Unpacking France's Emissions Paradox: The Role of FDI

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Motivation

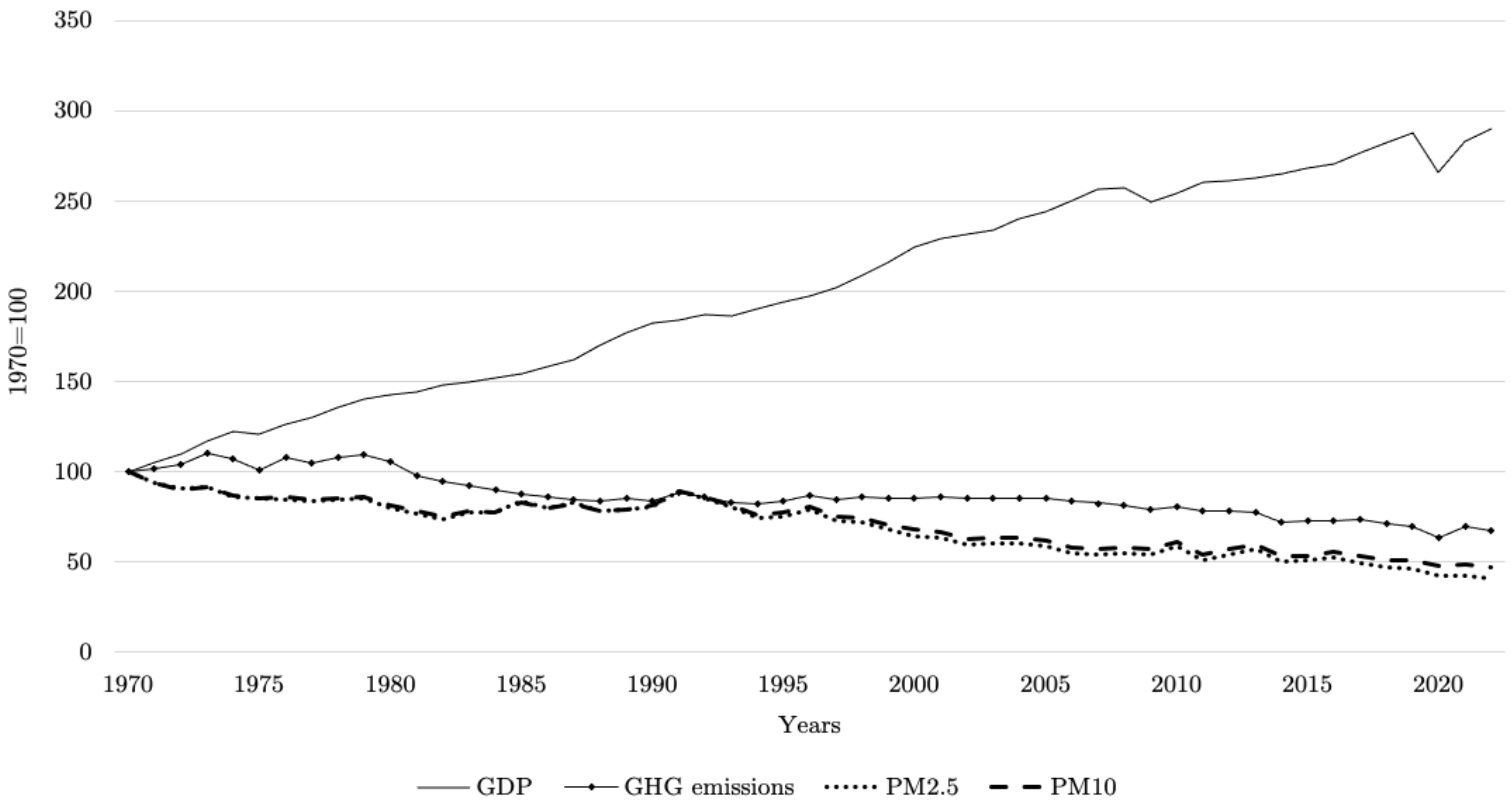


Figure: Breaking the Link Between Economic Growth and Emissions in France

Objective : determine whether the observed reduction in GHG genuinely indicates a sustainable transition to a low-emission economy or is merely an artifact of shifting polluting activities abroad.

