



Research on the Influence Effect of Open Government Environmental Data on Urban Green Innovation

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Abstract. Open data is a new way for governments to increase transparency, increase public trust and share data elements. In this paper, the green innovation capacity is measured by the number of green patent licenses in the form of quasi-natural experiments. The research shows that the openness of government environmental data directly improves the ability of urban green innovation, and indirectly affects the ability through the enhancement of public attention and the promotion of green technology progress. This effect is more significant in eastern cities and has no relation with urban resource endowment. Therefore, the government should increase the quantity and variety of open data, ensure data quality, standardize and promote the construction of open data platform.

Keywords: Open government environmental data, Urban green innovation, Quasi-natural experiments

1 Introduction

Green innovation is an innovative mode that emphasizes resource saving and environmental improvement by innovation with novelty and value^[1]. In the context of digital economy, the development of urban green innovation especially needs to focus on the new production elements such as technology, knowledge and data. Open government data refers to a series of behaviors of local governments, to improve transparency, enhance public trust and share data elements. Open government environmental data (OGED) directly provide stakeholders with access to relevant local or national environmental information^[2]. Not only it can improve environmental justice for vulnerable groups and narrow 'Data Gap'^[3], but can facilitate cross-country flows of data elements to address international consensus. Therefore, it is very important to analyze whether the OGED can promote the level of urban green innovation or not.

The possible contributions of this paper are as follows: first, it explores the current situation and shortcomings of the opening of specific data types, and enriches the theoretical and empirical research on OGED; reveals the green innovation driving effect of OGED, probes into its mechanism and heterogeneity difference, and provides suggestions for the system construction and development of the next stage of OGED in China.

2 Research Hypothesis

This paper argues that OGED has a positive impact on the level of urban green innovation. OGED reduces the time cost of data acquisition and accelerates the introduction of emerging technologies. OGED also facilitates the exchange and sharing of data, thereby helping the private sector to understand market needs and to spark incremental and disruptive innovation^[4]. Open data also increases government transparency, enabling citizens to make an objective and scientific assessment of the government's environmental performance^[5].

Hypothesis 1: OGED can promote the ability of urban green innovation.

It has been proved by a lot of research that increasing public concern on environment is important to promote the ability of urban green innovation. The more the public pays attention to the environment, the more aware they are of the severity of environmental problems, and the greater the demand for environmental protection, energy saving, low carbon emission reduction and other services and products, it can foster green innovation on the demand side and promote market vitality.

Hypothesis 2: OGED can enhance citizens' environmental attention.

Green technology progress to energy-saving, carbon reduction and pollution reduction concept as the core. It can improve the efficiency of energy input utilization at the enterprise, industrial and macro levels, change the traditional energy production structure^[6], and thus enhance the level of urban green innovation. Existing research shows that data play an important role in driving technological progress and economic growth^[7].

Hypothesis 3: OGED can promote the progress of green technology.

3 Research Design

3.1 Model Setting

This paper takes OGED as a quasi-natural experiment that use naturally occurring events to estimate the effects of policies or interventions, without the need to randomly assign subjects. GI_{it} represents the green innovation level of city i in year t ; $OGED_{it}$ is a dummy variable; When $OGED_{it}$ equals to 1, it means that city i open government environmental data at time when equals to 0 it means vice versa. $Control_{it}$ is the control variable at the city level, ε_i and ε_t represent the urban individual and time fixed effects, ε_{it} is the residual term. The basic model is set as follows:

$$GI_{it} = \alpha + \beta OGED_{it} + \gamma Control_{it} + \varepsilon_i + \varepsilon_t + \varepsilon_{it}$$

3.2 Data Source and Indicator Selection

This paper takes China's prefecture-level cities from 2012 to 2021 as the research object. The data mainly come from the statistical yearbook of China.

Explained variable: Green Innovation. The number of green patents per 10,000 people is used to measure the level of urban green innovation. Explanatory variable: Open Government Environmental Data. The virtual variables are assigned 0 or 1 according to the first published time of the related data under the modules of “Environment” and “Resource”.

