

Supplementary Material

The Dual Environmental and Economic Effects of the Emission Trading Scheme under Local Fiscal Pressure: "Efficient Markets" and "Promising Governments"

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1 Supplementary Information

S 1 The execution time of each pilot area

Shandong province 2003: http://lyc.sdein.gov.cn/dtxx/200405/t20040519_716196.html

Shanxi (a) province 2010:

http://www.shanxi.gov.cn/sxszfxxgk/sxsrmzfczm/sxszfbgt/flfg_7203/szfgfxwj_7205/201002/t20100208_146049.shtml

Jiangsu province 2006: http://sthjt.jiangsu.gov.cn/art/2006/10/19/art_1614_4061703.html

Henan province 2013: <http://sthjt.henan.gov.cn/2012/12-26/1032924.html>

Shanghai 2014: <https://sthj.sh.gov.cn/hbzhwywpt1272/hbzhwywpt1157/20140929/0024-92342.html>

Tianjin 2008:

http://sthjt.tj.gov.cn/ZWGK4828/ZCWJ6738/sthjwj/202012/t20201221_5097826.html

Zhejiang province 2007: http://sthjt.zj.gov.cn/art/2007/6/22/art_1201816_15007565.html

Hubei province 2008: http://sthjt.hubei.gov.cn/fbjd/xxgkml/ghjh/200801/t20080125_561348.shtml

Hunan province 2014:

http://sthjt.hunan.gov.cn/sthjt/sthjswzx/c101079/c101083/202012/t20201225_14060489.html

Hebei province 2011: <http://hbepb.hebei.gov.cn/hbhjt/zwgk/zc/101612404313890.html>

Chongqing 2010:

http://sthjj.cq.gov.cn/zwgk_249/zfxxgkml/zcwj/qtwj/201902/t20190220_5232226.html

Shanxi (b) province 2010: <http://www.sxerex.com/JianJie.asp>

Inner Mongolia autonomous region 2011:

https://sthjt.nmg.gov.cn/xxgk/zfxxgk/fdzdgnr/gzxzgfxwx/202109/t20210907_1877697.html

2 Supplementary Tables

Table S 1 Parallel trend test and dynamic effect of staggered DID

Year	lnSO ₂ (1)	lnProfits (2)
2004	-0.043013 (0.0341)	0.076090 (0.1462)
2005	-0.089362* (0.0432)	0.163511 (0.1244)
2006	-0.123659** (0.0408)	0.140400 (0.1320)
2007	-0.101248* (0.0428)	0.469575* (0.1972)
2008	-0.175863*** (0.0403)	0.369043** (0.1412)
2009	-0.174428*** (0.0461)	0.497994*** (0.1493)
2010	-0.277626*** (0.0540)	0.694872** (0.2218)
2011	-0.266481*** (0.0589)	1.368032** (0.4877)
2012	-0.205569*** (0.0513)	0.909764*** (0.1937)
2013	-0.612040*** (0.1076)	1.277868*** (0.2117)
2014	-0.309352*** (0.0743)	1.624858*** (0.2329)
2015	-0.375907*** (0.0686)	1.914841*** (0.2561)
2016	-0.333481*** (0.0921)	2.227040*** (0.2996)
2017	-0.258682* (0.1095)	2.559235*** (0.3634)
Constant	8.962470*** (0.5118)	-4.3e+00*** (1.1697)
Control variables	Y	Y
City FE	Y	Y
Year FE	Y	Y
<i>N</i>	4196	4092
adj. <i>R</i> ²	0.8022	0.7556

Note: Standard errors in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table S 2 Balance test of cross-sectional matching (lnSO₂)

Variable	Unmatched Matched	Mean		%reduct		t-test		V(T)/ v(c)
		Treated	Control	%bias	bias	t	P> t	
lnPop_density	U	5.9516	5.5445	45.3		14.50	0.000	0.98
	M	5.9506	5.9398	1.2	97.4	0.38	0.704	1.12*
GDP_growth	U	11.831	11.823	0.2		0.06	0.954	0.63*
	M	11.833	11.983	-3.3	-1742.4	-1.05	0.293	0.71*
Ind2_ratio	U	50.638	46.924	34.9		11.03	0.000	0.60*
	M	50.643	50.559	0.8	97.7	0.25	0.802	0.67*
FDI	U	95.537	51.968	22.1		7.25	0.000	2.98*
	M	94.913	95.807	-0.5	97.9	-0.13	0.899	1.64*
lnTech_innovation	U	6.5865	5.7728	44.9		14.38	0.000	1.01
	M	6.5842	6.6574	-4.0	91.0	-1.21	0.228	0.91
lnEdu_expenditure	U	2.8085	2.175	35.4		11.34	0.000	0.97
	M	2.8059	2.9129	-6.0	83.1	-1.81	0.070	0.93
lnSci_expenditure	U	5.3469	4.89	26.0		8.31	0.000	0.99
	M	5.3452	5.3684	-1.3	94.9	-0.42	0.672	1.22*
lnSO ₂ _intensity	U	-4.6725	-4.6666	-0.5		-0.15	0.882	0.76*
	M	-4.6723	-4.7118	3.1	-567.3	0.96	0.335	0.79*
lnPM2.5_intensity	U	-11.7	-11.311	-35.8		-11.41	0.000	0.85*
	M	-11.699	-11.763	5.9	83.6	1.77	0.077	0.80*
Emp_structure	U	.88706	.99143	-15.9		-5.04	0.000	0.74*
	M	.88714	.91369	-4.0	74.6	-1.40	0.162	1.21*