Contributions of Existing Literature

To dissect the phenomenon of decoupling emissions from economic growth, Grossman and Krueger (1991) investigated the underlying mechanisms :

- **A Scale Effect** : Outsourcing an increasing amount of production activities abroad to decrease national emissions output.

- **A Composition Effect** : Outsourcing an increasing share of polluting production activities overseas to decrease domestic emissions.

  Supported by the **Pollution Haven Hypothesis** (Copeland & Taylor, 1993), suggesting that developed nations often reduce domestic emissions by outsourcing their pollution-intensive industries.

- **A Technique Effect** : Improving production processes that lower emissions per unit of output.

  Related to the **Porter Hypothesis** (Porter & Van der Linde, 1995), proposing that stringent environmental regulations stimulate innovation and lead to cleaner production.

Goals of the Paper and Main Findings

- We investigate the role of manufacturing FDI in the French decoupling by building on the recent study by Levinson (2023).
- We confirm the dominant role of the scale effect as discussed by Levinson (2023) by applying his strategy to French FDI.
- By analyzing emission intensities based on destination countries and temporal factors, we demonstrate the presence of both effects, with the scale effect accounting for 53% of emissions reduction, composition for 20%, and technique for 27%.
- We further show that environmental regulation plays a key role in shaping these effects.

