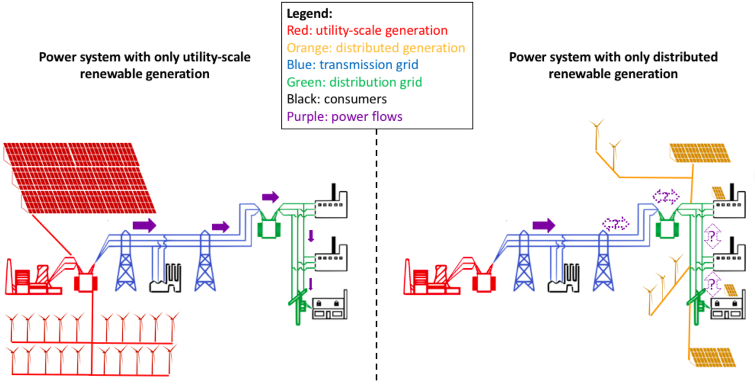
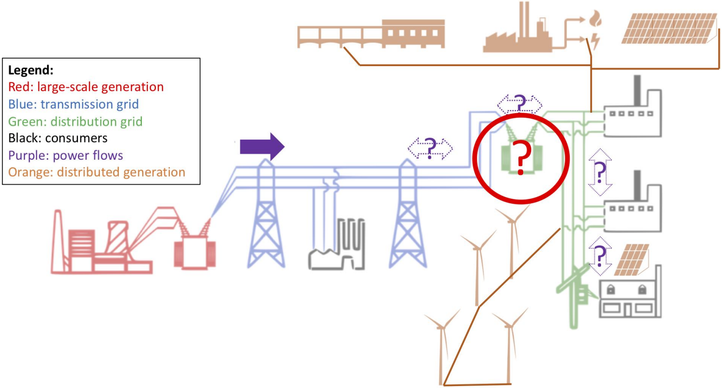
Can Distributed Intermittent Renewable Generation Reduce Future Grid Investments? Evidence from France

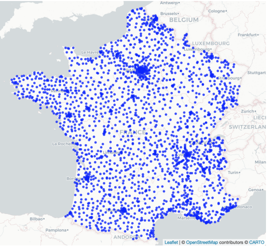
Nicolas Astier, Ram Rajagopal and Frank A. Wolak

NBER Summer Institute
Environmental & Energy Economics
26 July 2022

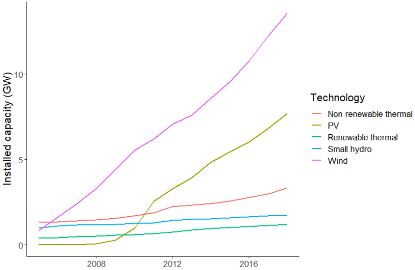
Grid-scale vs distributed units




Legend:
Red: large-scale generation
Blue: transmission grid
Green: distribution grid
Black: consumers
Purple: power flows
Orange: distributed generation
?

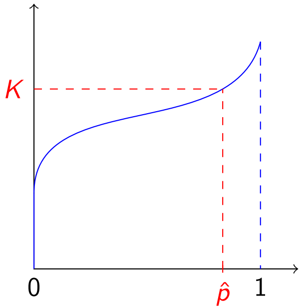


Hourly substation-level net load levels for 2,000+ substations from 1 Jan 2005 to 31 Dec 2018.

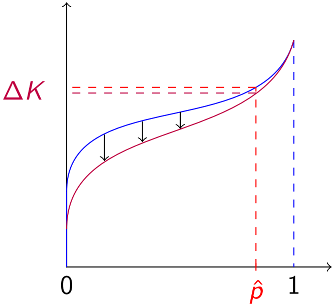


Substation-level installed capacity for each technology in each year.

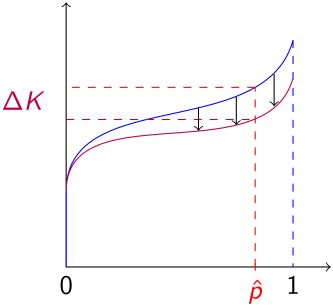
Load duration curve and grid planning



Load duration curve and grid planning



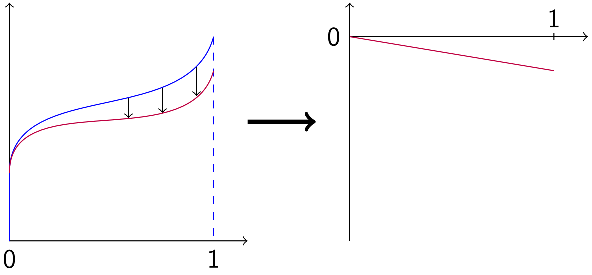
Small capacity savings



Large capacity savings

Quantile impact functions

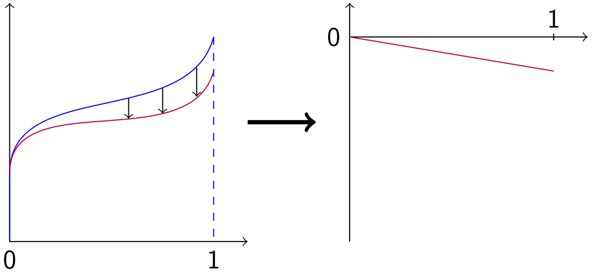
General idea:



