CompNet The Competitiveness Research Network

Energy transition
a CompNet/MDI-based Assessment

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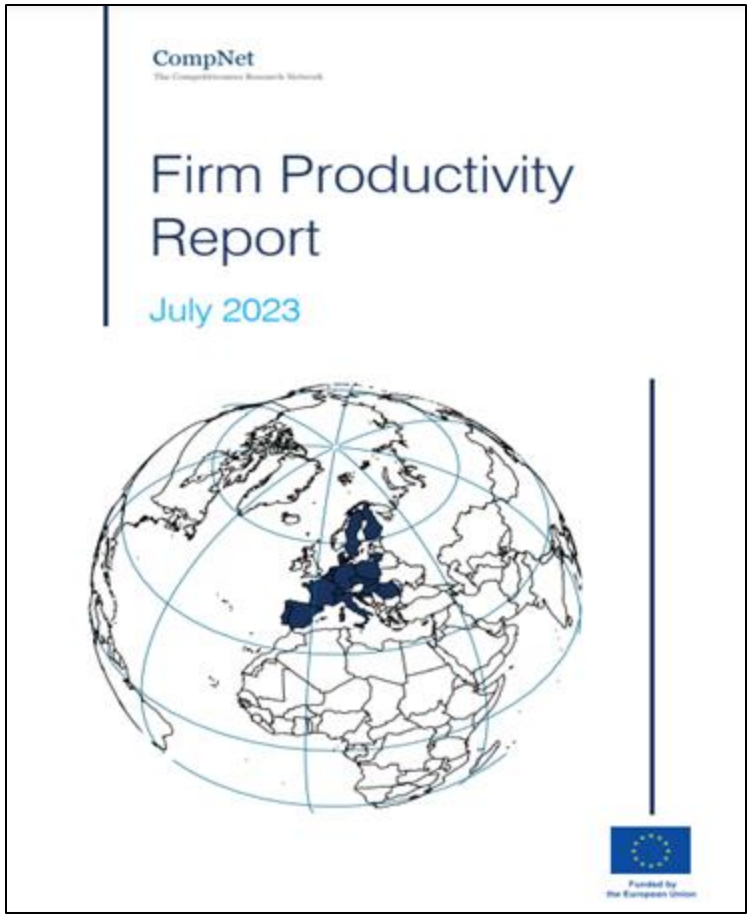
Roadmap

- The work so far:
  - Motivation
  - Key findings
- Where we are
  - Motivation
  - Summary statistics (MDI)
- Next steps using MDI
  - Possible areas of research
  - Empirical strategy

The Work so Far



2023 CompNet Firm Productivity Report Chapter 4
"Reacting to energy price shocks"

1) Key findings

- **European firms compress profits to absorb short-term price shocks**
  - but it's uncertain if it's due to their inability to raise prices (pass-through) or necessity to cost-cutting necessity.
- **Energy price shocks result in increased layoffs but also drive firms to improve energy efficiency, particularly in reducing fossil fuel consumption**
  - highlighting their adaptability during economic turbulence.
- **Research emphasizes distinct effects of electricity and natural gas price shocks on firms**
  - necessitating customized strategies to address energy price fluctuations
- **Large corporations are more vulnerable to energy price shocks than SMEs, and productive firms are better at surviving such shocks**
  - potentially causing less productive businesses to exit the market.

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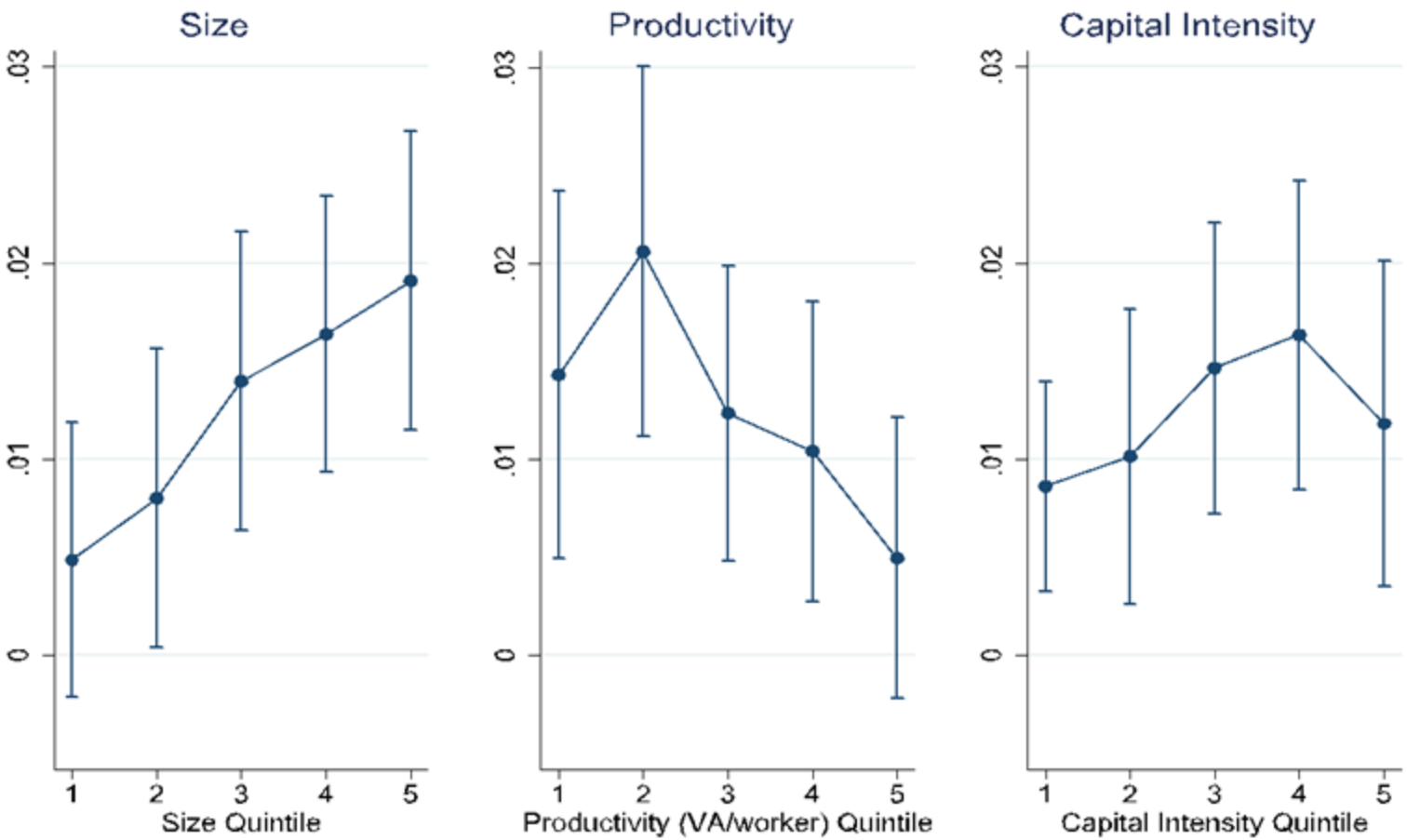
1) Key findings

