

Exporting Pollution

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All views expressed in this paper are those of the authors and not necessarily those of Hermes Investment Management or Hermes EOS.

Climate Change and the Environment – Why do we care?

- **Recent developments**

- International Energy Agency (IEA): *“Carbon emissions from advanced economies set to rise in 2018 for first time in five years, reversing a declining trend”* – 4 December 2018
- Intergovernmental Panel on Climate Change (IPCC): *“Global net human-caused emissions of carbon dioxide (CO₂) would need to fall by about 45 percent from 2010 levels by 2030, reaching ‘net zero’ around 2050.”*

- **Involved stakeholders**

- Governments
- Consumers
- Investors

Pollution Haven Hypothesis (PHH)

- **Polluting activities by firms are performed in countries with weak environmental policies**
 - Implication: Crowding out (“a concerted effort is needed”)
- **Demand effect**
 - Firms export polluting operations rather than incur cost of cleaner operations
- **Supply effect**
 - Countries impose weak environmental policies in order to to attract polluting firms for short term benefits (e.g., investments, GDP growth)

Summary of Results

- Aggregate firm-year analysis
 - Firm's CO₂ emissions globally, at home, and abroad as a function of home country environmental regulation
 - Firms pollute less at home and more abroad when environmental policy in their home country is strict
- Gravity firm-foreign country-year analysis
 - Firm's CO₂ emissions in foreign country as a function of distance between home and foreign country regulation
 - Firms pollute more in those foreign countries where regulatory distance from domestic regulation is higher

Contribution

Existing evidence

- Mostly macro-level evidence at country or industry level
 - Pollution proxied with FDI or trade
 - Environmental regulation proxied with income levels, actual pollution
- Limited micro-level evidence
 - Dam & Scholtens (2012)
 - BenKheder & Zugravu (2012)
- Results are mixed but tend to support PHH

Our study

- Use direct measure of environmental regulation at country-year level
- Use direct measure of pollution at firm-country-year level



Micro-level evidence for PHH.
Important lens for institutional
investors.

Data

Pollution (GHG) data

- Carbon Disclosure Project, CDP
- CO₂ emissions of 1,970 firms
 - 48 home countries
 - 218 foreign countries
 - 2008-2015
- Scope 1 and/or 2 emissions
- Restriction
 - Firm reports $\geq 85\%$ of global emissions on country level

Environmental regulation data

- World Economic Forum, WEF
- Index of environmental regulation
 - Stringency (SER)
 - Enforcement (EER)
 - 150 countries
 - 2008-2015
 - Continuous scale 0 – 7 (higher value = stricter regulation)
- $SEER = (SER * EER) / 7$

CDP: Nationality of 1,970 firms that report CO₂

| homecountry | number of unique firms |
|----------------|------------------------|
| USA | 469 |
| United Kingdom | 262 |
| Japan | 218 |
| Canada | 114 |
| Australia | 93 |
| France | 71 |
| South Africa | 67 |
| Sweden | 63 |
| Germany | 59 |
| Korea (South) | 48 |
| Switzerland | 47 |
| Netherlands | 40 |
| Spain | 40 |
| Brazil | 36 |
| Italy | 36 |
| Taiwan | 36 |

| homecountry | number of unique firms |
|-------------|------------------------|
| Norway | 31 |
| India | 30 |
| Finland | 29 |
| Denmark | 22 |
| Ireland | 19 |
| Hong Kong | 15 |
| Portugal | 12 |
| Belgium | 11 |
| New Zealand | 11 |
| Austria | 10 |
| Singapore | 10 |
| Mexico | 8 |
| Turkey | 8 |
| China | 7 |
| Colombia | 7 |
| Thailand | 6 |

| homecountry | number of unique firms |
|----------------|------------------------|
| Luxembourg | 4 |
| Russia | 4 |
| Chile | 3 |
| Greece | 3 |
| Israel | 3 |
| Malaysia | 3 |
| Poland | 3 |
| Argentina | 2 |
| Hungary | 2 |
| Philippines | 2 |
| Cyprus | 1 |
| Czech Republic | 1 |
| Malta | 1 |
| Pakistan | 1 |
| Peru | 1 |
| UAE | 1 |

