

CLIMATE RISKS AND FDI

BY GU AND HALE

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Theoretical framework

- Firm chooses projects to get an expected operating profit:

- productivity (z)

- cost of capital (r)

- fixed cost (f)

$$E(\Pi_{in}) = \beta \left[\frac{A_i z_{in}^{\sigma-1} \left(1 - \frac{1}{\sigma}\right)^{\sigma-1}}{\sigma r_i^{\sigma-1}} - E(f_i) \right] \geq 0$$

- Open a project only if productivity high enough, so number of projects

$$M_i = N_i [1 - F(\bar{z})] = N_i \left(\frac{b_i}{\bar{z}}\right)^{v_i} = N_i b_i^{v_i} \left[\frac{A_i \left(1 - \frac{1}{\sigma}\right)^{\sigma-1}}{E(f_i) \sigma r_i^{\sigma-1}} \right]^{\frac{v_i}{\sigma-1}}$$

$$FDI_i = \beta \frac{b_i^{v_i} (\sigma - 1)}{1 - (\sigma - v_i)} \frac{1}{E(f_i)^{\frac{1-(\sigma-v_i)}{\sigma-1}}} \left[\frac{A_i \left(1 - \frac{1}{\sigma}\right)^{\sigma-1}}{\sigma r_i^{\sigma-1}} \right]^{\frac{v_i}{\sigma-1}}$$

- As cost realized, actual firms that stay in operation $M_{id} = N_i b_i^{v_i} \left[\frac{A_i \left(1 - \frac{1}{\sigma}\right)^{\sigma-1}}{f_{id} \sigma r_i^{\sigma-1}} \right]^{\frac{v_i}{\sigma-1}}$

Interpretation as climate shocks

- Projects are choices of FDI (like M&A) by MNE
- Physical climate risk: higher f

Proposition 1. Physical risk *When a target country's physical climate risk increases such that the affiliate's expected overhead cost $E(f_i)$ increases, or when a disaster actually happens, it reduces the number of affiliates in the target country.*

- Transition risk: higher r

Proposition 2. Transition risk *When climate policies increase emission unit cost r_i , the number of MNE's affiliates in the target country decreases; and the policies reduce the effect of physical risk from Proposition 1.*

- Emissions productivity: z and its distribution b

Proposition 3. Emission Productivity. *When technology becomes greener which increases the emission productivity distribution's lower bound b_i (i.e., shifting distribution right and increasing the emission productivity mean), the number of MNE's affiliates in the target country increases; and in this case higher emission productivity amplifies the effect of climate risks from Propositions 1 and 2.*

Is climate all about disasters and choices?