Notes: * if variance ratio outside [0.91; 1.09] for U and [0.91; 1.09] for M

Covariates for PSM are mainly based on the control variables in the two original regression equations, respectively. And further adjustments are made: First, variables influencing a region to become the pollutant ETS pilot in China are added, including the population density, GDP growth, the percentage of secondary industry, SO₂ intensity, and PM2.5 intensity to reflect cities' characteristics of population pressure, economic development, industrial structure, and pollution (Li and Wen, 2016). Second, *Population* (due to adding *Pop_density*), *pGDP* (due to adding *Pop_density* and *GDP_growth*), and *Ind_structure* (due to adding *Ind2_ratio*) are removed. Third, several control variables of Eq (2) (*Edu_expenditure*, *Sci_expenditure*, and *Emp_structure*) are added as the covariates of PSM for SO₂ emission to reflect the fiscal expenditure on education and technology and the structure of employees.

Variable definition:

Pop_density: Household registered population at year-end/Total land area of the administrative region (persons/sq.km).

GDP_growth: gross regional product(GRP) growth rate (%).

Ind2_ratio: The secondary industry as a percentage to GRP (%).

SO₂_intensity: Industrial SO₂ emissions/gross regional product (GRP).

PM2.5_intensity: PM2.5/gross regional product (GRP).

Table S 3 Balance test of cross-sectional matching (lnProfits)

Variable	Unmatched Matched	Mean		%reduct		t-test		V(T)/ v(c)
		Treated	Control	%bias	bias	t	P> t	
lnPop_density	U	5.9529	5.5596	43.9		13.94	0.000	0.98
	M	5.9522	5.9477	0.5	98.9	0.16	0.875	1.18*
GDP_growth	U	11.846	11.959	-2.5		-0.80	0.422	0.67*
	M	11.844	11.969	-2.8	-10.9	-0.87	0.383	0.70*
FDI	U	95.803	52.604	21.8		7.08	0.000	2.92*
	M	96.057	108.32	-6.2	71.6	-1.64	0.101	1.31*
lnTech_innovation	U	6.5883	5.7685	45.2		14.36	0.000	1.01
	M	6.5915	6.5927	-0.1	99.9	-0.02	0.985	0.83*
lnSci_expenditure	U	5.3474	4.8881	26.1		8.29	0.000	0.99
	M	5.3509	5.2624	5.0	80.7	1.52	0.127	0.97
lnSO ₂ _intensity	U	-4.6724	-4.6667	-0.4		-0.14	0.888	0.75*
	M	-4.6772	-4.6385	-3.1	-585.7	-0.94	0.345	0.78*
lnPM _{2.5} _intensity	U	-11.702	-11.307	-36.3		-11.49	0.000	0.85*
	M	-11.793	-11.731	2.5	93.0	0.74	0.459	0.74*
Emp_structure	U	.88779	.99544	-16.3		-5.13	0.000	0.73*
	M	.88929	.89208	-0.4	97.4	-0.15	0.880	1.40*
lnFixed_assets	U	8.6543	7.9191	64.7		20.51	e.000	0.93
	M	8.651	8.6223	2.5	96.1	0.78	0.435	0.98
lnCurrent_assets	U	8.6589	7.8779	58.2		18.46	0.000	0.96
	M	8.6596	8.609	3.8	93.5	1.13	0.258	0.91
lnInd2_labor	U	12.086	11.432	60.8		19.23	0.000	0.80*
	M	12.086	12.106	-1.9	96.9	-0.55	0.581	0.70*
lnEdu_expenditure	U	2.8079	2.1731	35.4		11.24	0.000	0.97
	M	2.8063	2.8517	-2.5	92.8	-0.73	0.465	0.79*
lnEnergy	U	5.7578	5.1924	40.1		12.73	0.000	0.91*
	M	5.7627	5.6857	5.5	86.4	1.66	0.096	0.89*

Notes: * if variance ratio outside [0.91; 1.10] for U and [0.91; 1.10] for M. Variable definition is as above.

Ind2_ratio is excluded

Table S 4 Balance test of phase-by-phase matching (lnSO₂)

