Controlsit is the control variable, μi and ηt represent city fixed effects and time fixed effects, and εit is the random disturbance term.

3.2. Selection of Variables

3.2.1. Explained Variables

Drawing on Lu [7], Cheng[8] study green technological innovation (Gti) is measured by means of green patent grants.

3.2.2. Explanatory Variables

This paper takes the core explanatory variable (Did) of the implementation of the strategy of "national-level big data pilot area" and assigns a uniform value to each prefecture-level city. Since Guizhou Province was approved as the first pilot area in February 2016, and the second batch of pilot cities was announced by the state in October of the same year, because of the large time difference between the two, and considering the policy lag, this paper draws on the study of Chang [9], assigning a value of 1 to the first batch of pilot areas from 2016, and assigning a value of 1 to the second batch from 2017, with the rest of the values being zero.

3.2.3. Control Variables

According to the existing studies [4,9,10], this paper mainly controls the following variables in the process of empirical research: the level of economic development (Pgdp) is expressed by GDP per capita, the level of government expenditure on science and technology (Gov) is expressed by the proportion of financial expenditure on science and technology to GDP, the degree of financial development (Fin) is expressed by the total amount of deposits and loans of financial institutions/GDP, and the level of informationization (Inf) is expressed by the postal and telecommunications revenue/GDP, and industrial enterprises (Num) is expressed by the number of industrial enterprises above scale.

The research sample of this paper is 282 prefecture-level cities in China, and the time span is 2013-2020. The data come from China Urban Statistical Yearbook of past years, of which the patent data come from the State Intellectual Property Office, and the article adopts the interpolation method to deal with the missing values and anomalies in the data.

4. Empirical Analysis

4.1. Benchmark Regression

As shown in Table 1, the results of the benchmark regression have no control variables added in columns (1) and (2), while columns (3) and (4) are the results of adding the control variables explored in this paper. The results show that the estimated coefficients for the Big Data Integrated Experimental Area are significantly positive whether or not control variables are added. Research hypothesis 1 is basically verified, i.e., it indicates that the construction of the comprehensive experimental zone of big data can improve the level of green technological innovation.

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Table 1. Baseline regression

	(1)	(2)	(3)	(4)
	Gti	Gti	Gti	Gti
Did	0.8072***	0.1292**	0.6118***	0.1501***
	(0.0436)	(0.0509)	(0.0696)	(0.0507)
Pgdp			0.1489***	0.0180**
			(0.0362)	(0.0077)
Gov			-3.9584***	-0.7056
			(1.3637)	(1.1687)
Fin			0.1889***	-0.0116
			(0.0673)	(0.0100)
Inf			1.5400*	-0.6132
			(0.8143)	(0.5969)
Num			0.0225	-0.0959**
			(0.0433)	(0.0407)
City	Yes	Yes	Yes	Yes
Year	No	Yes	No	Yes
_cons	4.8557***	4.4375***	3.5506***	4.5163***
	(0.0060)	(0.0196)	(0.2724)	(0.0833)
R2	0.1681	0.7031	0.3585	0.7080
N	2256	2256	2256	2256

Standard errors in parentheses * p < 0.1, ** p < 0.05, *** p < 0.01.

4.2. Parallel Trend Test

Whether the double difference model can be effective also needs to be tested to see if it satisfies the parallel trend assumption. Therefore, model (2) was developed for regression analysis as follows:

$$Gti_{it} = \partial + \sum_{k=-3}^{2} \beta_k D_{i,t0+k} + \gamma Controls_{it} + \eta_t + \mu_i + \varepsilon_{it}$$

