Fueling the future: Macro-level impacts of environmental policies through firm-level responses

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*The views expressed here are those of the authors and do not necessarily reflect those of the OECD.

Introduction

- The transition to a low-carbon economy is essential to reducing greenhouse gas emissions and mitigating climate change

- The Draghi Report calls for a faster energy transition to strengthen European competitiveness

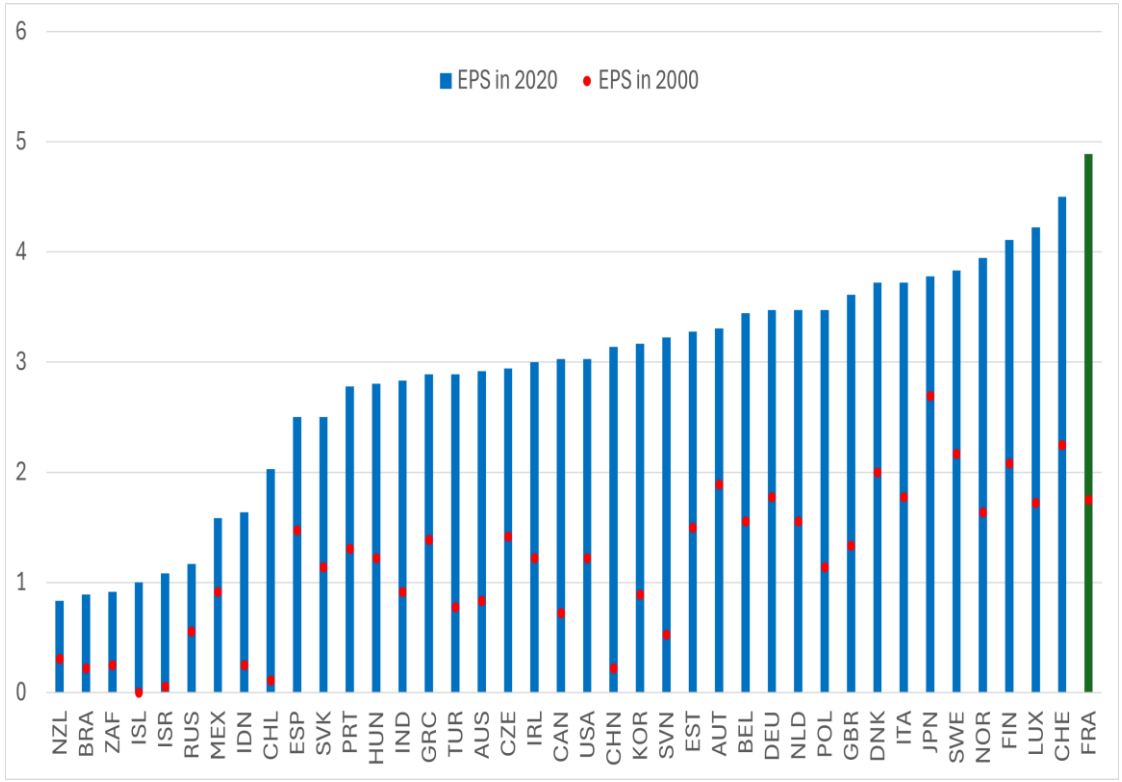
- Policymakers implemented a wide range of environmental policies

  - Emission standards, carbon taxes, subsidies, ...