Variable	Unmatched Matched	Mean		%reduct		t-test		V(T)/ v(c)
		Treated	Control	%bias	bias	t	P> t	
lnPop_density	U	5.9516	5.5445	45.3		14.50	0.000	0.98
	M	5.9516	5.8761	8.4	81.5	2.74	0.006	1.27*
GDP_growth	U	11.831	11.823	0.2		0.06	0.954	0.63*
	M	11.831	11.955	-2.8	-1424.7	-0.95	0.344	0.96
ln2_ratio	U	50.638	46.924	34.9		11.03	0.000	0.60*
	M	50.638	49.005	15.3	56.0	4.76	0.000	0.64*
FDI	U	95.537	51.968	22.1		7.25	0.000	2.98*
	M	95.537	114.1	-9.4	57.4	-2.44	0.015	1.17*
lnTech_innovation	U	6.5865	5.7728	44.9		14.38	0.000	1.01
	M	6.5865	6.6922	-5.8	87.0	-1.66	0.097	0.76*
lnEdu_expenditure	U	2.8085	2.175	35.4		11.34	0.000	0.97
	M	2.8085	2.955	-8.2	76.9	-2.33	0.020	0.74*
lnSci_expenditure	U	5 . 3469	4.89	26.0		8.31	0.000	0.99
	M	5 . 3469	5.4049	-3.3	87.3	-0.97	0.330	0.88*
lnSO ₂ _intensity	U	-4.6725	-4.6666	-0.5		-0.15	0.882	0.76*
	M	-4.6725	-4.6481	-1.9	-311.7	-0.57	0.569	0.68*
lnPM _{2.5} _intensity	U	-11.7	-11.311	-35.8		-11.41	0.000	0.85*
	M	-11.7	-11.775	6.9	80.7	1.99	0.046	0.70*
Emp_structure	U	.88706	.99143	-15.9		-5.04	0.000	0.74*
	M	.88706	.91462	-4.2	73.6	-1.40	0.162	1.03

Notes:* if variance ratio outside [0.91; 1.09] for U and [6.91; 1.09] for M. Variable definition is as above.

Table S 5 Balance test of phase-by-phase matching (lnProfits)

Variable	Unmatched Matched	Mean		%reduct		t-test		V(T)/ v(c)
		Treated	Control	%bias	bias	t	P> t	
lnPop_density	U	5.9529	5.5596	43.9		13.94	0.000	0.98
	M	5.9529	5.9124	4.5	89.7	1.44	0.150	1.18*
GDP_growth	U	11.846	11.959	-2.5		-0.80	0.422	0.67*
	M	11.846	11.997	-3.4	-33.9	-1.02	0.308	0.62*
FDI	U	95.803	52.604	21.8		7.08	0.000	2.92*
	M	95.803	101.47	-2.9	86.9	-0.78	0.437	1.44*
lnTech_innovation	U	6.5883	5.7685	45.2		14.36	0.000	1.01
	M	6.5883	6.4852	5.7	87.4	1.60	0.109	0.76*
lnSci_expenditure	U	5.3474	4.8881	26.1		8.29	0.000	0.99
	M	5.3474	5.3398	0.4	98.3	0.13	0.896	0.94
lnSO ₂ _intensity	U	-4.6724	-4.6667	-0.4		-0.14	0.888	0.75*
	M	-4.6724	-4.5666	-8.3	-1770.8	-2.38	0.017	0.61*
lnPM _{2.5} _intensity	U	-11.702	-11.307	-36.3		-11.49	0.000	0.85*
	M	-11.702	-11.678	-2.2	94.0	-0.63	0.529	0.70*
Emp_structure	U	.88779	.99544	-16.3		-5.13	0.000	0.73*
	M	.88779	.92269	-5.3	67.6	-1.65	0.098	0.80*
lnFixed_assets	U	8.6543	7.9191	64.7		20.51	0.000	0.93
	M	8.6543	8.6108	3.8	94.1	1.16	0.244	0.92
lnCurrent_assets	U	8.6589	7.8779	58.2		18.46	0.000	0.96
	M	8.6589	8.5521	8.0	86.3	2.32	0.020	0.81*
lnln2_labor	U	12.086	11.432	60.8		19.23	0.000	0.80*
	M	12.086	12.021	6.1	90.0	1.78	0.075	0.68*
lnEdu_expenditure	U	2.8079	2.1731	35.4		11.24	0.000	0.97
	M	2.8079	2.8628	-3.1	91.4	-0.86	0.389	0.72*
lnEnergy	U	5.7578	5.1924	40.1		12.73	0.000	0.91*
	M	5.7578	5.6848	5.2	87.1	1.54	0.124	0.82*

Notes: if variance ratio outside [0.91; 1.10] for U and [0.91; 1.10] for M. Variable definition is as above.