Key Statistics about France's FDI trends

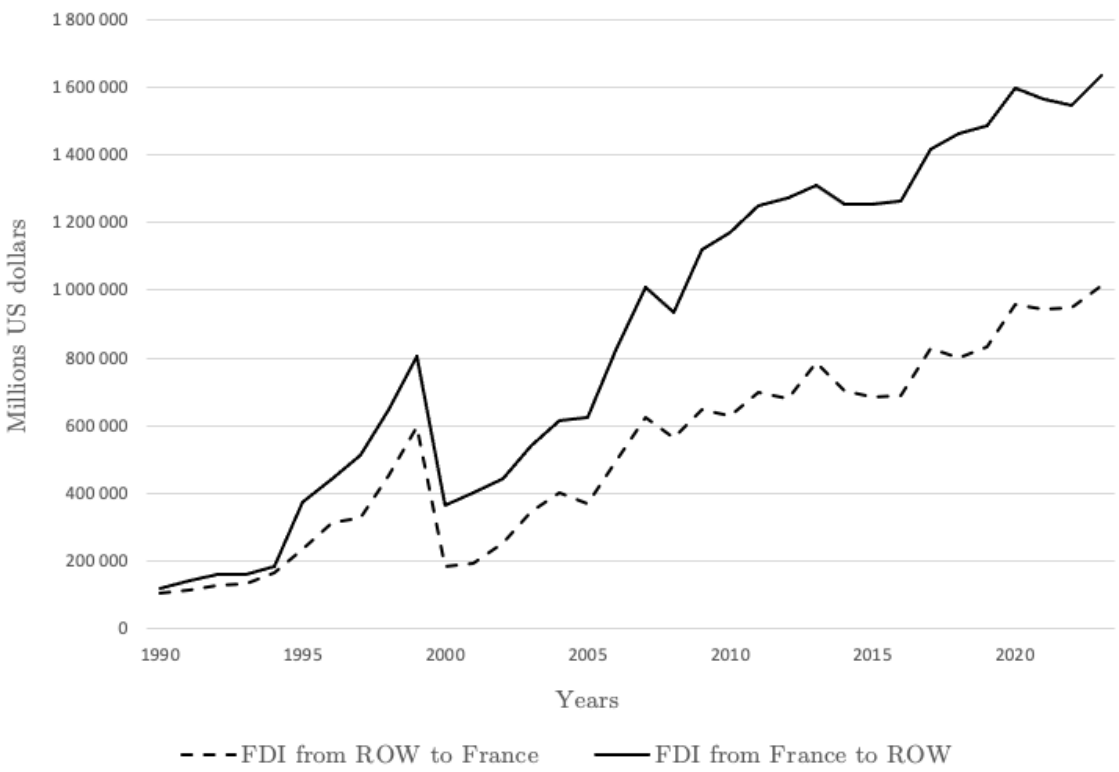


Figure: FDI stocks from and to France

- Outbound FDI grew 13-fold from 1990 and 2023, while inbound FDI expanded nine times.

Key Statistics about France's FDI trends

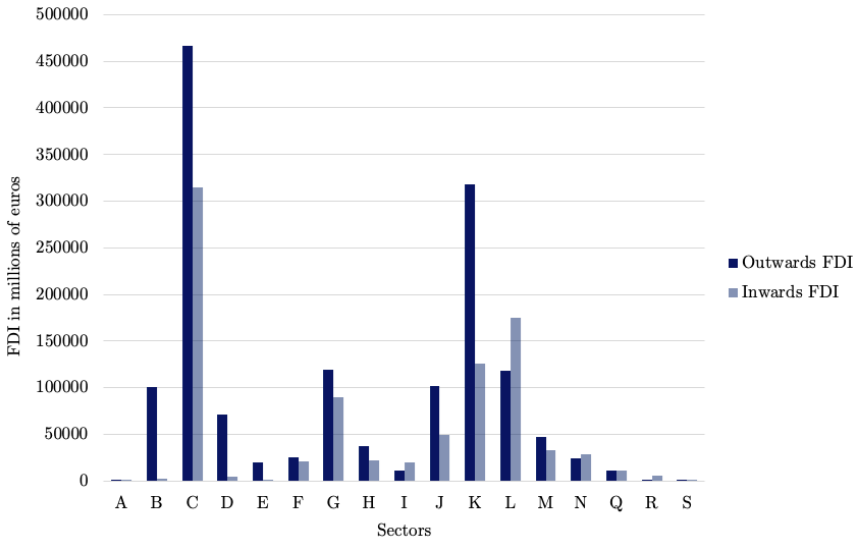


Figure: 2023 FDI inwards and outwards by sectors

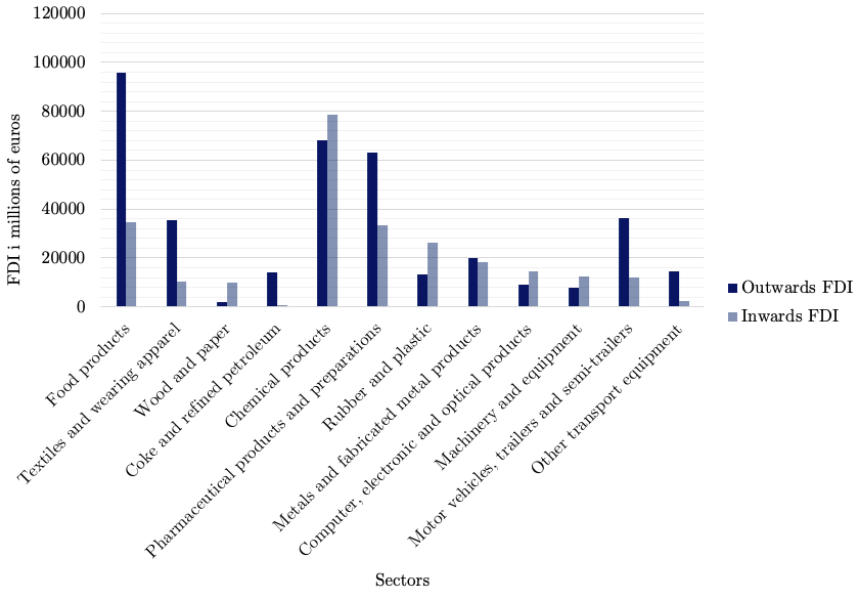


Figure: 2023 FDI inwards and outwards by manufacturing sectors

- Manufacturing dominates both inbound and outbound FDI, particularly in chemicals and pharmaceutical products, where pollution concerns are significant.

