Spatial distribution of coal-fired power plants in China

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ONLINE APPENDIX

Appendix A. Figures

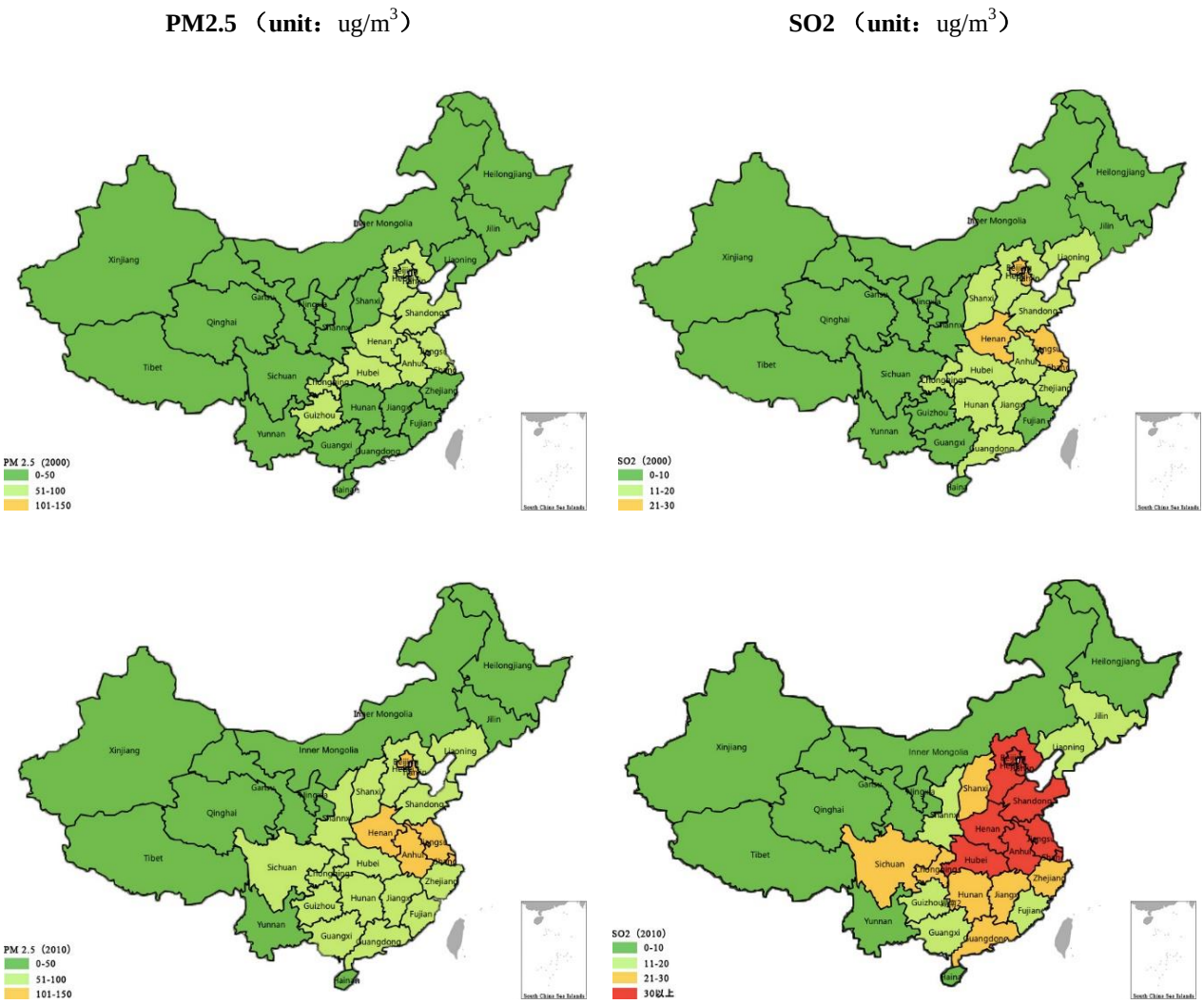


Figure A1. Evolution and spatial distribution of air quality in China

Notes: Data are from satellite-based Aerosol Optical Depth (AOD) retrieval techniques maintained by the National Aeronautics and Space Administration (NASA). For a detailed description of the data, see Fu *et al*. (2017).

