Measuring the Effectiveness of Carbon Pricing: The Impact on Corporate ESG Performance and Carbon Emissions

A Thesis Presented to The Graduate Faculty

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Motivation and Data Gap

- As climate change effects become more evident, there is a growing need for companies to adopt sustainable practices and stringent policies.
- ESG can serve as a valuable guideline for companies, helping them implement environmentally responsible business practices.
- How accurately do ESG ratings reflect the actual corporate environmental performance?
  - In and Schumacher (2021) argue that the E pillar of ESG is the most insufficient measure of company performance due to the lack of information availability and quality.

Data Gap

- Studies that investigated carbon and ESG data, commonly have limited measuring techniques, small sample sizes, and short time periods often yielding insignificant results (In and Schumacher, 2021).
- Future research should focus on unraveling heterogeneous impacts of different carbon prices on firms' environmental performance (Yu et al., 2022).

Research Questions

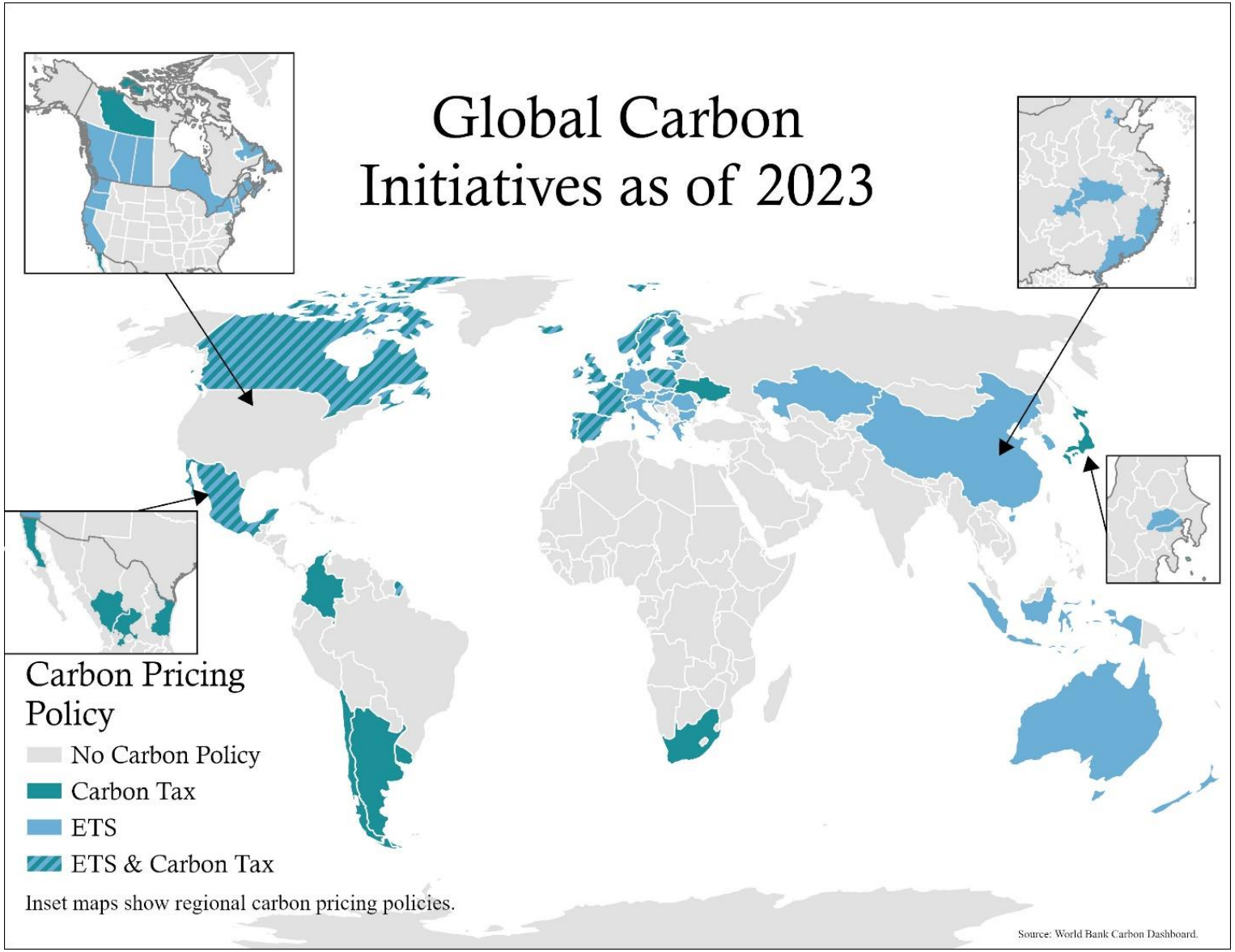
- Price level is the main determinant of the effectiveness of the policy (Sumner et al., 2011; Marron et al., 2015; Gugler et al., 2021)

H1. An increase in carbon prices leads to a decrease in corporate carbon emissions.

