Going Green: Multinational Activity and Environmental Practices

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Extended Abstract

Motivation & Contribution The global fragmentation of production has flourished at a time of unprecedented climate change and urgent need for concerted environmental action worldwide. This has raised concerns about the impact of heterogeneous environmental standards across countries on firm incentives to innovate or adopt green technologies, if pollution-intensive stages of production can be relocated to countries with less regulation. Multinational companies have attracted the most scrutiny and controversy because of their global footprint in offshoring to both affiliated and unrelated parties. Even if MNCs maintain clean headquarters, are MNC affiliates also green and greener than local firms? How does MNC presence affect the environmental performance of domestic firms and of the host country overall? Could MNCs promote climate goals by facilitating knowledge transfer from advanced economies with stronger environmental standards and cleaner production methods to developing countries with weaker standards and dirtier processes?

Environmental practices provide an academically interesting and highly policy-relevant context in which to study technology spillovers among firms in connected economies. First, emerging trade-climate research finds that countries with strong environmental regulation have a comparative advantage in clean industries, and exporting firms emit less and invest more in clean technology than non-exporters in developed economies (Forslid et al 2018, Broner et al 2020). Moreover, MNC parents pass on their clean technology to foreign subsidiaries, who are in turn less emission intensive, use cleaner energy, and adopt more environmental practices than local producers (Cole et al 2017). However, this work has so far ignored potentially important spillovers across firms. Second, a large literature has established productivity spillovers from MNC affiliates to domestic competitors, upstream suppliers, downstream buyers, and firms that hire former MNC employees (Javorcik 2004, Poole 2013). Environmental technologies may thus also diffuse and be quantifiable, as emissions are directly observed, unlike measurement-error prone productivity. Lastly, the climate setting features two externalities – global impact of local environmental activity, and local impact of global innovation. Understanding any greening effects of MNCs will thus inform the scope for multilateral policy actions, such as deep-integration agreements that span trade, investment and environmental issues.

This paper empirically evaluates the diffusion of environmental practices from multinational companies to domestic firms in a host country, through employment transitions in the labor market. We exploit rich data for Brazil on firm ownership and emissions of pollutants, matched to comprehensive employer-employee records. We first assess to what extent multinational affiliates are less pollution intensive than domestic producers within narrow sector-region segments of the economy. We then examine how the pollution intensity of domestic firms evolves if and after they hire former MNC employees. This captures the transfer of technological and organizational knowhow across firms embedded in human capital that makes subsequent technology change possible and profitable. Next, we capitalize on different dimensions of heterogeneity across firms, workers, sectors, regions and MNC origin countries to inform the mechanisms behind any environmental upgrading.

Finally, we establish how aggregate emission volumes and emission intensity move with MNC activity within sector-regions and regions over time.

Insights & Implementation We use exceptional micro data for Brazil that is ideally suited to studying the impact of employee-mediated firm-to-firm links on the spillover of environmental technology. Newly collected IADB data report firm emissions of 4 key pollutants and an aggregated emissions score. We characterize firms' environmental practices with 5 corresponding measures of pollution intensity, defined as pollution per worker. The data identifies the sector and ownership status of MNC affiliates as standard, but unusually also the parent sector and origin country. We also observe firms' export and import status, for both goods and services. Finally, we trace firm-to-firm employment transitions from RAIS labor files, with information on the duration and occupation of each employment spell.

Our analysis suggests three striking patterns. First, the subsidiaries of multinational companies have significantly lower pollution intensity across all emission metrics than domestic manufacturers, even when we look within narrow industries and 250 or 550 disaggregated economic regions. Second, domestic firms that hire their first employee with past MNC experience or that increase their share of MNC-experienced employees record a sizeable reduction in pollution intensity. This is consistent with cross-firm spillovers of environmental practices. Third, there is a negative correlation between average firm emissions per worker and the average firm share of workers with MNC experience across finely disaggregated sectors and regions; Figure 6 illustrates this with aggregated heat maps across the 26 Brazilian states. This is indicative of a positive effect of MNC presence on aggregate environmental outcomes.

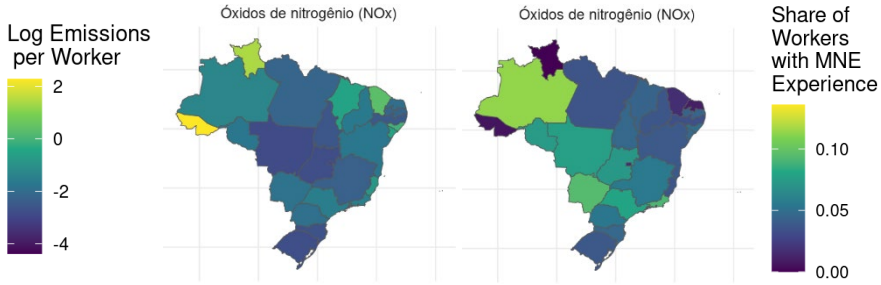


Fig.6 Brazil. Average firm emissions per worker and share of workers with MNC experience across states.

Our next step is to solidify the econometric evidence for these patterns and explore the economic mechanisms that generate them.