Key Statistics about France's FDI trends

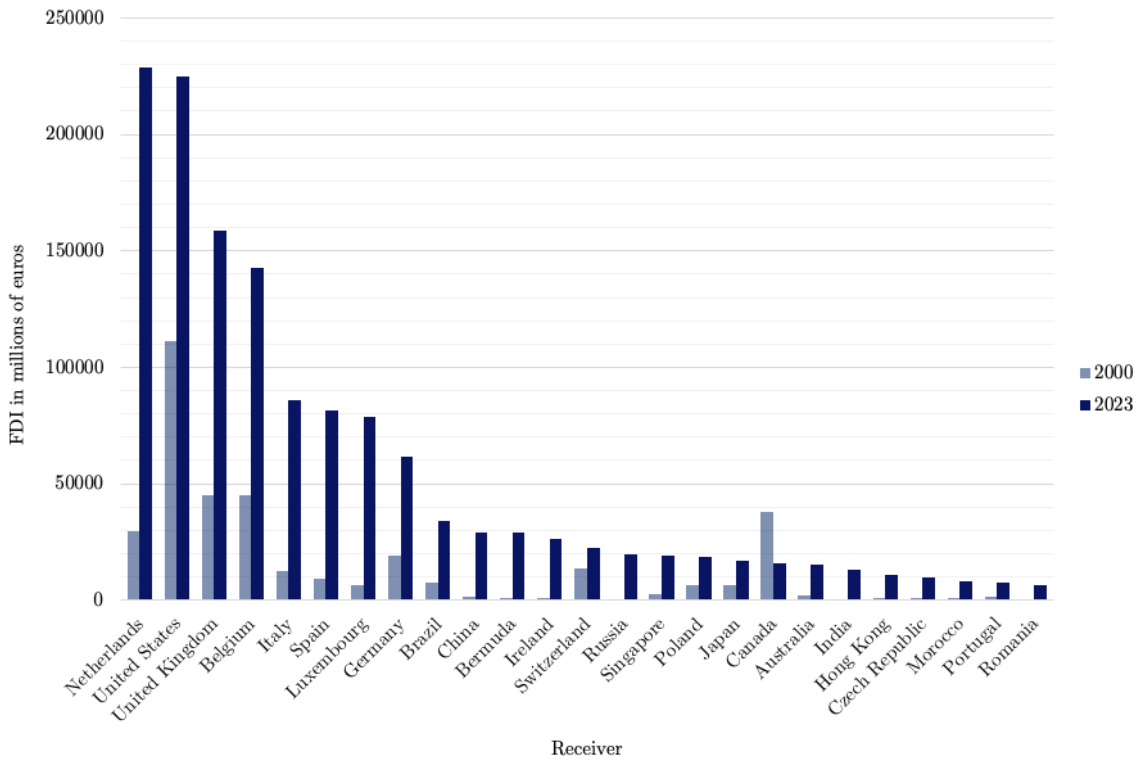


Figure: French FDI outwards for 2000 and 2023

- French FDI has shifted from primarily targeting developed countries to a more diversified approach that includes emerging markets.

Methodology and Data

- **Methodology based on Levinson's approach** : multi-step accounting exercise to assess how high-income countries reduce domestic pollution by importing products instead of manufacturing them domestically.