Table S 6 PSM-DID test

	PSM-DID						Staggered DID with PSM			
	(1)Weight not empty		(2)Common support		(3)Weighted regression		(4)Cross-section matching		(5)Phase by phase matching	
	lnSO ₂	lnProfits	lnSO ₂	lnProfits	lnSO ₂	lnSO ₂	lnProfits	lnSO ₂	lnProfits	lnSO ₂
Treat×Post	-0.242723*** (0.0389)	0.593392*** (0.0941)	-0.254925*** (0.0356)	0.832429*** (0.0972)	-0.102704** (0.0395)	0.203475 (0.1458)	-0.163523*** (0.0292)	0.486893*** (0.1005)	-0.113276*** (0.0292)	0.332646** (0.1138)
lnPopulation	-0.030966 (0.0586)		-0.033450 (0.0465)		-0.000588 (0.0489)		-0.014125 (0.0577)		-0.080533 (0.0460)	
lnpGDP	0.202990*** (0.0419)		0.219663*** (0.0411)		0.142098** (0.0503)		0.202514*** (0.0421)		0.186183*** (0.0431)	
Ind_structure	-0.006824 (0.0231)	0.093764 (0.0976)	-0.015126 (0.0220)	0.040821 (0.0998)	0.014089 (0.0306)	0.114662 (0.1216)	-0.006538 (0.0232)	0.100317 (0.0980)	0.028496 (0.0273)	0.011140 (0.1381)
FDI	-0.000386*** (0.0000)	0.003653*** (0.0006)	-0.000366*** (0.0000)	0.003739*** (0.0006)	-0.000507*** (0.0000)	0.004163*** (0.0006)	-0.000405*** (0.0001)	0.003689*** (0.0006)	-0.000349*** (0.0001)	0.003790*** (0.0007)
lnTech_innovation	-0.021241 (0.0235)	-0.127491* (0.0559)	-0.001887 (0.0223)	-0.162867** (0.0535)	-0.003896 (0.0269)	-0.265970** (0.0840)	-0.026169 (0.0236)	-0.122711* (0.0559)	-0.021953 (0.0248)	-0.148800* (0.0754)
lnFixed_assets		-0.014258 (0.0934)		-0.011371 (0.0908)		-0.070316 (0.1678)		-0.000888 (0.0943)		0.020628 (0.1212)
lnCurrent_assets		0.169769 (0.0910)		0.214796* (0.1043)		0.138795 (0.1409)		0.126991 (0.0920)		0.181236 (0.1350)
lnInd2_labor		0.480144*** (0.0907)		0.474332*** (0.0859)		0.353908** (0.1168)		0.489653*** (0.0909)		0.502348*** (0.1059)
lnEdu_expenditure		0.371632*** (0.0609)		0.385163*** (0.0618)		0.410439*** (0.1014)		0.383500*** (0.0612)		0.554912*** (0.0759)
lnSci_expenditure		-0.158505 (0.1125)		-0.143860 (0.1068)		-0.495224* (0.2094)		-0.130987 (0.1128)		-0.267552 (0.1482)
Emp_structure		-0.176314** (0.0632)		-0.133433* (0.0625)		-0.227729* (0.0926)		-0.179705** (0.0636)		-0.153494* (0.0620)
lnEnergy		-0.001813 (0.0514)		0.014979 (0.0477)		0.061280 (0.0586)		0.008053 (0.0519)		0.085175 (0.0655)
Constant	8.871295*** (0.5467)	-5.144717*** (2.1089)	8.553868*** (0.5004)	-5.428403*** (2.0831)	9.315837*** (0.6217)	-4.329401 (1.7237)	8.767743*** (0.5453)	-5.195229*** (1.3096)	9.402824*** (0.5250)	-5.706709*** (1.7000)
City FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
N	3720	3516	4127	4005	3720	3516	3720	3516	3158	3087
adj. R ²	0.7762	0.7878	0.7989	0.7486	0.7799	0.8272	0.7753	0.7876	0.7992	0.7364

Note: Standard errors in parentheses * p < 0.05, ** p < 0.01, *** p < 0.001

The neighbor(5) matching within caliper(0.1) is used in cross-sectional matching, and neighbor(2) matching is adopted in phase-by-phase matching. After matching, the propensity score densities of the two groups are highly overlapped (Figure S 2 and Figure S 3), the requirement of common support is satisfied (Figure S 4), and p values of the selected covariates in the balance test are not statistically significant (Table S 2-Table S 5), which indicates no systematic difference between the treatment and control groups and an effective matching result.

Table S 6 shows the results of PSM-DID in different processing methods. Columns (1)-(3) show PSM-DID: column (1) chooses samples in which the weight values generated by matching are not empty, column (2) selects samples meeting the common support hypothesis with the treatment group, and column (3) adopts weighted regression. Columns (4) and (5) are the results of staggered DID with cross-sectional matching and phase-by-phase matching, respectively. All of these results are significant and consistent with the results of the benchmark regression equations.

Table S 7 Coefficients and p-value for pseudo-treatment groups

Variable	Obs	Mean	Std. Dev.	Min	Max
coefficient (lnSO ₂)	500	0.0020163	0.0597808	-0.1953459	0.16049
p-value (lnSO ₂)	500	0.4695475	0.2833494	0.0031399	0.9977337
coefficient (lnProfits)	500	-0.0027917	0.1701376	-0.4830889	0.7580459
p-value (lnProfits)	500	0.4988551	0.2928053	0.0002121	0.996188

Table S 8 Sobel Tests

	lnProfits				F.lnProfits			
	Coef	Std Err	Z	P> Z	Coef	Std Err	Z	P> Z
Sobel	0.0354	0.0128	2.778	0.00546	0.0360	0.0127	2.848	0.00441
Goodman-1(Aroian)	0.0354	0.0129	2.754	0.00589	0.0360	0.0128	2.818	0.00483
Goodman-2	0.0354	0.0126	2.804	0.00505	0.0360	0.0125	2.878	0.00401
a coefficient =	-0.256	0.0376	-6.807	0	-0.228	0.0371	-6.139	8.30e-10
b coefficient =	-0.138	0.0455	-3.043	0.00234	-0.158	0.0492	-3.214	0.00131
Indirect effect =	0.0354	0.0128	2.778	0.00546	0.0360	0.0127	2.848	0.00441
Direct effect =	0.845	0.105	8.013	0	0.846	0.109	7.789	0
Total effect =	0.881	0.105	8.391	0	0.882	0.108	8.154	0
Proportion of total effect that is mediated:	0.0402				0.0409			
Ratio of indirect to direct effect:	0.0419				0.0426			
Ratio of total to direct effect:	1.042				1.043			