Our empirical analysis is guided by a stylized conceptual framework. Firms in developing countries choose to adopt cleaner technologies if this enhances profits. Globalization may raise their returns to adoption by increasing export access to important developed markets, if producers and consumers there value a green supply chain. Globalization may also lower the cost of adoption, if it improves awareness of available technologies or facilitates access to equipment and managerial knowhow necessary to implement superior technologies. Upgrading may also feature fixed costs or depend on a firm's distance to the frontier.

We use this conceptual lens to inform the mechanisms driving environmental spillovers from MNC affiliates to domestic firms. We study the role of knowledge of the technological frontier with heterogeneity in best environmental practices across sectors, environmental practices across MNCs, and environmental standards across MNC parent countries. We parse the role of organizational capacity to become greener with heterogeneity in the occupation of job switchers (manager vs. technician vs. other) at their former MNC and new domestic employer. We isolate the role of the public infrastructure for environmental change with regional variation in energy access across Brazil. Finally, we consider the role of economies of scale in environmental upgrading with heterogeneity in size and distance to the clean frontier across domestic firms.

Broader Implications This paper connects parallel research on MNC activity and spillovers and on the globalization-environment nexus. It illuminates the channels and challenges to knowledge transfer across firms and to technological change within firms in connected economies. It does so in the context of pressing climate needs, and highlights the role of firm links through labor market networks. The results bear important implications for multilateral deep-integration initiatives, as well as for national policies targeting investment promotion and sustainable growth.

Going Green*

Multinational Activity and Environmental Practices

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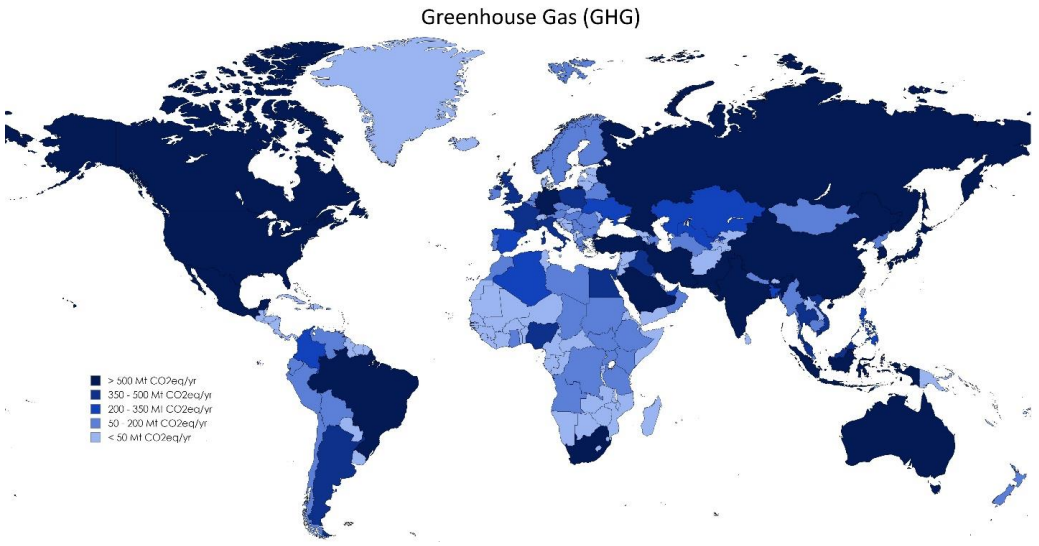
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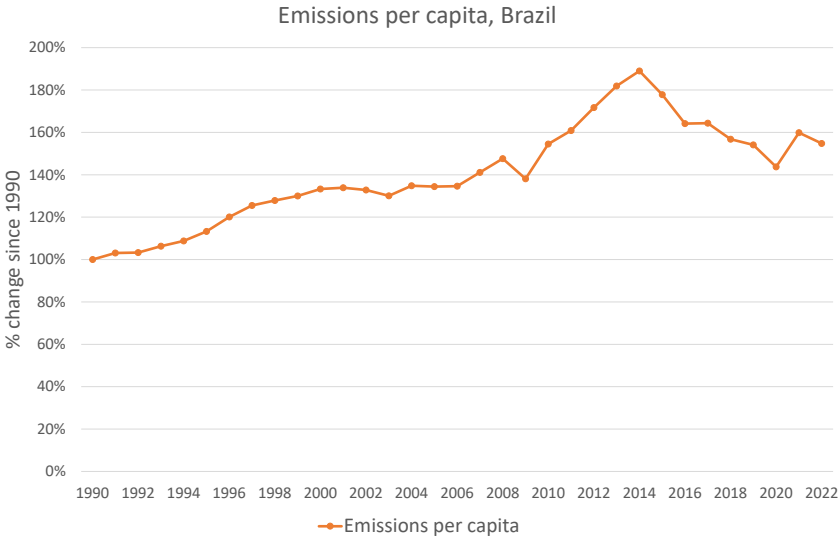
* The views and interpretations in this presentation are strictly those of the authors and should not be attributed to the Inter-American Development Bank, its executive directors, or its member countries.

