Has "the Belt and Road initiative" Improved the Pollution Level?

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Abstract：Based on the panel data of 278 prefecture-level cities in China from 2008 to 2018, this paper adopts DID method to verify the impact of "the Belt and Road initiative" on pollution level of these cities, the results are still robust through the placebo test and PSM -DID, the mechanism is also analyzed.　The study found that "the Belt and Road initiative" has a significant effect on the emission of wastewater, waste gas and dust of cities in China; the mechanism test shows that "the Belt and Road initiative" has significantly reduced urban environmental pollution by promoting foreign investment, upgrading industrial structure and technological innovation.

1 Introduction

In 2013, Chinese President Xi Jinping put forward "the Belt and Road Initiative ", which aims to make full use of the resources of the countries along the border to achieve the prosperity and development of China's economy, meanwhile boost the economic growth of these countries. "the Belt and Road initiative" has greatly promoted the import and export trade of China.[1] With the increase of China's export trade volume, the pollutants discharged from the production are also increasing.　There is a "double-edged sword" between economic development and environmental issues, there is little academic research on the impact of "the Belt and Road initiative" on the environment.　The research on "the Belt and Road initiative" is mainly carried out from the perspective of economic development and political relationship, and there is little literature on environmental issues, this paper studies the environmental effects of "the Belt and Road initiative" by using the data of municipal pollution emission, which provides a solid theoretical and empirical support for promoting "the Belt and Road initiative".

This paper uses the difference in difference model (DID) to evaluate the environmental performance of "the Belt and Road initiative", according to the basic steps set up by the DID model, two dummy variables are constructed: (1) urban dummy variable C.　Select the initiative node cities as the treatment groups and the non-node cities as the control groups.　(2) The policy time dummy variable T, define the year in 2013 and later as 1, the year before as 0.　In addition, this paper uses the propensity score matching method (PSM) to eliminate the sample selection bias, uses PSM-DID to assess the impact of "the Belt and Road initiative" on environmental pollution more accurately.

2 Materials and Methods

Based on the above analysis, the regression model based on DID method is set as follows:

$$pollution_{it} = \alpha_0 + \alpha_1 did_{it} + \sum_{i=1}^{N} \lambda_j X_{it}$$
$$+ u_i + \varphi_t + \varepsilon_{it} \qquad (1)$$

The interpreted variables $pollution_{it}$ are the pollution l index, the emission of industrial sulfur dioxide waste (So2), industrial waste water (H2o) and dust (Dust).[2]

explanatory variable did_{it}, the interactive items of city dummy variable (c) and policy time dummy variable (t)，i denotes cities, and t denotes time, according to the "Vision and Action for Promoting the Co-construction of the Silk Road" issued by the State Council, 36 node cities are identified, which are assigned a value of 1, and the remaining cities are 0, for the year dummy variable, define the year in 2013 and later as 1, the year before as 0. Control variables X_{it}, including the level of economic development (lnperGDP, logarithm of Per capita GDP), the expenditure on science and technology (st), human capital (lncol, logarithm of the number of College students）and basic construction (lnnet, logarithm of internet households）etc.，u_i denotes individual fixed effect, φ_t denotes time fixed effect，ε_{it} are random disturbances.

The data in this paper are from the Statistical Bulletin of National Economic and Social Development, China's Statistical Yearbook of Cities, Statistical Yearbook of Cities, China's Statistical Yearbook, etc.

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3 Results & Discussion

3.1 Basic Regression

In Table 1, column (1)- (3) is a regression without adding control variables, and column (4) - (6) is a regression test with control variables to test the impact of "the Belt and Road initiative" on emission of waste gas, wastewater and dust. The estimation results show that whether the control variables are added or not, the "the Belt and Road initiative" construction restrains pollutant discharging.

Table 1 Impact of the Belt and Road Initiative on Environmental Pollution

	(1) So2	(2) H2o	(3) dust	(4) So2	(5) H2o	(6) dust
did	-2.649***	-0.214***	-0.128*	-1.774***	-0.143***	-0.191**
	(-8.94)	(-4.66)	(-1.78)	(-5.53)	(-2.74)	(-2.38)
time	-4.449***	-0.358***	-0.475***	-7.667***	-0.354***	-0.570***
	(-20.84)	(-10.73)	(-9.19)	(-12.23)	(-3.49)	(-3.66)
lnperGDP				0.703**	-0.021*	-0.050
				(2.55)	(-1.46)	(-0.73)
st				-0.000***	-0.000***	0.000
				(-4.87)	(-3.31)	(0.68)
……	……	……	……	……	……	……
Sample size	3,038	3,039	3,033	3,038	3,039	3,033
R^2	0.377	0.128	0.295	0.399	0.130	0.311
Urban fixed effect	YES	YES	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES	YES	YES