Table S 9 Bootstrap tests

		Observed Coef .	Bias	Bootstrap Std . Err .	[95% Conf. Interval]		
For current lnProfits:	_bs_1	0.0354299	-0.0002206	0.01183108	0.0138253	0.0616776	(p)
					0.0144929	0.0628503	(BC)
	_bs_2	0.8452775	-0.004311	0.10263337	0.6459482	1.047004	(p)
					0.665298	1.056241	(BC)
Proportion of total effect that is mediated:		0.0402289					
For next year lnProfits:	_bs_1	0.0360354	-0.0005798	0.0117913	0.0135747	0.0583599	(P)
					0.0172262	0.067266	(BC)
	_bs_2	0.84604185	-0.0102743	0.10240633	0.6525256	1.028117	(P)
					0.6776969	1.083789	(BC)
Proportion of total effect that is mediated:		0.04085288					

Note: _bs_1 and _bs_2 are the indirect and direct effect, respectively.

(p) means percentile confidence interval, and (BC) means bias-corrected confidence interval.

Table S 10 Sobel Tests based on staggered DID

	Coef	Std Err	Z	P> Z
Sobel	0.0275	0.00970	2.839	0.00452
Goodman-1(Aroian)	0.0275	0.00981	2.808	0.00499
Goodman-2	0.0275	0.00959	2.872	0.00408
a coefficient =	-0.186	0.0321	-5.797	6.80e-09
b coefficient =	-0.148	0.0455	-3.257	0.00113
Indirect effect =	0.0275	0.00970	2.839	0.00452
Direct effect =	0.640	0.0898	7.123	0
Total effect =	0.667	0.0895	7.453	0
Proportion of total effect that is mediated:	0.0413			
Ratio of indirect to direct effect:	0.0430			
Ratio of total to direct effect:	1.043			

Table S 11 Bootstrap tests based on staggered DID

	Observed Coef .	Bias	Bootstrap Std . Err .	[95% Conf. Interval]		
_bs_1	0.02754077	0.0001628	0.00918824	0.0114636	0.0471222	(p)
				0.0114636	0.0472974	(BC)
_bs_2	0.63980377	-0.0027117	0.10866473	0.4379031	0.8565001	(p)
				0.4631471	0.8940552	(BC)
Proportion of total effect that is mediated:			0.04126919			
Note:_bs_1 and _bs_2 are the indirect and direct effect, respectively.						
(p) means percentile confidence interval, and (BC) means bias-corrected confidence interval.						

Table S 12 Validity test of instrumental variables

Underidentification test (Kleibergen-Paap rk LM statistic):	16.124
Chi-sq(2) P-val =	0.0003
-redundant- option:	
IV redundancy test (LM test of redundancy of specified instruments):	16.124
Chi-sq(2) P-val =	0.0003
Instruments tested: Garbage_disposal Green_space	
Weak identification test (Cragg-Donald Wald F statistic):	7.934
(Kleibergen-Paap rk Wald F statistic):	12.337
Stock-Yogo weak ID test critical values: 10% maximal IV size	19.93
15% maximal IV size	11.59
20% maximal IV size	8.75
25% maximal IV size	7.25
Source: Stock-Yogo (2005). Reproduced by permission.	
NB: Critical values are for Cragg-Donald F statistic and i.i.d. errors.	
Hansen J statistic (overidentification test of all instruments):	0.237
Chi-sq(l) P-val =	0.6265
-endog- option:	
Endogeneity test of endogenous regressors:	51.735
Chi-sq(l) P-val =	0

Note: *Garbage_disposal* denotes the domestic garbage disposal rate and *Green_space* is green space per capita. Data sources are the China City Statistical Yearbook

Kleibergen-Paap rk LM statistic strongly rejects the null hypothesis of under-identification, and the Hansen J statistic (p-value is 0.6265) does not reject the null hypothesis that all instrumental variables are exogenous. The p-value of the instrumental variables redundancy test is significant, rejecting the hypothesis of existing redundancy instrumental variables. Without the assumption of the error term to be independently identically distributed, Kleibergen-Paap rk Wald F statistic is chosen to test the weak instruments. The result indicates that the null hypothesis of weak instruments can be rejected if the real significance level exceeding 15% can be accepted.

Table S 13 Weak instrument robust tests

Weak instrument robust tests and confidence sets for linear IV

H0: $\beta_{\text{industrial_profits:lnS02}} = 0$

Test	Statistic	p-value	Conf, level	Conf. Set
CLR	stat(.) = 53.36	0.0000	95%	[-13.9078,-4.74111]
K	chi2(1) = 50.39	0.0000	95%	[-13.7623,-4.74111]
J	chi2(1) = 3.35	0.0671	95%	[... ,-2.99507]
K-J	<n.a. >	0.0000	95% (96%,99%)	[-14.1988, -4.5956]
AR	chi2(2) = 53.75	0.0000	95%	[... , -4.3046]
Wald	chi2(1) = 18.34	0.0000	95%	[-11.4706,-4.26822]

Confidence sets estimated for 100 points in [-15.0718^-6.67018].

Number of obs N = 3821.