- **Own contribution** : focus on outward manufacturing FDI rather than imports to assess the pollution potentially offshored by French firms.

$$EE_{FRjt} = \sum_{k=1}^{K} \left(\frac{CO2_{\{FR,j\}kt}}{Output_{\{FR,j\}kt}} \times FDI_{FRjkt} \right) \tag{1}$$

where EE_{jt} represents FDI embodied emissions from country i to country j at time t, $\frac{CO2_{\{FR,j\}kt}}{Output_{\{FR,j\}kt}}$ is emission intensities of sector k and FDI_{FRjkt} represents the total amount of FDI sent from French sector k to country j at time t.

Methodology and Data

A Two-Step Analysis :

- **Section One**: Conduct a mirror analysis of Levinson's approach, assuming homogeneous production technologies across countries.

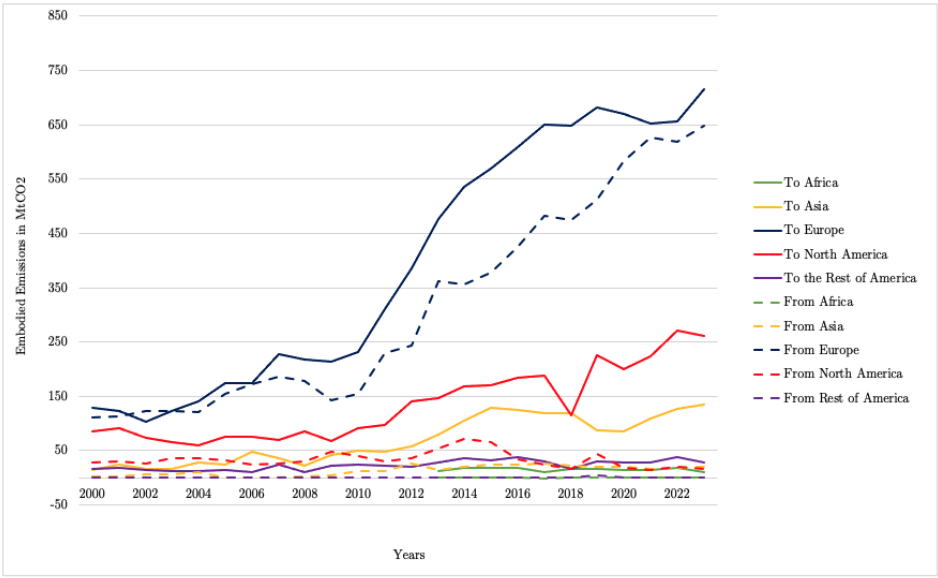
$$EE_{FRjt} = \sum_{k=1}^{K} \left(\frac{CO2_{FRk2000}}{Output_{FRk2000}} \times FDI_{FRjkt} \right) \tag{2}$$

- **Section Two**: Introduce variations in emission intensities based on real-world conditions for further assessment.

$$TEE_{FRjt} = \sum_{k=1}^{K} \left(\frac{CO2_{FRkt}}{Output_{FRkt}} \times FDI_{FRjkt} \right) \tag{3}$$

$$REE_{FRjt} = \sum_{k=1}^{K} \left(\frac{CO2_{jkt}}{Output_{jkt}} \times FDI_{FRjkt} \right) \tag{4}$$