Addressing Climate Change Has Become an Imperative



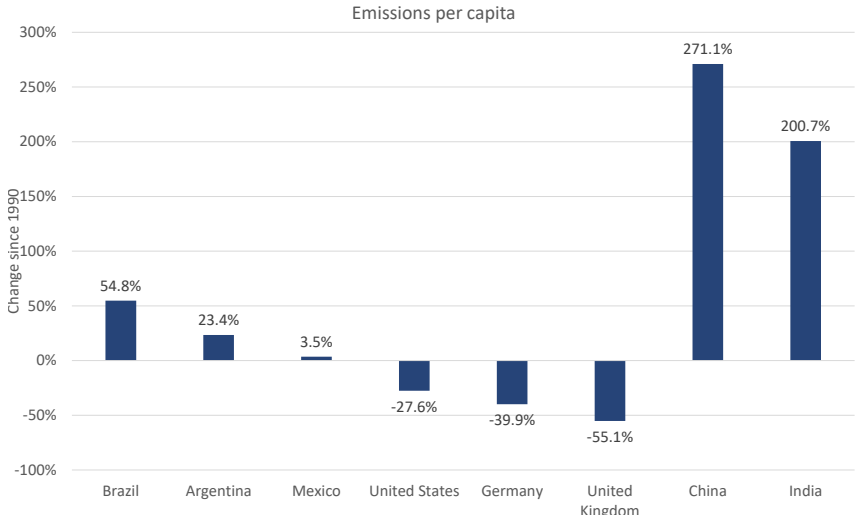
This Is Particularly the Case for Countries Such as Brazil

Brazil's emissions per capita have increased by 54% since 1990



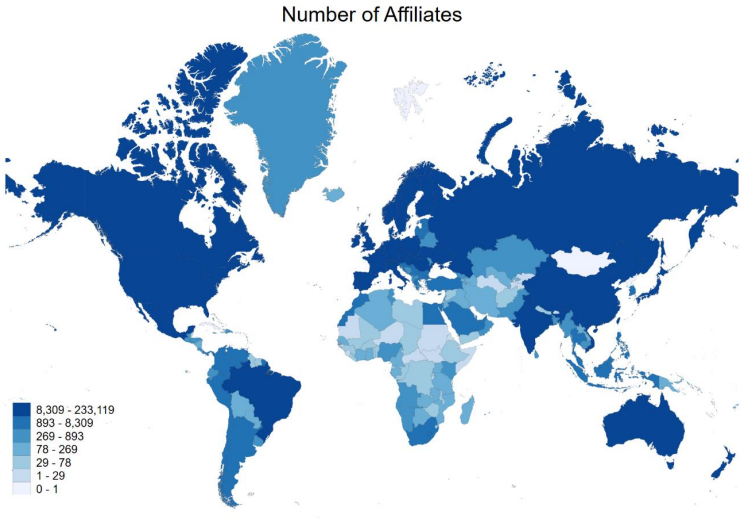
This Is Particularly the Case for Countries Such as Brazil

Brazil's increase has been large even relative to other LAC countries



Multinational Firms Are Important Global Actors

Brazil has a large number of foreign affiliates



Data source: DNB 2022.

Can Multinational Firms Be Part of the Solution?

The research question

- Multinational firms account for large shares of global economic activity (output, exports and imports, employment, R&D).
- They have broad and diversified relationships with domestic firms.
- These relationships have been found to be associated with knowledge transfer to domestic firms.
- **Question:** Do multinational firms transfer better environmental practices to domestic firms, thereby helping them improve their environmental outcomes?

This Paper
What we do

- We examine whether having workers with experience at a multional firm's foreign affiliate before been hired by the domestic company affects firms' emissions and the mechanisms thereof.
- To do so, we (so far) primarily apply a difference-in-differences strategy on a dataset that combines:
  - firm-pollutant level emissions data over time;
  - firm-employee data over time;
  - firm-level data on foreign affiliates of multinational firms data over time.

This Paper
What we find (so far)

- Domestic firms that hired employees with previous experience in multinational firms' foreign affiliates experienced larger reductions in emissions per employee.
- This effect is larger:
  - Firms are further away from the technology frontier.
  - Firms are relatively large.
  - Firms are located in regions with access to cleaner energy/electricity sources.
- Hiring of manager with previous experience in foreign affiliates was associated with reduction in emissions per employees. Hiring of other employees also seem to matter.

This Paper
Related literature

- FDI Spillovers, in general, and through labor turnover, in particular.
- The effects of FDI and multinational production on the environment, in general, and climate change in particular.

Outline

1 Data and Descriptive Statistics

2 Empirical Approach

3 Estimation Results

4 Conclusions

Data
Main datasets

- The analysis makes use of three main sets of databases.

1. **Databases on Emissions**

- *IBAMA database at the establishment-pollutant-activity-year Level:* data on firms' emissions by pollutant over the period 2013-2018.

2. **Database on Employment**

- *RAIS-Annual Social Information Report at the Employer-Employee Level:* data on firms' employment over the period 1985-2018.

3. **Databases on Foreign Affiliates**

- *Dun and Bradstreet's WorldBase and Brazil's Central Bank at the firm Level:* data on foreign affiliates for the period 2010-2018.