Control variables: the level of economic development (lnGDP), which is measured by the logarithm of each city's annual GDP; the Industrial Structure (IS), measured by the ratio of tertiary sector of the economy output to total output, Human Capital (HC) is measured by the number of college students per 10,000 in each city, Population Density (PD) is measured by the ratio of urban population at year-end.

Intermediary variables: Public Attention, as measured by the Baidu Index's combined annual search index of web pages and mobile sites for “Environmental pollution” keywords; Green Technology Progress (TEC), the directional distance function and GML productivity index based on Super-SBM were constructed, and the GML index was decomposed into technical efficiency (EC) and technical progress (TEC).

4 Empirical Analyses

4.1 Benchmark Regression

In Table 1, Model (1) & (3) reported regression results before and after controlling for individual and time-fixed effects after adding only explanatory variables respectively. Model (2) & (4) reported results after adding control variables on this basis. The results show that OGED can significantly promote the level of urban green innovation. After adding control variables, the coefficient of OGED was still significant. *Hypothesis 1* is supported.

Table 1. Results of benchmark regression

	(1)	(2)	(3)	(4)
OGED	1.410***	0.742***	0.466***	0.388***
<i>lnGDP</i>		0.465***		0.464***
<i>IS</i>		0.000***		-0.001
<i>PD</i>		-0.079***		0.138***
<i>HC</i>		0.011***		-0.013***
City	No	No	Yes	Yes
Year	No	No	Yes	Yes
N	2170	2170	2170	2170
Adj. R ²	0.2243	0.5301	0.486	0.5310

4.2 Robustness Test

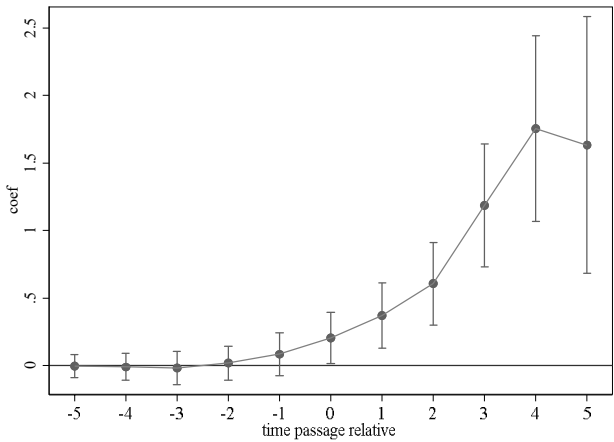


Fig. 1. Result of parallel trend test

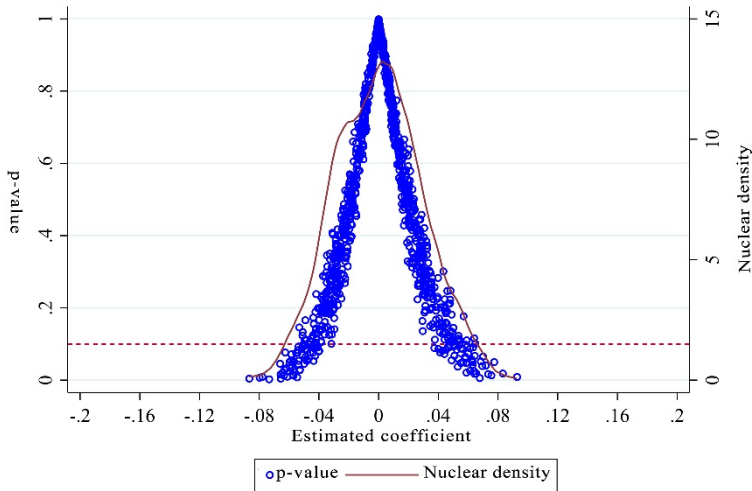


Fig. 2. Results of placebo test

The parallel trend test results are shown in Fig.1. Before OGED, the r_k estimation coefficients were not significant which indicates that there was no significant difference between the treatment group and the control group; After OGED, the r_k estimation coefficients were significantly positive in all years, which means that the green innovation ability of the treatment group and the control group began to form a big difference. Figure 2 shows that after randomization, the coefficients of the explanatory variables are normally distributed around 0. Most of the estimated coefficients have p values

greater than 0.1. This indicates that the significance and intensity of OGED are obviously weakened after double random treatment, which indirectly confirms the robustness of this conclusion.