Section 1 : Using Levinson's approach



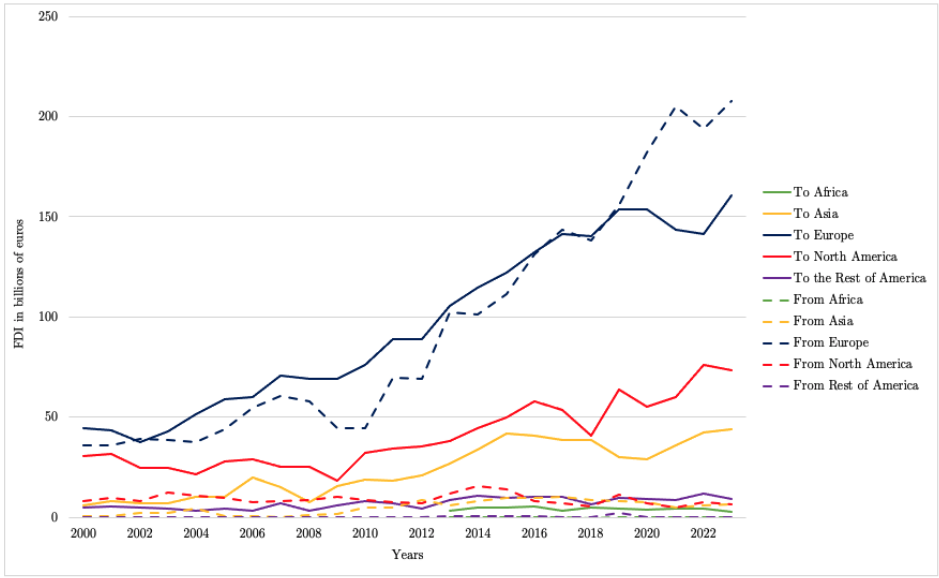


Figure: Emissions embodied in FDI and FDI by country group

- Using Levinson's decomposition method, we find strong evidence of a scale effect, while the composition effect remains limited, confirming Levinson's original conclusions.

Section 2 : Refining the Framework

- We now consider the time variation to decompose between the scale, composition and technique effect **in the case of France**.

Table: Decomposition of Emission Reductions by Destination

Region	(1) All	(2) Scale & Composition	(3) Scale	(4) Composition	(5) Technique
Africa	38.16	48.39	50.19	-1.80	-10.23
Asia	6.03	8.91	7.01	1.90	-2.88
Europe	2.75	4.43	2.74	1.69	-1.68
North America	1.28	2.01	1.64	0.37	-0.73
Rest of America	1.33	1.98	2.00	-0.02	-0.65
World	2.19	3.45	2.50	0.95	-1.26

Note: Column (1) is based on Eq. (3); Column (2) on Eq. (2); Column (3) reports the ratio of FDI volume between 2015 and 2000; Column (4) the difference between Column (2) and (3) and Column (5) the difference between Column (1) and (2).

- The **scale effect** is consistently positive, reflecting a significant increase in relocations between 2000 and 2015. The **composition effect** is generally positive but relatively weak, suggesting that the sectoral distribution of French investments abroad has not undergone major changes over time. Finally, the **technique effect** is consistently negative, indicating sustained efforts by French firms to improve emission efficiency.

Section 2 : Refining the Framework

Table: Relative Contribution of Scale, Composition, and Technique Effects in EE

Share of Each Effect	**Scale Effect**	**Composition Effect**	**Technique Effect**
French FDI in Africa	81%	3%	16%
French FDI in Asia	60%	16%	24%
French FDI in Europe	45%	28%	27%
French FDI in North America	60%	14%	26%
French FDI in the Rest of America	75%	1%	24%
French FDI in the World	53%	20%	27%

- The increase in the volume of worldwide outward FDI accounts for 53% of the reduction in emissions recorded in France, the offshoring of more pollution-intensive activities explains around 20%, and improvements in production technologies contribute roughly 27%.

Carbon Leakage

- What are the real emissions embodied (REE) in FDI, considering the emission intensities of the destination countries? Relaxing assumptions of homogeneity and invariance, we compare observed emissions from offshoring ($REE_{FR\,jt}$) with counterfactual domestic emissions ($TEE_{FR\,jt}$), accounting for scale, composition, and technique effects.

