[*IMPACT OF ENERGY-SAVING POWER GENERATION DISPATCH POLICY ON POLLUTANT EMISSIONS AND ENERGY CONSUMPTION IN CHINA*]

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Overview

The scale of power grid and installed power generation in China both rank first of the world. However, the phenomenon of abandoning solar and power become serious in recent years. In order to improve the energy useage efficiency, achieve energy conservation and alleviate the environmental pollution caused by China's electricity sector, the government proposes to implement energy saving power generation dispatching policy.
This paper investigates whether the policy which is initiated in Jiangsu, Guangdong, Henan, Sichuan and Guizhou from 2008 really works in China. We prove that for the power plants in the five provinces, if the coal consumption when generating one unit of electricity is increased by one percent compared to the level before the policy intervention, the electricity generation hours will be reduced by 0.03 percent. If the SO_2, NO_x and dust emissions per unit of electricity generation reduce by one percent, the electricity generation hours will be assigned more by 0.103, 0.085 and 0.069 percent, respectively. We further do a battery of robustness checks to prove that the results we obtain previously are crediable. Finally, we calculate the saved coal and reduced pollutant emissions in two situations. We find that the amounts of saved coal and reduced pollutant emissions of this policy are considerable.

Methods

Triple difference method is employed as the method and identification strategy. The specific formula is as follows:

$$\ln Hours_{ipt} = \alpha + \beta_1 \ln Key_{ipt} * Post_t * Policy_p + X_{ipt} + \eta_i + \lambda_t + I_p + \varepsilon_{ipt} \quad (1)$$

Where, the $Hours_{ipt}$ indictes the electricity generation hours for power plant i in province p at year t. Key_{ipt} represent the emission intensities of SO_2, NO_x or dust as well as the coal consumption intensity for power plant i in province p at year t. $Post_t$ is the dummy variable for time of policy implementation. It is equal to 1 when the policy has been implemented and zero otherwise. $Policy_p$ is the dummy variable for whether the policy is implemented in province p. X_{ipt} are other control variables. η_i, λ_t, I_p indicate the fixed effects of power plant, year and province respectively.

Results

1. Whether more electricity generation hours are assigned to the power plants with lower intensities of pollutant emissions and coal consumption

Table1 The triple difference results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
DisPostSo2	-0.0422*	-0.103***						
	(-1.71)	(-3.07)						
DisPostNox			-0.0409**	-0.0849***				
			(-1.96)	(-3.22)				
DisPostDust					-0.0304*	-0.0691***		
					(-1.85)	(-3.19)		
DisPostEne							-0.0136	-0.0303***
							(-1.34)	(-2.88)
Powerplant	Y	Y	Y	Y	Y	Y	Y	Y
Provincial	Y	Y	Y	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y	Y	Y	Y
ln_openness	N	Y	N	Y	N	Y	N	Y
ln_industrial structure	N	Y	N	Y	N	Y	N	Y
ln_urban rate	N	Y	N	Y	N	Y	N	Y

ln_GDP per capita	N	Y	N	Y	N	Y	N	Y
ln_fuel	N	Y	N	Y	N	Y	N	Y
ln_gasn	N	Y	N	Y	N	Y	N	Y
ln_gasc	N	Y	N	Y	N	Y	N	Y
N	4231	4231	4231	4231	4231	4231	4231	4231
R2_a	0.290	0.295	0.290	0.295	0.290	0.295	0.290	0.295

Note: The dependent variable in all the eight columns are the log value of the power generation hours. The standard errors are calculated when clustering at the power plant level. The "Powerplant", "Provincial" and "Year" mean individual fixed effect, provincial fixed effect and year fixed effect, respectively. ln_openness, ln_industrial structure, ln_urban rate and ln_GDP per capita means the log value of openness, industrial structure, urban rate and GDP per capita respectively. These four variables are at the provincial level. ln_fuel, ln_gasn, ln_gasc means the log value of the average sulfur content of fuel coal, number of exhaust gas treatment facilities and capacity of exhaust gas treatment facilities. "DisPostSO$_2$", "DisPostNox", "DisPostDust", "DisPostEne" mean the crossing multiply terms of treatment dummy variable, after policy implementation dummy variable and SO_2 intensity, NO_x intensity, Dust intensity and energy intensity respectively.

From Table 1, it can be seen that when controlling the fixed effects of individual, provincial and year, four other control variables at provincial level as well as the control variables at the power plant level, the signs of the crossing terms are all negative and significant. This signifies that the higher the pollution intensities or the energy consumption intensity are, the less power generation hours will be assigned to the power plant. In this way, it proves the effectiveness of the energy-saving electricity generation dispatch policy. Because the theme of the policy is to establish the electricity generation dispatching mode based on the energy consumption and emissions, the results in Table 1 show that compared with those power plants where the new dispatching policy is not implemented and the time before the policy implementation, if the levels of energy consumption and emissions are higher than those before, the electricity generation hours will be assigned less by the dispatching center.