CDP: 218 foreign countries in which firms emit CO₂

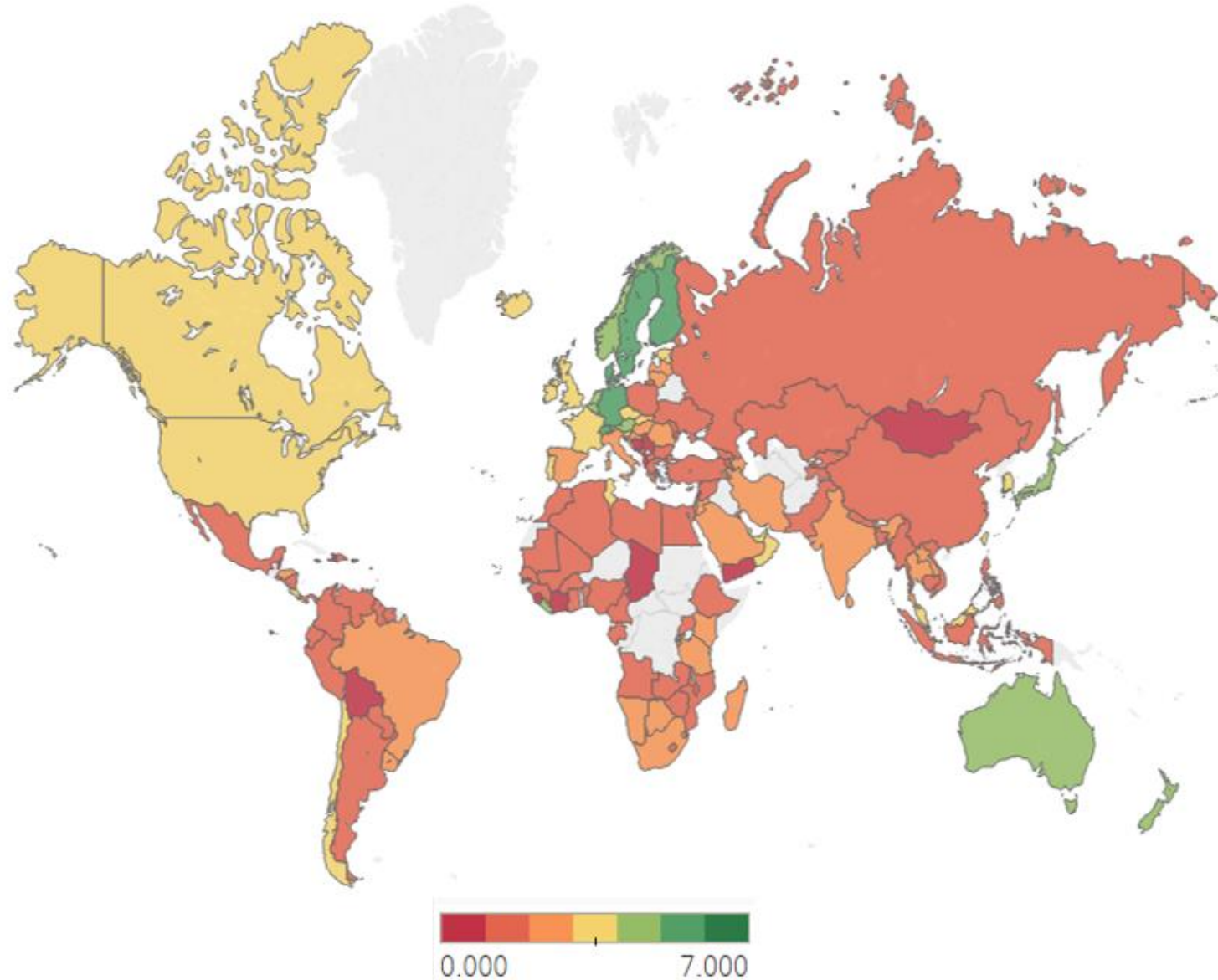
| foreign country | % of sample |
|-----------------|-------------|
| USA | 4.24 |
| China | 4.18 |
| United Kingdom | 3.66 |
| Germany | 3.44 |
| Canada | 3.01 |
| France | 2.92 |
| Brazil | 2.70 |
| India | 2.67 |
| Mexico | 2.56 |
| Australia | 2.50 |
| Spain | 2.39 |
| Italy | 2.36 |
| Netherlands | 2.21 |
| Singapore | 2.13 |
| Poland | 2.00 |
| Belgium | 1.83 |
| Malaysia | 1.82 |
| Thailand | 1.67 |
| Czech Republic | 1.57 |
| Japan | 1.55 |
| Argentina | 1.48 |
| Russia | 1.47 |
| Ireland | 1.47 |