- Impact of electricity shocks on energy cost share is greater for large firms
- Productive firms seem to be less affected (energy cost share) by energy price shocks
- Impact increases with capital intensity. But declines (highest quintilie)
  - suggest economies scale



2) Where we are (MDI)–Motivation (IEA, 2022)

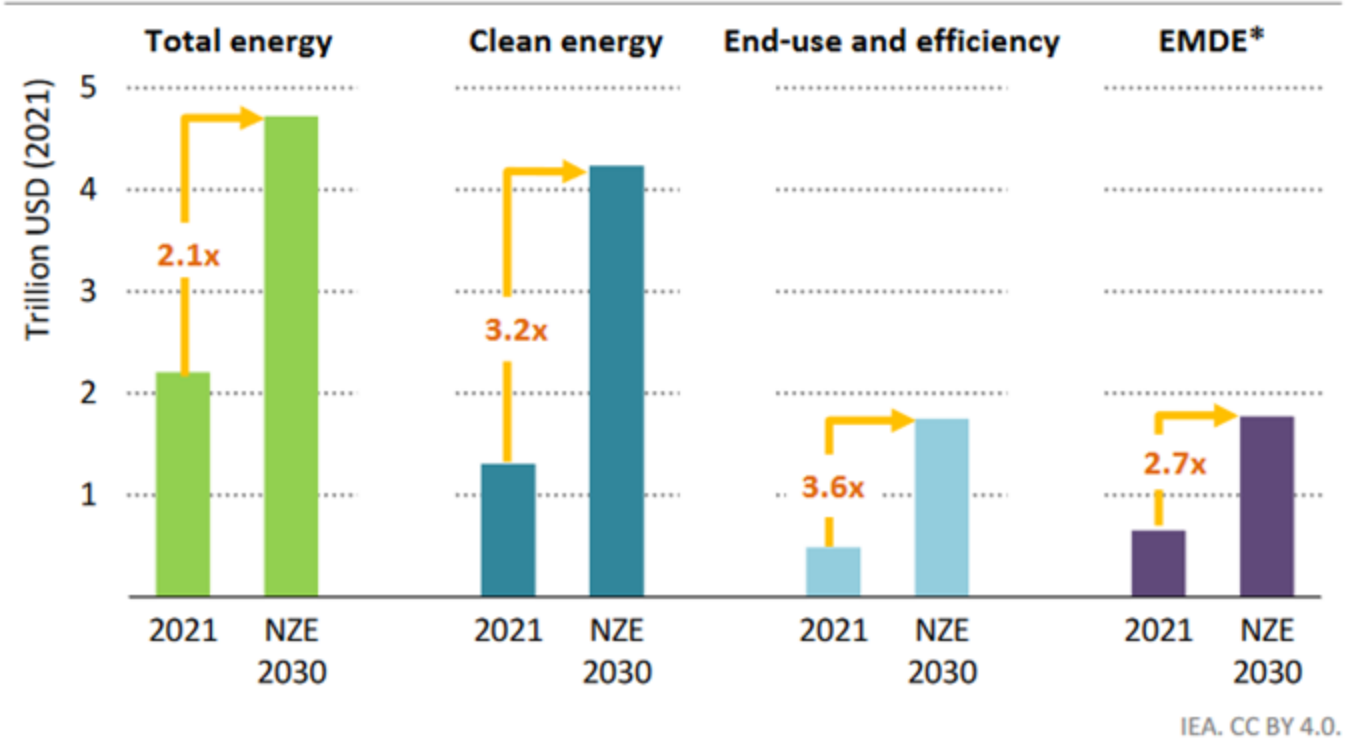
Energy crisis

- War & maintenance postponed from 2020 due to Covid
- High fuel prices (natural gas) responds to 90% increase in electricity generation costs.
  - Renewable energy minimal impact on this increase energy transitions solution to crisis.
- Impact:
  - Inflation
  - Mainly low-income households, (significant income share on energy and food)

2) Where we are (MDI)– Motivation (IEA, 2022)

Energy transition

Figure 1.18 ▷ Energy investment in the NZE Scenario, 2021 and 2030



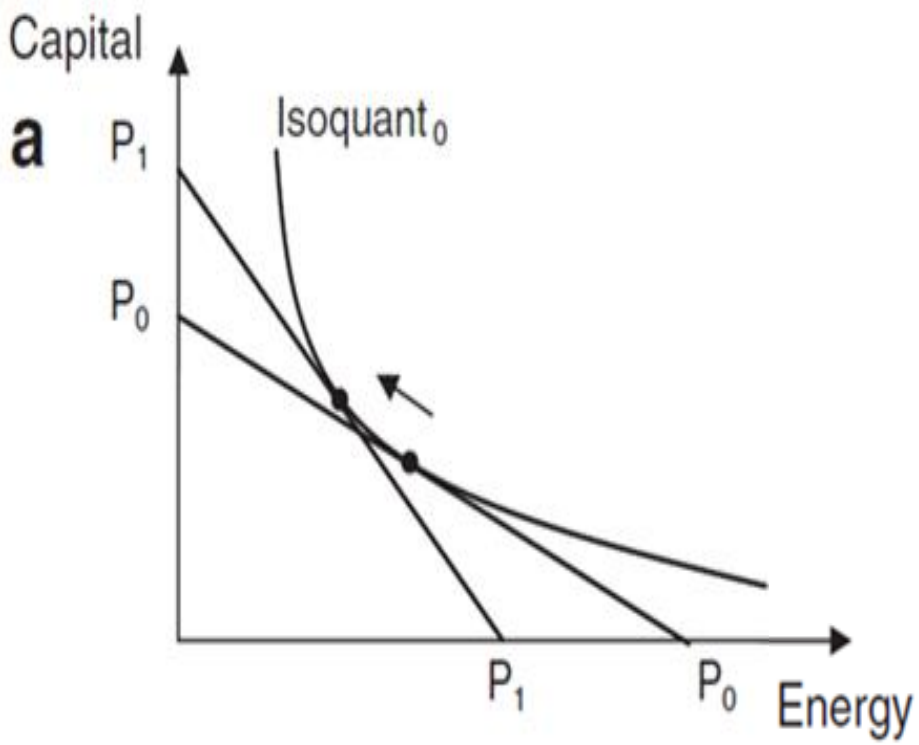
- By mid-century, electricity demand 75% higher than today :
  - Clean electricity, electrification and energy efficiency crucial for NZE *
  - Uncertainty for oil security relates to the adequacy of investment
  - Efficiency measures have reduced energy consumption but challenges:
    - Stock turnover (e.g., long-lived assets) ⍰ policies accelerate retrofits
- European Union has set 'Energy Efficiency First' as main objective of "Clean Energy for All Europeans" proposal (EC 2016)