Note: t statistics are shown in brackets, *, * * and * * * are significant at 10%, 5% and 1%, respectively, the same below

3.2 parallel trend detection

The premise of DID is that the experimental group and the control group must have the similar change trend before being affected by the policy, i.e., parallel trend test is required before the use of DID. "the Belt and Road initiative" was first proposed in 2013, but its top-level design to practical promotion stage has been since 2014, as can be clearly seen from Figure 1, the change trend of So2 emission of the experimental group and the control group in the early stage is basically the same, due to certain time lag in policies, the difference has been shown since 2014, and the difference is very significant after 2015（due to limited space, this paper only reports the parallel trend test of So2）.
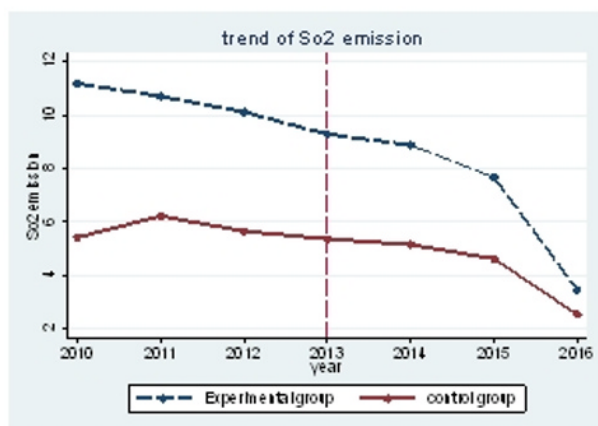

Figure 1 Parallel Trend Test

3.3 robustness test

3.3.1 PSM-DID

As the selection of node cities may be influenced by city size and economic development level, may not be random, the text uses the propensity score matching method (PSM) to match in order to avoid the error caused by such randomness, and then uses DID method to make a new estimation of the obtained samples, table 2 is the regression result, and the regression coefficients are significant and close to the regression coefficients of the original DID model, further verifying the robustness of the model.

Table 2 PSM-DID

variable	(1) So2	(2) H2o	(3) dust
did	-1.682***	-0.119**	-0.180**
	(-5.13)	(-2.34)	(-2.25)
time	-7.885***	-0.381***	-0.542***
	(-11.92)	(-3.75)	(-3.38)
Constant	-23.446***	0.512	8.038***
	(-3.58)	(-0.51)	(-5.09)
Sample	3,038	3,039	3,033
R^2	0.399	0.142	0.33
Urban fixed effect	YES	YES	YES
Year fixed effect	YES	YES	YES

3.3.2 placebo test

In order to eliminate the interference of policies or random factors other than "the Belt and Road initiative", this paper makes up the time when the Initiative was launched to conduct a placebo test. Assuming that "the Belt and Road initiative" was launched 3 years in advance, if the regression result is still significantly positive, it indicates that there are other factors besides "the Belt and Road initiative"; on the contrary, it proves that the above research results are true and reliable. Table 3 shows the results of the placebo test, it can be seen that the estimated results of did1 under fictitious time are not significant, thus the influence of other factors can be excluded.

Table 3 placebo test results.

variable	(1) So2	(2) H2o	(3) dust
did1	-1.980	-0.188	-0.188
	(-1.47)	(-0.36)	(-1.50)
time	-4.515	-0.361*	-0.470
	(-0.56)	(-1.60)	(-0.94)
Sample	3,038	3,039	3,033
R^2	0.399	0.142	0.330
Urban fixed effect	YES	YES	YES
Year fixed effect	YES	YES	YES

3.4 Mechanism analysis

This paper refers to Wen Zhonglin's[3] three-step approach to test the impact of "the Belt and Road initiative" on urban pollution emission through the intermediary variables of foreign investment, industrial structure upgrading and innovation. The logarithm of actually utilized foreign direct investment (lnfdi) is adopted to represent the level of foreign investment, the industrial structure upgrade is measured by the ratio of tertiary industry to secondary industry (indstr), and the number of patents is used to represent the level of urban innovation.