- Empirical analyses have shown low convergent validity of ESG ratings causing a commensurability problem (Halbritter & Dorfleitner, 2015; Gangi et al., 2022)
- When firms disclose carbon emissions, carbon market policies can be more effective in reducing emission (Yu et al., 2022)
- Yu et al. (2022) point out that the link between carbon policies and corporate environmental performance could vary depending on the complexity of the policy.

H2. Implementation of carbon pricing mechanisms significantly improve corporate ESG ratings.

H3. Implementation of carbon pricing mechanisms significantly improve corporate environmental ('E') pillar ratings.


Global Carbon Initiatives as of 2023
Carbon Pricing Policy
No Carbon Policy
Carbon Tax
ETS
ETS & Carbon Tax
Inset maps show regional carbon pricing policies.
Source: World Bank Carbon Dashboard.

Data

- Institutional Shareholder Services (ISS) ESG
  - ESG Rating Data
  - Climate Data
- S&P 500 Capital IQ
  - Demographic and financial data
- World Bank Carbon Dashboard
  - Up to date information on carbon pricing policies
- World Bank country-level CPI data

Dependent Variables

Corporate Carbon Emission

- Measured as the sum of scope 1 and 2 emissions
- ISS ESG collects data on corporate carbon emissions including both officially reported emissions and estimated figures for non-disclosed emissions

ESG Rating and 'E' Rating

- Based on a scale of 1 through 4

D -	D	D +	C -	C	C +	B -	B	B +	A -	A	A +
1.00-<1.25	1.25-<1.50	1.50-<1.75	1.75-<2.00	2.00-<2.25	2.25-<2.50	2.50-<2.75	2.75-<3.00	3.00-<3.25	3.25-<3.50	3.50-<3.75	3.75-<4.0
Poor			Medium			Good			Excellent		

- 40% Social and Governance, and 60% Environmental
- ISS collects its ESG data and rates companies based on a holistic and gradual materiality framework

Independent Variable

- Two continuous carbon price variables split into real term ETS and carbon tax prices.
  - Sumner et al. (2011) and Marron et al. (2015) highlight, pricing carbon can significantly lower future emissions, with the effectiveness depending on price levels.
  - Yu et al. (2022) point out that the link between carbon policies and corporate environmental performance could vary depending on the complexity of the policy.
  - Using continuous price variables allows me to look at the effect a 1 USD increase in carbon pricing has on corporate carbon emissions, ESG ratings, and ‘E’ ratings.

