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Environmental Regulation and Employment

-- Based on the 11th Five-Year Plan in China

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Abstract

This paper focuses on the SO_2 reduction target based on the 11th Five-Year Plan in 2006 to study the impact of environmental regulation on employment. Based on the panel data in China from 2001 to 2010, this paper use DDD method to find that environmental regulation will reduce employment in polluting industries to a certain extent. From the perspective of different enterprise ownership, we find that private enterprises are more sensitive to environmental regulation than state-owned enterprises, and domestic enterprises are more sensitive to environmental regulation than foreign-owned enterprises. From the perspective of different regions and city scales, we find that the eastern regions and middle-size cities are more sensitive to environmental regulation, while the western regions and small-size cities have a smaller response to environmental regulation.

Keywords

Environmental Regulation; Employment; DDD.

1. Introduction

Environmental pollution is a serious problem for China's sustainable development. The 11th Five-Year Plan not only strengthens the implementation of environmental regulation, but also requires the protection of employment. Therefore, it is particularly critical to deal with the relationship between environmental regulation and employment. With the rapid growth of China's economy, the problem of environmental pollution is becoming more and more serious, SO_2 emissions and other air pollution problems are the key targets of China's government.

The scholars' analysis of the impact between environmental regulation and employment can be roughly divided into three categories: First, Mishra and Smyth (2012) believe that environmental regulation will directly affect employment by increasing enterprises' production costs, thus leading to the increase of employment. Second, Berman and Bui (2001) believe that stricter environmental regulation will increase employment through the input of quasi-fixed factors such as pollution reduction technology. Third, Wang Yong (2013) found that there is a nonlinear relationship between environmental regulation and employment by using China's data. Therefore, the relationship between environmental regulation and employment still needs to be analyzed through empirical test. This paper is based on the analysis of the impact of environmental regulation policies on employment, in order to find a balance between environmental regulation and employment.

2. Background

In recent decades, with the rapid growth of China's economy, China's air pollution has become more and more serious. Considering the long-term sustainable development of China's economy, the central government began to restrict SO_2 emission from the 9th Five-Year Plan (1996-2000). In 1998, the two-control-zone (TCZ) policy had been implemented to limit the

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SO_2 emissions. Then in the 10th Five-Year Plan (2000-2005) proposed to ensure that the two-control zone's SO_2 emissions will be 20% less than 2000 levels.

However, the effect of TCZ policy is not obvious, so during the 11th Five-Year Plan (2005-2010), the central government implement more stringent measures to ensure that SO_2 emissions will reduce by 10% in 2010 compared with 2005. In order to do that, the government further formulate the provincial-level SO_2 reduction target. The target is based on a lot of factors, including economic development level, industrial structure, environmental capacity and etc. Figure 1 shows that the total SO_2 emissions and the industrial SO_2 emissions have shown a significant downward trend after 2006.This means that the 11th Five-Year Plan has achieved remarkable results.

