

Do Domestic Firms Become Cleaner in the Presence of FDI? Testing FDI Spillover Effects on Firm Air Pollution in China, 1998-2007

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Overview

Research question: Do domestic firms become cleaner in the presence of foreign direct investments (FDI)?

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 \Rightarrow FDI-encouraged industries (112) vs. industries with no change (300).

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Main findings:

- FDI deregulation increases domestic firms' air pollution emissions, and by quite a bit (\approx 10%);
- evidence for both agglomeration (i.e., good, positive spillovers) and competition effects; yet the competition effect dominates the agglomeration effect, resulting in an overall increase in firm emissions;
- the competition effect mostly affects firm emissions through the production stage rather than the end-of-pipeline abatement stage.

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FDI and their host countries

The importance of FDI:

- pre-Covid: 1.5 trillion U.S. dollars in 2019;
- first half of 2021: 870 billion dollars;
- 11.3 trillion dollars of FDI has been made in developing countries by 2019;

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But is FDI really that good?

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But is FDI really that good?

Competing mechanisms:

- An agglomeration effect: domestic firms can benefit from foreign multinationals through knowledge spillovers, labor pooling, and the supply of specialized inputs (Aitken and Harrison 1999);
- A competition effect: if foreign multinationals are more productive, domestic firms may lose market shares and consequently experience a fall in productivity due to diminishing scale economies (Lu et al. 2017).

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FDI and the environment

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- The impact of environmental regulations on FDI location decisions (e.g., the pollution haven hypothesis (PHH));

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- The impact of environmental regulations on FDI location decisions (e.g., the pollution haven hypothesis (PHH));
- The impacts of FDI on the environment:

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- The impact of environmental regulations on FDI location decisions (e.g., the pollution haven hypothesis (PHH));
- The impacts of FDI on the environment:
 - Does FDI improve the environmental quality in FDI host countries and their sub-national administrative units?

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 - Are foreign firms indeed cleaner than domestic firms?

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Competing mechanisms:

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 - knowledge spillovers;
 - labor pooling;
 - the supply of specialized inputs;
 - green purchasing.

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- An agglomeration effect (\approx pollution halo effect) \Rightarrow domestic firms benefit from foreign multinationals through:
 - knowledge spillovers;
 - labor pooling;
 - the supply of specialized inputs;
 - green purchasing.
- A competition effect \Rightarrow domestic firms may lose market shares to FDI and consequently experience a fall in productivity due to diminishing scale economies:
 - lower efficiency in use of inputs;
 - lower incentive to invest in abatement.

FDI and domestic firms: existing studies

Very few past studies:

- Albornoz et al. 2009 and 2014 on Argentinean firm adoption of environmental management practices;
- Gallagher and Zarsky 2007 on sustainable industrial development in Mexican IT sector;
- Gao et al. 2021 on electricity intensities for domestic firms in China.

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How is our study different?

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How is our study different?

- do not measure emissions directly vs. our firm emission variables (waste gas, SO₂, and soot) + emission removal variables;

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- do not have causal identification vs. our DID based on a plausibly exogenous relaxation of FDI regulations upon WTO accession in 2001;
- do not explore and test causal pathways/mechanisms vs. our thorough tests on agglomeration effect, competition effect, as well as potential selection and reallocation effects

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- do not explore and test causal pathways/mechanisms vs. our thorough tests on agglomeration effect, competition effect, as well as potential selection and reallocation effects ⇒ first study to bring in the competition effect into the FDI-environment literature.

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A panel of major polluting firms in China, 1998-2007 $\Rightarrow \approx 87,000$ firm-year observations.

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A panel of major polluting firms in China, 1998-2007 $\Rightarrow \approx 87,000$ firm-year observations.

- Major polluting firm data from the Ministry of Environmental Protection: firms contributing 85% of total emissions of the major pollutants in a county \Rightarrow waste gas, SO₂, and soot.
- Annual Survey of Industrial Firms (ASIF): all SOEs + non-SOEs with annual sales ≥ 5 million RMB;

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- Annual Survey of Industrial Firms (ASIF): all SOEs + non-SOEs with annual sales ≥ 5 million RMB;
- “Catalogue for the Guidance of Foreign Investment Industries” in 1997 and 2002:
 - encouraged industries (112) \Rightarrow treated;
 - discouraged industries (7);
 - unchanged industries (300) \Rightarrow control;
 - mixed industries (5).