OECD EPS index has increased across time and countries

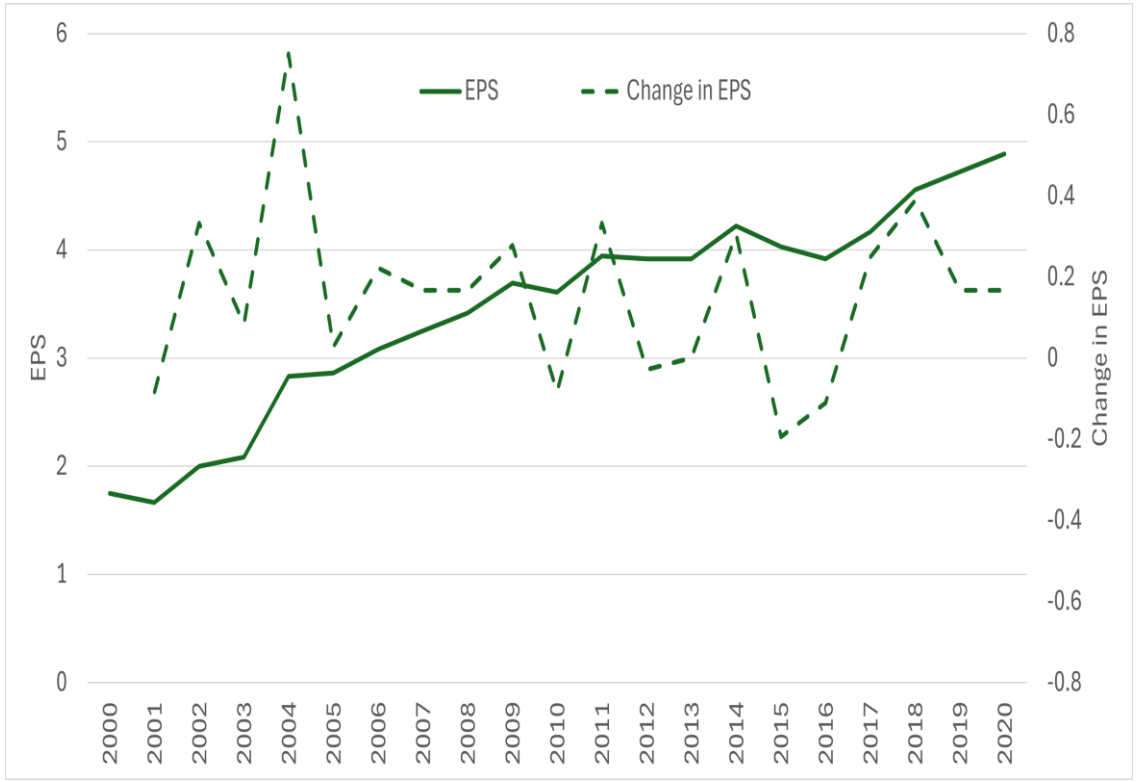
Cross-country

2000 vs 2020



France

2000-2020



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This paper

- Leveraging firm-level data on fuel expenditure and consumption to answer:

1. Do environmental policies raise the price of high-carbon fuels relative to low-carbon ones?
    - Does this vary across firms?
2. Do these relative price changes influence firms' energy mix towards lower-carbon options?

Related literature

- Energy prices & firm-level outcomes:
  - Marin and Vona (2021); Dussaux (2020); Dechezlepretre, Nachtigall, and Stadler (2020); Andre, Costa, Demmou, and Franco (2023); Fontagne, Martin, and (2023)

- Environmental policy indicators & emissions:
  - Frohm, D'Arcangelo, Kruse, Pisu, Sila (2023); D'Arcangelo, Pisu, Rajvan, and Dender (2022); Dechezlepretre, Nachtigall, and Venmans (2023); Kalantzis, Khalid, Solovyeva, and Wolski (2024)

- **We focus on relative prices as price signal mechanism**

Preview of the results

- Stricter environmental policies raise the relative price of high-carbon fuels to low-carbon ones
  - But this price adjustment is less pronounced for large energy-consuming firms
  - However, this differential effect diminishes over time
- Policy impacts on energy pricing and firm behavior unfolds gradually, especially for big firms

Data & Empirical strategy

- Granular firm-level data (France, Portugal, Slovenia, Austria*, Germany*)
  - Energy expenditure and consumption by fuel type
  - Balance sheet