Method = **lagrange multiplier (LM)**. Weight on K in K-J test = 0.800.

Tests robust to heteroskedasticity.

Wald statistic in last row is based on ivregress estimation and is not robust to weak instruments.

Weak instrument robust tests based on CLR, K, J, K-J, AR, and Wald all show significant p-value, indicating no weak instruments.

Table S 14 Sobel Tests based on fiscal pressure subsamples

	High fiscal pressure subsample				Low fiscal pressure subsample			
	Coefficient	Std Err	Z	P> Z	Coefficient	Std Err	Z	P> Z
Sobel	0.00868	0.00638	1.360	0.174	0.0518	0.0264	1.961	0.0499
Goodman-1(Aroian)	0.00868	0.00675	1.286	0.198	0.0518	0.0268	1.934	0.0531
Goodman-2	0.00868	0.00599	1.448	0.148	0.0518	0.0261	1.988	0.0468
a coefficient	-0.124	0.0751	-1.651	0.0988	-0.286	0.0505	-5.658	1.50e-08
b coefficient	-0.0700	0.0292	-2.399	0.0164	-0.181	0.0867	-2.090	0.0366
Indirect effect	0.00868	0.00638	1.360	0.174	0.0518	0.0264	1.961	0.0499
Direct effect	0.347	0.0912	3.809	0.000140	0.944	0.189	4.988	6.10e-07
Total effect	0.356	0.0913	3.902	0.000096	0.996	0.188	5.302	1.10e-07
Proportion of total effect that is mediated:				0.0244				0.0520
Ratio of indirect to direct effect:				0.0250				0.0549
Ratio of total to direct effect:				1.025				1.055

Table S 15 Regional dynamic analysis

	Eastern		Central		Western	
	lnSO ₂ (1)	lnProfits (2)	lnSO ₂ (3)	lnProfits (4)	lnSO ₂ (5)	lnProfits (6)
2004	0.085519 (0.1940)	0.144726 (0.4760)	0.000747 (0.1042)	0.012921 (0.2263)	0.204344 (0.2581)	-0.124533 (0.5878)
2005	0.018533 (0.2014)	0.244188 (0.4393)	-0.104365 (0.0971)	-0.062135 (0.2246)	0.188426 (0.2225)	-0.175600 (0.5795)
2006	-0.160534 (0.1544)	0.398951 (0.4108)	-0.152584 (0.0941)	0.023925 (0.2231)	0.259691 (0.2230)	-0.142668 (0.5747)
2007	-0.375334* (0.1513)	0.210023 (0.3852)	-0.171593 (0.0977)	0.099425 (0.1967)	0.272086 (0.2161)	0.042078 (0.5491)
2008	-0.406056** (0.1433)	0.337955 (0.4479)	-0.227247* (0.0975)	0.134253 (0.2144)	0.266948 (0.2151)	-0.074038 (0.5172)
2009	-0.446004** (0.1450)	0.368925 (0.3645)	-0.245382* (0.0956)	0.240360 (0.1977)	0.139754 (0.2124)	0.228106 (0.4773)
2010	-0.310941* (0.1543)	0.778565 (0.4581)	-0.245378** (0.0951)	0.352512 (0.2105)	-0.010637 (0.2247)	0.121136 (0.5111)
2011	0.014518 (0.1875)	1.134920* (0.4635)	0.017019 (0.1454)	0.439323* (0.1953)	0.317104 (0.2594)	1.637486 (1.0693)
2012	-0.239850 (0.1605)	1.888362*** (0.5314)	-0.275617* (0.1213)	0.360886 (0.1914)	0.207121 (0.2259)	0.584700 (0.4878)
2013	-0.845833*** (0.2242)	1.434656** (0.4514)	0.539945** (0.2029)	0.394269* (0.1980)	0.150853 (0.2310)	0.715304 (0.4589)
2014	-0.171772 (0.1770)	1.840431*** (0.4558)	-0.231596* (0.1111)	0.301230 (0.2225)	0.179267 (0.2255)	1.299697 (0.6923)
2015	-0.331220* (0.1566)	1.680292*** (0.4666)	-0.271769** (0.0971)	0.385288 (0.2598)	0.178786 (0.2246)	3.014341 (2.2502)
2016	-0.235280 (0.1734)	1.604960** (0.5006)	-0.529759*** (0.1267)	0.514041 (0.2911)	-0.110281 (0.2439)	0.766288 (0.6271)
2017	-0.319634 (0.1916)	1.407757* (0.5775)	-0.848177*** (0.1338)	0.531067* (0.2583)	-0.011324 (0.2724)	0.942432 (0.6125)
Constant	9.545314*** (1.0161)	-2.988929 (2.3188)	10.35027*** (0.7234)	-10.1769*** (1.1736)	4.571871 (2.9538)	-6.681841*** (1.9484)
Controls	Y	Y	Y	Y	Y	Y
City FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
<i>N</i>	1505	1481	1462	1417	1229	1194
adj. <i>R</i> ²	0.8136	0.8300	0.8002	0.7891	0.8126	0.4219

Standard errors in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table S 16 Differences in fiscal pressures between regions.