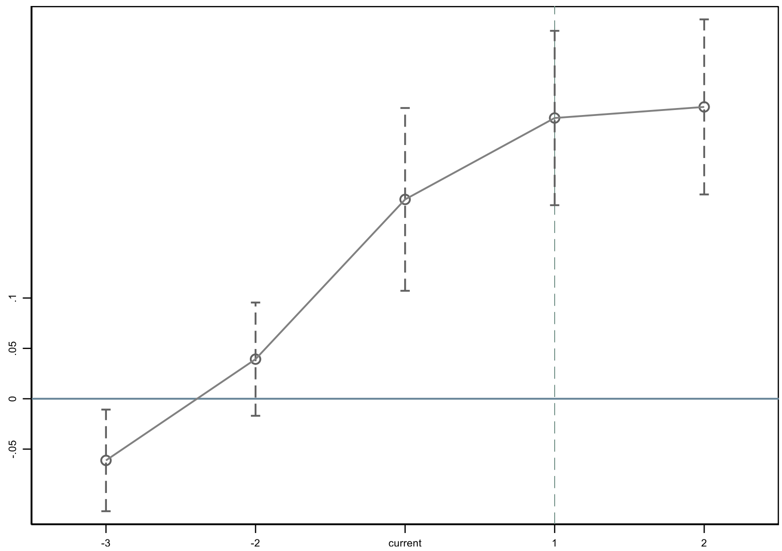

Figure 1. Parallel trend test

ISSN: 2692-7608 DOI: 10.6981/FEM.202309_4(9).0009

As shown in Figure 1, the regression coefficients of each year before the implementation of the strategy of "national-level big data comprehensive pilot zone" are not significant, but after the implementation of the policy, the regression coefficients begin to rise significantly and show a steady increase, which proves that the test of parallel trend is passed, and also indicates that the big data comprehensive pilot zone significantly improves the level of green technological innovation in the city.

5. Robustness Tests

5.1. Replacement of Explanatory Variables

In order to avoid the bias of the estimation results caused by the differences in the variable estimation methods, this paper adopts the green total factor productivity to re-estimate the green technological innovation [11,12], and then substitutes it into the baseline regression model to check the robustness of the results, which are shown in column 1 of Table 2. It can be seen that after replacing the estimation method of the explanatory variables, the estimated coefficient of green technological innovation in the test area is still positive at the 1% significance level indicating the robustness of the previous results.

5.2. Excluding Other Policy Confounds

Other policies implemented during the sample period may confound the baseline regression results. Therefore, this paper further controls for the effects of "low-carbon pilot cities" and "new energy demonstration cities" implemented during the same period. The regression results are shown in columns (2) and (3) of Table 2. After controlling for these two policies separately, the regression results still hold, indicating the robustness of the previous results.

5.3. Excluding the Impact of the COVID-19

Table 2. Robustness test

	(1)	(2)	(3)	(4)
	variables	other policy		COVID-19
Did	0.0388***	0.1821***	0.1876***	0.1956***
	(0.0068)	(0.0461)	(0.0485)	(0.0470)
Pgdp	0.0041***	0.0171	0.0166	0.0159
	(0.0014)	(0.0135)	(0.0156)	(0.0135)
Gov	0.7161***	3.6487**	4.0577*	3.5258**
	(0.1931)	(1.7383)	(2.0757)	(1.7107)
Fin	0.0026	-0.0203	-0.0160	-0.0202
	(0.0025)	(0.0131)	(0.0127)	(0.0132)
Inf	0.0304	-0.5053	-0.6331	-0.4781
	(0.0947)	(0.5131)	(0.6253)	(0.4960)
Num	-0.0370***	0.0359	0.0558	0.0360
	(0.0055)	(0.0347)	(0.0541)	(0.0348)
City	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
_cons	0.9933***	4.1786***	4.1430***	4.1451***
	(0.0134)	(0.0800)	(0.0830)	(0.0850)
R2	0.2977	0.7624	0.6676	0.7630
N	2256	2256	1974	2256

Standard errors in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

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In 2020, China experienced a serious impact of the COVID-19, which had a significant impact on China's economic and social development, therefore, the impact of the 2020 data on the empirical results of this paper exists, so the data of 2020 is deleted to re-run the regression analysis, as shown in column (4) of Table 2, as shown in the results of the regression, the exclusion of the impact of the COVID-19, the estimated coefficients of Did are significantly positive, which further confirms the the robustness of the previous results.

5.4. Placebo Test

Consider the possibility that there are unobservable factors that may bias the results, in addition to the possibility that urban green technology innovation may be affected by the construction of a comprehensive pilot zone for big data and other variables. To rule out this possibility, a placebo test is conducted to enhance the robustness of the empirical results. Specifically, some cities were randomly selected as the experimental group for the placebo test in 2014, 2015, and 2016, while one year was randomly selected as the implementation time of the policy in the above experimental group, and this process was repeated 300 times to obtain 300 estimated coefficients, which resulted in the results of the placebo test shown in Figure 2. As can be seen from Figure 2, the estimated coefficients from the random sample are all distributed around 0 and are characterized by a normal distribution, while the true estimated coefficient (0.2008) is far from this range, which further suggests that there are no other unknown factors influencing the coefficients.