Data

Environmental outcomes: Who reports

- **IBAMA database at the establishment-pollutant-activity-year Level: data on firms' emissions by pollutant over the period 2013-2018.**
  - *Who Reports:* Entities registered in the Federal Technical Registry of Potentially Polluting Activities and/or Users of Natural Resources (CTF/APP) and carry out activities for which it is mandatory to fill in the form "Emissions of Atmospheric Pollutants" in the Annual Report of Potentially Polluting and User Activities of Environmental Resources (RAPP).
    - The CTF/APP identifies individuals and legal entities under environmental control and environmental inspection, as provided for in federal or national legislation (Source: IBAMA).
    - Individuals and legal entities that carry out activities under environmental control are required to register with the CTF/APP according to Normative Instruction No. 13.

Data

Environmental outcomes: Activities subject to emission reporting

Extraction and Treatment of Minerals	Textile, Clothing, Footwear and Fabric Industr
Industry of Non-Metallic Mineral Products	Plastic Products Industry
Metallurgical Industry	Tobacco Industry
Mechanical Industry	Diverse Industries
Electrical Material, Electronic and Communications Industry	Chemical Industry
Transport Material Industry	Food and Beverage Industry
Wood Industry	Utilities
Pulp and Paper Industry	Transportation, Terminals, Warehouses, and Commerce
Rubber Industry	Tourism
Leather Industry	Use of Natural Resources
Activities subject to environmental control and inspection not listed in Annex VIII of Law	Activities subject to environmental control and inspection not listed in Annex VIII of Law

Source: IBAMA.

Data

Environmental outcomes: How and what to report and sanctions

- **IBAMA Database at the establishment-pollutant-activity-year Level: data on firms' emissions by pollutant over the period 2013-2018.**
  - *How and What to Report:*
    - Firms report through IBAMA's website.
    - Firms report total amount of emissions for 4 pollutants (tons/year): Particulate Material (PM), Carbon Monoxide (CO), Sulfur Oxides (SOx) and Nitrogen Oxides (NOx).
  - *Consequences of non-reporting, untimely reporting, and inaccurate reporting:*
    - Failure to report: Sanction foreseen in section 2 of article 17-C, of Law nÂº 6.938.
    - Failure to report on time: Sanction foreseen in article 81 of Decree nÂº 6.514.
    - Submitting false or inaccurate information: Sanction foreseen in article 69-A of Law 9.605 and in article 82 of Decree 6.514.

Data

Environmental outcomes: Pollutants

- **PM (Particulate Matter)**
  - Fine particles with a diameter of 1 or 2.5 micrometer or smaller.
  - Environmental impact: Reduces visibility, affects climate, damages ecosystems and plants.
  - Economic sources: Industrial activities, transportation, residential heating.
- **CO (Carbon Monoxide)**
  - A colorless, odorless gas from incomplete combustion of fossil fuels.
  - Environmental impact: Indirect greenhouse effect, ground-level ozone formation.
  - Main sources: Motor vehicle exhaust, industrial processes, residential fuel combustion.
- **NOx (Nitrogen Oxides)**
  - Gases primarily composed of nitrogen dioxide (NO2) and nitric oxide (NO).
  - Environmental impact: Contributes to acid rain, smog, and ground-level ozone formation.
  - Main sources: Power plants, industrial facilities, vehicular emissions.
- **SOx (Sulfur Oxides)**
  - Gases primarily composed of sulfur dioxide (SO2).
  - Environmental impact: Leads to acid rain, damaging crops, forests, and buildings.
  - Main sources: Coal-fired power plants, oil refineries, metal processing.

Descriptive Evidence

Summary statistics

	Domestic Firms						MNE Firms			
Year	Avg # Pollutants	# Establish.	# Workers	Avg # of Workers	Avg MNE Experience	Avg Share MNE Experience	Avg # Pollutants	# Establish.	# Workers	Avg # Workers
2013	1.8963	5,578	2,003,997	266.56	0.63	0.07	2.54	1,219	1,659,760	718.82
2014	1.9585	6,379	2,359,412	266.66	0.66	0.08	2.58	1,545	2,046,801	688.93
2015	2.0122	7,043	2,560,434	256.69	0.67	0.09	2.65	1,707	2,136,460	656.16
2016	2.0839	7,467	2,594,267	238.31	0.68	0.09	2.63	1,753	2,053,265	611.27
2017	2.1274	7,832	2,677,992	231.24	0.69	0.10	2.69	1,714	2,115,682	610.23
2018	2.1368	8,216	2,760,833	224.88	0.69	0.12	2.72	1,773	2,160,947	600.60