4.3 Test for Heterogeneity

Different location, factor endowment and other internal conditions of the city will have an impact on the implementation of the same government behavior around the effect. In this paper, the city samples were divided according to geographical location and natural resource endowment, and the heterogeneity was tested by Fischer's Permutation test. The heterogeneity test results are as follows:

Table 2. Results of test for heterogeneity

	East	Other	Resource-based	Other
<i>OGED</i>	0.548***	0.288***	0.543***	0.604***
<i>lnGDP</i>	2.913***	0.571***	0.353***	1.550***
<i>IS</i>	-0.000	0.0115***	0.01***	0.00561**
<i>PD</i>	0.248***	0.0500***	0.0158	0.121***
<i>HC</i>	0.001	0.002***	0.003***	0.001
<i>_cons</i>	-23.91***	-4.822***	-3.028***	-12.05***
City	control	control	control	control
Year	control	control	control	control
<i>Empirical p</i>	-0.259*		0.061	
N	760	1410	560	1610
Adj. R ²	0.580	0.422	0.518	0.445

Table 2 shows the result of test for heterogeneity. The empirical p value of location heterogeneity is significant, which indicates that the impact of OGED on urban green innovation is heterogeneous in the location of the city. Among them, the effect of eastern cities is more obvious. This may be because the eastern cities are the first to open data and have a high level of basic innovation. In addition, there are many urban agglomerations in the eastern region, which means they have better connectivity and can make use of open environmental data more effectively.

The empirical p value of resource endowment heterogeneity is not significant, which indicates that the effectiveness of municipalities in OGED is not affected by cities' natural resources.

4.4 Mechanism Testing

The results in Table 3 show that OGED significantly increased public attention. This may be because that OGED increases the exposure of environmental information and

breaks down the barriers of information transmission between the government and the public. Public could face up to environmental issues more directly in digital form, realize their seriousness and choose a wide range of green products and services. So as to promote green innovation and enhance market vitality. *Hypothesis 2* is validated.

The results also show that OGED has a significant role in promoting green technology progress. Since green technology progress is a continuous process, TEC lags one period to explore the long-term effect. It means that OGED also has a significant long-term promotion effect on the progress of green technology. *Hypothesis 3* is validated.

Table 3. Results of mechanism testing

	Green Innovation	PA _t	TEC _t	TEC _{t+1}
<i>OGED</i>	0.388***	1.908 ***	0.130 **	0.116**
<i>lnGDP</i>	0.464***	6.702 ***	-0.424***	-0.498***
<i>IS</i>	-0.001	-0.027	-0.019***	-0.015***
<i>PD</i>	0.138***	0.695***	0.005	0.015
<i>HC</i>	-0.013***	0.009**	0.001**	0.001**
City	control	control	control	control
Year	control	control	control	control
N	2170	2170	2170	1953
Adj. R ²	0.5310	0.6162	0.3167	0.2976

5 Conclusion & Advice

This paper studies the impact of OGED on urban green innovation. OGED can significantly improve the level of urban green innovation, promote public awareness of the environment and the progress of green technology. The impact is related to the geographical location of the city, but not to the resource endowment of the city itself. Therefore, the government should fully understand the important role of environmental data. It's important to increase data supply, improve data sharing mechanism and regulate relevant laws and regulations. They should also focus on privacy protection in the process. Then, update and check the data in time to ensure their accuracy and enhance data sharing cooperation to build a rich and secure data open platform.

The deficiencies are as follows: some data may be removed or hided so it's hard to get the exact time of OGED more accurately; In the selection of mechanism variables, there is a lack of analysis on the enterprise level such as the awareness of corporate environmental responsibility; China's OGED is not mature enough, so the time span is short.

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