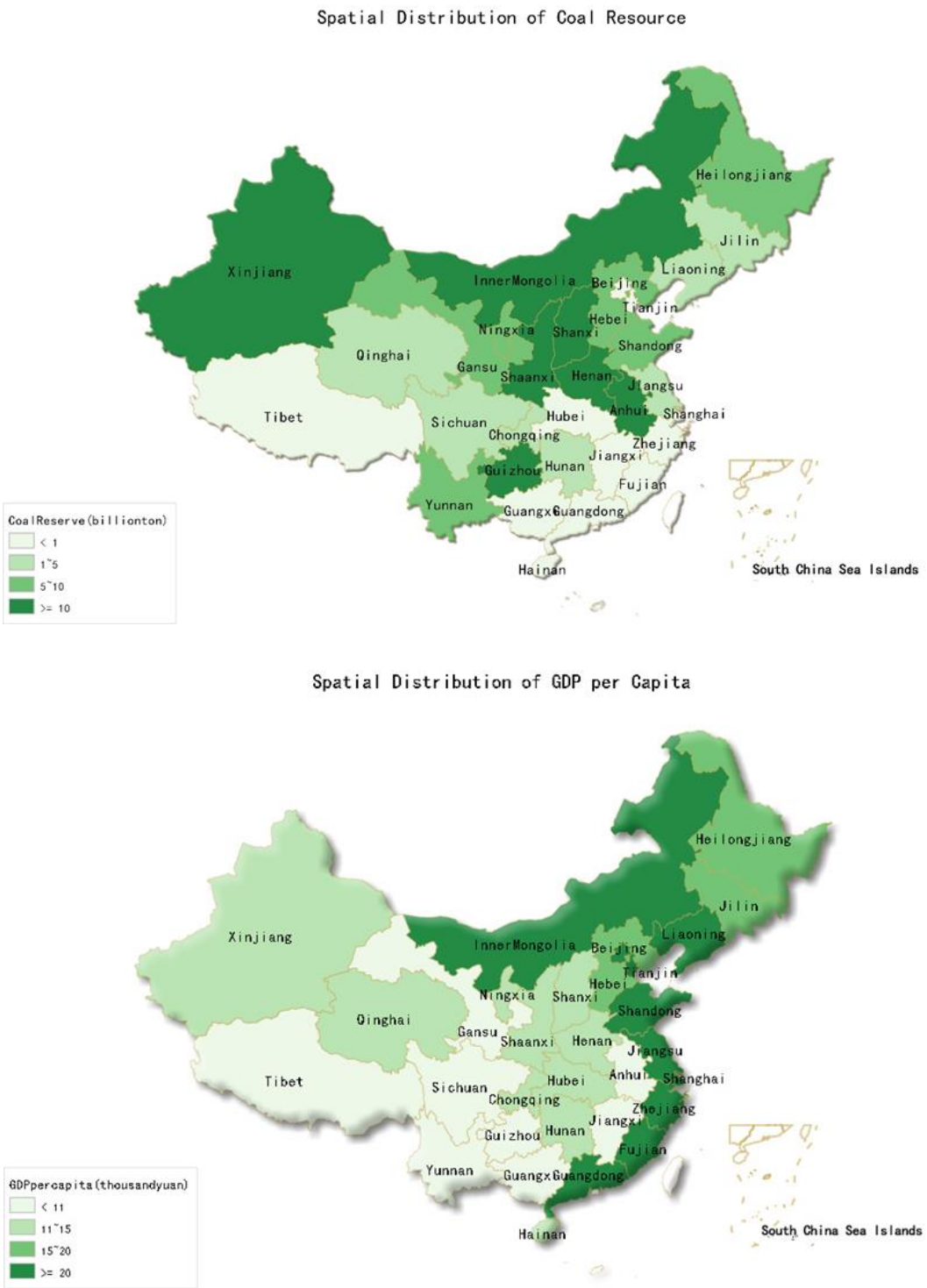
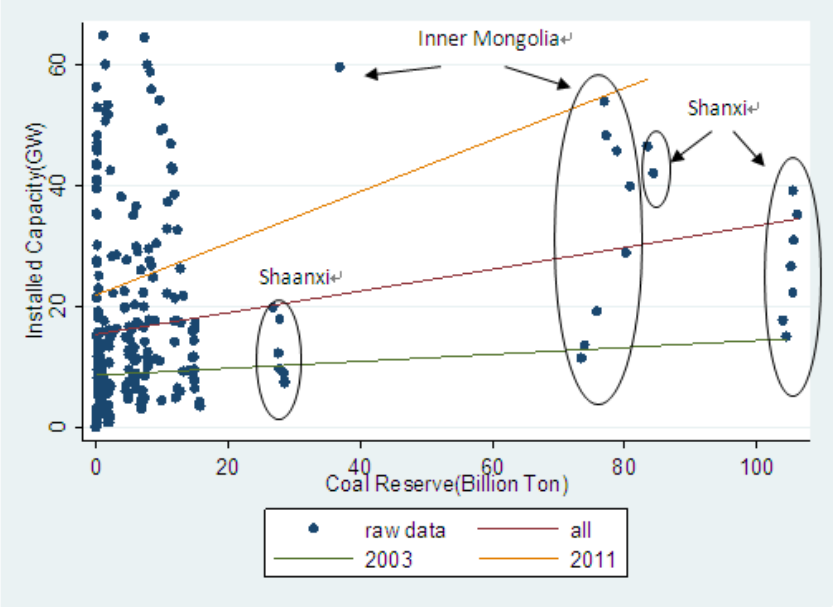


