

# Director networks and carbon emissions

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# Background

- Why are corporate directors important to firms' decarbonization?
  - The long-term focus and strategic nature of decarbonization
  - Important monitors
  - Corporate directors face increased scrutiny and bear the ultimate responsibility of decarbonization
    - *In 2022 the board directors at Shell were personally threatened with legal action for failing to reduce the company's carbon emissions (Sterling, 2022)*
    - *A small group of activist investors defeated Exxon Mobil's board and installed three directors to push the company to reduce its carbon footprint (Phillips, 2021).*



## Focusing on corporate carbon emissions

- Prior studies show that director connections have a positive impact on corporate sustainability. They focus on aggregate measures of sustainability and environmental performance (Amin et al., 2020; Alves, 2021; Iliev & Roth, 2023).
  - Reducing emissions is costly.
  - Firms may have incentives to improve their aggregate environmental score through, for example, declaring intentions, without real reductions in carbon emissions (Asgharian et al., 2024; In & Schumacher, 2021; Kacperczyk & Peydró, 2022).

# Focusing on corporate carbon emissions

- **Absolute CO2 emission levels v.s. emission intensity**
  - Bolton and Kacperczyk (2021, 2024): regulations target activities where absolute emission levels are high.
  - Aswani, Raghunandan, & Rajgopal (2024a, 2024b): emission intensity better captures a firm's emissions performance since this metric avoids mechanical correlations with firm size.

## This paper shows

- **Causal peer effects** of emission levels and emission intensities socially-connected firms.
- The effect is mostly driven by **firms emulating greener peers** (i.e., peers with relatively lower emissions).
- Board connectedness helps in improving aggregate environmental score but not in reducing actual emissions, suggesting **greenwashing and complexity of decarbonization**.

# Director connections and firm relationships

- **Network of individual directors:** Two board directors are socially connected if they currently sit on the same board or if they have sit on the same board in the past.
- **Firm network:** Two firms are directly connected if they share at least one director or if their directors are socially connected through directorship in other firms (Fracassi, 2017)



# Data

- Data sources
  - BoardEx: Historical profile of board directors' employment
  - Asset4: Firms' CO2 emissions and emission intensity
  - Refinitiv Eikon: Accounting data
- Data from 3,304 firms, 44,464 board directors in 35 countries from the period 2003- 2020

# Staggered DiD using peer firms' regulation shocks

- **Staggered treatment:** A firm is considered treated in year  $t$  if any of its peer firms with headquarters in a foreign country becomes subject to a mandatory carbon-emissions regulation that comes into effect in that year (data from “Carrots & Sticks” reports)
- **Stacked regression:** for each treatment year, we construct a cohort of treated and never-treated control firms, stack the cohorts, and estimate

$$Emissions_{f,c,t} = \lambda Regulation_{f,c,t} + \rho X_{f,t-1} + \mu_{f,c} + \theta_{c,t} + \varepsilon_{f,c,t}$$



## Staggered DiD

The introduction of a carbon regulation in the headquarter country of the peer firm conveys

- a **8.99%** reduction in the focal firm's emission level.
- a **6.6%** reduction in the focal firm's emission intensity relative to the sample mean emission intensity (3.32 ton/million USD).

	(1) <i>Emission level</i>	(2) <i>Emission intensity</i>
<i>Regulation</i>	-0.0899*** (0.0257)	-0.219* (0.125)
Firm controls	Yes	Yes
Cohort-firm fixed effects	Yes	Yes
Cohort-year fixed effects	Yes	Yes
Observations	51,331	51,331
$R^2$	0.983	0.948