	Obs	Mean	Std. Dev.	Min	Max
Eastern	1,515	0.057974	0.0869998	-0.0166734	1.383277
Central	1,485	0.1205794	0.2045086	-0.0671475	5.121069
Western	1,258	0.1719757	0.2041919	-0.0190586	2.549742

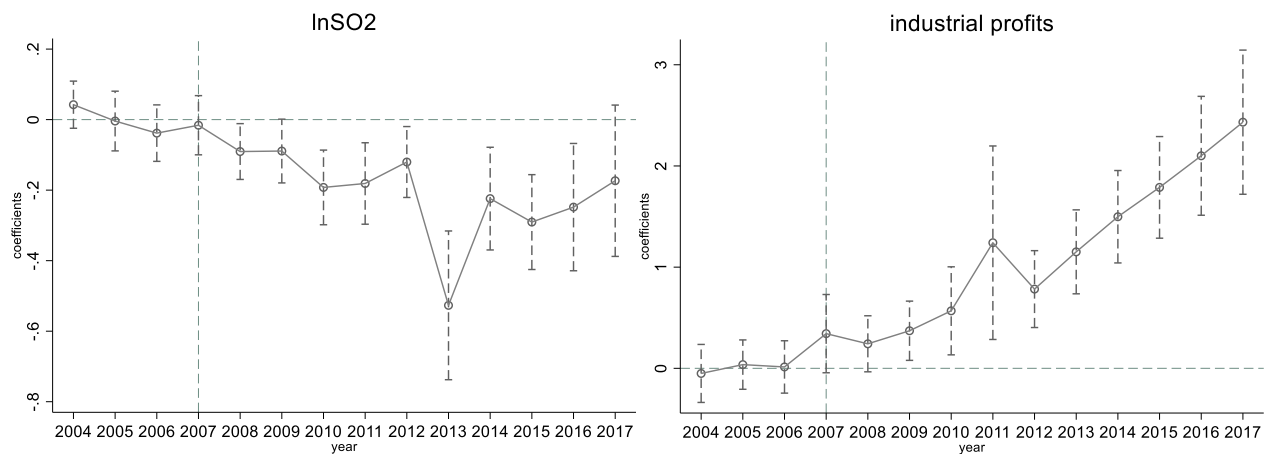
Table S 17 Bootstrap tests for the eastern region.

	Observed Coef .	Bias	Bootstrap Std . Err .	[95% Conf. Interval]		
_bs_1	0.06695644	-0.0013578	0.03732398	0.0057489	0.1550572	(p)
				0.0169737	0.1841761	(BC)
_bs_2	0.76587564	-0.0038646	0.21872014	0.3486704	1.218203	(p)
				0.3624695	1.224679	(BC)
Proportion of total effect that is mediated:			0.08039609			

Note: _bs_1 and _bs_2 are the indirect and direct effect, respectively.

(p) means percentile confidence interval, and (BC) means bias-corrected confidence interval.

3 Supplementary Figures

**Figure S 1.** Parallel trend test of staggered DID. (left: lnSO2, right: lnProfits)

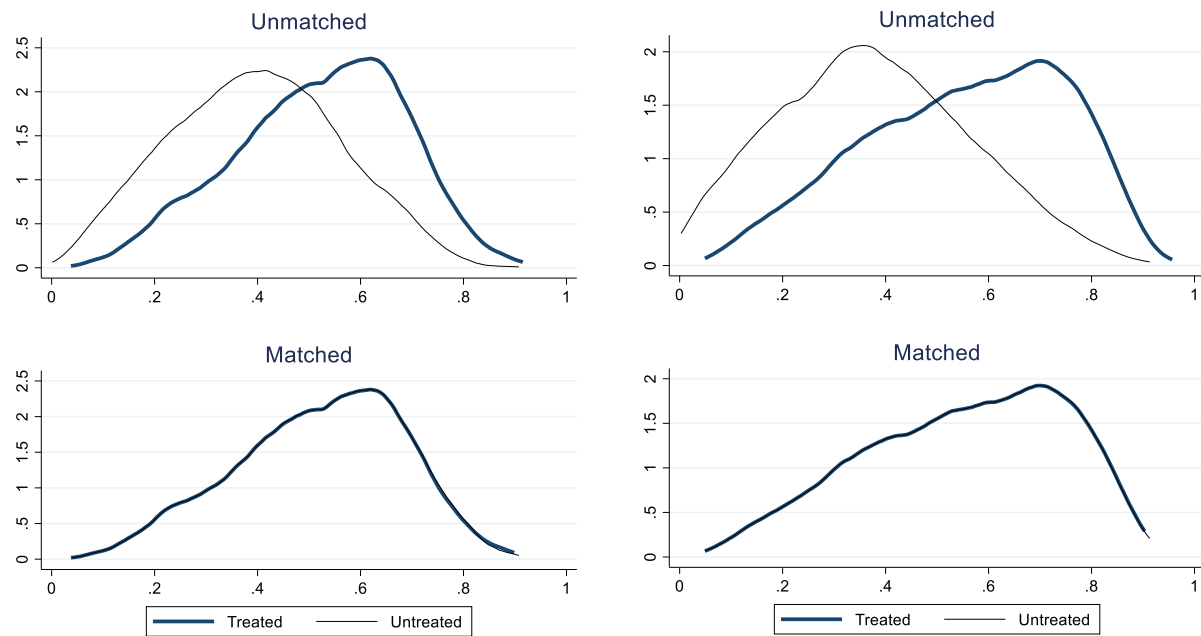


Figure S 2. The density plots of cross-sectional PSM. (left: $\ln SO_2$, right: $\ln Profits$)