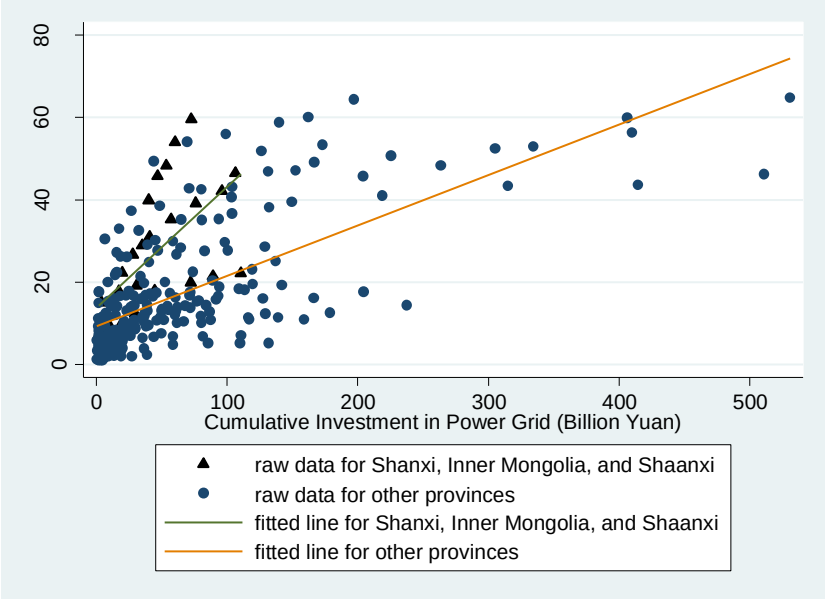
Figure A2. Spatial distributions of economic development and coal resource in China

Notes: Data are from the *China Statistical Yearbook*, and are average annual values from 2003 through 2011.

Panel A. Coal reserve and capacity



Panel B. Power grid coverage and capacity



A3. Factor endowment and power capacity

Notes: Data on coal reserve and power grid investment are collected from the *China Statistical Yearbook* from 2003 through 2011. Panel A plots the correlation between coal reserve and installed capacity. Dots are yearly data at province level. Lines are fitted for all data points, with 2003 in green and 2011 in yellow. Panel B plots the correlation between investment in the power grid and the installed power capacity. Dots are yearly data at province level. The steeper line is for Shanxi, Inner Mongolia, and Shaanxi and the longer line is for the rest of the provinces.

Appendix B. The index of institutional quality and legal environment

The index consists of four first-level indexes and eight second-level indexes, including 1) the development of market intermediaries (measured by the ratio of lawyers to local population and the ratio of certified public accountants to local population), 2) protection of the legitimate rights and interests of producers (measured by the number of filed legal cases divided by GDP, and the ratio of cases closed to cases filed), 3) protection of intellectual property rights (measured by the number of patent applications divided by the number of scientific and technical personnel, and the number of patents approved by the number of scientific and technical personnel), and 4) protection of consumers' rights and interests (measured by the number of consumer complaints divided by GDP, and the ratio of complaints solved by complaints filed).

Appendix C. Between estimator vs. within estimator

In this paper, we choose a "between estimator" over a "within estimator" for two reasons. One reason is that, for some explanatory variables, coal-fired power capacity does not react to absolute changes in those variables (which is what a within estimator estimates) but to their relative changes across provinces (which is what a between estimator estimates). Relative changes are salient here because firms choose a location by comparing these factors across provinces. The other reason is that, in the case of an explanatory variable whose absolute change does affect capacity, the results of the between estimator and the within estimator are similar, i.e., the regression results are stable to adding province fixed effects.

Take coal reserves as an example of the first reason. In a regression with province fixed effects, the coefficient of coal reserve is interpreted as how the change in coal reserve affects the change in power capacity for the same province. But we know that the power capacity growth in a province is not driven by the change in its own coal reserve. Instead, power firms choose a site for a coal-fired electricity plant by comparing the potential profits in different provinces, which are affected by factors that vary across provinces, such as coal reserve, market size, etc., Given that a province's coal reserve generally decreases over time (coal reserve equals the detected total reserve minus the amount of coal mined in the last year), we would expect a within estimator to yield a negative coefficient of coal reserve. This hypothesis is confirmed by the regression results, as shown by the first two columns in table A1. For comparison, table A1, column 1 replicates column 2 of table 2 in the main text, which does not include province fixed effects. Continuing in table A1, the second column adds province fixed effects to the

regression that has been reproduced in the first column. The coefficient of coal reserve becomes negative and statistically significant. This within estimator says that, for the same province, we observe a decrease in coal reserve and an increase in capacity. It does not show how a power firm chooses a province when it faces provinces with different coal reserves. Therefore, a within estimator is not what we want for the purposes of this paper.

