Assessment of pollution suppression effect of the Smart City Policy——Empirical analysis based on the PSM(Q)-DID model

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Abstract: This paper proposed a PSM(Q)-DID model based on quadratic discriminant analysis, which was under the framework of Difference In Difference (DID) and propensity score matching (PSM). Using panel data from 202 cities in China from 2005 to 2015, this paper evaluated the impact of smart cities on urban environmental pollution based on the PSM(Q)-DID model, and further compared with the regression results of the PSM-DID model. The contribution of this paper lies in that the PSM(Q)-DID model proposed has more accurate scoring ability, which is a richness of the existing policy evaluation methods, and the evaluation results based on this model are further confirmation of the pollution suppression effect of the Smart City Policy.

1. Introduction

Since the reform and opening up, the level of China's urbanization has been continuously improved. The urbanization rate has increased from 17.92% to 58.52% in 2017. At the same time, the problem of environmental pollution is getting worse. Scholars have studied the factors of environmental pollution from different angles, including environmental control [1], international trade [2], fiscal and taxation system [3], urbanization [4, 5] and other aspects. Among these factors, urbanization is closely related to the focus of this paper. A common view is that urbanization has increased environmental pollution. However, we believe that the urbanization in these studies is based on the traditional urban development pattern. It is worth considering whether there is a new pattern that can avoid or reduce environmental pollution.

On December 5, 2012, the central government decided to build smart cities in 90 prefecture-level cities. This kind of policy is considered to be an innovation of the traditional urban development model, which is beneficial to urban environmental governance. Shi Daqian (2017) used the PSM-DID model to evaluate the suppression effect of this innovation to environmental pollution, and believed that the implementation of the Smart City Policy has reduced urban waste gas and wastewater emissions and has a mitigating effect on environmental pollution [6].

Based on the research of Shi Daqian and other scholars, this paper proposes a DID model based on Quadratic Discriminant analysis, and uses year-by-year matching operation [7] in the matching process to assess the impact of the Smart City Policy on environmental pollution.

2. Model and Data

2.1. PSM(Q)-DID model

The implementation of the Smart City Policy in 2012 constituted a quasi-natural experiment, and the PSM-DID model can be use to evaluate the implementation effect. However, the PSM method base on the Logistic regreesion model may underestimate or overestimate the probability of a city is classified as a smart city, which results in bias in matching samples.

This paper uses the Quadratic Discriminant Analysis to estimate the probability that each city is classified as a smart city. It has a higher accuracy than the Logistic model in the matching process in each year. Figure 1 shows the comparison results of the AUC value of the two scoring models. The closer the AUC value is to 1, the higher the accuracy of the model

The DID model can be expressed by Equation 1.

$$y_{it} = \beta_0 + \beta_1 \mathrm{dudt} + \sum_{j=0}^{N} b_i X_{itj} + \epsilon_{it} \quad (1)$$

Where y represents the environmental pollution level, dt represents the policy time dummy variable, which is equal to 1 in 2012, otherwise it is 0, du is the dummy variable of the experimental or control group. The smart city is regarded as the experimental group, denoted by 1, ϵ is the disturbance item, X represents the control variable.

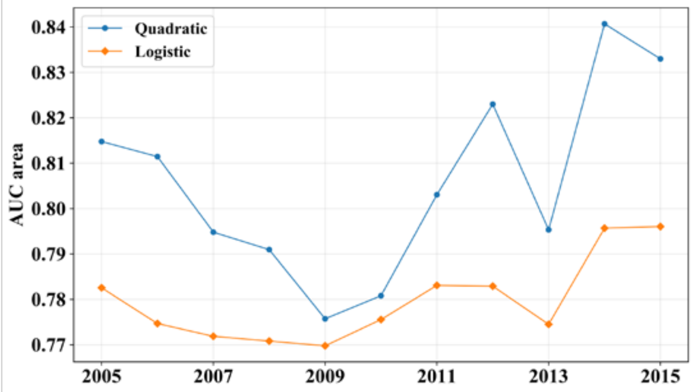

Figure 1. The comparison results of the AUC value of the two scoring models.

2.2. Variables and data description

In this paper, the explanatory variable is the level of urban environmental pollution, which is represented by waste gas and wastewater [8]. Both indicators have two forms: per capita and total.