Empirical specification

$$Y_{fit} = \alpha_f + \beta Treatment_i \times post_t + \phi X'_{fit} + Z_{i,t0} \times \gamma_t + \gamma_t + \varepsilon_{fit} \quad (1)$$

- Y_{fit} : air pollution emissions by firm f in industry i and in year t ;
- $Treatment_i$: whether industry i belongs to the FDI encouraged category;
- $post_t$: 1 if year is 2002 and afterwards; 0 otherwise;
- X'_{fit} : time-varying firm characteristics \Rightarrow value-added, SOE dummy, export dummy, and capital-labor ratio;
- α_f/γ_t : fixed firm effects/fixed year effects;
- ε_{fit} : s.e. clustered at the firm and industry-year levels;
- $Z_{i,t0} \times \gamma_t$: FDI-encouraged industry determinant variables interacting with year dummies.

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Addressing an endogeneity concern

FDI encouraged vs. no change industries not randomly chosen by the government.

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Addressing an endogeneity concern

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FDI encouraged vs. no change industries not randomly chosen by the government.

Following Lu et al. 2017, we include criterion variables used by the government when it comes to FDI deregulations, based on “Provisions on Guiding Orientation of Foreign Investment” of the State Council in 2002 \Rightarrow industry level determinants:

- new product intensity;
- exporting intensity;
- number of firms;
- the average age of firms.

Main results

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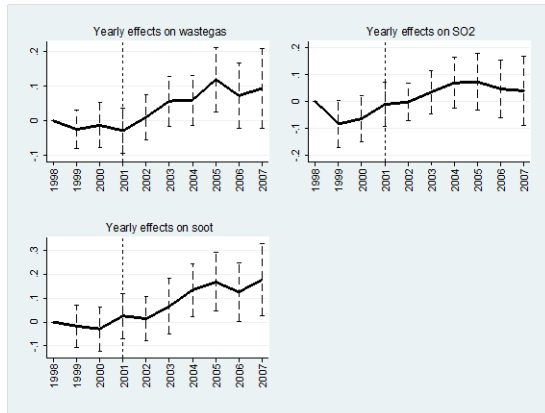
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Table 1: Main results.

Dependent variable:	Waste gas	SO2	Soot	Waste gas	SO2	Soot
	(1)	(2)	(3)	(4)	(5)	(6)
FDI Treatment*Post2002	0.0901*** (0.0240)	0.0819*** (0.0289)	0.1200*** (0.0338)	0.0783*** (0.0231)	0.0716** (0.0285)	0.1109*** (0.0334)
Observations	87,810	87,810	87,810	87,810	87,810	87,810
Additional controls:						
Firm fixed effects	yes	yes	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes	yes	yes
Control for determinants of FDI deregulations	yes	yes	yes	yes	yes	yes
Control for initial conditions	yes	yes	yes	yes	yes	yes
Control for time-varying firm characteristics	no	no	no	yes	yes	yes

Note: Standard errors are clustered two ways at the firm and industry-year level and shown in parentheses. Determinants of FDI regulation changes include interactions of the year dummies with new product intensity, export intensity, number of firms, and industry age. Initial conditions include interactions of the year dummies with industry-level pollution intensity in the initial period. The time-varying firm characteristics are value-added, state-owned enterprise dummy, export dummy, and capital-labor ratio. ***, ** and * denote significance at the 1, 5, and 10% level respectively.

Testing for pre-trends: event studies



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Robustness checks and heterogenous effects

Controlling for other policies:

- other environmental policies:
 - Two Control Zone (TCZ);
 - provincial pollution reduction targets.

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Robustness checks and heterogenous effects

Controlling for other policies:

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- SOE reform;
- tariff reduction.

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Robustness checks and heterogenous effects

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Heterogenous effects by:

- R&D intensity;
- local official characteristics;
- firm initial pollution intensity.

Robustness checks and heterogenous effects

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- SOE reform;
- tariff reduction.

Heterogenous effects by:

- R&D intensity;
- local official characteristics;
- firm initial pollution intensity.
- firm ownership: SOEs are much better protected from FDI competition effect;

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Agglomeration vs. competition effects

No agglomeration effect vs. weaker (than competition) agglomeration effect?

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Agglomeration vs. competition effects

No agglomeration effect vs. weaker (than competition) agglomeration effect?

Where are we mostly likely to find an agglomeration effect?

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Agglomeration vs. competition effects

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No agglomeration effect vs. weaker (than competition) agglomeration effect?