| foreign country | % of sample |
|----------------------|-------------|
| Korea (South) | 1.44 |
| Sweden | 1.44 |
| Switzerland | 1.38 |
| Indonesia | 1.35 |
| South Africa | 1.34 |
| Chile | 1.23 |
| Taiwan | 1.21 |
| Denmark | 1.20 |
| Hungary | 1.19 |
| Turkey | 1.19 |
| Austria | 1.11 |
| Portugal | 1.06 |
| Philippines | 1.03 |
| New Zealand | 1.01 |
| Finland | 0.99 |
| Norway | 0.99 |
| Vietnam | 0.95 |
| Romania | 0.93 |
| Hong Kong | 0.88 |
| United Arab Emirates | 0.88 |
| Colombia | 0.81 |
| Slovakia | 0.76 |
| Peru | 0.72 |

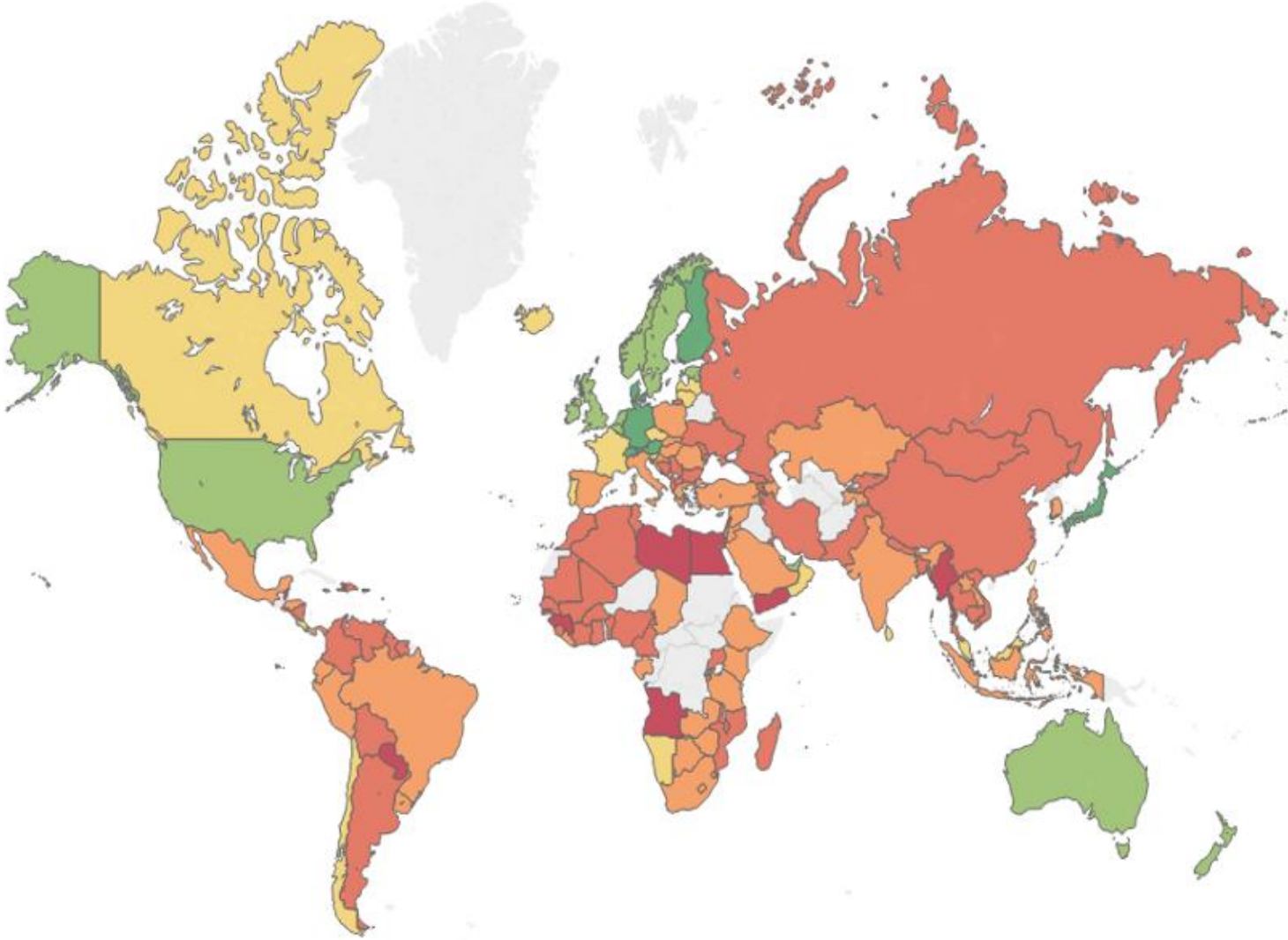
| foreign country | % of sample |
|--------------------|-------------|
| Greece | 0.66 |
| Egypt | 0.58 |
| Luxembourg | 0.56 |
| Venezuela | 0.56 |
| Ukraine | 0.53 |
| Israel | 0.50 |
| Puerto Rico | 0.49 |
| Morocco | 0.47 |
| Bulgaria | 0.46 |
| Saudi Arabia | 0.42 |
| Uruguay | 0.40 |
| Costa Rica | 0.38 |
| Lithuania | 0.37 |
| Croatia | 0.35 |