Descriptive Evidence

Summary statistics

		Domestic Firms					MNE Firms		
Year	Pollutant	# Establish.	# Workers	Avg # of Workers	Avg MNE Experience	Avg Share MNE Experience	# Establish.	# Workers	Avg # Workers
2013	Material Particulado (MP)	4,069	830,260	209.450	0.573	0.060	959	624,222	667.617
2013	Monóxido de carbono (CO)	1,979	418,965	217.080	0.578	0.057	405	297,308	735.911
2013	Óxidos de enxofre (SOx)	663	242,373	379.895	0.792	0.089	381	271,072	713.347
2013	Óxidos de nitrogênio (NOx)	1,025	512,399	519.674	0.823	0.104	588	467,158	791.793
2014	Material Particulado (MP)	4,713	1,013,114	219.764	0.618	0.070	1,225	755,052	627.641
2014	Monóxido de carbono (CO)	2,329	511,773	224.167	0.604	0.069	536	365,631	682.147
2014	Óxidos de enxofre (SOx)	817	284,230	364.397	0.787	0.102	494	349,927	714.137
2014	Óxidos de nitrogênio (NOx)	1,215	550,295	468.336	0.824	0.116	743	576,191	776.538
2015	Material Particulado (MP)	5,235	1,051,521	205.295	0.636	0.078	1,393	778,157	592.205
2015	Monóxido de carbono (CO)	2,639	567,963	221.514	0.624	0.073	602	398,077	665.681
2015	Óxidos de enxofre (SOx)	944	316,786	346.593	0.772	0.109	551	361,749	677.433
2015	Óxidos de nitrogênio (NOx)	1,415	624,164	453.937	0.817	0.122	822	598,477	738.860
2016	Material Particulado (MP)	5,653	1,060,634	190.933	0.645	0.083	1,418	765,092	566.735
2016	Monóxido de carbono (CO)	2,845	587,946	212.793	0.642	0.081	626	368,750	593.800
2016	Óxidos de enxofre (SOx)	1,070	317,384	305.765	0.770	0.114	550	346,612	644.260
2016	Óxidos de nitrogênio (NOx)	1,564	628,303	410.656	0.816	0.130	857	572,811	673.895
2017	Material Particulado (MP)	5,974	1,130,848	194.605	0.662	0.092	1,366	759,413	564.200
2017	Monóxido de carbono (CO)	3,086	593,955	198.117	0.641	0.084	689	403,831	586.964
2017	Óxidos de enxofre (SOx)	1,151	303,290	274.471	0.748	0.119	551	353,021	645.377
2017	Óxidos de nitrogênio (NOx)	1,707	649,899	389.861	0.804	0.132	892	599,417	676.543
2018	Material Particulado (MP)	6,275	1,174,864	191.909	0.663	0.107	1,396	751,298	547.993
2018	Monóxido de carbono (CO)	3,266	592,856	186.668	0.656	0.102	735	411,195	567.166
2018	Óxidos de enxofre (SOx)	1,202	318,817	271.103	0.759	0.142	594	381,055	653.611
2018	Óxidos de nitrogênio (NOx)	1,829	674,296	373.986	0.804	0.151	929	617,399	671.816

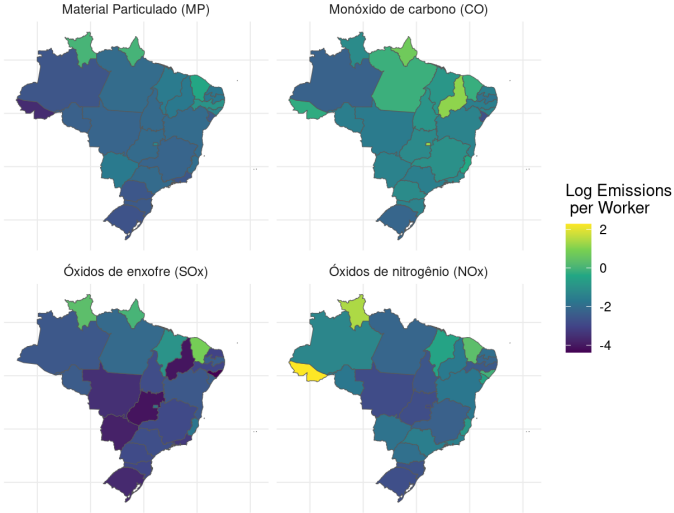
Data and Descriptive Evidence

Summary statistics

		Domestic Firms			MNE Firms		
Year	Pollutant	Avg Emissions	Avg Emissions per Worker	Avg Log Emissions per Worker	Avg Emissions	Avg Emissions per Worker	Avg Log Emissions per Worker
2013	Material Particulado (MP)	4,408,544	14,957	-3.652	29,173	19	-3.800
2013	Monóxido de carbono (CO)	76,851	964	-2.282	678,211	3,390	-2.689
2013	Óxidos de enxofre (SOx)	13,356	58	-4.279	4,032	17	-3.900
2013	Óxidos de nitrogênio (NOx)	19,915	79	-2.743	44,388	122	-2.565
2014	Material Particulado (MP)	26,650	563	-3.697	3,947	31	-3.861
2014	Monóxido de carbono (CO)	129,539	2,276	-2.355	796,501	694	-2.884
2014	Óxidos de enxofre (SOx)	123,089	2,157	-4.378	2,109	13	-4.113
2014	Óxidos de nitrogênio (NOx)	123,213	790	-2.924	8,210	54	-2.802
2015	Material Particulado (MP)	30,662,614	97,941	-3.800	3,860	10	-3.929
2015	Monóxido de carbono (CO)	130,661	2,144	-2.392	14,923	43	-2.861
2015	Óxidos de enxofre (SOx)	339,298,321	1,088,227	-4.258	1,170	8	-4.425
2015	Óxidos de nitrogênio (NOx)	32,490,397	104,445	-2.932	2,912	12	-3.053
2016	Material Particulado (MP)	11,084	263	-3.794	8,888	12	-4.091
2016	Monóxido de carbono (CO)	88,855	2,693	-2.337	50,419	369	-2.853
2016	Óxidos de enxofre (SOx)	116,891	2,964	-4.110	644	2	-4.471
2016	Óxidos de nitrogênio (NOx)	104,135	329	-2.769	2,090	4	-3.140
2017	Material Particulado (MP)	1,819	122	-3.778	6,778	12	-4.012
2017	Monóxido de carbono (CO)	33,478	121	-2.278	110,667	373	-3.228
2017	Óxidos de enxofre (SOx)	1,127	38	-4.067	599	2	-4.607
2017	Óxidos de nitrogênio (NOx)	3,452	42	-2.891	2,876	6	-3.211
2018	Material Particulado (MP)	15,196	232	-3.767	11,563	227	-4.055
2018	Monóxido de carbono (CO)	28,749	442	-2.407	25,262	83	-3.215
2018	Óxidos de enxofre (SOx)	781	37	-4.206	610	5	-4.735
2018	Óxidos de nitrogênio (NOx)	2,472	47	-2.855	874	3	-3.441