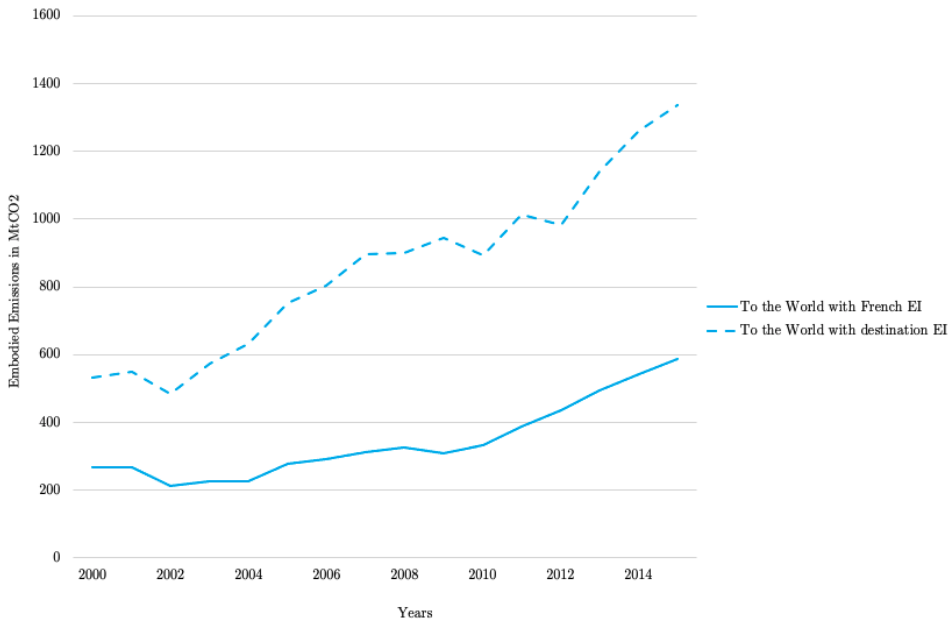


Figure: Real Pollution Embodied in FDI vs. Counterfactual Emissions Without Offshoring

- Offshoring has led to a significant increase in emissions: in 2000, emissions based on destination intensities were twice as high as those using French intensities, rising to 2.3 times higher by 2015.

Carbon Leakage

This model explores the relationship between environmental regulations and carbon leakage, offering insights into potential pollution haven effects.

- **Model:**

$$CL_{FRjt} = \gamma_1 + \gamma_2 \ln(ERTR_{FRt}) + \gamma_3 \ln(ERTR_{jt}) + \eta_j + \eta_t + \epsilon_{FRjt}$$

  CL_{FRjt} represents the extra emissions due to the offshoring of French production, calculated as the difference of the logarithms between Eq.(3) and Eq.(2); $ERTR$ stands for Environmentally Related Tax Revenues for France and country j; and η refers to country and time fixed effects.

- **Results:**
  - French regulations increase the emissions gap by 0.35%.
  - Host country regulations are associated with a reduction in the gap by 0.13%.
  - A 1% reduction in the regulatory gap is associated with a 0.13% decrease in the emissions difference. Hence, harmonizing regulations across countries can mitigate carbon leakage.

Technique Effect

This model examines the technique effect, providing insights into how environmental regulations might relate to changes in emission intensities.

- **Model:**

$$\ln(EI_{it}) = \gamma_1 + \gamma_2 \ln(ERTR_{it}) + \eta_i + \eta_t + \epsilon_{it}$$

  $ln(EI_{it})$ is the logarithm of emission intensities, representing emissions per unit of output and η are country and time fixed effects.

- **Results:**
  - Environmental taxes are associated with a 0.13% reduction in emission intensities.
  - Stronger associations observed in developed economies.

Concluding Remarks & Policy Implications

- We investigate France's apparent decoupling between production growth and declining domestic emissions.
- By adapting Levinson's methodology using variant country-year emission intensities, we identify :
  - **a scale effect**: primary driver (53%)
  - **a composition effect**: moderate (20%)
  - **a technique effect**: significant (27%)
- Domestic emission reductions may come at the cost of higher global emissions.
- Environmental regulations are key determinants of both carbon leakage and technique effects.
- Stronger and harmonized **environmental regulations** can reduce FDI-embodied emissions.
- Future research should:
  - Use more **granular sectoral data**.
  - Extend time coverage post-2015 to capture post-Paris Agreement dynamics.