# Controls

	(1)	(2)
	<i>Emission level</i>	<i>Emission intensity</i>
<i>Board size</i>	-0.00112 (0.00135)	-0.0117 (0.00810)
<i>Board diversity</i>	-0.171*** (0.0520)	-0.507* (0.286)
<i>Board independence</i>	0.128** (0.0512)	-0.421 (0.267)
<i>Board tenure</i>	0.00207 (0.00376)	0.0567** (0.0241)
<i>Board age</i>	0.0116*** (0.00239)	-0.00805 (0.0126)
<i>Size</i>	0.437*** (0.0217)	-0.547*** (0.153)
<i>Leverage</i>	-0.148*** (0.0543)	1.107** (0.449)
<i>Tobin's q</i>	0.00117 (0.00155)	-0.0239*** (0.00627)
<i>RoA</i>	-0.000343 (0.000723)	-0.0200*** (0.00515)
<i>Cash ratio</i>	-0.514*** (0.115)	-2.450*** (0.694)
<i>CEO duality</i>	0.0441** (0.0200)	-0.154 (0.0998)
<i>GDP per capita</i>	-0.250*** (0.0610)	-0.143 (0.419)
<i>CO2 to GDP</i>	0.940*** (0.356)	9.420*** (2.032)



## Placebo analysis – pairwise regression

- Following the approach of Asgharian, et al. (2024), we form a “connected” sample and an “unconnected” sample
  - **Connected:** firm-pair years falling within the relationship period
  - **Unconnected:** firm-pair years outside the relationship period

$Emissions_{f,t}$

$$\begin{aligned} &= \alpha_{f,p} + \alpha_{f,p}^* + \lambda_t + \beta_1 Emissions_{p,t-1} \times Connected + \beta_2 Emissions_{p,t-1} \times Unconnected \\ &+ \rho Connected + \gamma_f' X_{f,t-1} \times Connected + \gamma_p' X_{p,t-1} \times Connected + \gamma_f' X_{f,t-1} \times Unconnected \\ &+ \gamma_p' X_{p,t-1} \times Unconnected + \varepsilon_{fp,t} \end{aligned}$$

# Results

## Connected vs. Unconnected

- Positive peer effect is found on both emission level and emission intensity.
- Peer effect is only found in the connected period → Unlikely to be driven by selection.

	(1) <i>Emission level</i>	(2) <i>Emission intensity</i>
<b>A: <math>Emission\_P \times Connected</math></b>	<b>0.0120***</b> (0.0019)	<b>0.0055***</b> (0.0018)
<b>B: <math>Emission\_P \times Unconnected</math></b>	<b>0.0010</b> (0.0017)	<b>0.0010</b> (0.0015)
<b><i>P</i>-value (<math>H_0: A = B</math>)</b>	<b>0.0000</b>	<b>0.0557</b>
Focal-firm controls	Yes	Yes
Peer-firm controls	Yes	Yes
Pair fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
Observations	1,847,712	1,847,712
$R^2$	0.9865	0.9612

# Is the peer effect driven by greener peers?

Sharing of best practices vs. Diffusion of information on green washing

Norms to reduce carbon footprints vs. Norms in networks with lax environmental standards



Greener peers' effect vs. Browner peers' effect

## All-sector results: Greener peers vs. Browner peers

	All sectors			
	(1)	(2)	(3)	(4)
	<i>Emission level</i>	<i>Emission level</i>	<i>Emission intensity</i>	<i>Emission intensity</i>
A: $Emissions\_P \times Greener\_peer$	0.0491*** (0.0023)	0.0727*** (0.0024)	0.2179*** (0.0144)	0.1088*** (0.0077)
B: $Emissions\_P \times Browner\_peer$	0.0388*** (0.0027)	0.0636*** (0.0027)	0.0092*** (0.0018)	0.0154*** (0.0023)
P-value ( $H_0: A = B$ )	0.0006	0.0055	0.0000	0.0000
Sector-year adjusted	No	Yes	No	Yes
Focal firm controls	Yes	Yes	Yes	Yes
Peer firm controls	Yes	Yes	Yes	Yes
Pair fixed effect	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes
Observations	919,082	919,082	919,082	919,082
$R^2$	0.9877	0.9784	0.9655	0.9512

- Greener-peer effect is stronger than browner-peer effect.
- Stronger Greener-peer effect is more pronounced in *Emission intensity* than for *Emission levels* → indicating firms using *Emission intensity* as the primary metric to benchmark their emission performance against their peers.