2) Where we are – MDI energy-related available data

- **Countries available: FR, PT, SI, AT**
- **MDI SBS:** Purchases of energy products (in value)
- **MDI BS:** Energy input
  - Sub-item of intermediate inputs; all expenses of the firm for energy covering all sorts of fuels, heat or electricity (e.g. solid fuels like coal or wood, liquid fuels like gasoline, gas fuels like natural gas). It should refer to operating expenses, ideally excluding expenditures for further resale or expenditures used as inputs for further production
- **MDI ENER:** Energy total expenditure, total consumption, self-generated energy
  - natural gas, light fuel oil, district heating, steam, liquid petroleum gas, coal and coal products, other petroleum products, other gas products, renewable energy, other non-renewable
  - quantity self-generated (total, by fossil fuels, renewables, other sources).

2) Where we are (MDI) – Energy efficiency

Measure energy efficiency: key concepts*



- K and E as inputs, energy use cost-minimization (energy efficiency) at tangency.

- **A - relative E price change (P0 to P1):**
  - Externality or missing knowledge about ener. intensity process→
    lower relative ener P → ener inefficiency choices

    Relative E price changes:
  - form future E prices expectations
  - equipment lifetime
- **B - technological change:** shift iso left (↑ ener eff.)

*Based on reviews from Gillingham et al. - 2009 and Gillingham et al. - 2018

2) Where we are (MDI) – Key concepts

Measure energy efficiency: key concepts*

- Energy efficiency ⇎ Energy conservation (decrease consumption/demand)
  - E.g., **"Rebound effect"** demand increase in response to efficiency

- "Energy efficiency gap": significant Δ between
  - Observed energy efficiency < (estimated) optimal energy use - Why?
    - Market barriers and failures (externality, credit constraints)
    - Behaviour failures (systematic biases in decision making → underinvestment)
    - High initial costs vs uncertain future energy saving costs

- Energy intensity vs Energy efficiency
- Use a **Stochastic Frontier approach** instead (FIlippini M., Hunt L.C., 2015)

*Based on reviews from Gillingham et al. - 2009 and Gillingham et al. - 2018

Where we are (MDI) – Summary statistics (FR data)

Sample: *How many firms have information about energy prices*?*

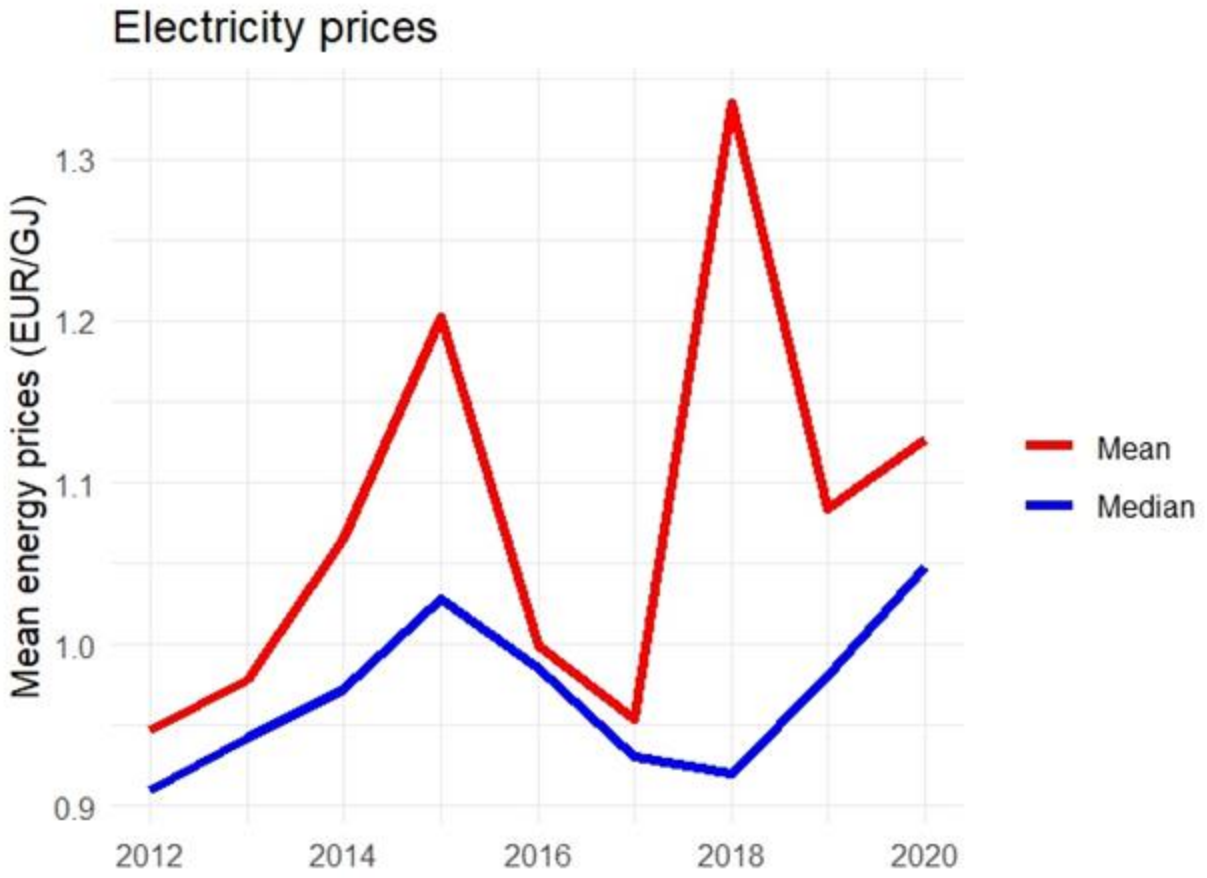
Year	Elec.	Coal	OthGas	LFO	LPG	NatGas	OthPet	Renew	Steam
2012	7321	91	41	2414	1728	4982	333	257	214
2013	6830	73	16	2224	1492	4659	283	274	244
2014	6462	71	12	2129	1411	4535	256	122	0
2015	9696	89	35	2805	1820	6099	272	145	0
2016	6948	86	33	2510	1550	4775	226	122	0
2017	6905	77	29	2583	1563	4752	204	121	0
2018	6845	80	28	2669	1484	4496	186	122	0
2019	6775	0	138	0	1556	0	0	0	0
2020	5675	71	197	2271	1220	3813	188	163	0