| Ecuador | 0.34 |
| Estonia | 0.32 |
| Serbia | 0.32 |
| Pakistan | 0.32 |
| Ghana | 0.30 |
| Dominican Republic | 0.30 |
| Guatemala | 0.29 |
| Latvia | 0.29 |
| Kazakhstan | 0.28 |

| Average across firms | | | | | |
|--------------------------|-----------------|--|--|---|---|
| Year | Number of firms | Firm's global emissions in metric tons | Firm's emissions in home country in % of firm's total global emissions | Number of countries in which firm has emissions | Environmental regulation (SEER) in home country |
| Scope 1 Emissions | | | | | |
| 2008 | 573 | 5,004,705 | 71.9 | 6.0 | 3.9 |
| 2009 | 792 | 3,110,120 | 73.2 | 6.0 | 4.0 |
| 2010 | 734 | 3,119,675 | 61.4 | 8.1 | 4.1 |
| 2011 | 807 | 3,059,106 | 61.5 | 8.2 | 4.1 |
| 2012 | 855 | 3,145,869 | 58.8 | 8.6 | 4.2 |
| 2013 | 883 | 2,990,603 | 59.1 | 9.1 | 4.1 |
| 2014 | 1,030 | 2,724,609 | 56.8 | 9.0 | 4.2 |
| 2015 | 1,054 | 2,623,531 | 56.5 | 9.0 | 4.1 |