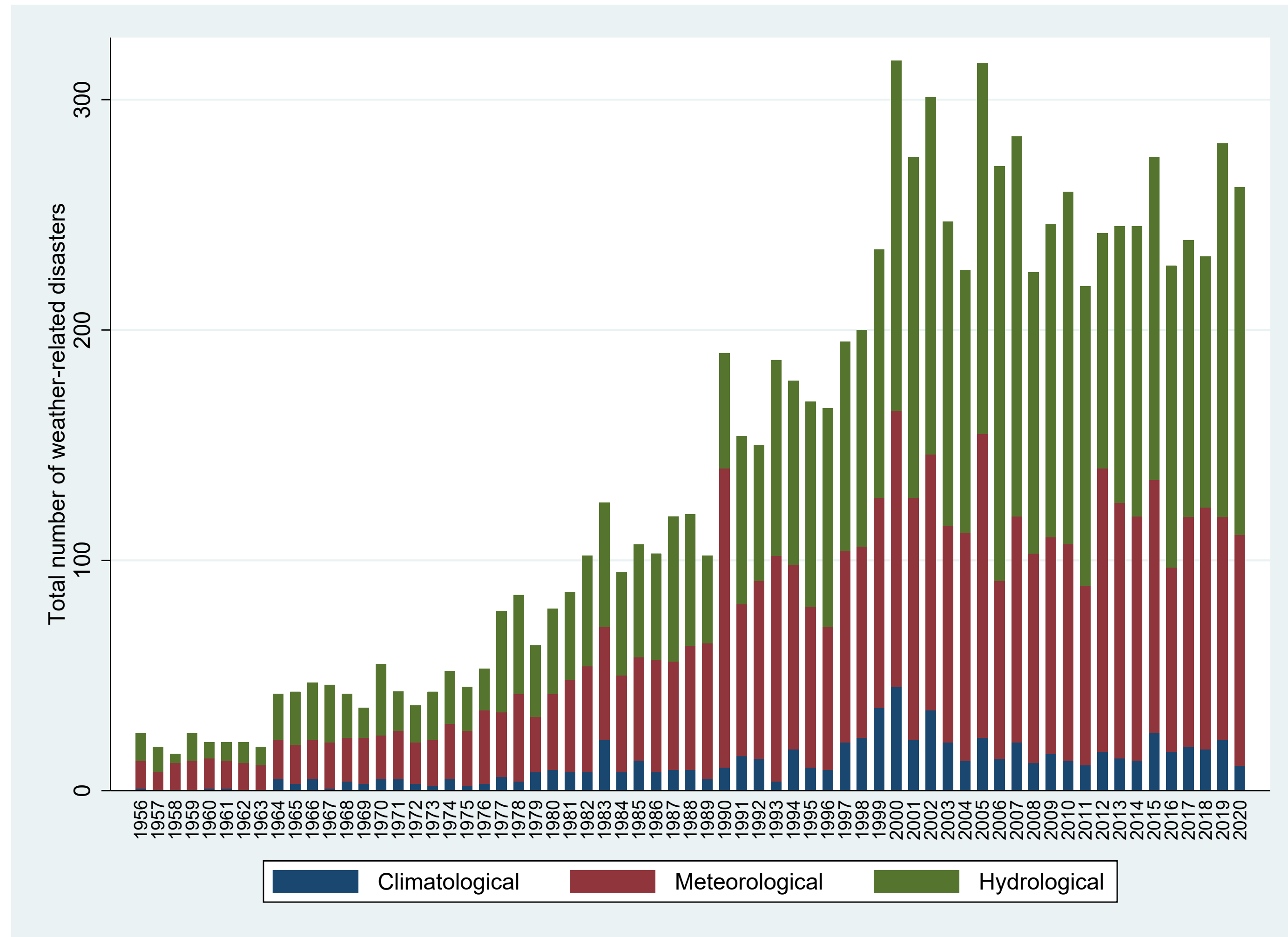
- **FDI is a form of delegated philanthropy**
 - Bringing in social responsibility of rich countries into emerging economies.
 - Reactive to past disasters, as opposed to anticipation of future ones. Standards as seals of approval.
 - Benabou Tirole (2010)
- **FDI is an importer of pollution to EM, hidden from AE customer**
 - Distribution of perceived costs because consumers' tastes are diluted across borders.
 - Less information and free riding.
 - Hart Zingales (2017).
- **FDI is an attempt to differentiate in response to competition**
 - Climate variables and location choices proxying for source country consumer tastes.
 - Aghion et al (2022).

From climate to choices: mankind's role

- **Climate is not exogenous: disasters as driven by FDI.**
 - FDI changes z distribution.
 - Improves climate because it brings more efficient technology.
 - Alfaro-Urena, Manelici, Vasquez (2022) on impact of FDI on productivity of suppliers
- **Climate regulation is not exogenous: standards driven by FDI**
 - FDI changes r costs.
 - Imposing standards: Harrison and Scorse (2010) sweat shops, Amengual and Distelhorst (2020) on GAP labor standards, Boudreau (2021) safety committees in Bangladesh, De Jangle et al (2015) and Dagusanu and Nunn (2018) on fair trade coffee and redistribution.
 - Alfaro-Irina, Faber, Manelici, Vasquez (2022) on ambiguous effects of labor standards, improving wages but lowering sales and employs.