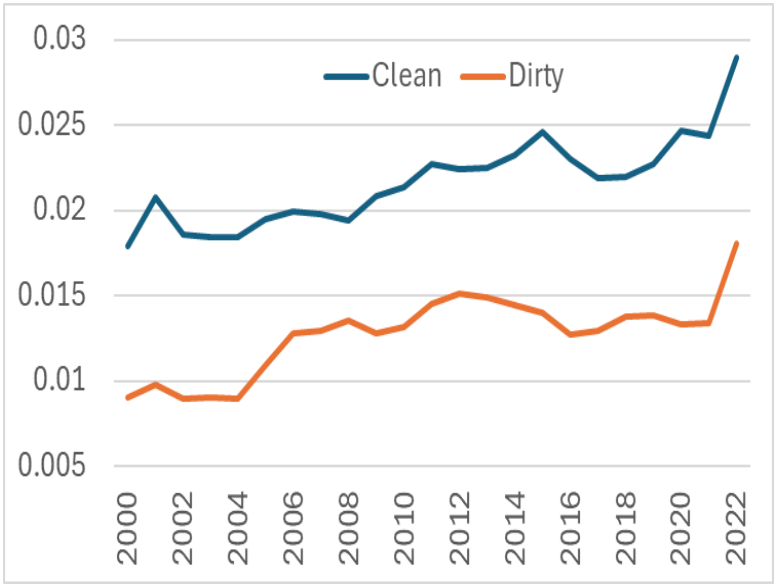
- Other data:
  - OECD Environmental Policy Stringency (EPS) index
  - Sector-level data (Sato et al., 2019)

- Empirical strategy:
  - Exposure to EPS & Local projections

Dirty energy remains cheaper, and the transition to clean energy is slow

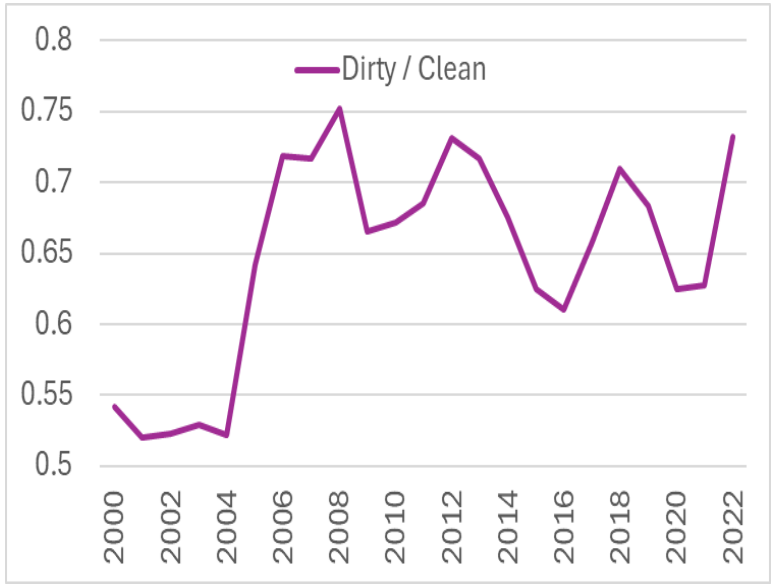
Energy prices

Mean



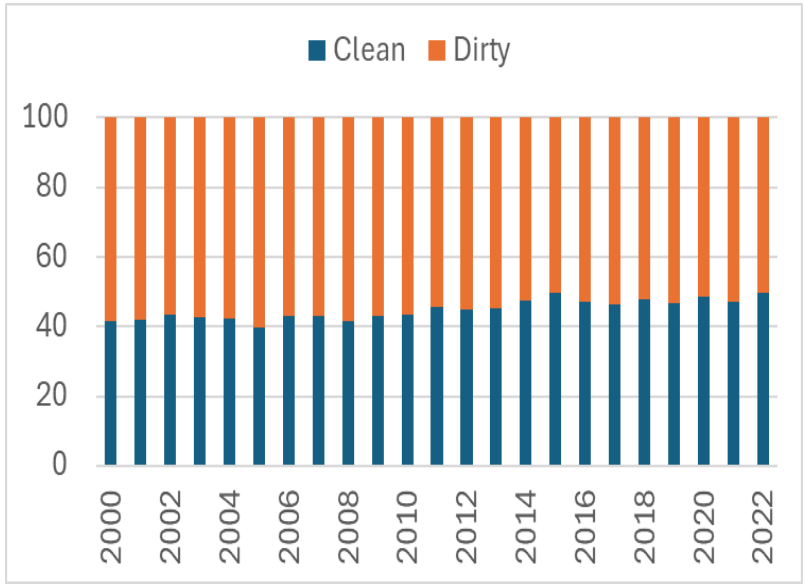
Relative energy prices

Mean



Energy mix

Mean



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EPS on relative energy prices, quantities, and expenditures