Where are we mostly likely to find an agglomeration effect?

⇒ when foreign and domestic firms are in the same production chain, but in different stages of the production: foreign firms may have incentives to train or educate their domestic clients or suppliers by providing more technologies, training, or support.

Agglomeration vs. competition effects

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- backward FDI: downstream (buyer) industries;
- forward FDI: upstream (supplier) industries.

agglomeration vs. competition

Table 4: Differentiating agglomeration and competition effect by considering FDI types, source countries, and locations.

Dependent variable:	Waste gas	SO2	Soot	Waste gas	SO2	Soot	Waste gas	SO2	Soot
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Horizontal FDI	0.0809*** (0.0235)	0.0677** (0.0289)	0.1049*** (0.0336)	0.0693** (0.0345)	0.0680 (0.0422)	0.1328*** (0.0505)			
Backward FDI	0.0021 (0.0585)	-0.0007 (0.0702)	-0.1770** (0.0823)						
Forward FDI	-0.1980** (0.0802)	-0.3263*** (0.1002)	-0.2320** (0.1181)						
Horizontal FDI* Developed country dummy				0.0240 (0.0439)	0.0008 (0.0530)	-0.0422 (0.0628)			
FDI from same prefecture							0.4595 (0.3114)	0.2218 (0.4027)	0.1349 (0.4519)
FDI from different prefecture							5.7361*** (2.0769)	5.4004** (2.5614)	5.2007* (3.1230)
Observations	87,810	87,810	87,810	87,810	87,810	87,810	85,754	85,754	85,754
Additional controls:									
Firm fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Control for determinants of FDI deregulations	yes	yes	yes	yes	yes	yes	yes	yes	yes
Control for initial conditions	yes	yes	yes	yes	yes	yes	yes	yes	yes
Control for time-varying firm characteristics	yes	yes	yes	yes	yes	yes	yes	yes	yes
Control for environmental policies	yes	yes	yes	yes	yes	yes	yes	yes	yes
Control for other policies	yes	yes	yes	yes	yes	yes	yes	yes	yes

Note: Standard errors are clustered two way at the firm and industry-year level and shown in parentheses. Determinants of FDI regulation changes include interactions of the year dummies with new product intensity, export intensity, number of firms, industry age. Initial conditions include interactions of the year dummies with industry-level pollution intensity in initial period. The time-varying firm characteristics are value-added, state-owned enterprise dummy, export dummy, and capital-labor ratio. Environmental policies include Two Control Zones policy and emission reduction policy. Other policies are (1) tariff reductions by controlling for interactions of the year dummies with output tariff, input tariff, and export tariff; and (2) SOE reforms by controlling for interactions of the year dummies with the number of state-owned enterprises as a share of total number. ***, ** and * denote significance at the 1, 5, and 10% level respectively.

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Production process or the end of pipeline?

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Table 5: More evidence for causal mechanisms.

Dependent variable:	TFP	New product ratio	Patent	Output	Markups	Profitability	Waste gas removal	SO2 removal	Soot removal
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
FDI Treatment*Post2002	-0.0831*** (0.0235)	0.0028 (0.0034)	0.0019 (0.0059)	0.0217* (0.0115)	-0.3575* (0.1990)	-0.0741 (0.0807)	0.0210* (0.0118)	0.1925** (0.0976)	0.0564 (0.0885)
Observations	87,509	76,339	87,810	87,735	87,509	87,735	83,362	82,290	74,505
Additional controls:									
Firm fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Control for determinants of FDI deregulations	yes	yes	yes	yes	yes	yes	yes	yes	yes
Control for initial conditions	yes	yes	yes	yes	yes	yes	yes	yes	yes
Control for time-varying firm characteristics	yes	yes	yes	yes	yes	yes	yes	yes	yes
Control for environmental policies	yes	yes	yes	yes	yes	yes	yes	yes	yes
Control for other policies	yes	yes	yes	yes	yes	yes	yes	yes	yes

Note: Standard errors are clustered two way at the firm and industry-year level and shown in parentheses. Determinants of FDI regulation changes include interactions of the year dummies with new product intensity, export intensity, number of firms, industry age. Initial conditions include interactions of the year dummies with industry-level pollution intensity in initial period. The time-varying firm characteristics are value-added, state-owned enterprise dummy, export dummy, and capital-labor ratio. Value-added is not included in Column (4). Environmental policies include Two Control Zones policy and emission reduction policy. Other policies are (1) tariff reductions by controlling for interactions of the year dummies with output tariff, input tariff, and export tariff; and (2) SOE reforms by controlling for interactions of the year dummies with the number of state-owned enterprises as a share of total number. ***, ** and * denote significance at the 1, 5, and 10% level respectively.