Data: extreme weather (f)

Figure 5: Climate-related disaster events by type



- **Measurement**

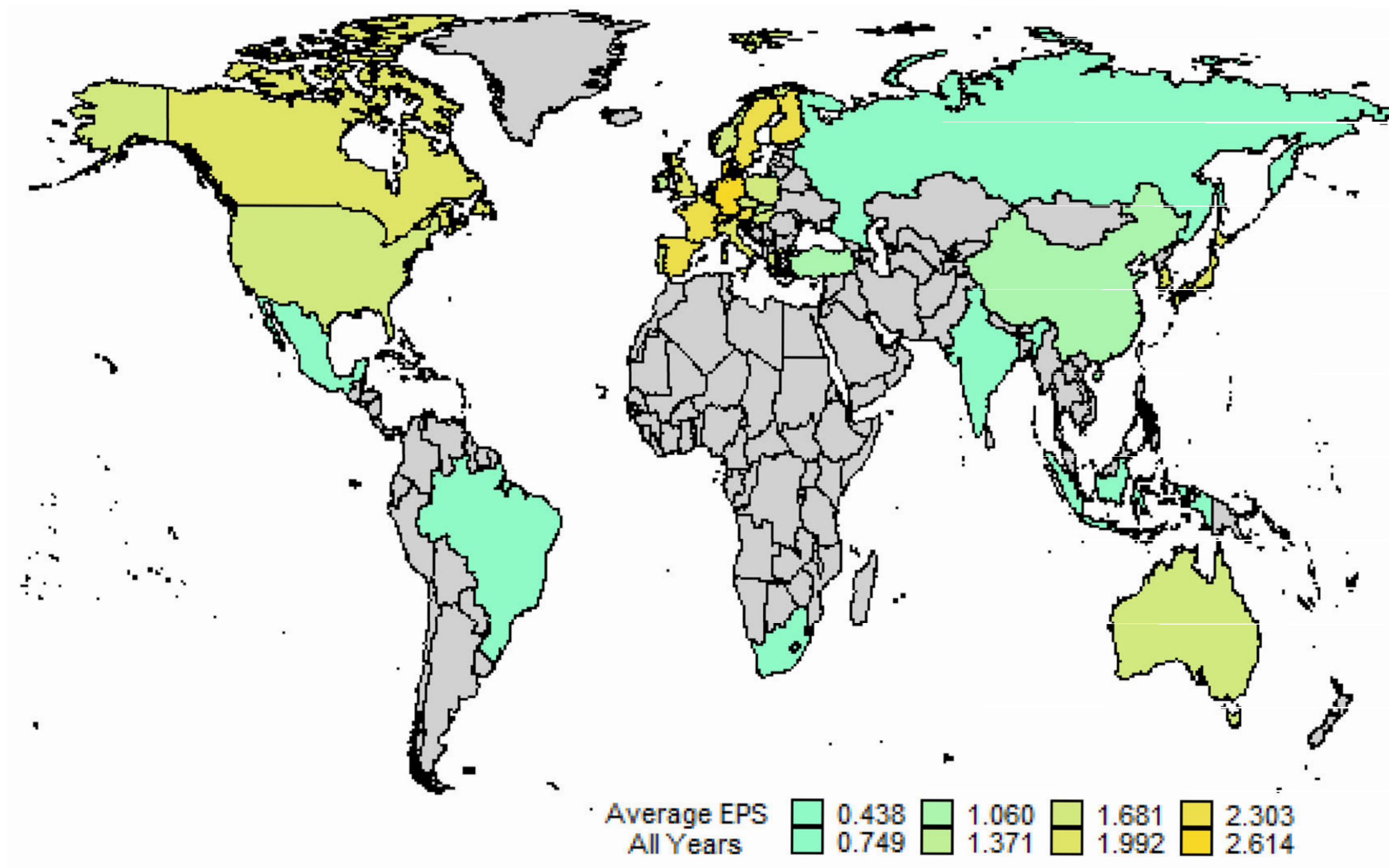
- Monthly count of disaster events
- 10 or more human deaths; 100 or more people injured or left homeless; declaration by the country of a state of emergency and/or an appeal for international assistance