The control variables selected in this paper are as follows: City openness(open), expressed as the proportion of total imports and exports in GDP [9]. The level of economic development was expressed in logarithm of GDP per capita (lnrgdp) and the square term of the economic development level (lntgdp) was add. Technical innovation (inno), expressed in terms of patents per capita [10]. The industrial structure(ss) is measured by the proportion of the added value of the secondary industry to GDP [11].

3. Empirical results and analysis

In this paper, a one-to-one proximity matching method was used to match the smart city and non-smart city samples in each year.

Table 1 shows the regression results based on the PSM-DID and PSM(Q)-DID models. Both models show that smart city construction has a negative impact on various pollution indicators. The results of the PSM(Q)-DID model show that smart cities have significantly reduced the total wastewater discharge (TWW) by about 16.3% and the per capita wastewater discharge (PCWW) by about 18.9%. In addition, although the PSM(Q)-DID results show that the implementation of the Smart City Policy reduced the total waste gas emissions (TWG) by 4.3% and the per capita waste gas emissions (PCWG) by 6.9%, the coefficient is not significant.

Compared with the PSM-DID model, in the construction equations of the four interpreted variables, the absolute value of the coefficient of the DID term is small, indicating that the PSM-DID model overestimates the pollution suppression effect of the Smart City Policy.

Table.1. The pollution suppression effect of the Smart City Policy based on the PSM-DID and PSM(Q)-DID models

	PSM-DID				PSM(Q)-DID			
Varibles	PCWG	PCWW	TWG	TWW	PCWG	PCWW	TWG	TWW
DID	-0.144*** (0.044)	-0.224*** (0.048)	-0.112*** (0.040)	-0.192*** (0.044)	-0.069 (0.046)	-0.189*** (0.050)	-0.043 (0.041)	-0.163*** (0.046)
lnrgdp	1.439** (0.762)	-1.117 (0.830)	0.741 (0.700)	-1.814** (0.778)	2.679*** (0.813)	-1.49** (0.888)	1.844** (0.725)	-2.325** (0.814)
lntgdp	-0.082*** (0.037)	0.056 (0.040)	-0.044 (0.034)	0.094** (0.037)	-0.144*** (0.039)	0.07**(0.043)	-0.097*** (0.035)	0.118**(0.039)
lninno	0.079*** (0.026)	-0.020 (0.029)	0.047** (0.024)	-0.051* (0.027)	0.071**(0.028)	0.003(0.031)	0.008(0.025)	-0.06**(0.028)
lnopen	-0.017 (0.030)	0.001 (0.033)	0.004 (0.027)	0.023 (0.031)	-0.042(0.034)	-0.042(0.037)	-0.012(0.030)	-0.012(0.034)
lnss	-0.122 (0.205)	-0.077 (0.223)	0.391** (0.189)	0.192 (0.210)	-0.031(0.228)	-0.180(0.249)	0.279(0.203)	0.130(0.228)
_cons	-8.328*** (3.614)	4.260(3.933)	-0.594(3.318)	11.994*** (6.688)	-13.91*** (3.834)	6.905**(4.184)	-5.928*(3.416)	14.885*** (3.835)

Note: Standard deviations in parentheses, *, ** and *** are significant at the levels of 10%, 5% and 1%, respectively.

4. Conclusion

Based on the panel data of 202 prefecture-level cities in China from 2005 to 2015, this paper proposed the PSM(Q)-DID model to empirically test the impact of smart city construction on urban environmental pollution. The conclusion of this paper shows that the smart city has significantly reduced urban environmental pollution, and on average can reduce urban wastewater emissions by 16%-19% which is relatively small compared to the results under the PSM-DID model (19-22%), indicating that PSM(Q)-DID model has a low assessment of the environmental governance capabilities of smart cities. While in the waste gas equation based on the PSM(Q)-DID model, the Smart City Policy’s effect disappears.

This paper verified that the Smart City Policy has a certain suppression effect on environmental pollution. Specifically, the suppression of wastewater discharge is significant, but the impact of waste gas discharge is not significant. In additon,

Although this paper has achieved some results, there are still deficiencies, such as lack of placebo test and mechanism test, etc.

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