$$pollution_{it} = \alpha_0 + \alpha_1 did + \sum_{i=1}^{N} \lambda_j X_{it} + u_i + \varphi_t + \varepsilon_{it}$$

$$（2）$$

$$M_{it} = \alpha_0 + \beta_1 did_{it} + \sum_{i=1}^{N} \lambda_j X_{it} + u_i + \varphi_t + \varepsilon_{it}$$

$$（3）$$

$$pollution_{it} = \alpha_0 + \gamma_1 did_{it} + \gamma_2 M_{it} + \sum_{i=1}^{N} \lambda_j X_{it}$$
$$+ u_i + \varphi_t + \varepsilon_{it}$$

$$（4）$$

Based on the principle of intermediary effect, if α_1, β_1 and γ_2 all pass the significance test, and the absolute value of γ_1 is smaller than that of α_1, or the significance level decreases, the hypothesis of intermediary effect holds. Table 4 reports the results of the intermediate effect test (due to space limitations, only the results of the So2 mechanism test are reported). Columns (1)(2)(3), (1)(4)(5), (1)(6)(7) represent the test results of foreign direct investment (lnfdi), industrial structure upgrading (indstr) and urban innovation (patent) as intermediate variables respectively.

The explanatory variable in column (2) is the intermediate variable lnfdi, which is significantly positive at the level of 1%, indicating that the initiative has a significant promotion effect on foreign direct investment in node cities. When did and lnfdi are included in the regression in column (3), the absolute value of the estimated coefficient of did is less than the coefficient in column (1), which proves that foreign direct investment plays an intermediary role. The "pollution halo" hypothesis holds that foreign direct investment will bring advanced technology and management experience, local governments can make more effective use of various resources, improve the efficiency of energy use, reduce pollutant emission and improve environmental quality. Similarly, it can be proved that industrial structure upgrading (indstr) and urban innovation (patent) play an intermediary role.

Table 4 Mechanism Test of Environmental Effects of "the Belt and Road initiative"

variable	(1) So2	(2) lnfdi	(3) So2	(4) indstr	(5) So2	(6) patent	(7) So2
did	-2.649***	0.252**	-2.441***	0.509***	-2.431***	13.477***	-1.722***
	(-8.94)	(2.02)	(-8.32)	-4.23	(-8.34)	-26.33	(-5.29)
lnfdi			-0.824**				
			(-3.32)				
indstr					-0.427**		
					(-2.24)		
patent							-0.0687***
							(-6.62)

Sample	3,038	2,986	2,872	3,157	3,033	3,151	3,027
R^2	0.807	0.831	0.819	0.840	0.815	0.841	0.811
Urban fixed effect	YES	YES	YES	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES	YES	YES	YES

"the Belt and Road initiative" reduces the flow cost of factors, promotes the resource optimization of production factors, broadens the market scope, and promotes the structural optimization of export trade,[4] its node cities, due to their geographical location and preferential policies, have a strong "siphon" effect, bringing a large number of factors such as human resources, high-tech enterprises and capital together, thus bringing about the upgrading of industrial structure and the improvement of the local level of technological progress, the resulting reallocation of factors will inevitably have an important impact on pollution emission and energy efficiency. With the continuous progress of technological innovation and the

upgrading and optimization of production technologies, production equipment, production methods and production modes to improve the efficiency of the use of resources and energy, the entire region will realize the transformation from an extensive economy to a technology-intensive economy. The industrial structure will gradually change from a labor-intensive industry with high emission and high energy consumption to a knowledge-intensive industry with low emission and low energy consumption, thus reducing pollution emission.

4 Conclusions and implications

"the Belt and Road initiative" put forward by General Secretary Xi Jinping in 2013 has had a profound impact on all aspects of China's economic and social development. This paper regards the implementation of "the Belt and Road initiative" as a quasi-natural experiment, and evaluates the impact and internal mechanism of "the Belt and Road initiative" on prefecture-level pollution emission through DID model. The study found that "the Belt and Road initiative" effectively curbed urban pollutant emission, including urban sulfur dioxide emission, wastewater emission and dust emission, and this conclusion is still robust after PSM-DID and changing the year of the initiative, in addition, "the Belt and Road initiative" can effectively promote foreign direct investment, industrial structure upgrading and urban scientific and technological innovation, and thus curb pollutant emission.

Based on the above analysis, the following enlightenment can be drawn from this article: We should be cautious about the large amount of foreign direct investment brought by "the Belt and Road initiative", optimize the structure of FDI[5], and gradually increase the proportion of industries such as high-tech industry and high-end service industry, so as to promote the transformation and upgrading of economic structure and industrial structure; according to the different geographical features and natural endowments of each city, formulate the development strategy for each city based on local conditions; governments should break the monopoly of administrative regions, reduce the barriers to factors flow, optimize the spatial distribution of industries; further expand our opening up and promote international exchanges and cooperation in energy-saving and environmental protection industries, new energy technologies and green industry technologies.

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