- **Reserve causality?**

- FDI changing standards may affect severity of incidents
- Proclivity to declare state of emergency and ask for help

Data: transition risk (r)

Figure 9: Environmental policy stringency



- **Measurement**

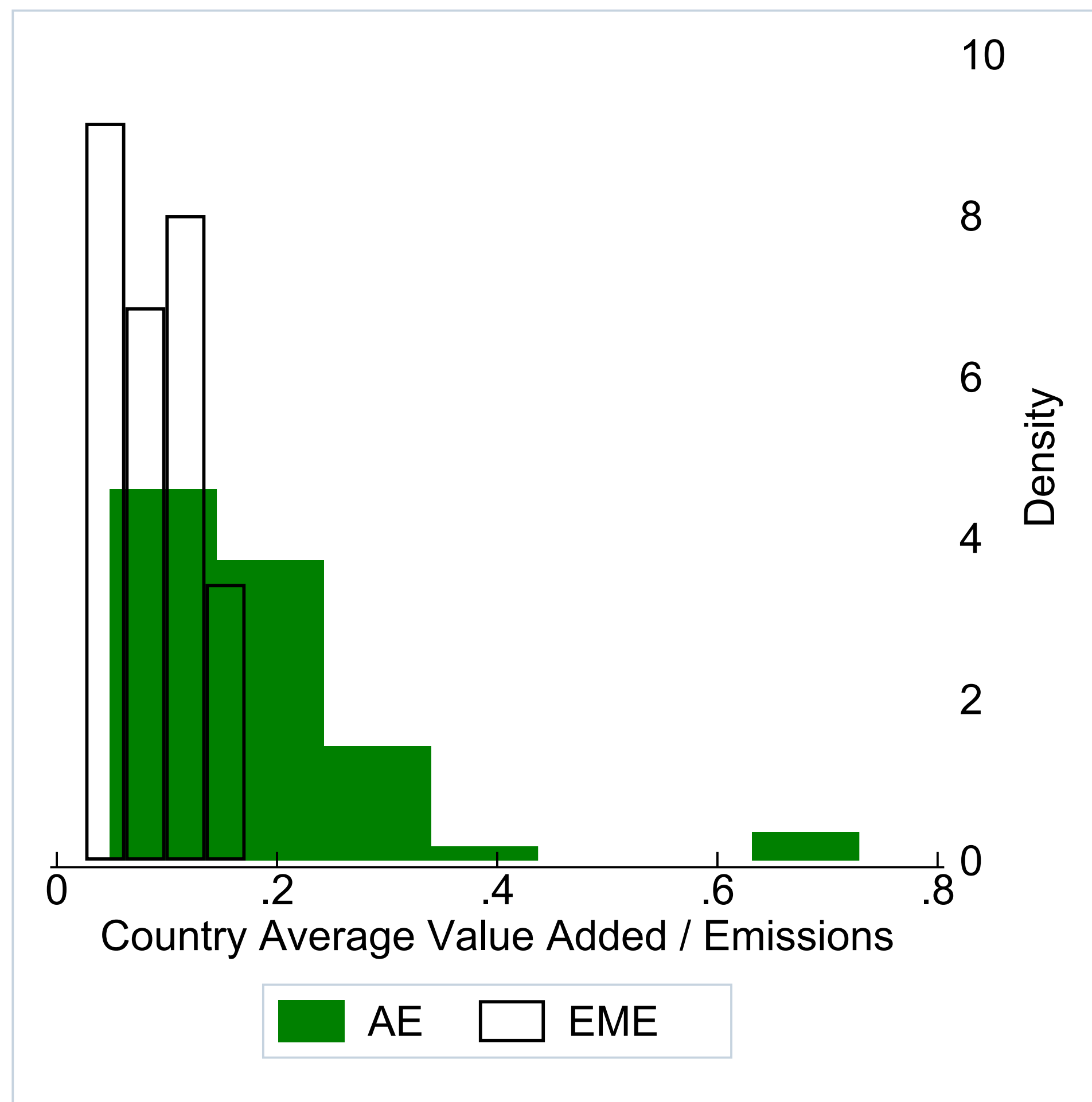
- Environmental policy stringency (EPS) index data at country level from OECD (1990- 2015).
- CO2 tax