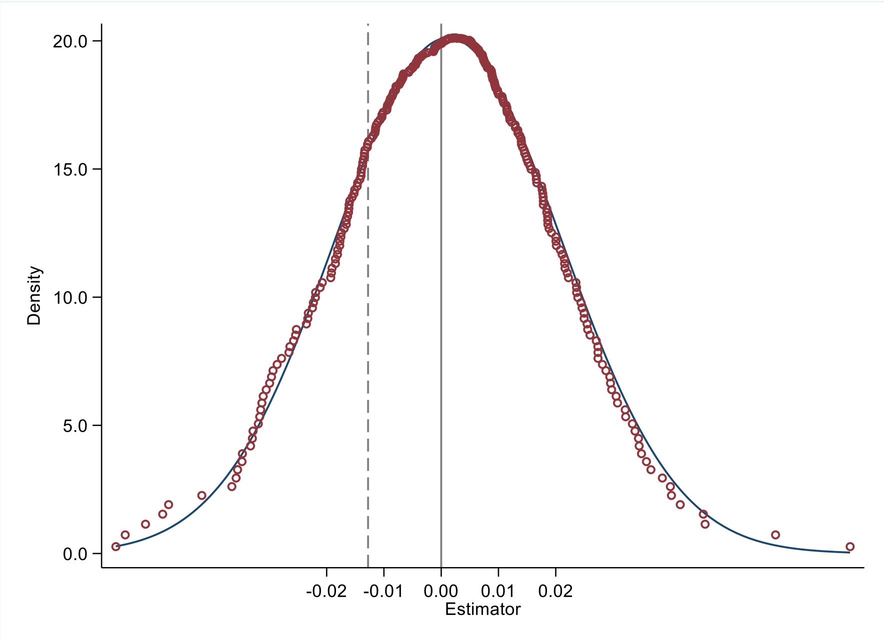

Figure 2. Placebo test

6. Heterogeneity Analysis

Differences in the location of cities may lead to differences in the level of construction in the test area. Therefore, the regressions of the zones where the observations are located subdivided into east, center, and west respectively according to latitude and longitude are used to explain whether the zones where the cities are located can affect the hypotheses of this paper. Columns (1) (2) (3) of Table 3 show the regression results of the divided east, center and west, respectively, from which it can be seen that the impact of the construction of the pilot zone on urban green technology innovation presents a positive and significant level of 5% in both the eastern and central cities, and the estimated coefficients of the eastern cities are slightly larger

ISSN: 2692-7608 DOI: 10.6981/FEM.202309_4(9).0009

than those of the central cities, while there is no effect in the western cities. This is also in line with the expectations of China's economic and social development, most of the cities in the eastern region of China are cities with high level of economic development, and their industrial and talent advantages are also much better than those of the central and western cities, and the construction of the pilot zone cannot be separated from the support of industrial and talent advantages, so that this difference occurs.

Table 3. Heterogeneity analysis

	(1)	(2)	(3)
	East	Center	West
Did	0.1712**	0.1661**	0.0833
	(0.0754)	(0.0677)	(0.0813)
Pgdp	-0.0001	0.1027***	-0.0469**
	(0.0111)	(0.0200)	(0.0191)
Gov	2.3967	6.2088***	2.7421*
	(2.1100)	(2.0448)	(1.5912)
Fin	-0.125***	0.0109	0.0117
	(0.0378)	(0.0068)	(0.0355)
Inf	-0.0641	0.9427	-1.1945
	(0.6999)	(1.2551)	(0.8591)
Num	0.0008	0.3209**	0.4094**
	(0.0359)	(0.1381)	(0.1913)
City	Yes	Yes	Yes
Year	Yes	Yes	Yes
_cons	5.3322***	3.3483***	3.5246***
	(0.1597)	(0.1465)	(0.1457)
R2	0.8024	0.7721	0.7563
N	808	800	648

7. Conclusions and Suggestions

7.1. Conclusions

Based on the panel data of 282 cities in 2013-2020, this paper empirically examines the impact of the construction of national-level big data comprehensive pilot zones on green technological innovation with the pilot policy of "national-level big data comprehensive pilot zones", with the following conclusions.(1) Comprehensive big data pilot zones can significantly improve green technology innovation, a conclusion that still holds after a series of robustness tests such as the parallel trend test, the placebo test, and the exclusion of other policy effects method.(2) The results of the heterogeneity test show that the construction of the pilot area does not play a significant role in green technology innovation in western cities compared to eastern and central cities.

7.2. Suggestions

First, the State and the Government can form different combinations through the scientific design of policy tools, and then continuously improve policies; pilot cities can condense successful experiences and technologies into reproducible and replicable case experiences, and cities can then tailor them to their own development situation and gradually expand the scope of implementation on a national scale.

ISSN: 2692-7608 DOI: 10.6981/FEM.202309_4(9).0009

Secondly, there is significant heterogeneity in the impact of big data comprehensive pilot zones on urban green technology innovation. For the less developed regions in the west, it is necessary to give full consideration to the differences in the city's own development foundation, and give more policy support and assistance to further stimulate the double welfare effect of economy and environment brought about by the construction of the pilot zone.

Acknowledgments

This paper was supported by Anhui University of Finance and Economics Graduate Research and Innovation Program (ACYC2021125) and Provincial Quality Engineering Program for Higher Education Institutions in Anhui Province (2022jyxm006).

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