Groups	Countries ISO Codes
Africa	*AGO, BDI, BEN, BFA, BWA, CAF, CIV, CMR, COD, COG, DJI, DZA, EGY, ERI, ETH, GAB, GHA, GIN, GMB, KEN, LBR, LBY, LSO, MAR, MDG, MLI, MOZ, MRT, MUS, MWI, NAM, NER, NGA, RWA, SEN, SLE, SOM, STP, SWZ, SYC, TCD, TGO, TUN, TZA, UGA, ZAF, ZMB, ZWE*
Asia	*AFG, ARE, ARM, AZE, BGD, BHR, BRN, BTN, CHN, GEO, HKG, IDN, IND, IRN, IRQ, ISR, JOR, JPN, KAZ, KGZ, KHM, KOR, KWT, LAO, LBN, LKA, MAC, MDV, MMR, MNG, MYS, NPL, OMN, PAK, PHL, PRK, QAT, SAU, SGP, SYR, THA, TJK, TKM, TWN, UZB, VNM, YEM*
Europe	*ALB, AUT, BEL, BGR, BIH, BLR, CHE, CYP, CZE, DEU, DNK, ESP, EST, FIN, GBR, GRC, HRV, HUN, IRL, ISL, ITA, LIE, LTU, LUX, LVA, MDA, MKD, MLT, MNE, NLD, NOR, POL, PRT, ROU, RUS, SMR, SRB, SVK, SVN, SWE, TUR, UKR*
Rest of America	*ABW, ARG, ATG, BHS, BLZ, BMU, BOL, BRA, BRB, CHL, COL, CRI, CUB, CYM, DOM, ECU, GTM, GUY, HND, HTI, JAM, MEX, NIC, PAN, PER, PRY, SLV, SUR, TTO, URY, VEN, VGB*
North America	*CAN, USA*

Figure: List of Countries by Group

NACE Division	RMRIO Codes	NACE Division	RMRIO Codes
C10	35–43, 45	C20	56–60, 69
C11	44	C22	91
C12	90	C23	61–67
C13	46	C24	70–81
C14	47	C25	82, 92
C15	48	C26	84, 86, 87
C16	49, 50	C27	85
C17	51–53	C28	83
C18	134	C29	88
C19	54, 55	C30	89

Figure: Correspondence between RMRIO and NACE Divisions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All countries				**Africa & Asia**			
$Ln(ERTR_{it})$	0.233***		0.345***		0.409***		0.586***	
	(0.0580)		(0.0741)		(0.110)		(0.135)	
$Ln(ERTR_{jt})$	-0.127***		-0.127***		-0.0612**		-0.100***	
	(0.0342)		(0.0341)		(0.0278)		(0.0257)	
$Diff\ Ln(ERTR_{ijt})$		0.110***		0.127***		0.00330		0.100***
		(0.0355)		(0.0341)		(0.0313)		(0.0257)
Observations	973	973	973	973	323	323	323	323
R-squared	0.107	0.082	0.154	0.154	0.225	0.000	0.307	0.307
Number of countries	69	69	69	69	25	25	25	25
Destination FE	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	NO	NO	YES	YES	NO	NO	YES	YES

Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Figure: Identification of a carbon leakage effect

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	All countries		**Africa and Asia**		**Europe**		**North America**		**Latin America**	
$Ln(ERTR_{it})$	-0.509***	-0.129***	-0.355***	-0.100***	-0.810***	-0.275***	-1.214*	-0.581***	-0.333**	-0.132**
	(0.0641)	(0.0344)	(0.0553)	(0.0257)	(0.0759)	(0.0527)	(0.175)	(3.90e-06)	(0.128)	(0.0599)
Observations	992	992	323	323	460	460	30	30	175	175
R-squared	0.537	0.846	0.543	0.794	0.742	0.956	0.911	0.991	0.352	0.755
Number of countries	70	70	25	25	31	31	2	2	12	12
Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES

Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Figure: Identification of a technique effect