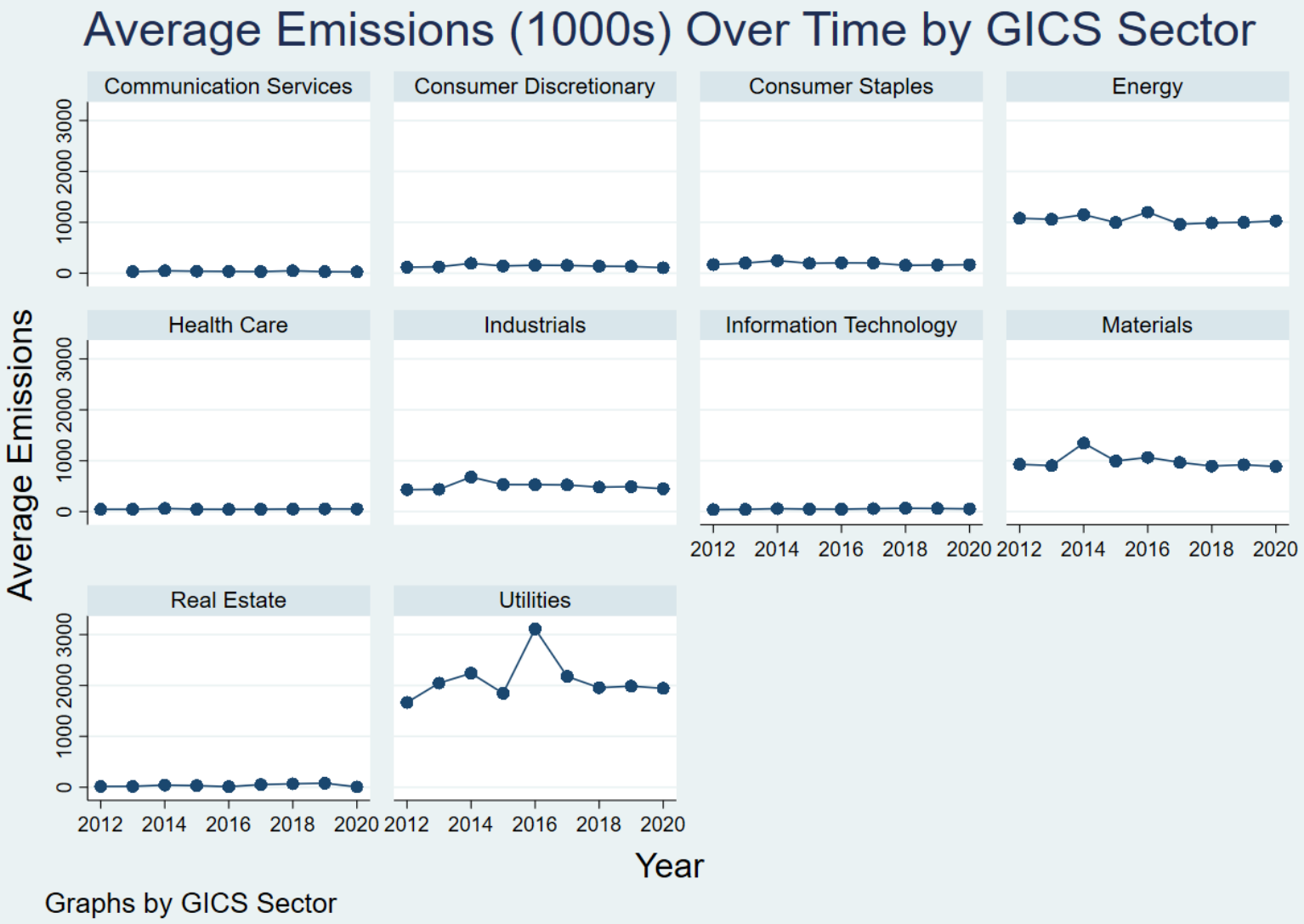
Control Variables

Variable	Definition	Expected Findings	
		ESG	*Carbon Emissions*
Tobin's Q	Total market capitalization, preferred stock, and total debt divided by total assets.	+ (Shu and Tan, 2023)	+ (Luo and Tang, 2023)
Company Size	The natural logarithm of total assets.	+ (Yan et al., 2022; Shu and Tan, 2023)	+ (Chen, Xu, et al., 2022: Luo and Tang, 2023)
Leverage	Debt-to-asset ratio calculated as total liabilities divided by total assets.	- (Yan et al., 2022; Shu and Tan, 2023)	**0** (Chen, Xu, et al., 2022) - (Luo and Tang, 2023)
ROA	The return on assets.	+ (Yan et al., 2022; Shu and Tan, 2023)	+ (Chen, Xu et al., 2022) - (Luo and Tang, 2023)
Capex	Capital Expenditure refers to the funds a company spends on acquiring, upgrading, or maintaining physical assets such as property, equipment, buildings, or infrastructure.		

Note: '+' = significantly positive; '-' = significantly negative; '**0**' = statistically insignificant