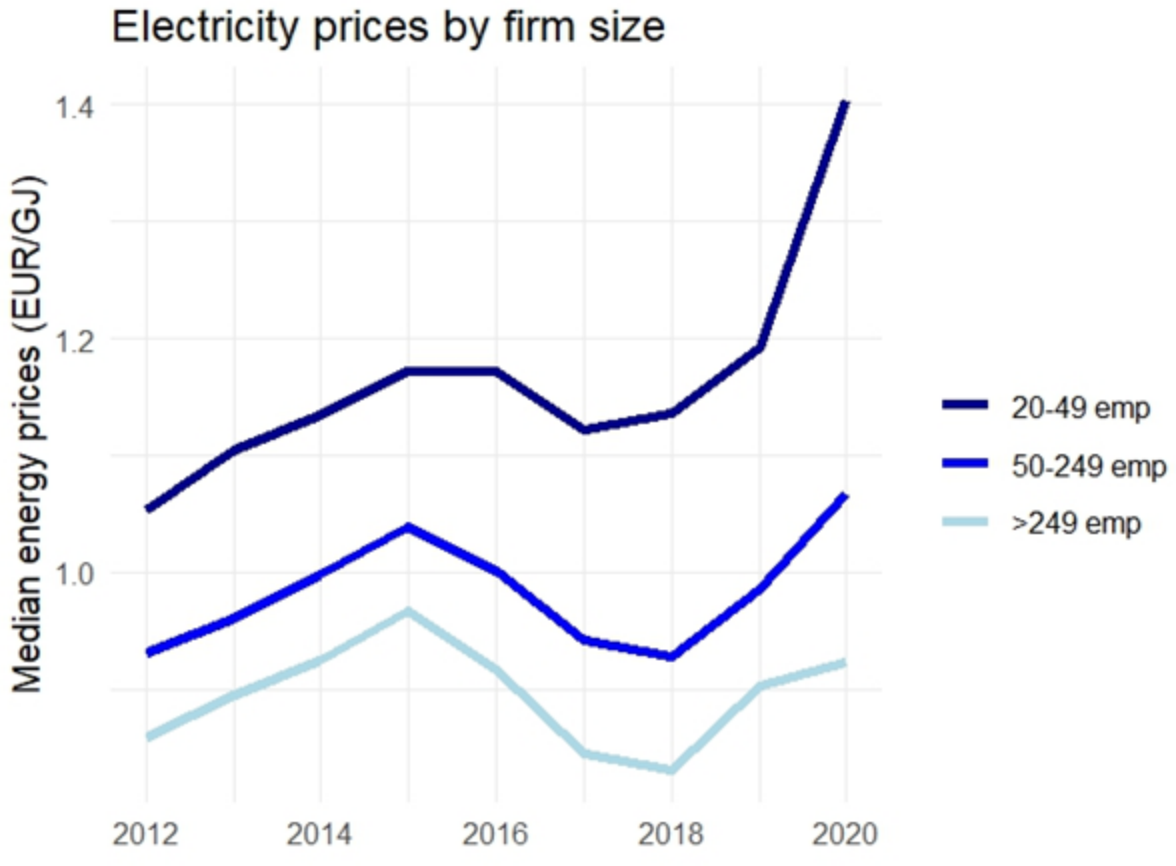
Table 1: LFO: Light Fuel Oil, LPG: Liquid Petro Gas, OthPet: Other Petro Prod, Renew: Renewable Energy

OBS: N° missing/zeroes omitted (but see patterns over years)

****electr_exp***/electr_q (quantitiy consumed in GJ)

Where we are (MDI) – Summary statistics (FR data)