	Dependent variable:					
	ln P_{dirty}/P_{clean}		ln Q_{dirty}/Q_{clean}		ln Exp_{dirty}/Exp_{clean}	
	(1)	(2)	(3)	(4)	(5)	(6)
ln *EPS*	0.2315***		-0.3811***		-0.1339***	
	(0.0056)		(0.0149)		(0.0130)	
ln *m-EPS*		0.0168***		-0.2039***		-0.1833***
		(0.0032)		(0.0087)		(0.0077)
Fixed Effects	Firm	Firm	Firm	Firm	Firm	Firm
Observations	128,540	128,540	128,560	128,560	128,663	128,663
R^2	0.57112	0.55382	0.81172	0.81113	0.79965	0.80239

Note: This table reports the results of regressions estimating the effect of green policy making on relative energy prices, quantities, and expenditures, expressed in logarithmic form. The models are specified as: $\ln p^H_{isct}/p^L_{isct} = \beta_1 EPS_{ct} + \alpha_i + \text{Controls}_{isct-1} + \epsilon_{isct}$, where p^H_{isct} and p^L_{isct} represent the prices of high and low-carbon energy, respectively, and Controls_{isct-1} denotes the control variables lagged by one period. Standard errors are reported in parentheses below the coefficient estimates. Significance levels are indicated as follows: *** p<0.01, ** p<0.05, * p<0.1.

Local projections

- Examine dynamic impact of the policies on relative price estimating various versions of the following econometric model:

$$\ln \frac{p^{Dirty}_{isct+h}}{p^{Clean}_{isct+h}} = \beta^h_1 \ln EPS_{ct} \times D_{i0} + \beta^h_2 \ln EPS_{ct} \times D_{i0} \times Firm - Char_{i0}$$
$$+ \beta^h_3 Firm - Char_{i0} + \delta_{icst} + \text{Controls}_{isct-1} + \epsilon_{isct+h} \text{ for } h = 0, 1, \ldots, 4$$

where:

- $\boldsymbol{D_{i0}}$**:** Exposure to EPS is measured by (i) energy intensity, defined as the ratio of energy expenditure to value added; and (ii) carbon intensity, defined as the ratio of high-carbon fuel to low-carbon fuel consumption
- $\boldsymbol{Firm - Char_{i0}}$**:** are captured by (i) young firm dummy (equal to 1 for firms younger than 10 years); and (ii) mega consumer dummy, defined as firms accounting for more than 90% of total energy consumption

Mega consumes and old firms are less affected

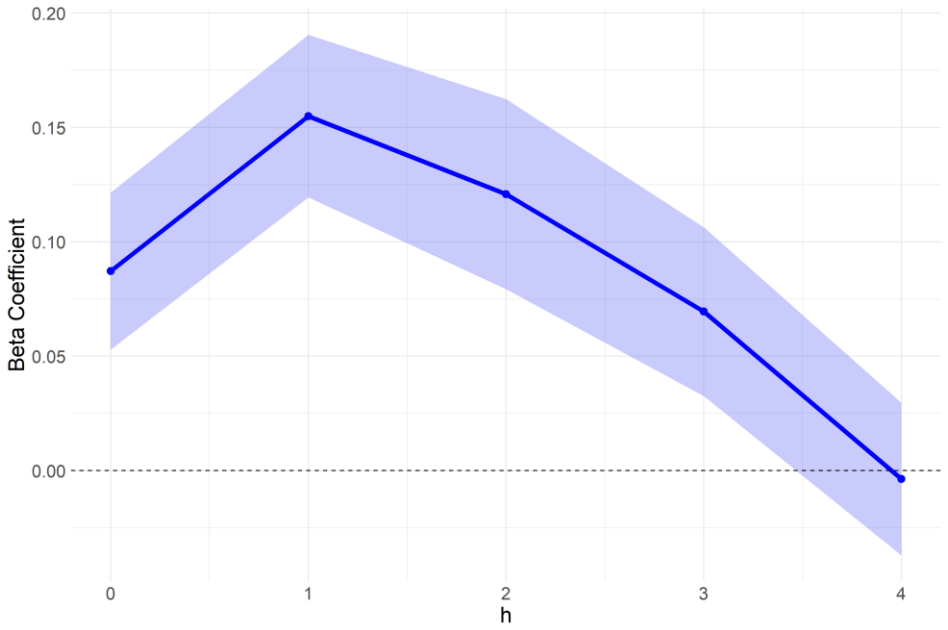
Dependent Var.	$\ln P_{dirty}/P_{clean}$	
$\ln EPS$	0.2253***	0.2226***
	(0.0065)	(0.0073)
$\ln EPS \times Mega - Consumer$	-0.1266***	
	(0.0186)	
$\ln EPS \times Young - Firm$		0.0921***
		(0.0180)
Fixed Effects	Firm	Firm
	Sector	Sector
Observations	116,035	116,035
R^2	0.56555	0.56138