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Domestic Chinese firms become *dirtier* in the presence of FDI:

- The competition effect dominates the agglomeration effect, resulting in an overall increase in firm emissions;
- FDI deregulation significantly reduce firm total factor productivity and markup, suggesting that the competition effect mostly affects firm emission through the production stage rather than the end-of-pipeline abatement stage;
- Our main results do not change after we rule out a potential reallocation effect and keep out selection effect (see *backup* slides).

Contributions

- speaks to a large literature on the relationship between FDI and the economic performances of FDI-host country firms \Rightarrow *negative* effects do not stop at productivity!

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- speaks to a large literature on the relationship between FDI and the economic performances of FDI-host country firms \Rightarrow *negative* effects do not stop at productivity! \Rightarrow CO2?

Contributions

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- speaks to a large literature on the relationship between FDI and the economic performances of FDI-host country firms \Rightarrow *negative* effects do not stop at productivity! \Rightarrow CO2?
- contributes to the FDI and the environment literature: rich firm-level data, causal identification, and efforts differentiating various causal mechanisms.

Contributions

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- speaks to a large literature on the relationship between FDI and the economic performances of FDI-host country firms \Rightarrow *negative* effects do not stop at productivity! \Rightarrow CO2?
- contributes to the FDI and the environment literature: rich firm-level data, causal identification, and efforts differentiating various causal mechanisms.
- contributes to a much broader literature on globalization and the environment: often focuses on trade; we reveal similar underlying causal mechanisms that work both in the trade-environment and FDI-environment connections \Rightarrow market share and economies of scale as what drives the result.

reallocation effect?

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Table 6: Testing the reallocation effect.

Dependent variable:	Incumbent		
	Log output	Log sales	Log value-added
	(1)	(2)	(3)
FDI Treatment*Post2002	0.0505** (0.0208)	0.0458** (0.0201)	0.0574** (0.0250)
FDI Treatment*Post2002*Firm's pollution intensity in initial year	-0.0007 (0.0105)	0.0023 (0.0101)	0.0038 (0.0125)
Observations	56,279	56,268	56,342
Additional controls:			
Firm fixed effects	yes	yes	yes
Year fixed effects	yes	yes	yes
Control for determinants of FDI deregulations	yes	yes	yes
Control for initial conditions	yes	yes	yes
Control for time-varying firm characteristics	yes	yes	yes

Note: Pollution intensity is measured as the ratio of pollution emission to output. "Firm's pollution intensity in initial year" is defined as a dummy, which is equal to 1 if pollution intensity is above its mean value and 0 otherwise. Standard errors are clustered two way at the firm and industry-year level and shown in parentheses. Determinants of FDI regulation changes include interactions of the year dummies with new product intensity, export intensity, number of firms, industry age. Initial conditions include interactions of the year dummies with industry-level pollution intensity in initial period. The time-varying firm characteristics are state-owned enterprise dummy, export dummy, and capital-labor ratio. ***, ** and * denote significance at the 1, 5, and 10% level respectively.

keeping out selection effect

Table 7: testing the effect of FDI using a sample of firms that are included both before and after WTO accession: incumbent firms.

Dependent variable:	Incumbent		
	Waste gas	SO2	Soot
	(1)	(2)	(3)
FDI Treatment*Post2002	0.0953*** (0.0254)	0.0765** (0.0314)	0.1162*** (0.0374)
Observations	56,346	56,346	56,346
Additional controls:			
Firm fixed effects	yes	yes	yes
Year fixed effects	yes	yes	yes
Control for determinants of FDI deregulations	yes	yes	yes
Control for initial conditions	yes	yes	yes
Control for time-varying firm characteristics	yes	yes	yes

Note: Standard errors are clustered two way at the firm and industry-year level and shown in parentheses. Determinants of FDI regulation changes include interactions of the year dummies with new product intensity, export intensity, number of firms, industry age. Initial conditions include interactions of the year dummies with industry-level pollutants in initial period. The time-varying firm characteristics are value-added, state-owned enterprise dummy, export dummy, and capital-labor ratio. ***, ** and * denote significance at the 1, 5, and 10% level respectively.

Literature and motivations

Data and Method

Empirical Findings

Exploring Mechanisms

Conclusion

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