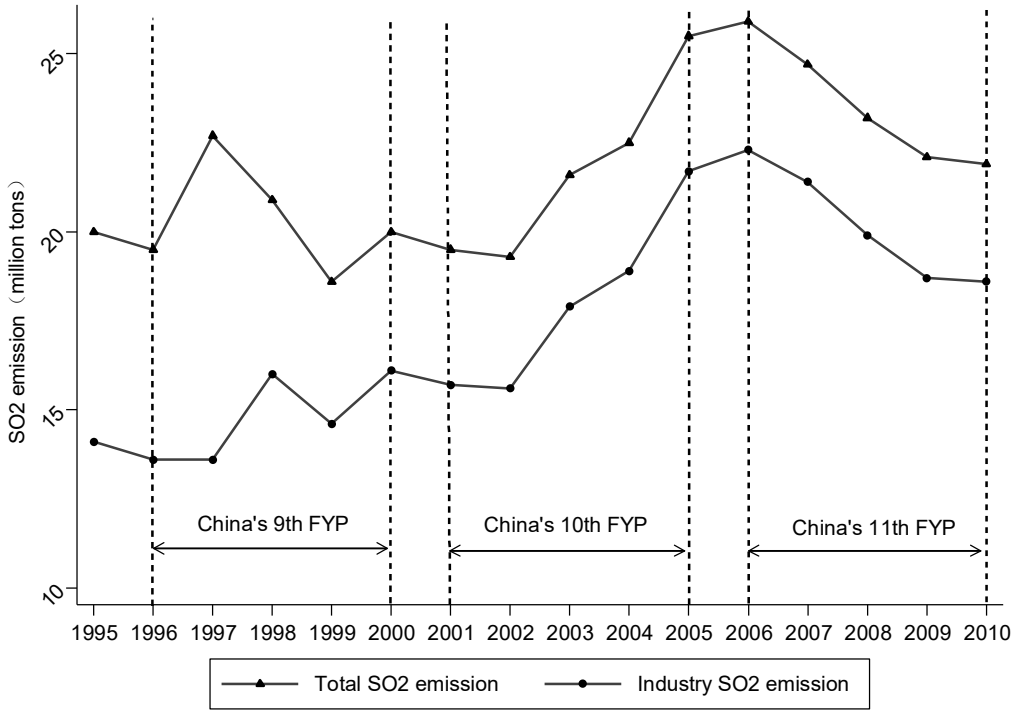

Fig 1. SO_2 emission trend (1995-2010)
Data Source: China Statistical Yearbooks (1996-2011)

Generally speaking, the provinces with more serious pollution undertake higher SO_2 reduction targets. The provincial-level SO_2 reduction target is shown in Figure 2, we found that SO_2 reduction target in the eastern regions generally have a relatively large pollution reduction target, while the central and western regions have a relatively small-size one. Because the document did not give the city-level SO_2 emission reduction targets, and city-level SO_2 emissions are difficult to be accurately collected, but can be estimated from the industrial production activities of each city. Therefore, according to the paper of Chen (2018), we use the output value of two-digit industry in 2005 to estimate the SO_2 reduction target of each city:

$$\Delta SO_{2\ c,05\text{-}10} = \Delta SO_{2\ p,05\text{-}10} \times \sum_{i=1}^{39} \mu_i \frac{output_{ci}}{output_{pi}} \quad (1)$$

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The second item on the right side of the equation (1) is the weighted average value of the output value of two-digit industry in city c that is calculated by taking the proportion of SO_2 emission of each industry in 2005 with μ_i as the weight.