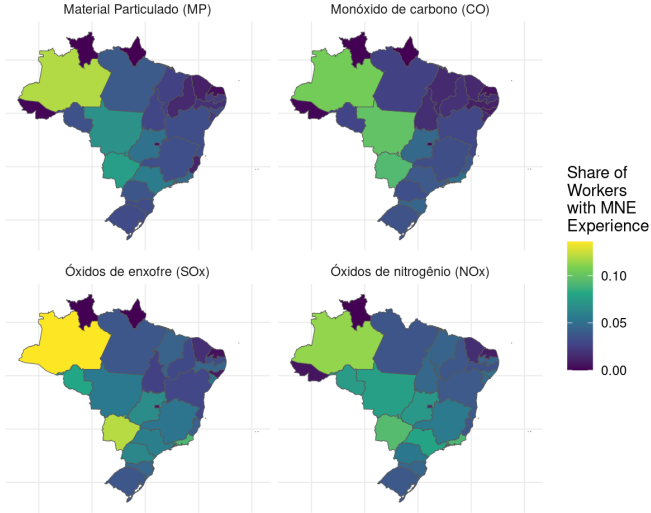
Descriptive Evidence

Average pollution per employee by pollutant, 2018



Descriptive Evidence

Share of employees with MNE experience by pollutant, 2018



Descriptive Evidence

Emissions and employees with (no) MNE experience (municipalities, 2018)

	(1)	(2)	(3)
log(1 - sh_wkrs)	1.142*	1.134**	0.815+
	(0.419)	(0.414)	(0.434)
Fixed Effects			
Year	X	X	X
State	X		
Meso Region		X	
Micro Region			X
Observations	16672	16672	16672

Authors' calculations based on data from WorldBase, Central Bank of Brazil, RAIS, and IBAMA.
Note: + p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001.

Descriptive Evidence

Emissions and employees with (no) MNE experience (municipalities)

	(1)	(2)	(3)	(4)	(5)	(6)
log(1 - sh_wkrs)	0.966*	0.946*	0.628+	0.965***	0.947***	0.654***
	(0.386)	(0.382)	(0.370)	(0.174)	(0.176)	(0.182)
Fixed Effects						
Year	X	X	X			
State	X					
Meso Region		X				
Micro Region			X			
Municipality				X	X	X
State-Year				X		
Meso Region-Year					X	
Micro Region-Year						X
Observations	99922	99922	99922	99922	99922	99922

Authors' calculations based on data from WorldBase, Central Bank of Brazil, RAIS, and IBAMA.
Note: + p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001.

Outline

1 Data and Descriptive Statistics

2 Empirical Approach

3 Estimation Results

4 Conclusions

Empirical Approach (So Far)
Baseline Specification

- We estimate the following general empirical model on the sample of domestic firms:

$$\Delta_3 ln(E/L)_{fpirt} = \alpha \Delta_3 \mathrm{FA}_{firt} + \sum_{j=1}^{\mathrm{J}} \beta^{\mathrm{j}} \mathrm{X}^{\mathrm{j}}_{firt} + \rho_{p,i,r,t} + \varepsilon_{fpirt}$$

  - f, p, i, r, t correspond to establishment/firms, pollutant, sector (ISIC 4-digit), $r =$ (state, meso and micro region), and year, respectively;
  - E denotes emissions divided by total number of employees;
  - FA is a binary indicator that takes the value of one if the domestic firm has employees with previous experience at a foreign affiliate;
  - X set of control variables such as export/import status, and number of pollutants;
  - $\rho_{p,i,r,t}$ sets of pollutant, industry, region, year fixed effects, and the alternative combination.
  - Standard errors are clustered by firm-industry-region.

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Estimation Results

Baseline

	(1)	(2)	(3)	(4)	(5)	(6)
MNE Experience	-0.753***	-0.720***	-0.673***	-0.684***	-0.641***	-0.628***
	(0.080)	(0.069)	(0.063)	(0.076)	(0.061)	(0.078)
Fixed Effects						
Pollutant	X	X	X	X	X	X
Industry (4 digits)-Year	X	X	X			
State - Year	X					
Meso Region-Year		X				
Micro Region-Year			X			
State-Industry (4 digits)-Year				X		
Meso Region-Industry (4 digits)-Year					X	
Micro Region-Industry (4 digits)-Year						X
Observations	17084	17084	17084	17084	17084	17084

Authors' calculations based on data from WorldBase, Central Bank of Brazil, RAIS, and IBAMA.
Note: + p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001.