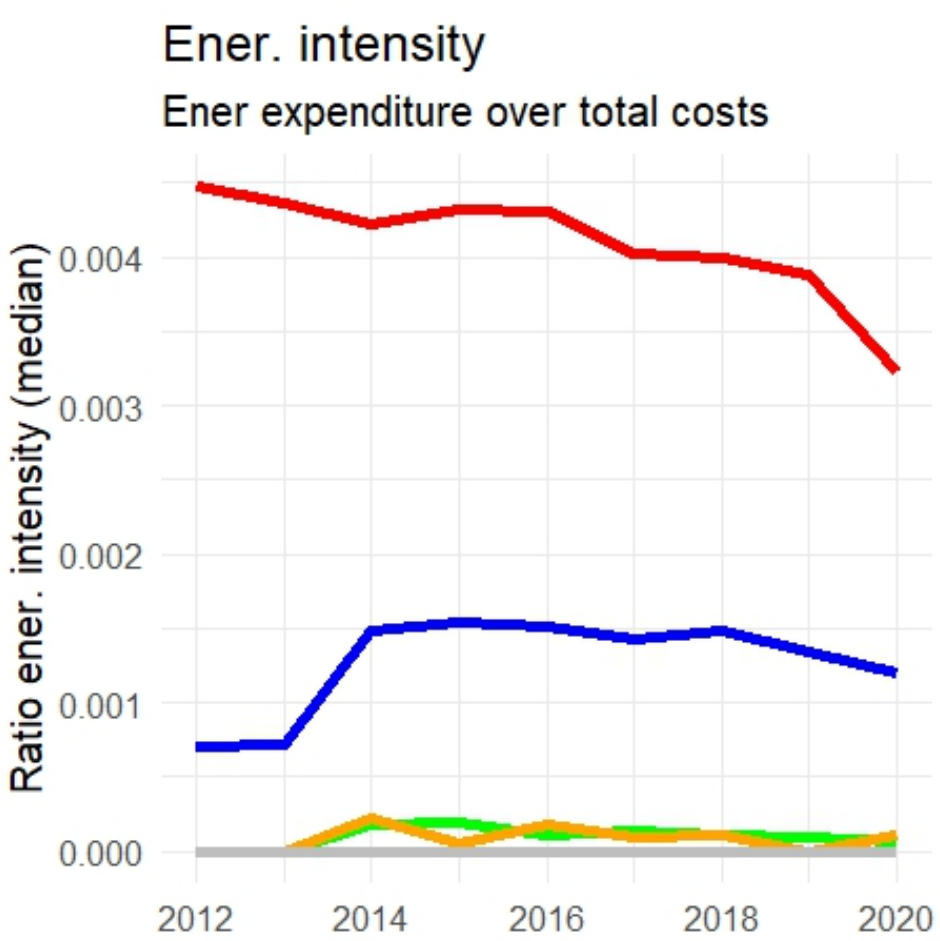


Some dispersion across firms

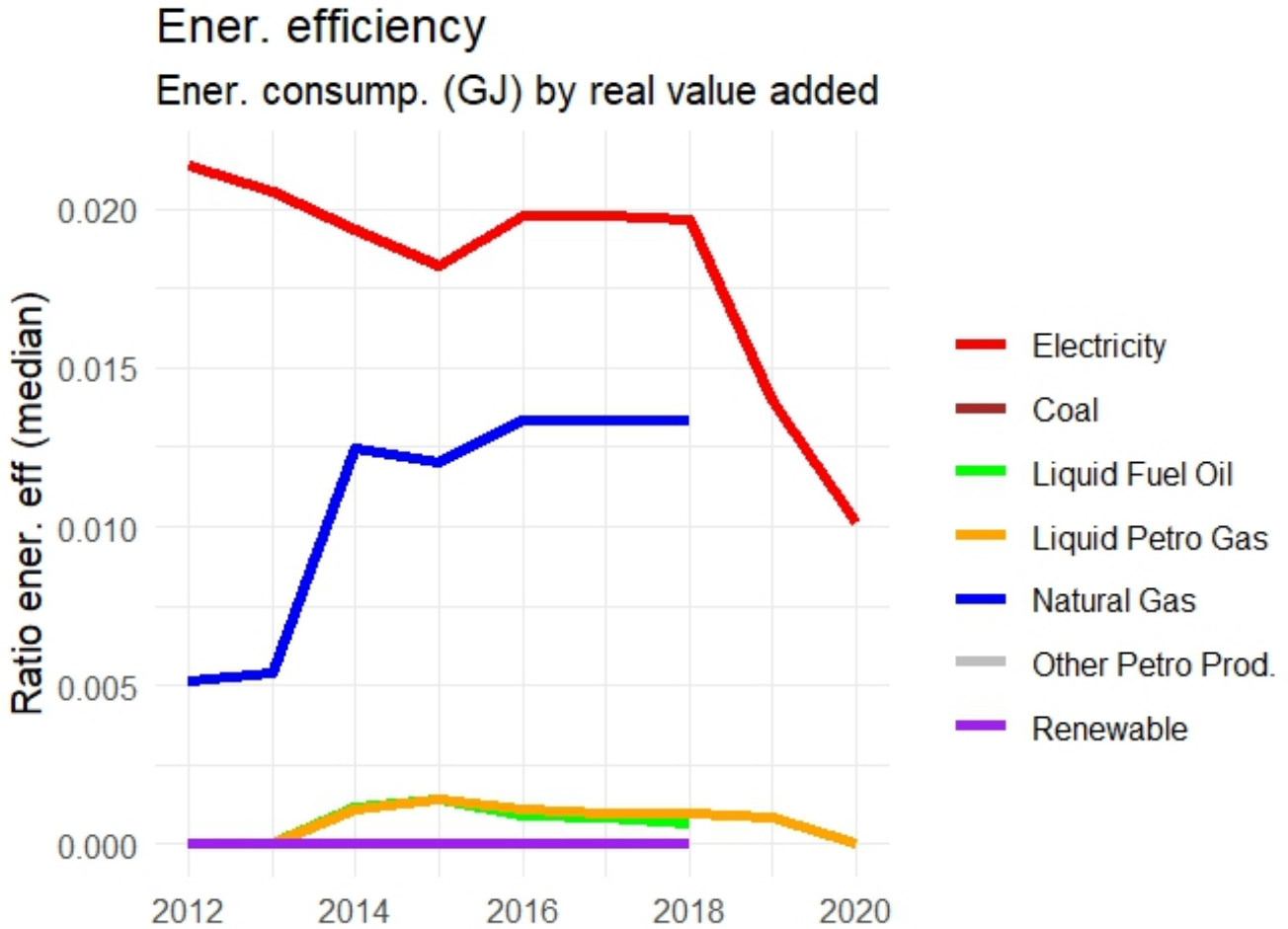
(Fontagne et al., 2023)

As expected, larger firms pay less

Where we are (MDI) – Summary statistics (FR data)



Tot. costs: labor costs, raw materials, depreciation (BS data)



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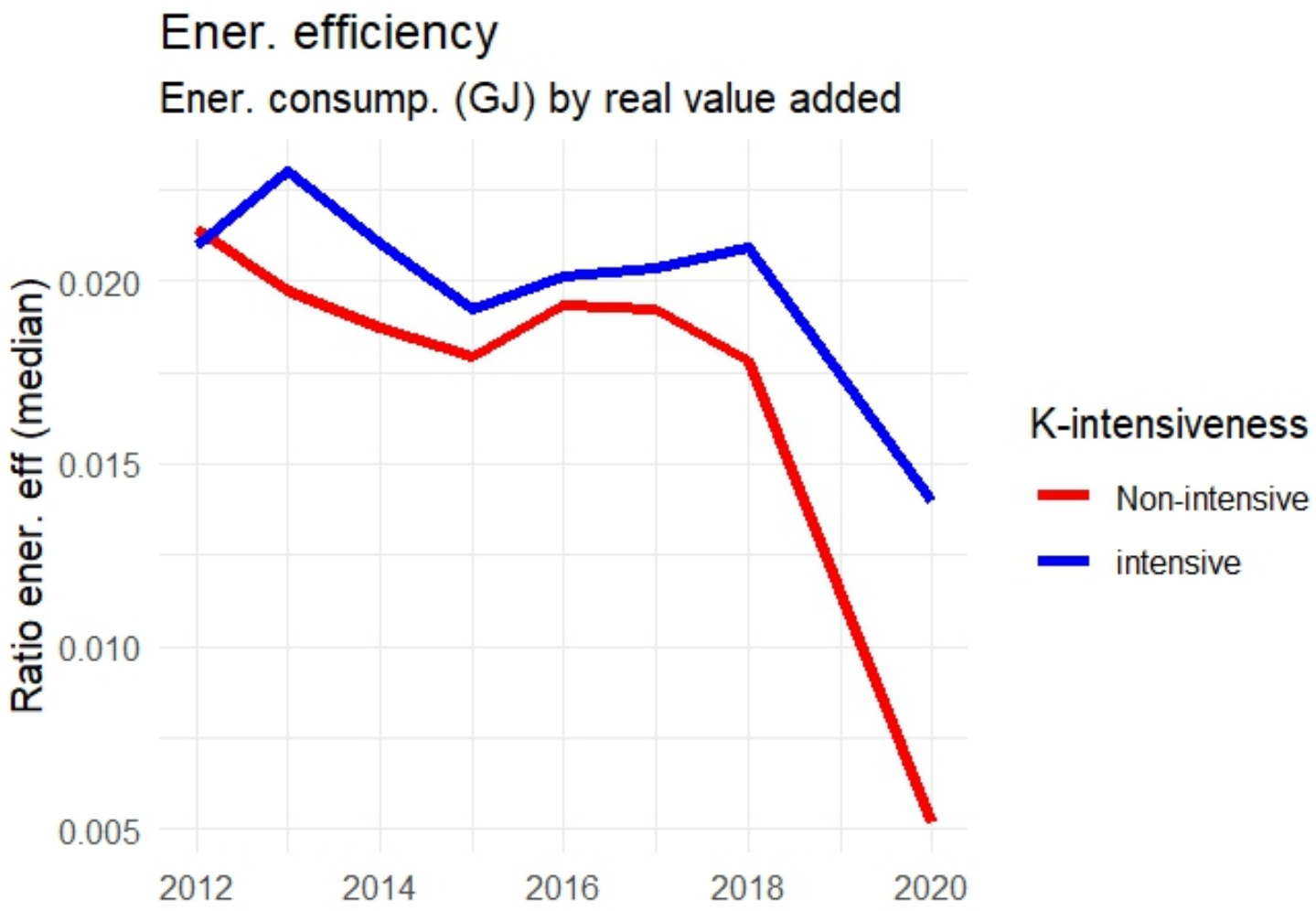