Regarding the specific sizes of the influences, when maintaining other variables unchanged, one percent increase in SO_2 emission intensity compared with the level before the treatment will result in 0.103 percent decrease in electricity generation hours averagely for the power plants. For NOx emission and dust emission intensity, one percent increase in them will make the power generation hours decrease by 0.08 percent and 0.07 percent respectively. One percent increase in energy consumption intensity will drop the power generation hour by 0.03 percent. We can further calculate the decreased emissions of the pollutants and the saved coal when comparing the actual emissions and the consumption and the counterfactual ones when assuming there is no policy implementation. This will be discussed in great detail in the following parts.

2. The reduced pollutant emissions and saved coal

We will analyze the impacts on the pollutant emissions and coal consumptions after the policy in two situations in this section. In situation 1, because more electricity generation hours are assigned to the power plants with lower pollutant emissions and coal consumption intensities and in this way, more electricity will be produced compared to the situation if the policy were not implemented. We thus assume that the amount of more produced electricity is generated by those power plants with higher pollutant emissions and coal consumption intensities. Then the gap of the amount of pollutant emissions and coal consumptions between the two kinds of power plants are the reduced pollutant emissions and saved coal consumption.

Similarly, the cases are on the contrary in situation 2. Because less electricity generation hours are assigned to the power plants with higher pollutant emissions and coal consumption intensities, less electricity is produced compared to the situation in which there were no policy intervention. If the amount of less produced electricity is generated by the power plants with lower pollutant emissions and coal consumption intensities, and then the gap of the amount of pollutant emissions and coal consumptions between the two kinds of power plants are the reduced pollutant emissions and save coal consumption. The results are shown in Table 6.

Table 6. The saved coal consumption and reduced pollutant emissions (thousand tons)

Situation 1	coal	so2	nox	dust
Guangdong	1855.32	1080.84	423.50	1021.84
Guizhou	427.10	1352.69	191.97	1501.39
Henan	31912.48	6577.95	4003.78	6030.38
Jiangsu	2481.75	6134.26	2944.89	3960.46
Sichuan	2227.27	1292.10	313.93	1212.25
Total	38903.92	16437.84	7878.08	13726.33
Situation 2	coal	so2	nox	dust
Guangdong	152.67	26.90	22.62	1.90

Guizhou	7.18	51.69	0.71	0.57
Henan	161.35	38.32	6.27	4.93
Jiangsu	173.00	385.68	505.78	116.58
Sichuan	46.80	49.44	14.96	2.59
Total	541.00	552.03	550.35	126.57

From Table 6, the saved coal consumption and reduced pollutant emissions are all greater in situation 1 than situation 2. Because the amount of more produced electricity is larger than the amount of less produced electricity if there were no policy implementation, and in situation 1, the hypothetical power plants are characterized by lower emission and coal consumption intensities, the results are reasonable.

To be more specific, the total amount of saved coal is nearly 40 million tons in situation 1, which is approaching the total coal consumption in manufacture of textile of China in 2016. The reduced SO_2 and dust emissions reach 16 and 14 million tons respectively, which are 2.14 and1.38 million tons less than the total SO_2 and dust emissions in whole China in 2015. For the reduced NO_x, it is about half of the total emissions in whole China in 2015.

In situation 2, although the saved coal and reduced pollutant emissions are less than those in situation 1, they are still considerable when compared with other sectors. The saved coal is about 5.4 million tons, which is more than half of the total residential coal consumption in 2016. The reduced emissions of SO_2, NO_x and dust are 5.5, 5.5 and 1.3 million tons respectively, which account for about one third, one third and one twelfth of the total emission amounts in whole China in 2015.

Conclusions

This paper proves the effectiveness of China's energy saving electricity dispatching policy for power plants. We find that when the coal consumption generating one unit of electricity increases by one percent, the electricity generation hours assigned to the power plant will be reduced by 0.03 percent. If concerning the pollutant emissions, when the intensities of SO_2, NO_x or dust increase by one percent, the electricity generation hours will be decreased by 0.103, 0.085 and 0.069 percent respectively. After considering the influences of global economic crisis and other policies such as electricity generation rights trade, the previous results still stand. Further, a battery of robustness checks are done to ensure that the results we get are credible. At last, we calculate the effect of this policy on the coal consumption and pollutant emissions. When comparing the real coal consumption and pollutant emissions with the counterfactural ones, the results show that the amounts of saved coal consumption and reduced pollutant emissions are substantial. They can even reach the total amounts of the coal consumption or emissions in some industries respectively in whole China for several years.