- **Reverse causality and other regulations?**

- FDI as form of pressure (like fair trade or anti sweatshops)
- FDI as bringing standards
- EPS correlates with other forms of regulatory state.

Data: country-industry transition (r)

Figure 4: Histogram of Country Average Emission Productivity by Group



- **Measurement**

- Interact previous r with:
- emissions by country-industry and year from World Input-Output Database version 2016 (WIOD 16) environmental accounts

- **Key control**

- Industry/firm composition
- May be more amenable to FDI
- May be more related to emissions and regulation.

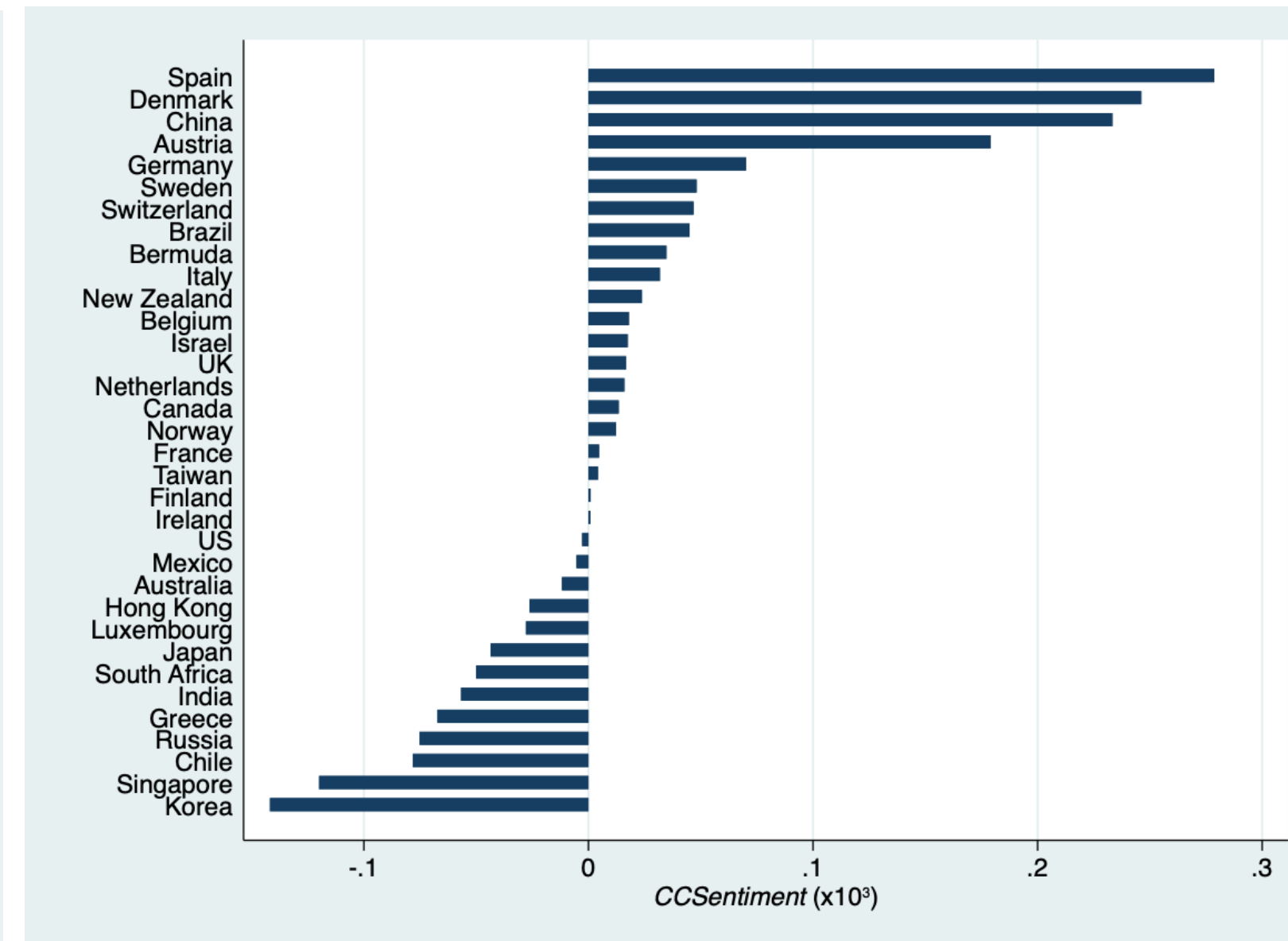
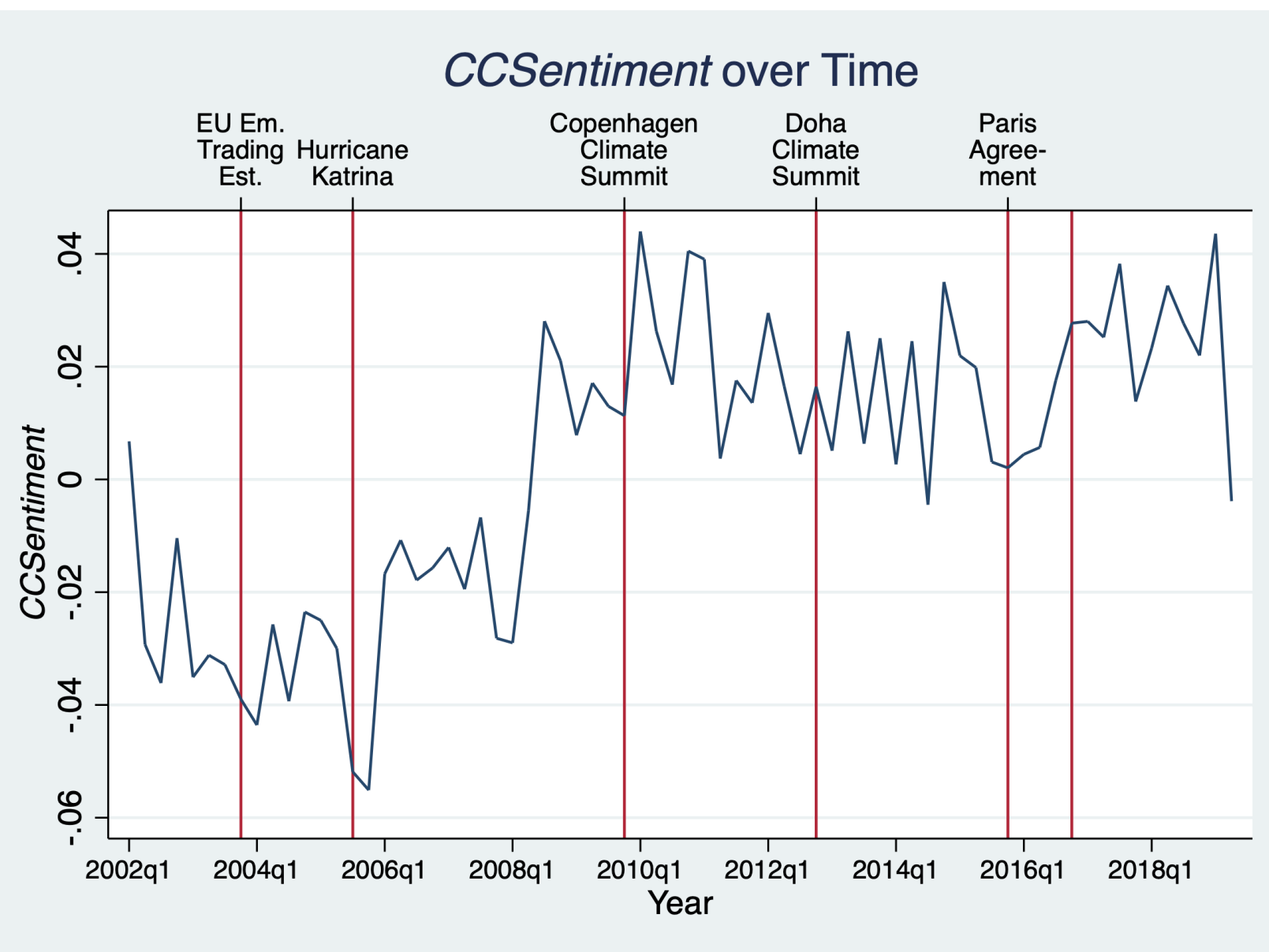
Data: firm transition (r)