Note: Mega Consumers are defined as firms that account for more than 90% of total energy consumption, while Standard Consumers represent firms that consume less than 10% of total energy. Young firms are defined as those younger than 10 years. This table presents regression results from the model: $\ln p^H_{isct}/p^L_{isct} = \beta_1 \ln EPS_{ct} \times Firm - Char_{i0} + \beta_2 \ln EPS_{ct} + \beta_3 Firm - Char_{i0} + \delta_{icst} + \text{Controls}_{isct-1} + \epsilon_{isct}$, where $FirmChar_{i0}$ represents either $Mega - Consumer_{i0}$ or $Young - Firm_{i0}$. Standard errors are in parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

Policies are effective overall, but less so for mega consumer

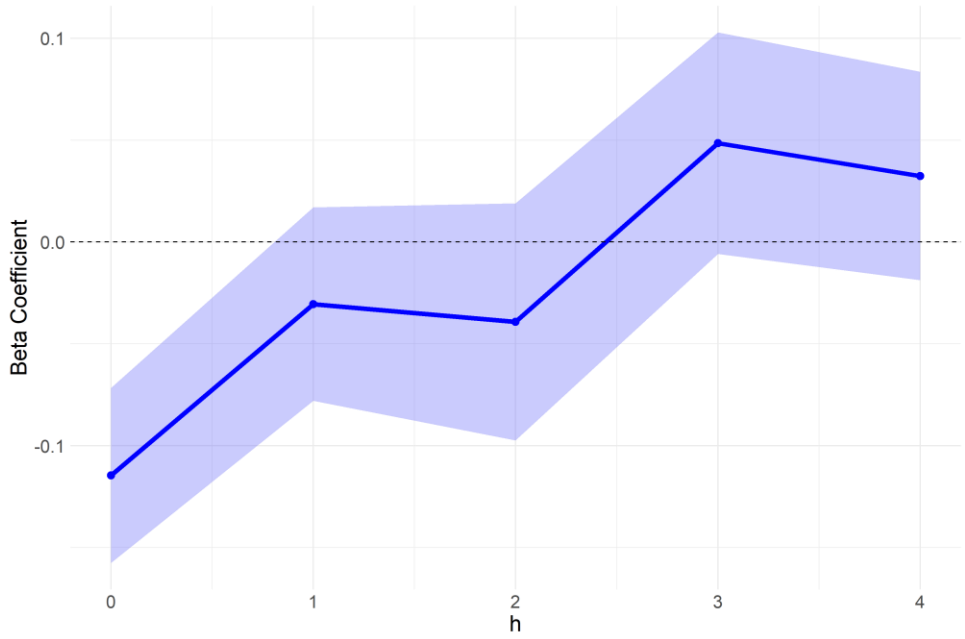
Intensity × Exposure

on relative prices



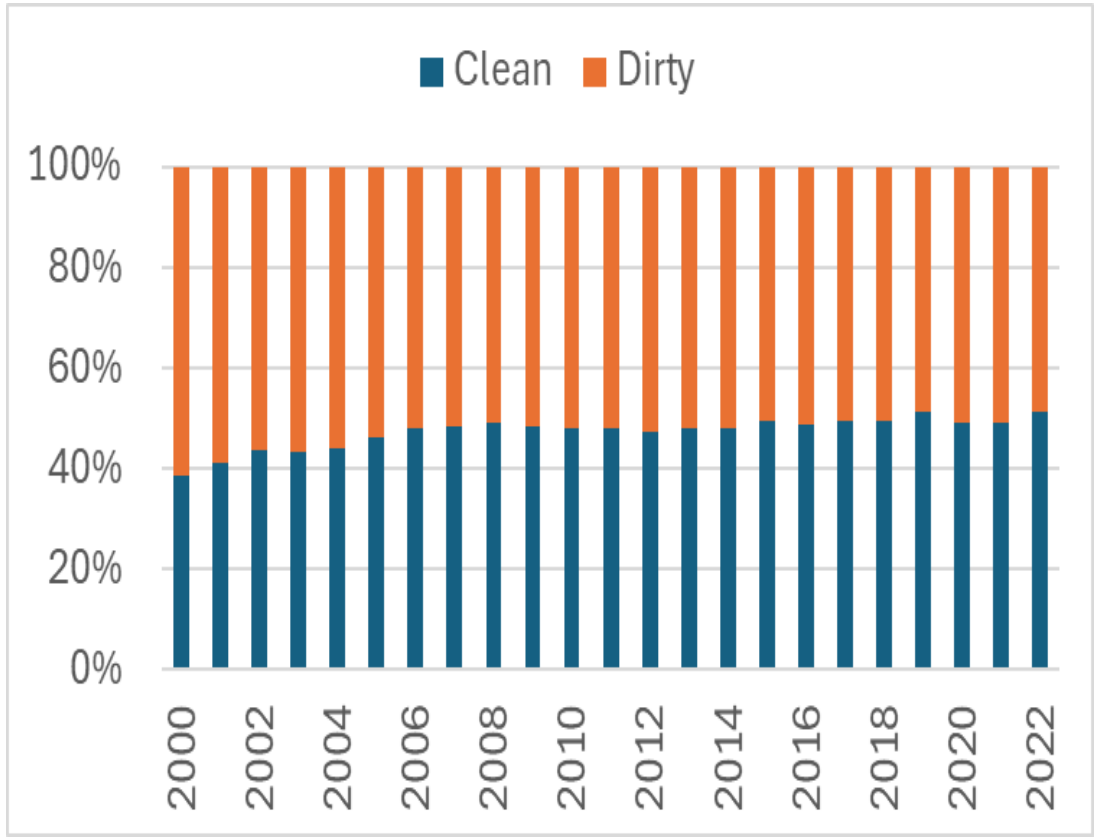
Intensity × Exposure × Mega firm

on relative prices

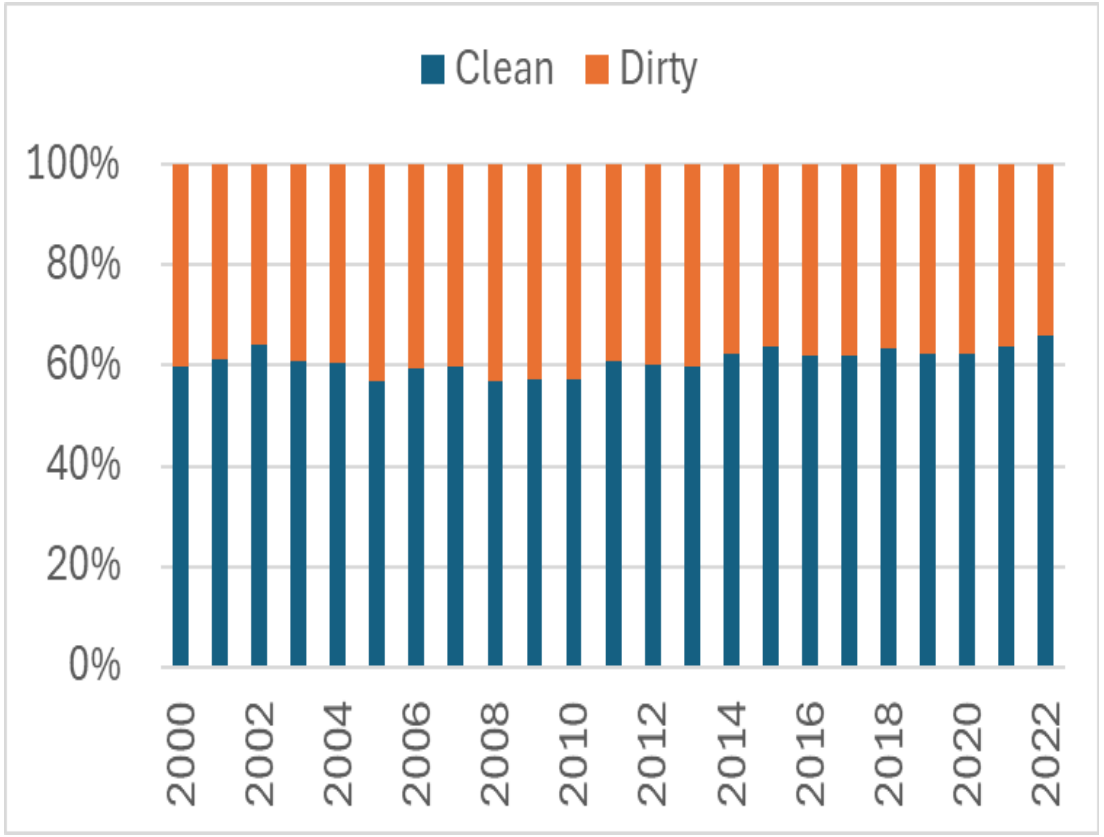