Summary Statistics – Carbon Dataset

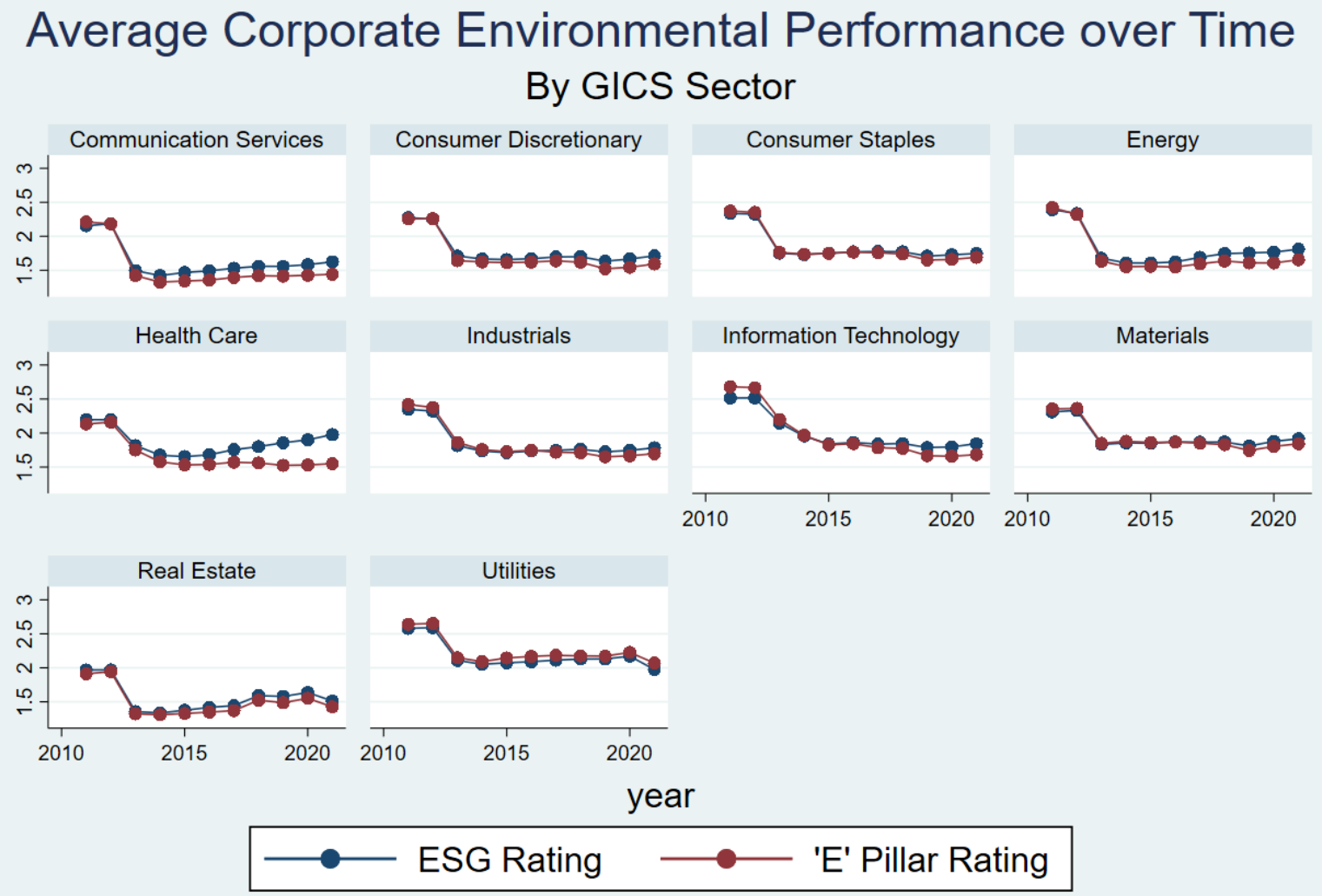
	Full Sample mean	No Carbon Policy mean	ETS mean	Carbon Tax mean	ETS & Carbon Tax mean
Carbon Policy & Pricing					
ETS	0.253	0.000	1.000	0.000	0.000
Carbon Tax	0.177	0.000	0.000	1.000	0.000
ETS & Carbon Tax	0.138	0.000	0.000	0.000	1.000
ETS Real Price	3.537	0.000	7.409	0.000	12.051
Carbon Tax Real Price	6.020	0.000	0.000	2.498	40.481
Carbon Performance					
Carbon Emissions (in 1000s)	413.823	410.858	523.839	290.153	379.676
Control Variables					
Tobin's q	1.478	1.602	1.642	0.908	1.522
Company Size	7.944	8.252	6.453	10.523	6.405
Leverage	0.009	0.010	0.013	0.001	0.012
Return on Assets	6.462	5.696	8.847	4.419	7.103
Capex	4,587.463	4,938.987	4,949.626	979.893	7,448.899
Emission Source					
Approximated Emissions	0.273	0.292	0.264	0.254	0.253
CDP Report	0.063	0.025	0.098	0.066	0.115
CO2 Emissions	0.005	0.001	0.001	0.024	0.004
Reported Emissions	0.091	0.043	0.089	0.149	0.169
Modelled Emissions	0.567	0.638	0.548	0.507	0.459
Observations	94,312	40,760	23,879	16,677	12,996



- The highest polluting sectors are Utilities, Energy, Materials, and Industrials
- High polluting sectors experienced a spike in 2014 and 2016.