factor cost (SBS). K-intensity: if ratio K/L (fixed_assets/pay) > median

3) Next steps using MDI – areas of research

Research objective: *How firms can improve their energy efficiency?*

a. Trade
b. Exposure to energy shocks
c. Cleansing effects

3) Next steps using MDI – areas of research

Literature: broad strands

- Energy market → Energy efficiency:
  - ↑ E prices → conservation (short-run) vs limited by long lifetimes and slow turnover of energy-using K.
  - Persistent ↑ E prices → likely affect energy efficiency adoption (replace K and adopt new process)
  - Demand responsiveness captured by E price elasticity. (long-run elasticities > short-run)

- Technical change literature
  - factors (e.g., ↑ E prices, trade (Ling-Yun He, 2021)) → technology (e.g., Renewable energy patents adoption (Noailly, J., Smeets, R. 2022), R&D (Imbruno, M., Ketterer, T.D., 2018)

- Environment policies and business performance
  - Investigate the impact of enegy prices on firms' competitiveness (employment, TFP, wage, etc.) and emissions (Fontagne et al., 2023; Marin, G., Vona, F., 2021)

3) Next steps using MDI – areas of research

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3) Next steps using MDI – areas of research

Research objective: *How firms can improve their energy efficiency?*

a. Trade: Firms involved in trade:

+ productivity → energy efficiency/lower emissions or energy intensity

- (Chintrakarn 2013), (Forslid et al. 2018), (Roy & Yasar 2015), (Tran 2021), (Kwon et al. 2023)
- Across more/less energy intensive firms (Batrakova & Davies 2012), foreign owned (Cole et al. 2006, 2008); (Dardati & Saygili 2012), type emission (Holladay 2015); (Forslid et al. 2015); (Cui et al. 2012), energy-saving tech. adoption (Girma & Hanley 2015); (Cui et al. 2015), at plant level (Goldar & Goldar 2023); (Gutiérrez & Teshima 2018) via higher competition.
- by focusing sales on their core products (Barrows & Ollivier 2018)
- depends on the market export destination (Batrakova 2011; Blyde & Ramirez 2022)

3) Next steps using MDI – areas of research

Research objective: *How firms can improve their energy efficiency?*

a. **Trade:** firms self selection into trade → endogeneity

- Instrument export (X) status
  - lagged status (Girma & Hanley 2015); (Dardati & Saygili 2021); (Goldar 2022); multiple instruments (Roy & Yasar 2015); (Kwon et al. 2023); export destination FX (Blyde & Ramirez 2022)
- Propensity score matching (exporters vs non exporters) + Diff-Diff (Zhou et al. 2023); (Tran 2021)
- Model-motivated specifications (Richter & Schiersch 2017); (Forslid et al. 2018); (LaPlue 2019); (Ling-Yun & Huang 2021); (Zhou et al. 2022)

3) Next steps using MDI – areas of research

Research objective: *How firms can improve their energy efficiency?*

a. Trade: literature gaps

- Mixed evidence: (Dardati & Saygili 2021) find null effect using different energy efficiency measures
- Trade → firms' products/intermediate inputs composition (Barrows & Olivier 2018); (Kwon et al. 2023)
- Distinguish between importers, exporters, and their traded products.
- Trade destination matters for firms in developing countries (Batrakova 2011); (Blyde & Ramirez 2022), no firm data evidence regarding developed markets *(pollution haven hypothesis)*
- Absence of evidence in the MDI countries

3) Next steps using MDI – areas of research

Research objective: *How firms can improve their energy efficiency?*

a. **Do EU firms really improve their energy efficiency if exporting to countries with poor energy regulation? What are the mediating products?**

b. **Exposure to energy price shocks:** ↑ E prices

- Short-run: conservation vs slow asset turnover.
- Persistent ↑ E prices → energy efficiency adoption (replace K)

3) Next steps using MDI – areas of research

Research objective: *How firms can improve their energy efficiency?*

a. Trade

b. Exposure to energy shocks: ↑ E prices impact:

- Competitiveness (employment/wage and TFP) and energy consumption/emissions (Fontagne et al., 2023) ; (Marin & Vona, 2021); (Abeberese 2017); (Dussaux 2020); (Amann et al. 2021); (Deschenes 2010); (Hille & Möbius 2019), margins/profit (Rentschler & Kornejew, 2017), labour skills losers/winners (Marin & Vona, 2019)
- Pass-through (Ganapati et al., 2020)
- Short-run/Long-run (André et al., 2023)
- Switch energy sources (Rentschler & Kornejew, 2017); (Jo 2021) or electricity intensiveness (Abeberese 2017)
- ↑ energy efficiency - technical change literature:
  - innovation/renewable energy patents (Noailly & Smeets, 2022)
  - R&D (Imbruno & Ketterer, 2018)

3) Next steps using MDI – areas of research

Research objective: *How firms can improve their energy efficiency?*

a. Trade

b. **Exposure to energy shocks:** E prices faced by firms are endogenous

- Instrument (Bartik shift-share) (Fontagne et al., 2023) ; (Marin & Vona, 2021); (Abeberese 2017); (Dussaux 2020); (Jo 2021); (Sato et al. 2019); (Amann et al. 2021)
- Weather variation (Liski & Vehviläinen, 2020)
- Power outages literature (Cole et al. 2018); (Fisher-Vanden et al. 2015); (Allcott et al. 2016)