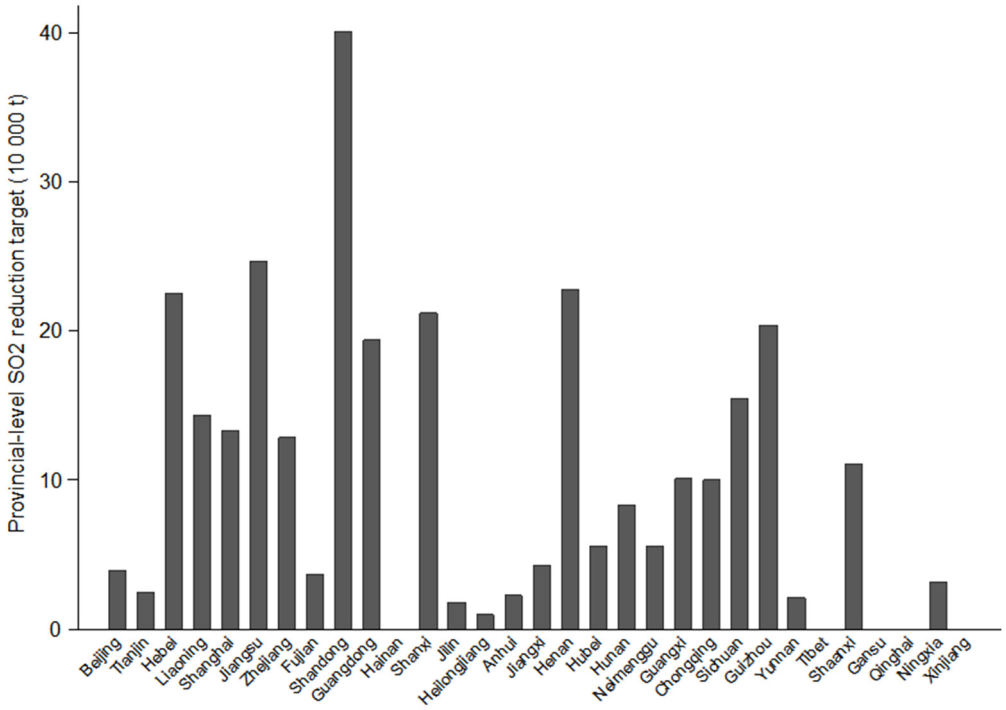

Fig 2. Distribution of provincial-level SO_2 reduction target

Data Source: The document "Reply to the Pollution Control Plan During the Eleventh Five-Year Plan," issued by the China State Council in 2006

3. Empirical Research

3.1. Empirical Strategy

DID can't eliminate interference of other policies and interference of regionsal characteristics that change with time during the implementation of policies. Based on this consideration, this paper combines three kinds of differences: time difference (before and after the 11th Five-Year Plan) and city difference (city-level SO_2 reduction targets) and industry differences (pollution intensity of different industries), according to Shi (2018), we use the SO_2 emission intensity to measure the pollution emission intensity of various industries. DDD regression model is as follows:

$$\ln Employ_{ict} = \beta \times \ln Target_c \times Post_t \times \ln SO_{2i} + \mu_{ct} + \delta_{ci} + \gamma_{ti} + \varepsilon_{ict} \quad (2)$$

$Employ_{ict}$ is the number of employees in industry i, in city c and year t. $Target_c$ is the SO_2 reduction target in city c. $Post_t$ is the dummy variable equal to 0 for 2001-2005 and 1 for 2006-2010, representing the time of policy implementation. SO_{2i} is the SO_2 emission intensity. μ_{ct} ,δ_{ci}, γ_{ti} and ε_{ict} are respectively fixed effect and error term.

3.2. DATA

This paper use 346 prefecture-level administrative areas of empirical research samples of China from 2001 to 2010, the data is from China Industry Business Performance Data.

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Industry-level data. In this paper, the SO_2 emission intensity of various industries in China in 2007 is used to measure the pollution degree of all 39 two-digit industry (Figure 3).