Mechanisms

Distance to the frontier, adoption costs, and embedded knowledge

- **Distance to the frontier**
  - Does the domestic firm position in the pollution spectrum in Brazil matters?
- **Adoption cost**
  - Are there economies of scale for implementing greener technologies?
  - Do gas pollutants are harder to reduce?
- **Embedded knowledge**
  - Does occupation at multinational firm matter?

Estimation Results

Mechanisms: Distance to frontier | Firm position in pollution spectrum (ISIC2)

	(1)	(2)	(3)	(4)	(5)	(6)
MNE Experience x Distance to frontier						
Low	-0.568***	-0.573***	-0.548***	-0.521***	-0.504***	-0.521***
	(0.093)	(0.075)	(0.069)	(0.096)	(0.067)	(0.079)
High	-1.041***	-0.952***	-0.887***	-0.940***	-0.888***	-0.847***
	(0.096)	(0.098)	(0.094)	(0.079)	(0.115)	(0.157)
Fixed Effects						
Pollutant	X	X	X	X	X	X
Industry (4 digits)-Year	X	X	X			
State - Year	X					
Meso Region-Year		X				
Micro Region-Year			X			
State-Industry (4 digits)-Year				X		
Meso Region-Industry (4 digits)-Year					X	
Micro Region-Industry (4 digits)-Year						X
Observations	17084	17084	17084	17084	17084	17084

Authors' calculations based on data from WorldBase, Central Bank of Brazil, RAIS, and IBAMA.
Note: + p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001.

Estimation Results

Mechanisms: Cost of adoption | Internal economies of scale

		(1)	(2)	(3)	(4)	(5)	(6)
MNE Experience x Firm Size							
	Small	-0.652***	-0.617***	-0.560***	-0.590***	-0.570***	-0.537***
		(0.065)	(0.057)	(0.060)	(0.061)	(0.068)	(0.083)
	Large	-1.838***	-1.849***	-1.848***	-1.739***	-1.441**	-1.560**
		(0.390)	(0.363)	(0.367)	(0.352)	(0.465)	(0.539)
Fixed Effects							
Pollutant		X	X	X	X	X	X
Industry (4 digits)-Year		X	X	X			
State - Year		X					
Meso Region-Year			X				
Micro Region-Year				X			
State-Industry (4 digits)-Year					X		
Meso Region-Industry (4 digits)-Year						X	
Micro Region-Industry (4 digits)-Year							X
Observations		17084	17084	17084	17084	17084	17084

Authors' calculations based on data from WorldBase, Central Bank of Brazil, RAIS, and IBAMA.
Note: + p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001.

Estimation Results

Mechanisms: Cost of adoption | Cost of technological change

	(1)	(2)	(3)	(4)	(5)	(6)
MNE Experience x Type of pollutant						
MP	-0.633***	-0.632***	-0.580***	-0.612***	-0.576***	-0.588***
	(0.057)	(0.050)	(0.055)	(0.056)	(0.046)	(0.062)
Other	-0.911***	-0.841***	-0.810***	-0.787***	-0.738***	-0.689***
	(0.112)	(0.114)	(0.101)	(0.110)	(0.125)	(0.121)
Fixed Effects						
Pollutant	X	X	X	X	X	X
Industry (4 digits)-Year	X	X	X			
State - Year	X					
Meso Region-Year		X				
Micro Region-Year			X			
State-Industry (4 digits)-Year				X		
Meso Region-Industry (4 digits)-Year					X	
Micro Region-Industry (4 digits)-Year						X
Observations	17084	17084	17084	17084	17084	17084

Authors' calculations based on data from WorldBase, Central Bank of Brazil, RAIS, and IBAMA.
Note: + p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001.

Estimation Results

Mechanisms: Heterogeneity by energy sources (cut points at the state level)

		(1)	(2)	(3)	(4)	(5)	(6)
MNE Experience x Energy Demand							
	Low	-0.742***	-0.660***	-0.733***	-0.658***	-0.579**	-0.584**
		(0.134)	(0.133)	(0.131)	(0.144)	(0.170)	(0.176)
	High	-0.766***	-0.789***	-0.600***	-0.710***	-0.715***	-0.680***
		(0.055)	(0.076)	(0.101)	(0.046)	(0.118)	(0.122)
Fixed Effects							
Pollutant		X	X	X	X	X	X
Industry (4 digits)-Year		X	X	X			
State - Year		X					
Meso Region-Year			X				
Micro Region-Year				X			
State-Industry (4 digits)-Year					X		
Meso Region-Industry (4 digits)-Year						X	
Micro Region-Industry (4 digits)-Year							X
Observations		17084	17084	17084	17084	17084	17084

Authors' calculations based on data from WorldBase, Central Bank of Brazil, RAIS, and IBAMA.
Note: + p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001.