Literature gaps:

- Firms adaptation: how the first energy shock differs from the following ones
- Dynamics & heterogeneity (André et al., 2023)
- Price shocks and trade (Aldy & Pizer 2014)

3) Next steps using MDI – areas of research

Research objective: *How firms can improve their energy efficiency?*

a. Trade
   i. Do EU firms really improve their energy efficiency if exporting to countries with poor energy regulation? What are the mediating products?
   ii. **How energy price shocks stimulate outsourcing ? *(pollution haven hypothesis)***

a. **Exposure to energy shocks:**
   i. **How subsequent energy price shocks affect firms energy-saving technology adoption?**

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Research objective: *How firms can improve their energy efficiency?*

a. Trade
   i. Do EU firms really improve their energy efficiency if exporting to countries with poor energy regulation? What are the mediating products?
   ii. How energy price shocks stimulate outsourcing ? (pollution haven hypothesis)
b. Exposure to energy shocks:
   i. How subsequent energy price shocks affect firms energy-saving technology adoption?
c. **Cleansing effects**

3) Next steps using MDI – areas of research

Research objective: *How firms can improve their energy efficiency?*

a. Trade
b. Exposure to energy shocks
c. Cleansing effects

- ↑ E prices
  - may lead low energy efficient firms to exit the market
  - improve the energy efficiency of entrants (Linn 2008)

- Relevant shocks have long-lasting TFP impact (André et al., 2023)

Possible empirical strategies:

- Kozeniauskas et al. 2022 investigates Covid effects across the productivity distribution
- Energy elasticities substitutions (i.e., Outline) (Mugabe et al., 2020)
- Impulse Function Responses (André et al., 2023) or survival analysis

Way forward

- **NPBs involved: AT, DE, FR, SI**
  - Interested in a., b., c., at different degrees
  - Short (AT) and medium to long term own products aligned to the research agenda

- **MDI data harmonization process**
  - AT: to be started
  - SI: ongoing
  - FR: established
  - DE: in contract phase

- Cooperation (MTeams channel):
  - Exchange of literature and codes (e.g., SFA codes)

Way forward

- How to move forward?
  - Medium/Long term: causal study
  - Short term: differences on summary statistics across countries firm level data
    - Summary statistics:
      - Energy mix, consumption, efficiency, intensity in time
      - Explore differences
        - e.g., Δ spot price, prices paid by firms, estimations (Sato et al., 2019)

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Appendix

Energy efficiency literature review*

Potential market failures	Potential policy options
Energy market failures	
Environmental externalities	Emissions pricing (tax, cap and trade)
Average-cost electricity pricing	Real-time pricing, market pricing
Energy security	Energy taxation, strategic reserves
Capital market failures	
Liquidity constraints	Financing/loan programs
Innovation market failures	
R&D spillovers[a]	R&D tax credits, public funding
Learning-by-doing spillovers	Incentives for early market adoption
Information problems	
Lack of information, asymmetric information	Information programs
Principal-agent problems	Information programs
Learning by using	Information programs

- Externality → E overuse & E efficiency underinvestment
  - Policy: emission price
- Lack of Information
  - about the availability of and savings from E-efficient products
  - Policy: information prog. (e.g., label products, E use feedback reports)
- Asymmetric information
  - buyers can't observe E efficiency benefits → sellers ignore and underinvest in E efficiency attributes.
  - Policy: Product minimum standards

*Based on reviews from Gillingham et al. - 2009 and Gillingham et al. - 20018

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- Principal-agent/split incentive
  - Incomplete information about building E efficiency by the principal may lead to underinvestment by the agent as she can't recoup efficiency investments in the rent/selling prices.
- LBD externalities (spillover)
  - adopter of a new E-efficient product creates knowledge about the product through its use, and others free ride such knowledge

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- Liquidity constraints
  - may force agents to opt for less E efficient products
  - Policy: direct subsidies, tax credits, tax deductions, rebates, or loan subsides
- Innovation market failures
  - R&D spillovers → underinvestment as firm unable capture all innovation efforts.
    - If E is underpriced, this issue is magnified
  - Policy: patent protection, R&D tax credits, and basic research funding.

*Based on reviews from Gillingham et al. - 2009 and Gillingham et al. - 20018

Energy efficiency literature review*

- Energy efficiency policy evaluation - challenges:
  - Measure 'free-riders,' who would have acted similarly (invest in E efficiency/reduce E use) without the policy
  - Spillover: policy nonparticipants act after observing the participants
  - Ignore (not account for) rebound effects
  - Selection of participants

- Common methodologies
  - **Difference-in-differences:**
    - studies exploit a boundary between two regions that is arguably arbitrarily defined, and thus entities on either side of the boundary (assumption of pre-common trends)
    - unexpected dramatic change that occurs at a certain time
  - **Regression discontinuity:** random assignment of the treatment to one side of the threshold
    - e.g., program eligibility cutoffs
  - **Matching**: treated entities are matched with similar control entities based on observables
  - **Panel and instrument (IV)**: (Fontagne et al., 2023; Marin, G., Vona, F., 2021; Dussaux D., 2020)

References

- Dussaux, D., 2020. "The joint effects of energy prices and carbon taxes on environmental and economic performance: Evidence from the French manufacturing sector," OECD Environment Working Papers 154, OECD Publishing.
- Linn, J., 2008, “Energy prices and the adoption of energy-saving technology”, The Economic Journal, Oxford University Press Oxford, UK
- Gillingham, K. et al., 2018. Advances in Evaluating Energy Efficiency Policies and Programs, Annual Review of Resource Economics, Annual Reviews, vol. 10(1), pages 511-532.
- Gillingham, K. et al., 2009. Energy Efficiency Economics and Policy, Annual Review of Resource Economics, 1, (1), 597-620.
- Fontagné, L. et al., 2023. The Many Channels of Firm’s Adjustment to Energy Shocks: Evidence from France, Working Papers DT/2023/05, DIAL (Développement, Institutions et Mondialisation).
- IEA (2022), World Energy Outlook 2022, IEA, Paris https://www.iea.org/reports/world-energy-outlook-2022, License: CC BY 4.0 (report); CC BY NC SA 4.0 (Annex A)
- Imbruno, M., Ketterer, T.D., 2018. Energy efficiency gains from importing intermediate inputs: firm-level evidence from indonesia. J Dev Econ 135, 117–141.
- Ling-Yun, H., Geng, H., 2021, How can export improve firms’ energy efficiency? The role of innovation investment. Structural Change and Economic Dynamics 59, 90-97.
- Marin, G., Vona F., 2021. The Impact of Energy Prices on Employment and Environmental Performance: Evidence from French Manufacturing Establishments, European Economic Review, vol 135, 103739.