Mega consumers exhibit a greater reliance on dirty energy

Mega consumers

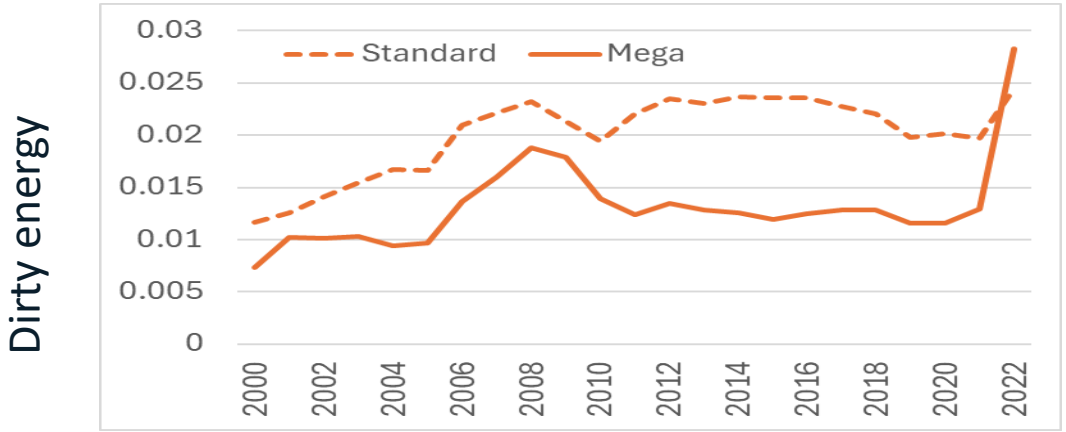


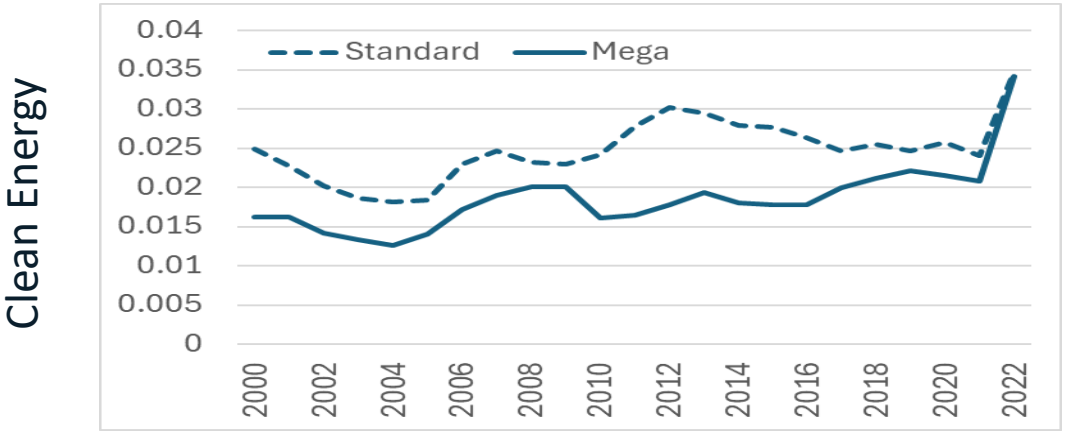
Standard consumers



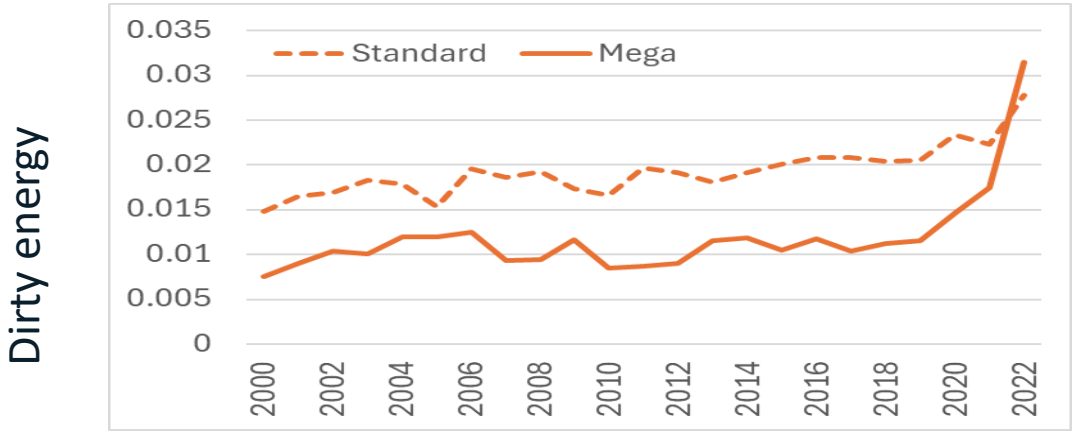
Mega consumers pay less for energy and face less price uncertainty

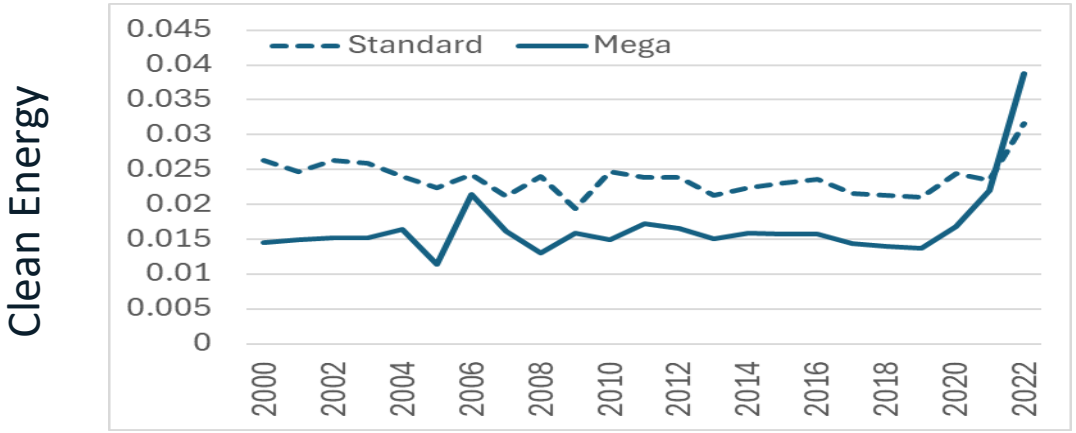
Energy prices





Standard deviation of energy prices





Conclusion & Policy implications

- Stricter policies do increase the relative price of high-carbon fuels, but
  - Large energy users experience a weaker price signal—though this effect lessens over time

- Policy impacts on firm behavior and energy choices are gradual, underscoring the need for consistent, well-designed interventions

- Policy recommendations:
  - Implement targeted measures and maintain stable & predictable policy framework
  - Continue collecting granular firm-level data to assess policy effectiveness

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