Summary Statistics – ESG Dataset

	Full Sample mean	No Carbon Policy mean	ETS mean	Carbon Tax mean	ETS & Carbon Tax mean
Carbon Policy & Pricing					
ETS	0.410	0.000	1.000	0.000	0.000
Carbon Tax	0.116	0.000	0.000	1.000	0.000
ETS and Carbon Tax	0.251	0.000	0.000	0.000	1.000
ETS Real Price	6.844	0.000	7.656	0.000	14.791
Carbon Tax Real Price	13.647	0.000	0.000	4.052	52.584
ESG Performance					
ESG Rating	1.789	1.677	1.831	1.727	1.851
Environmental Rating	1.708	1.601	1.707	1.749	1.784
Control Variables					
Tobin's q	1.939	2.001	2.027	1.590	1.901
Company Size	9.261	9.960	8.459	12.792	8.317
Leverage	0.001	0.001	0.001	0.000	0.001
Return on Assets	4.606	5.608	4.198	4.786	4.296
Capex	1,057.948	4,281.746	154.927	0.024	140.249
Observations	23,303	5,221	9,548	2,694	5,840



- All sectors experienced a significant drop in ESG ratings after 2012
- ESG and ‘E’ ratings are closely following together, except
  - Health Care sector displays increased ESG ratings
- Highest recent ESG ratings are in the Utilities sector

Empirical Model

- Following Van Emous et al. (2021), Chen, Zhuo, et al. (2022), Luo and Tang (2023), and Shu and Tan (2023)'s approach, I am estimating a fixed effects panel regression model

$$Y_{it} = \beta_1 CT\ price_{it} + \beta_2 ETS\ price_{it} + \sum_{i=1}^{n} \delta_i X_{it} + \gamma_i + \alpha_t + \varepsilon_{it}$$

- where i represents each company and t each year
- Dependent variable Y_{it} measures each companies' overall ESG performance, 'E' performance, or carbon emissions during year t
- $CT\ price_{it}$ and $ETS\ price_{it}$ contain the carbon tax prices and ETS prices
- $\sum_{i=1}^{n} \delta_i X_{it}$ includes all the control variables

Results

VARIABLES	(1) Emissions (1000s)	(2) ESG Rating	(3) 'E' Rating
ETS Price	-1.921***	0.005***	0.004***
	(0.634)	(0.0003)	(0.0003)
Carbon Tax Price	-1.429***	0.001**	3e-05
	(0.444)	(0.0003)	(0.0004)
Tobin's q	1.034	0.007***	0.006***
	(1.118)	(0.001)	(0.001)
Company Size	150.540***	0.041***	0.042***
	(6.298)	(0.003)	(0.004)
Leverage	11.324	0.699***	0.895***
	(7.555)	(0.196)	(0.255)
ROA	2.056***	-0.001**	-0.001***
	(0.259)	(0.0003)	(0.0003)
Capex	0.0003	1.9e-05**	2.7e-05***
	(0.006)	(8.58e-06)	(1.02e-05)
Constant	-926.887***	1.400***	1.180***
	(63.480)	(0.049)	(0.067)
Industry fixed-effects	Yes	Yes	Yes
Regional fixed-effects	Yes	Yes	Yes
Country fixed-effects	Yes	Yes	Yes
Observations	94,312	23,303	23,303
Number of id	17,662	4,525	4,525

This table shows the fixed effects regression results for models 1, 2, and 3.
Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Conclusion

Main Findings

- Carbon pricing reduces corporate emissions and enhances overall ESG ratings. However, results suggest the need for higher carbon prices to effectively change business behavior.
- ETSs effectively enhances environmental pillar ratings.
- Discrepancies in findings highlight the necessity for transparent and consistent ESG rating methodologies across agencies.
  - Larger companies exhibit higher corporate emissions and environmental performance.
  - Although carbon taxes significantly reduce corporate emissions it is not reflected in ‘E’ ratings, suggesting that ‘E’ metrics might not accurately represent environmental performance.

Policy Implications

- Results of this study and existing literature indicate that carbon emission reductions may not be sufficiently rapid, requiring higher carbon pricing levels (Sumner et al., 2011; Marron et al., 2015; Flues and Van Dender, 2020; Gugler et al., 2021).
  - Current carbon prices might reduce emissions but may not induce change in business behavior.
- Policy frameworks, particularly ETSs, must undergo continual modification to prevent price volatility that can undermine emission reduction efforts.
- ESG ratings reflect broader policy impacts that enhance S&G dimensions, highlighting the need for more transparent and consistent rating methodologies across SRAs.

Future studies should further explore the relationship between carbon policies and corporate environmental performance using various sources of ESG ratings as well as carbon data.

Future Work

- Future studies should further explore the relationship between carbon policies and corporate environmental performance using various sources of ESG ratings as well as carbon data.
  - Given the inherent variability in the accuracy and quality of different data sources, this approach can uncover discrepancies that necessitate refinement through policy interventions and regulatory frameworks.
- The effectiveness of recent regulatory endeavors, such as the EU CSRD should be assessed to assess the effectiveness in standardizing ESG disclosures across corporate entities and establishing a uniform metric for evaluating corporate sustainability.

Thank you!

Any Questions?