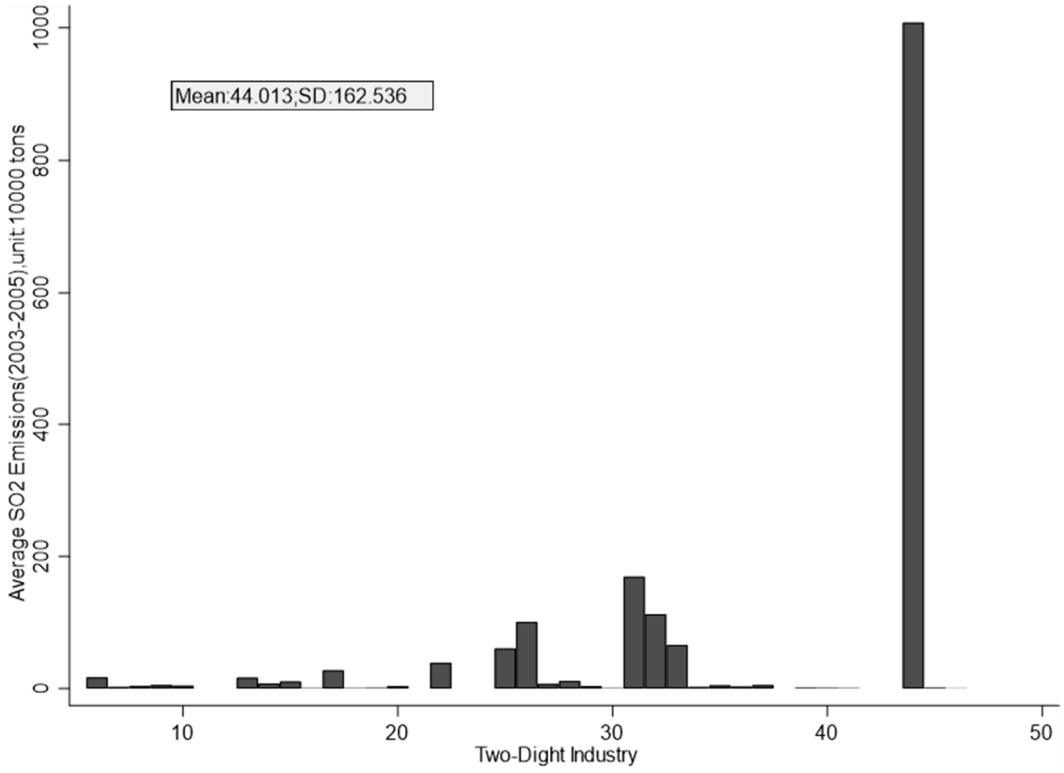

Fig 3. Distribution of industrial SO_2 emissions (2003-2005 average)
Data source: China Statistical Yearbooks (2004-2006)

Instrumental variable. According to Hering and Poncet (2014), we use the average ventilation coefficient from 2000 to 2004 as the instrumental variable.10 meters high wind speed information and boundary layer height (0.125° unit used for measuring 0.125° grid mixing height) are collected in the ERA - Interim database of ECMWF.

Table 1. Reports the detailed variable definitions and summary statistics

Variable	Mean	S.D.	Obs	Economic explanation
ln$Employ$	5.183	3.724	134,940	Logarithm of the number of employees
$Target$	0.875	1.615	346	The city-level SO_2 reduction target
lnVc	7.363	0.801	346	Logarithm of ventilation coefficient
lnSO_2	3.268	1.863	39	Logarithm of Industry SO_2 emission intensity

4. Results

4.1. Basic Analysis

Table 2 shows the average effect of environmental regulation on employment. The study found that the regression coefficient of SO_2 reduction target to employment is significantly negative.

The above conclusions means that, with the implementation of environmental regulation policies, enterprises in polluting industries will choose to reduce employment in the drive of profit maximization.

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Table 2. Impact of environmental regulation on employment

	$\ln Employ$
$\ln Target \times Post \times \ln SO_2$	-0.015***
	(0.001)
City-year Fixed effects	Yes
Industry-year Fixed effects	Yes
City-industry Fixed effects	Yes
Obs	134, 940
Adjusted R^2	0.903

Notes: (1) Standard errors in parentheses are clustering over city level. Variables are collapsed to the city-industry-year level.
(2) * p < 0.1, ** p < 0.05, *** p < 0.01.

4.2. Time Trend

According to Jacobson (1993), the test for variation over time model is set as follows:

$$\ln Employ_{ict} = \sum_{j=-5}^{4} \beta_t \times \ln Target_c \times Year_{2006+j} \times \ln SO_{2i} + \mu_{ct} + \delta_{ci} + \gamma_{ti} + \varepsilon_{ict} \quad (3)$$

$Year_{2006+j}$ represents the year dummy variable, β_t represents marginal impact of SO_2 reduction target on employment in year t. The time trend result is shown in Table 3. This paper finds that the estimated coefficient of environmental regulation on employment is not significant before 2006, indicating that there is no significant difference between the treatment group and the control group. Since the implementation of the policy in 2006, environmental regulation has a significant negative effect on employment, and the estimated coefficient shows a trend of increasing year by year. The results show that the policy effect of environmental regulation on employment is immediate, and the annual effect of the policy increases year by year.

4.3. Robust Test

To solve the endogeneity problem in the model, according to Cai (2016), this paper uses average ventilation coefficient from 2000 to 2004 was used as Instrumental variables of SO_2 reduction targets.

According to Jacobson (2002), two forces determine the degree of pollution diffusion. Specifically, the ventilation coefficient is defined as the product of the wind speed and the height of the mixing layer. The ventilation coefficient will increase as the air pollution diffuses, so the ventilation coefficient is inversely proportional to SO_2 reduction target.