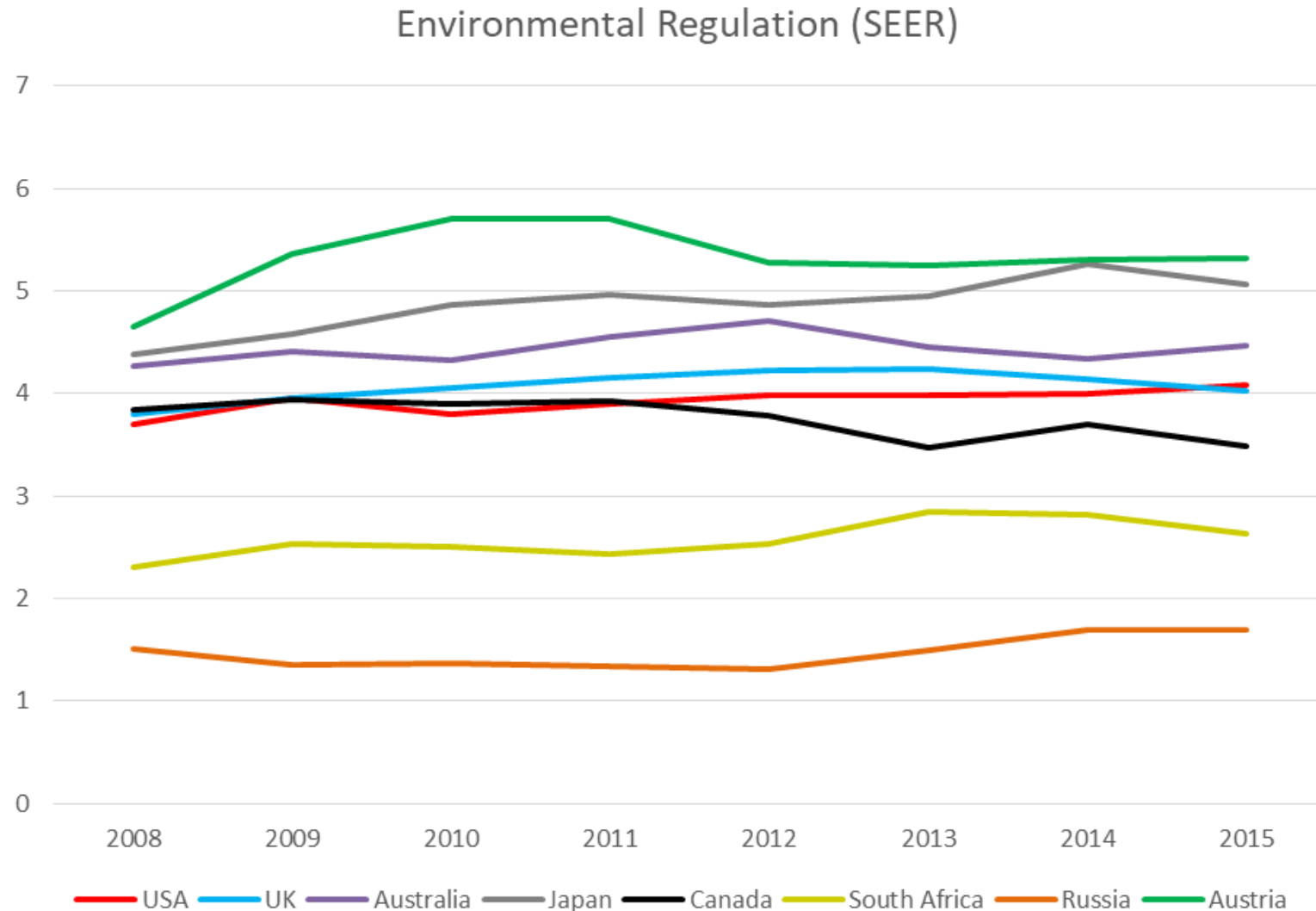
Environmental Regulation (SEER₂₀₀₈)



Environmental Regulation (SEER₂₀₁₅)



Changes in National Environmental Regulation over Time



Analyses

- **Aggregate analysis**
 - Dependent variables
 - CO₂ emissions of firm i in year t
 - Global emissions
 - Domestic emissions (HQ)
 - Emissions abroad (all foreign countries combined)
 - Key independent variable
 - Environmental regulation in home country h in year t
- **Gravity analysis**
 - Dependent variable
 - CO₂ emissions of firm i in foreign country f in year t
 - Key independent variable
 - Difference in environmental regulation between home and foreign country in year t (home – foreign)