References

- Abeberese, Ama Baafra; ,Electricity cost and firm performance: Evidence from India,Review of Economics and Statistics,99,5,839-852,2017,"MIT Press One Rogers Street, Cambridge, MA 02142-1209, USA journals-info ..."
- Barrows, Geoffrey; Ollivier, Hélène; ,Cleaner firms or cleaner products? How product mix shapes emission intensity from manufacturing,Journal of Environmental Economics and Management,88,,134-158,2018,Elsevier
- Batrakova, Svetlana; ,Flip side of the pollution haven: do export destinations matter?,,,,,2011,UCD Centre for Economic Research Working Paper Series
- Blyde, Juan S; Ramirez, Mayra A; ,Exporting and environmental performance: Where you export matters,The Journal of International Trade & Economic Development,31,5,672-691,2022,Taylor & Francis
- Dardati, Evangelina; Saygili, Meryem; ,Are exporters cleaner? Another look at the trade-environment nexus,Energy Economics,95,,105097,2021,Elsevier
- Forslid, Rikard; Okubo, Toshihiro; Ulltveit-Moe, Karen Helene; ,"Why are firms that export cleaner? International trade, abatement and environmental emissions",Journal of Environmental Economics and Management,91,,166-183,2018,Elsevier
- Girma, Sourafel; Hanley, Aoife; ,How green are exporters?,Scottish Journal of Political Economy,62,3,291-309,2015,Wiley Online Library
- Goldar, Bishwanath; Goldar, Amrita; ,Impact of export intensity on energy intensity in manufacturing plants: Evidence from India,The Journal of International Trade & Economic Development,32,4,639-664,2023,Taylor & Francis
- Kwon, Ohyun; Zhao, Hao; Zhao, Min Qiang; ,Global firms and emissions: Investigating the dual channels of emissions abatement,Journal of Environmental Economics and Management,118,,102772,2023,Elsevier

References

- LaPlue, Lawrence D; ,The environmental effects of trade within and across sectors,Journal of Environmental Economics and Management,94,,118-139,2019,Elsevier
- Richter, Philipp M; Schiersch, Alexander; ,CO2 emission intensity and exporting: Evidence from firm-level data,European Economic Review,98,,373-391,2017,Elsevier
- Roy, Jayjit; Yasar, Mahmut; ,Energy efficiency and exporting: Evidence from firm-level data,Energy Economics,52,,127-135,2015,Elsevier
- Tran, Trang My; ,Environmental benefit gain from exporting: Evidence from Vietnam,The World Economy,45,4,1081-1111,2022,Wiley Online Library
- He, Ling-Yun; Huang, Geng; ,How can export improve firms' energy efficiency? The role of innovation investment,Structural Change and Economic Dynamics,59,,90-97,2021,Elsevier
- Zhou, Kexuan; Yu, Linhui; Jiang, Xinlin; Kumar, Sanjay; ,Trade policy uncertainty and pollution emissions of export enterprises—The case of China-ASEAN free trade area,Review of International Economics,31,5,1719-1750,2023,Wiley Online Library
- Cole, Matthew A; Elliott, Robert JR; Occhiali, Giovanni; Strobl, Eric; ,Power outages and firm performance in Sub-Saharan Africa,Journal of Development Economics,134,,150-159,2018,Elsevier
- Liski, Matti; Vehviläinen, Iivo; ,Gone with the wind? An empirical analysis of the equilibrium impact of renewable energy,Journal of the Association of Environmental and Resource Economists,7,5,873-900,2020,"The University of Chicago Press Chicago, IL"
- Aldy, Joseph E; Pizer, William A; ,The competitiveness impacts of climate change mitigation policies,Journal of the Association of Environmental and Resource Economists,2,4,565-595,2015,"University of Chicago Press Chicago, IL"

References

- Amann, Juergen; Cantore, Nicola; Cali, Massimiliano; Todorov, Valentin; Cheng, Charles Fang Chin; ,Switching it up: The effect of energy price reforms in Oman,World Development,142,,105252,2021,Elsevier
- Deschenes, Olivier; ,Climate policy and labor markets,The design and implementation of US climate policy,,,37-49,2011,University of Chicago Press
- Hille, Erik; Möbius, Patrick; ,Do energy prices affect employment? Decomposed international evidence,Journal of Environmental Economics and Management,96,,1-21,2019,Elsevier
- Jo, Ara; ,Substitution between Clean and Dirty Energy with Directed Technical Change,Available at SSRN 4211251,,,,2022,
- Marin, Giovanni; Vona, Francesco; ,Climate policies and skill-biased employment dynamics: Evidence from EU countries,Journal of Environmental Economics and Management,98,,102253,2019,Elsevier
- Sato, Misato; Singer, Gregor; Dussaux, Damien; Lovo, Stefania; ,International and sectoral variation in industrial energy prices 1995–2015,Energy Economics,78,,235-258,2019,Elsevier
- Costantini, V., & Mazzanti, M. (2012). On the green and innovative side of trade competitiveness? The impact of environmental policies and innovation on EU exports. Research policy, 41(1), 132-153.
- Rentschler, J., & Kornejew, M. (2017). Energy price variation and competitiveness: Firm level evidence from Indonesia. In Fossil Fuel Subsidy Reforms (pp. 75-106). Routledge.
- Ganapati, S., Shapiro, J. S., & Walker, R. (2020). Energy cost pass-through in US manufacturing: Estimates and implications for carbon taxes. American Economic Journal: Applied Economics, 12(2), 303-342.
- Filippini, M., & Hunt, L. C. (2015). Measurement of energy efficiency based on economic foundations. Energy Economics, 52, S5-S16.

References

- Noailly, J., & Smeets, R. (2022). Financing energy innovation: Internal finance and the direction of technical change. Environmental and Resource Economics, 83(1), 145-169.
- Batrakova, S., & Davies, R. B. (2012). Is there an environmental benefit to being an exporter? Evidence from firm-level data. Review of World Economics, 148, 449-474.
- Gutiérrez, E., & Teshima, K. (2018). Abatement expenditures, technology choice, and environmental performance: Evidence from firm responses to import competition in Mexico. Journal of Development Economics, 133, 264-274.
- Fisher-Vanden, K., Mansur, E. T., & Wang, Q. J. (2015). Electricity shortages and firm productivity: evidence from China's industrial firms. Journal of Development Economics, 114, 172-188.