The results of the instrumental variable method are reported in Table 4. The results of the first stage are shown in columns (1), the SO_2 emission reduction target is negatively correlated with the ventilation coefficient (significant at the 1% level). F values in the first stage are significantly more than 10, indicating that the ventilation coefficient selected in this paper is not a weak instrumental variable (Olney, 2016). The results of the second stage are shown in column (2). It is found that the impact of environmental regulation on employment is still significantly negative after the introduction of ventilation coefficient as an instrumental variable, and the estimated coefficients are almost same as the results of the basic regression. The results indicate that the results of this paper are not caused by the endogeneity of policies or sample selection bias.

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Table 3. Testing pre-existing time trend

	ln$Employ$
ln$Target \times 2002 \times \ln SO_2$	0.002
	(0.006)
ln$Target \times 2003 \times \ln SO_2$	-0.001
	(0.005)
ln$Target$×2004×lnSO_2	-0.004
	(0.005)
ln$Target \times 2005 \times \ln SO_2$	-0.007
	(0.004)
ln$Target \times 2006 \times \ln SO_2$	-0.009**
	(0.005)
ln$Target \times 2007 \times \ln SO_2$	-0.013***
	(0.005)
ln$Target \times 2008 \times \ln SO_2$	-0.018***
	(0.005)
ln$Target \times 2009 \times \ln SO_2$	-0.021***
	(0.005)
ln$Target \times 2010 \times \ln SO_2$	-0.024***
	(0.005)
Constant	5.121***
	(0.026)
City-year Fixed effects	Yes
Industry-year Fixed effects	Yes
City-industry Fixed effects	Yes
Obs	134, 940,
Adjusted R^2	0.904

Notes: (1) Standard errors in parentheses are clustering over city level. Variables are collapsed to the city-industry-year level.

(2) * p < 0.1, ** p < 0.05, *** p < 0.01.(3) The year 2001 is the omitted category.

Table 4. Estimates

	(1)	(2)
	First stage	Second stage
	ln$Target \times Post \times \ln SO_2$	ln$employ$
ln$Vc \times Post \times \ln SO_2$	-1.363***	
	(0.228)	
ln$Target \times Post \times \ln SO_2$		-0.380***
		(0.077)
F value	35.61	5.18
Obs	134, 940	134, 940
Adjusted R^2	0.891	-0.112

Notes: (1) Standard errors in parentheses are clustering over city level. Variables are collapsed to the city-industry-year level.

(2) * p < 0.1, ** p < 0.05, *** p < 0.01.

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4.4. Heterogeneity Test

Although this paper has demonstrated the overall economic benefits of environmental regulation on employment, further research is needed to demonstrate whether there are certain differences in employment between different enterprise ownership, different regions and different city scales.

4.4.1. Ownership

This paper intends to explore whether environmental regulation will have different effects on employment of enterprises with different ownership. The results are shown in Table 5. According to columns (1)-(2), this paper finds that the employment of private enterprises is more sensitive to environmental regulation. Although the employment of state-owned enterprises is also significantly negative, the estimated coefficient is small-size, which indicates that private enterprises are more likely to reduce their labor demand in the face of environmental regulation than state-owned enterprises. The above heterogeneous effects may be attributed to the following reasons: First, private enterprises are more flexible in resource reallocation and efficiency improvement than state-owned enterprises; Second, state-owned enterprises usually have social goals such as improving the local investment environment rather than purely maximizing profits. When facing environmental regulation policies, state-owned enterprises tend to take the unemployment rate into consideration. Therefore, they are usually reluctant to directly reduce employment.

Table 5. Testing for heterogeneous regulation effects

	(1)	(2)	(3)	(4)
	SOE	Private	Foreign	Domestic
$\ln Target \times Post \times \ln SO_2$	-0.004***	-0.016***	-0.006***	-0.014***
	(0.001)	(0.001)	(0.001)	(0.001)
Constant	2.745***	4.232***	2.024***	4.955***
	(0.004)	(0.004)	(0.003)	(0.004)
City-year Fixed effects	Yes	Yes	Yes	Yes
Industry-year Fixed effects	Yes	Yes	Yes	Yes
City-industry Fixed effects	Yes	Yes	Yes	Yes
Obs	134, 940	134, 940	134, 940	134, 940
Adjusted R^2	0.803	0.881	0.854	0.894

Notes:(1) Standard errors in parentheses are clustering over city level. Variables are collapsed to the city-industry-year level

(2) * p < 0.1, ** p < 0.05, *** p < 0.01.