Aggregate Analysis of Scope 1 Emissions

| Dependent variable: | In(Global emissions (tons)) | In(Home emissions (tons)) | | In(Foreign emissions (tons)) | | Foreign emissions in % of global emissions | |
|-----------------------------|-----------------------------|---------------------------|------------------|------------------------------|----------------|--|-----------------|
| Specification: | OLS (1) | OLS (2) | Tobit (3) | OLS (4) | Tobit (5) | OLS (6) | Tobit (7) |
| SEER(home) | -0.15 *** | -0.29 *** | -0.30 *** | 0.24 ** | 0.28 ** | 2.65 ** | 3.31 *** |
| <i>Firm characteristics</i> | | | | | | | |
| In(Assets) | 0.05 *** | 1.06 *** | 1.06 *** | 1.24 *** | 1.30 *** | 1.28 ** | 1.82 ** |
| Foreign | 0.00 | -0.01 | -0.01 | 0.04 *** | 0.04 *** | 0.04 *** | 0.04 *** |
| Home | | | | | | | |
| In | | | | | | | |
| Q | | | | | | | |
| Firm | | | | | | | |
| In | | | | | | | |
| Adjusted R ² | 0.92 | 0.92 | 0.92 | 0.59 | 0.10 | 0.10 | 0.10 |
| Observations | 4,919 | 4,919 | 4,919 | 4,919 | 4,919 | 4,919 | 4,919 |
| of which censored at 0 | | | 226 | | 481 | | 481 |
| of which censored at 100 | | | | | | | 226 |

1 SD increase in SEER (+0.9) ⇒ 13% lower global emissions

1 SD increase in SEER (+0.9) ⇒ 24% lower home emissions

1 SD increase in SEER (+0.9) ⇒ 29% higher foreign emissions

Corporate Governance

| Dependent variable: | Foreign emissions in % of global emissions | | | |
|-----------------------------------|--|---------------------------|------------------------------|-----------|
| | ln(Global emissions (tons)) | ln(Home emissions (tons)) | ln(Foreign emissions (tons)) | |
| Specification: | OLS | Tobit | Tobit | Tobit |
| Panel A: Scope 1 Emissions | | | | |
| SEER | -0.14 ** | -0.22 * | 0.41 *** | 3.45 ** |
| SEER*I(Good governance) | 0.00 | -0.69 ** | -0.36 * | 4.67 * |
| F-test | 1.54 | 10.17 *** | 0.08 | 12.04 *** |
| Panel B: Scope 2 Emissions | | | | |
| SEER | -0.16 *** | -0.37 *** | 0.39 *** | 6.53 *** |
| SEER*I(Good governance) | -0.03 | -0.53 * | -0.22 | 4.33 * |
| F-test | 5.21 ** | 9.07 *** | 1.27 | 21.61 *** |