However, a within estimator may be helpful in explaining how power capacity is affected by other factors. Take electricity markets, for example. A within estimator shows how, for the same province, the increase in market demand induces an increase in power capacity. We regress capacity on market size variables (GDP per capita and population) without and with province fixed effects in table A1, columns 3 and 4, respectively. This shows that the regression results remain stable after adding the province fixed effects, although the significance changes due to the loss of the degree of freedom.

Table A1. Comparison of between estimator and within estimator

Dependent variable: Installed capacity of coal fired power plants				
	(1)	(2)	(3)	(4)
coal reserve	0.215***	-0.423***		
	(0.051)	(0.066)		
investment in power grid	0.193	-0.119		
	(0.172)	(0.151)		
cumulative investment in power grid	0.226***	0.087***		
	(0.057)	(0.022)		
investment * cumulative investment	-0.001**	-0.000		
	(0.001)	(0.000)		
GDP per capita			0.284**	0.266
			(0.114)	(0.235)
population			0.371***	0.245
			(0.062)	(0.282)
Constant	5.736***	16.762***	-9.656***	-4.860
	(1.233)	(1.356)	(3.063)	(17.892)
Province fixed effects	No	Yes	No	Yes
Observations	270	270	270	270
R-squared	0.584	0.941	0.576	0.927

Notes: Mixed OLS. All specifications have year dummies. Standard errors are clustered at the provincial level. **, *** represent 5% and 1% significance level, respectively.

A2. Complete table of all coefficients estimated in table 3 in the main text

Effects of electricity price on installed capacity of coal fired power plants

Dependent variable: Installed capacity of coal fired power plants					
	(1)	(2)	(3)	(4)	**(5)**
price	0.072				
	(0.043)				
price_lag1		0.079*			
		(0.044)			
average price over time			0.079*	0.077*	**-0.020**
			(0.044)	(0.041)	**(0.033)**
coal reserve					**0.207*** **
					(0.030)
investment on power grid					**0.001**
					(0.202)
accumulative investment on power grid					**0.071***
					(0.036)
investment * accumulative investment					**-0.000**
					(0.000)
GDP per capita					**0.273****
					(0.117)
population					**0.311*** **
					(0.092)
rail coverage					**1.463***
					(0.782)
Constant	-9.801	-10.742	-14.553	-15.818	**-6.291**
	(12.922)	(12.657)	(14.501)	(13.717)	**(9.247)**
Observations	210	210	210	240	**240**
R-squared	0.133	0.142	0.143	0.174	**0.760**

Notes: Mixed OLS. All specifications have year dummies. Standard errors are clustered at the provincial level. *, **, *** represent 10%, 5%, and 1% significance level, respectively.

A3. Complete table of all coefficients estimated in table 4 in the main text

Effects of utilization hours on installed capacity of coal-fired power plants

Dependent variable: Installed capacity of coal-fired power plants			
	(1)	(2)	**(3)**
hours lagged one year	0.000	0.001	**0.000**
	(0.001)	(0.001)	**(0.001)**
hours lagged two years	0.001	0.001	**0.001**
	(0.000)	(0.001)	**(0.001)**
hours lagged three yeas	0.001	0.001	**0.002*** **
	(0.001)	(0.001)	**(0.001)**
average price over time			**0.007**
			(0.037)
coal reserve			**0.195*** **
			(0.024)
investment in power grid			**-0.048**
			(0.182)
cumulative investment in power grid			**0.076** **
			(0.035)
investment * cumulative investment			**-0.000**
			(0.000)
GDP per capita			**0.228***
			(0.120)
population			**0.303*** **
			(0.100)
rail coverage			**1.828** **
			(0.797)
Constant	-1.302	-0.279	**-32.383** **
	(7.639)	(11.799)	**(15.556)**
Observations	420	240	**240**
R-squared	0.236	0.108	**0.785**

Notes: Mixed OLS. All specifications have year dummies. Standard errors are clustered at the province level. *, **, *** represent 10%, 5%, and 1% significance level, respectively.

References

Fu S, Brian Viard V and Zhang P (2017) Air pollution and manufacturing firm productivity: nationwide estimates for China, SSRN, Available at https://ssrn.com/abstract=2956505 or http://dx.doi.org/10.2139/ssrn.2956505.