- **Measurement**

- Interact previous r with:
- climate change exposure index for publicly traded firms from earnings conference calls
- Sautner et al 2020

- **Reverse causality**

- Are they responding to climate?
- Negative correlation with firm values in data, and the scope of the firm.



Regressions

- **Country level** (crowding out?)

$$FDIY_{igt} = \alpha_i + \alpha_t + \alpha_{gt} + CD'_{it-1}\beta_1 + \beta_2 EPS_{it-1} + \beta_3 I(Tax_{it-1}) + \beta_4 z_{it-1} + M'_{it-1}\gamma + \varepsilon_{it},$$

$$\Delta fdi_{ijt} = \alpha_{ij} + \alpha_t + CD'_{it-1}\beta_{t1} + CD'_{jt-1}\beta_{s1} + \beta_{t2} EPS_{it-1} + \beta_{s2} EPS_{jt-1} + \beta_{t3} I(Tax_{it-1}) \\ + \beta_{s3} I(Tax_{jt-1}) + \beta_{s4} z_{it-1} + \beta_{t4} z_{jt-1} + M'_{it-1}\gamma_s + M'_{jt-1}\gamma_t + \varepsilon_{ijt}.$$

- **Country-industry level** (scaling by industry value added?)

$$FDIV A_{ikt} = \alpha_{ik} + \alpha_{kt} + CD'_{it-1}\beta_1 + \beta_2 EPS_{it-1} + \beta_3 I(Tax_{it-1}) + \beta_4 z_{ikt-1} + M'_{it-1}\gamma + \varepsilon_{ikt},$$

$$FDIV A_{ikt} = \alpha_{ik} + \alpha_{kt} + \alpha_{it} + (z_{ikt-1} CD_{it-1})' \beta_1 + \beta_2 z_{ikt-1} EPS_{it-1} \\ + \beta_3 z_{ikt-1} I(Tax_{it-1}) + \beta_4 z_{ikt-1} + \varepsilon_{ikt},$$

- **Firm level** (what is variation?)

$$\Delta Naff_{fjikt} = \alpha_f + \alpha_i + \alpha_k + \alpha_t + CD'_{it-1}\beta_{t1} + CD'_{jt-1}\beta_{s1} + \beta_{t2} EPS_{it-1} + \beta_{s2} EPS_{jt-1} \\ + \beta_{t3} I(Tax_{it-1}) + \beta_{s3} I(Tax_{jt-1}) + \beta_{s4} z_{it-1} + \beta_{t4} z_{jt-1} + \beta_5 CCR_{ft-1} + M'_{it-1}\gamma_s + + \varepsilon_{fit},$$

Conclusions

1. Simple and insightful model of how costs and risks from climate affect location decisions of MNEs and their FDI choices
 - A. Other dimensions of FDI and endogeneity of climate
2. Great exhaustive data measuring these risks and costs with different levels of variation and aggregation
 - A. Endogeneity affects interpretations
3. Saturated regressions show small effects, and difference shocks/regulations
 - A. Research agenda ahead on separating these