Emission-Intensive Activities in the EU

| Activity by NACE code | Average kg of CO ₂ per euro of value added | | | | | | | |
|--|---|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
| Electricity, gas, steam and air conditioning supply | 6.29 | 5.69 | 5.70 | 5.91 | 5.63 | 5.56 | 5.26 | 5.24 |
| Manufacture of coke and refined petroleum products | 5.91 | 5.26 | 5.80 | 5.84 | 7.34 | 5.93 | 5.36 | 3.59 |
| Air transport | 4.10 | 4.47 | 3.93 | 3.88 | 3.74 | 3.70 | 4.10 | 4.35 |
| Water transport | 3.37 | 3.39 | 3.40 | 3.43 | 3.26 | 3.01 | 3.25 | 3.66 |
| Manufacture of other non-metallic mineral products | 3.36 | 3.31 | 3.27 | 3.09 | 3.03 | 2.97 | 2.92 | 2.92 |
| Manufacture of basic metals | 3.23 | 2.90 | 3.08 | 2.86 | 2.55 | 2.43 | 2.31 | 2.21 |
| Manufacture of chemicals and chemical products | 1.32 | 1.30 | 1.26 | 1.23 | 1.23 | 1.20 | 1.12 | 1.04 |
| Fishing and aquaculture | 1.27 | 1.23 | 1.19 | 1.24 | 1.23 | 1.21 | 1.11 | 1.11 |
| Manufacture of paper and paper products | 0.86 | 0.83 | 0.83 | 0.80 | 0.74 | 0.74 | 0.69 | 0.70 |
| Land transport and transport via pipelines | 0.79 | 0.78 | 0.78 | 0.75 | 0.72 | 0.73 | 0.72 | 0.72 |
| Crop and animal production, hunting and related service act. | 0.56 | 0.55 | 0.59 | 0.57 | 0.60 | 0.58 | 0.55 | 0.54 |
| Mining and quarrying | 0.54 | 0.54 | 0.53 | 0.55 | 0.51 | 0.52 | 0.53 | 0.53 |
| Sewerage, waste management, remediation activities | 0.43 | 0.42 | 0.43 | 0.41 | 0.41 | 0.41 | 0.41 | 0.40 |
| Manufacture of wood, paper, printing and reproduction | 0.39 | 0.38 | 0.39 | 0.36 | 0.36 | 0.37 | 0.35 | 0.34 |
| Water supply; sewerage, waste management, remediation act. | 0.37 | 0.36 | 0.37 | 0.35 | 0.34 | 0.35 | 0.35 | 0.34 |
| ... | | | | | | | | |
| Computer programming, consultancy, information service act. | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.01 | 0.01 |
| Financial and insurance activities | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Real estate activities | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Pollution Intensive Activities

| Dependent variable: | ln(Global emissions (tons)) | ln(Home emissions (tons)) | ln(Foreign emissions (tons)) | Foreign emissions in % of global |
|--------------------------------------|-----------------------------|---------------------------|------------------------------|----------------------------------|
| Specification: | OLS | Tobit | Tobit | Tobit |
| Panel A: Scope 1 Emissions | | | | |
| SEER | -0.20 *** | -0.37 *** | 0.24 ** | 3.76 *** |
| SEER*I(Pollution-intensive activity) | 0.30 *** | 0.28 ** | 0.24 ** | -0.11 |
| F-test | 1.59 | 0.32 | 8.54 *** | 4.27 ** |
| Panel B: Scope 2 Emissions | | | | |
| SEER | -0.23 *** | -0.51 *** | 0.30 *** | 7.03 *** |
| SEER*I(Pollution-intensive activity) | 0.12 ** | 0.11 | 0.21 ** | 0.39 |
| F-test | 2.82 * | 8.96 *** | 14.01 *** | 23.04 *** |

Robustness Checks

- Self-reporting to CDP
 - Only firms with externally verified emissions
 - Results are robust
- Strictness versus enforcement of environmental regulation
 - SER and EER are highly correlated (>0.7)
 - Use separately or orthogonalize (SER & residual EER)
 - Both matter
- Up next: The Gravity model

Gravity Analysis

| Dependent variable: | Scope 1 emissions | | Scope 2 emissions | |
|---------------------|------------------------------|--|------------------------------|--|
| | In(Foreign emissions (tons)) | Foreign emissions in % of global emissions | In(Foreign emissions (tons)) | Foreign emissions in % of global emissions |
| Specification: | Tobit (1) | Tobit (2) | Tobit (3) | Tobit (4) |

$SEER_{home} - SEER_{foreign}$

Controls - firm characteristics

In(Assets)

Foreign asset share

Controls - foreign country characteristics

In(GDP)

Gravity controls - country pair characteristics

In(Geographic distance)

Common border

Common colonial history

In(Trade)

Fixed effects

Year, Industry, Foreign Cty, Home Cty

Pseudo R-squared

Observations

of which censored at 0

of which uncensored

of which censored at 100

Conclusions

- Cross-sectional micro-level evidence in support of PHH
- But no crowding out
 - Firms in strictly regulated home countries have lower global emissions than firms in weakly regulated home countries
- Both stringency and enforcement of environmental regulation matter
- PHH behavior strongest among firms
 - With weak corporate governance – importance for institutional investors
 - With emission-intense activities – key for targeted regulatory efforts

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