## High-emitting sector results: Greener peers vs. Browner peers

	High emitting sectors	
	(5)	(6)
	<i>Emission level</i>	<i>Emission intensity</i>
A: $Emissions_P \times Greener\_peer$	0.0337*** (0.0046)	0.1885*** (0.0214)
B: $Emissions_P \times Browner\_peer$	0.0536*** (0.0083)	0.0184*** (0.0069)
P-value ( $H_0: A = B$ )	0.0172	0.0000
Sector-year adjusted	No	No
Focal firm controls	Yes	Yes
Peer firm controls	Yes	Yes
Pair fixed effect	Yes	Yes
Year fixed effect	Yes	Yes
Observations	164,612	164,612
$R^2$	0.9848	0.9505

- Sectors: Utilities; Transportation and Warehousing; Mining, Quarrying, and Oil and Gas Extraction
- High-emission firms may find it more difficult to cut emission levels and instead focus on intensity as their main environmental target.
- For focal firms in high-emitting sectors, it is almost twice as likely that the peer firm simultaneously had lower intensity and higher level of emissions, than the opposite combination.

# The effect of board centrality (connectedness)



- Compute director centrality in the network:

$$DirectorCentralityScore = \left[ \frac{1}{3} \{ Percentile(Degree_i) + Percentile(Eigenvector_i) + \right. \\ \left. Percentile(Betweenness_i) \} \right]$$

- Firm centrality is the average of *DirectorCentralityScore* of directors on the board.
- To mitigate endogeneity, we restrict our sample to those firms whose board has not changed from the prior year to the current year (following Amin et al., 2020)



## Results: network centrality

	All sectors				High emitting sectors			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	<i>Emission level</i>	<i>Emission level</i>	<i>Emission intensity</i>	<i>E-score</i>	<i>Emission level</i>	<i>Emission level</i>	<i>Emission intensity</i>	<i>E-score</i>
<i>Board centrality</i>	0.0055	-0.0006	-0.0074	0.1723***	0.0150***	0.0019	0.0671	0.1486***
	(0.0034)	(0.0034)	(0.0157)	(0.0434)	(0.0070)	(0.0075)	(0.0329)	(0.0578)
<i>Size</i>	0.8480***		-0.3861*	6.6504***	0.7572***		-1.8630***	7.5522***
	(0.0414)		(0.2045)	(0.6016)	(0.0947)		(0.6076)	(0.9854)
<i>Log(Revenue)</i>		0.9541***				0.9431***		
		(0.0391)				(0.0742)		
Firm controls	Yes		Yes	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes		Yes	Yes	Yes	Yes	Yes	Yes
Industry FEs	Yes		Yes	Yes	Yes	Yes	Yes	Yes
Country FEs	Yes		Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,069	3,065	3,069	3,069	642	642	642	642
<i>R</i> <sup>2</sup>	0.8121	0.8362	0.6242	0.5243	0.7124	0.7657	0.5839	0.6191

## Results: network centrality

- Improvement in environmental scores are not accompanied by actual environmental improvements in emission reductions.
  - suggestive of greenwashing among firms with well-connected boards
  - directors might have difficulties internalizing more specific, complex knowledge for emission reduction and using it to their firms' benefits.
  - more complex information and norms are more easily transmitted through direct, close ties (Uzzi, 1999), supported by the peer-effect results.

# Conclusion and implications

- Causal propagation effects of carbon-emissions levels and emission intensity among socially connected companies.
- Firms tend to use emission intensity as the primary metric to benchmark their emission performance against their social peers.
- The peer effect is primarily driven by firms mimicking greener peers than browner peers.
- For firms in high-emitting sectors, the focus on following peers with lower emission intensity leads to an unintended consequence – a stronger browner peer effect in terms of emission levels -- a caveat regarding the role of social network propagation.
- No evidence of causal effect on either emission level or emission intensity, pointing to limited advantages of board connectedness for carbon emission reductions.

Thank you!