Estimation Results

Mechanisms: Heterogeneity by energy sources (cut points at the sample level)

		(1)	(2)	(3)	(4)	(5)	(6)
MNE Experience x Energy Demand							
	Low	-0.715***	-0.658***	-0.651***	-0.626***	-0.537***	-0.583***
		(0.091)	(0.083)	(0.087)	(0.094)	(0.084)	(0.093)
	High	-0.888***	-0.942***	-0.765***	-0.886***	-1.228***	-0.929*
		(0.112)	(0.141)	(0.194)	(0.105)	(0.230)	(0.432)
Fixed Effects							
Pollutant		X	X	X	X	X	X
Industry (4 digits)-Year		X	X	X			
State - Year		X					
Meso Region-Year			X				
Micro Region-Year				X			
State-Industry (4 digits)-Year					X		
Meso Region-Industry (4 digits)-Year						X	
Micro Region-Industry (4 digits)-Year							X
Observations		17084	17084	17084	17084	17084	17084

Authors' calculations based on data from WorldBase, Central Bank of Brazil, RAIS, and IBAMA.
Note: + p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001.

Estimation Results

Mechanisms: Heterogeneity by electricity sources (cut points at the state level)

		(1)	(2)	(3)	(4)	(5)	(6)
MNE Experience x Energy Demand							
	Low	-0.659***	-0.615***	-0.696***	-0.589***	-0.552**	-0.536**
		(0.117)	(0.126)	(0.119)	(0.122)	(0.172)	(0.178)
	High	-0.861***	-0.840***	-0.645***	-0.784***	-0.750***	-0.736***
		(0.053)	(0.070)	(0.082)	(0.034)	(0.125)	(0.117)
Fixed Effects							
Pollutant		X	X	X	X	X	X
Industry (4 digits)-Year		X	X	X			
State - Year		X					
Meso Region-Year			X				
Micro Region-Year				X			
State-Industry (4 digits)-Year					X		
Meso Region-Industry (4 digits)-Year						X	
Micro Region-Industry (4 digits)-Year							X
Observations		17084	17084	17084	17084	17084	17084

Authors' calculations based on data from WorldBase, Central Bank of Brazil, RAIS, and IBAMA.
Note: + p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001.

Estimation Results

Mechanisms: Heterogeneity by electricity sources (cut points at the sample level)

		(1)	(2)	(3)	(4)	(5)	(6)
MNE Experience x Energy Demand							
	Low	-0.605***	-0.564***	-0.598***	-0.543***	-0.496***	-0.548***
		(0.071)	(0.080)	(0.090)	(0.074)	(0.081)	(0.102)
	High	-1.204***	-1.202***	-0.944***	-1.134***	-1.374***	-1.063*
		(0.152)	(0.139)	(0.169)	(0.151)	(0.230)	(0.401)
Fixed Effects							
Pollutant		X	X	X	X	X	X
Industry (4 digits)-Year		X	X	X			
State - Year		X					
Meso Region-Year			X				
Micro Region-Year				X			
State-Industry (4 digits)-Year					X		
Meso Region-Industry (4 digits)-Year						X	
Micro Region-Industry (4 digits)-Year							X
Observations		17084	17084	17084	17084	17084	17084

Authors' calculations based on data from WorldBase, Central Bank of Brazil, RAIS, and IBAMA.
Note: + p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001.

Estimation Results

Mechanisms: Embedded Knowledge | Occupation Categories

- **Managers:** This category includes various managerial positions across different departments, such as sales managers, production managers, financial managers, and other roles responsible for overseeing and directing specific functions within firms.
- **Other Occupations:**
  - *Directors:* This category includes directors and top executives, including chief executive officers, general managers, and other top decision-makers responsible for the overall direction and strategy of organizations.
  - *Technicians:* This category includes technical professionals, including engineers, IT professionals, scientists, architects, and other technical experts who apply scientific and technical knowledge to their work.
  - *Other Roles:* Med-level technical and support roles, administrative support roles, sales and service workers, agricultural and forestry workers, industrial and manufacturing workers, transportation and logistics workers.

Estimation Results

Mechanisms: Embedded Knowledge | Occupation at the MNE

	(1)	(2)	(3)	(4)	(5)	(6)
MNE Experience x Type of occupation						
Manager	-0.263***	-0.315***	-0.324***	-0.282***	-0.231**	-0.323**
	(0.045)	(0.041)	(0.039)	(0.054)	(0.075)	(0.120)
Other	-0.731***	-0.697***	-0.651***	-0.661***	-0.612***	-0.569***
	(0.083)	(0.071)	(0.062)	(0.088)	(0.072)	(0.085)
Fixed Effects						
Pollutant	X	X	X	X	X	X
Industry (4 digits)-Year	X	X	X			
State - Year	X					
Meso Region-Year		X				
Micro Region-Year			X			
State-Industry (4 digits)-Year				X		
Meso Region-Industry (4 digits)-Year					X	
Micro Region-Industry (4 digits)-Year						X
Observations	17084	17084	17084	17084	17084	17084

Authors' calculations based on data from WorldBase, Central Bank of Brazil, RAIS, and IBAMA.
Note: + p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001.

Outline

1 Data and Descriptive Statistics

2 Empirical Approach

3 Estimation Results

4 Conclusions

Conclusions

What we have learned so far and policy implications

- Multinational production seems to generate positive externalities in the form of transfer of better environmental practices to domestic firms through labor turnover.
- These benefits are neither factored in multinational firms' private calculations...
- ...nor in policy decisions by investment promotion agencies, which are increasingly involved in public sector sustainability efforts (nor are they aware of potential negative environmental biases).