According to column (3)-(4), this paper finds that the impact of environmental regulation policies on both domestic and foreign enterprises is significantly negative. Compared with domestic enterprises, foreign enterprises are also significantly negative, but the coefficient is smaller than that of domestic enterprises, which indicates that domestic enterprises are more likely to reduce their labor demand in the face of environmental regulation policies than foreign enterprises. One possible explanation is that foreign companies tend to be subject to stricter environmental regulation at their country and are therefore less sensitive to changes in China's environmental regulation.

4.4.2. Regions and Scales

Due to the vast territory of China, there are great differences in economic development level and industrial structure between different regions and different city scales.

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Therefore, this paper conducts a regression study on the impact of environmental regulation on employment in different regions by using samples from eastern, central and western regions and large, middle-size and small-size cities. The results are shown in Table 6. Column (1)-(3) indicates that environmental regulation have a negative and significant impact on employment in the eastern and western regions. Although the coefficient in the central regions is also negative, it is not statistically significant. As shown in column (4)-(6), environmental regulation has a significant negative impact on employment in large and middle-size cities, among which the impact coefficient is the largest in middle-size cities.

The results show that environmental regulation is more likely to reduce employment in the eastern regions and middle-size cities, but less likely to reduce employment in the central regions and small-size cities. One possible explanation is that there are differences in labor market structure and employment distribution between different regions and scales, so environmental regulation will have different effects on different regions and scales.

Table 6. The regulation effects on labor demand in different regions

	Regions			Scales		
	(1)	(2)	(3)	(4)	(5)	(6)
	East	Central	West	Large	Middle	Small
$\ln Target \times Post \times \ln SO_2$	-0.013***	-0.004	-0.009***	-0.008***	-0.011***	-0.006***
	(0.003)	(0.005)	(0.001)	(0.002)	(0.003)	(0.002)
Constant	6.852***	5.467***	3.624***	6.705***	5.362***	2.957***
	(0.002)	(0.010)	(0.009)	(0.002)	(0.007)	(0.016)
City-year Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry-year Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
City-industry Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Obs	39, 780	42, 510	52, 650	51, 480	43, 290	40, 170
Adjusted R^2	0.928	0.876	0.875	0.910	0.881	0.857

Notes: (1) Standard errors in parentheses are clustering over city level. Variables are collapsed to the city-industry-year level.

(2) * p < 0.1, ** p < 0.05, *** p < 0.01.

5. Conclusion

Behind China's rapid economic development, the extensive development model of high pollution and high energy consumption has also brought serious environmental pollution. In recent years, how to deal with the relationship between environmental regulation and employment has become a hot issue in environmental economics. Considering the sustainable development of China's economy, environmental regulation will be strengthened continuously. Therefore, a comprehensive evaluation of the impact of environmental regulation policies on employment is helpful for policy makers to formulate relevant policies that can achieve sustainable development of environment and employment through understanding the employment effect of environmental regulation. This paper focuses on the SO_2 reduction target based on the 11th Five-Year Plan in 2006 to study the impact of environmental regulation on employment. Based on the panel data from 2001 to 2010 in China, this paper use DDD method to find that environmental regulation will reduce the labor demand of enterprises in polluting industries to a certain extent, and the annual effect increases year by year over time. From the perspective of different enterprise ownership, we find that private enterprises are more sensitive to environmental regulation than state-owned enterprises, and domestic enterprises are more sensitive to environmental regulation than foreign-owned enterprises. From the perspective of different regions and city scales, we find that the eastern regions and middle-

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size cities are more sensitive to environmental regulation, while the western regions and small-size cities have a smaller response to environmental regulation.

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