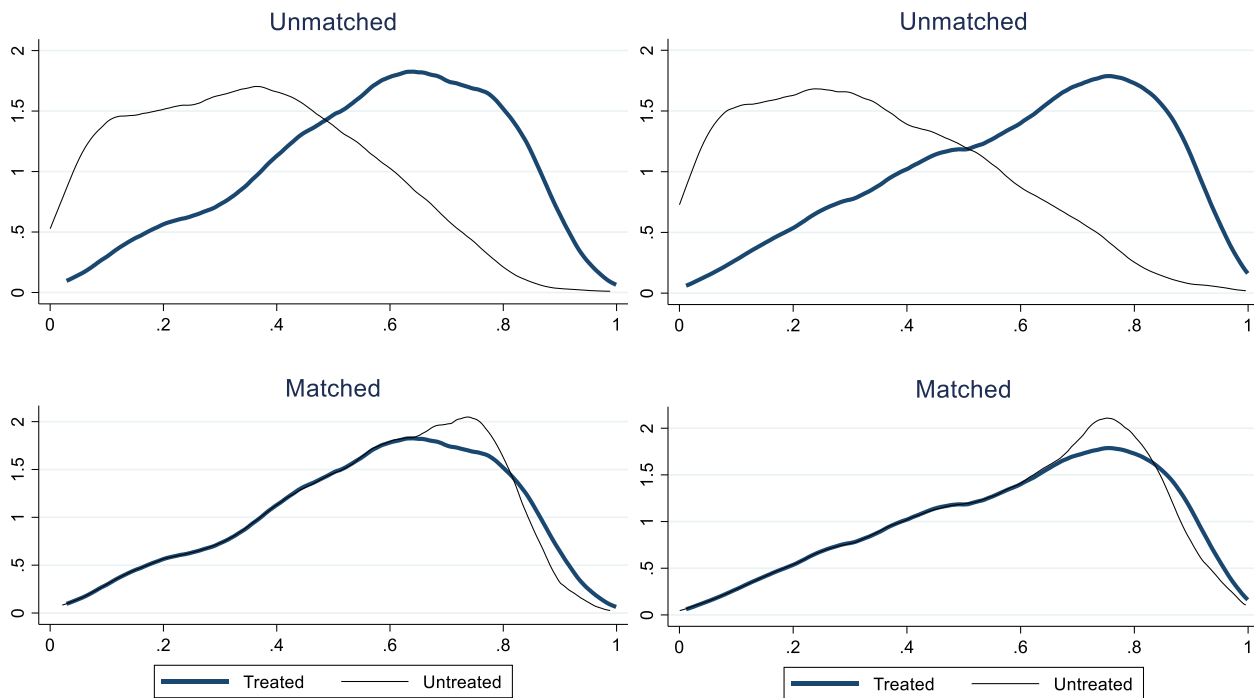


Figure S 3. Propensity score density of Phase-by-phase matching.(left: $\ln SO_2$, right: $\ln Profits$)

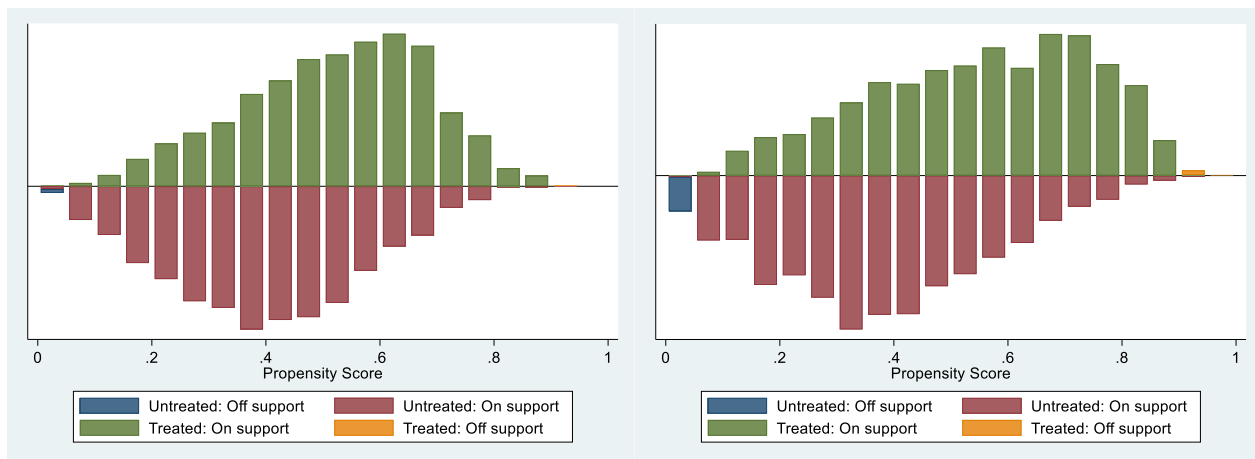


Figure S 4. Common support of PSM. (left: lnSO2, right: lnProfits)