Change in the load duration curve Quantile impact function

Quantile impact functions

General idea:

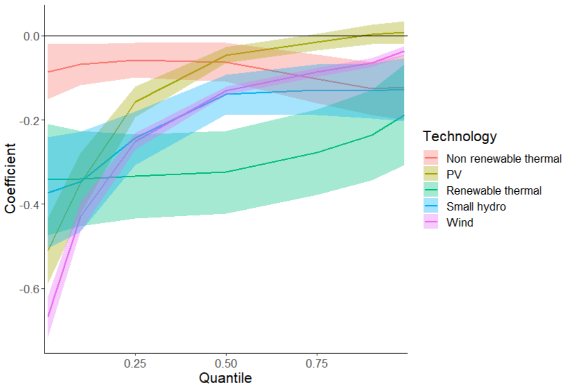


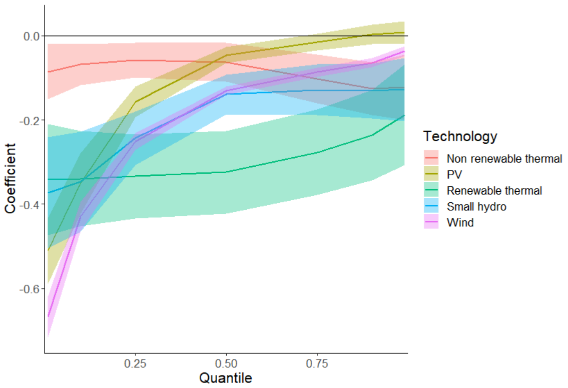
Change in the load duration curve Quantile impact function

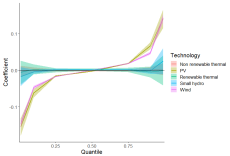
Econometrics:

$$Q_{q,s,y} = \sum_t \beta_{q,t} K_{t,s,y} + \delta_{q,s} + \delta_{q,y} + \epsilon_{q,s,y}$$

$\Rightarrow$ The tuple $(\hat{\beta}_{0.01,t}, \hat{\beta}_{0.1,t}, \hat{\beta}_{0.25,t}, \hat{\beta}_{0,5,t}, \hat{\beta}_{0.75,t}, \hat{\beta}_{0.9,t}, \hat{\beta}_{0.99,t})$ corresponds to the quantile impact function for technology t.


0.0
-0.2
-0.4
-0.6
Coefficient
0.25
0.50
0.75
Quantile
Technology
Non renewable thermal
PV
Renewable thermal
Small hydro
Wind





- Hourly ramps are changes in hourly net load from one hour to the next.
- If anything, larger ramps are likely to increase distribution network costs.

Policy discussion

- Is battery storage the silver bullet?

Policy discussion

💡 Is battery storage the silver bullet?

⇒ Under optimistic assumptions (perfect foresight, lossless and wear-free operations), adding battery storage induces noticeable impacts only at installation rates 5 to 10 times higher than currently observed rates in California.

Policy discussion

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Policy take-away: at least for the case of France, benefits from deferring future grid expansions cannot rationalize a substantially higher policy support for distributed wind and solar generation over utility-scale generation.

Climate Change Adaptation and Insurance Market Regulation

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[2]UC Berkeley and NBER

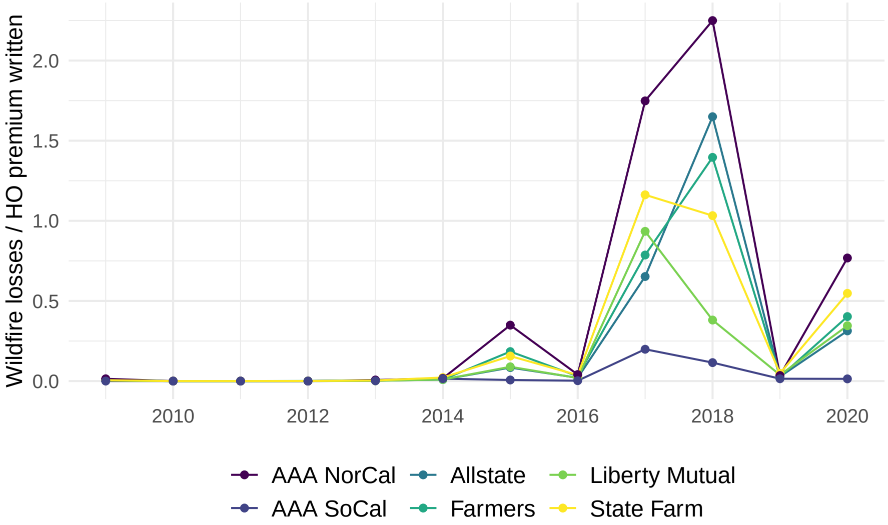
[3]UC Santa Barbara

July 26, 2022

Property insurance markets are central to climate change adaptation

- Natural disasters are getting worse. Recent large losses have disrupted private markets for property insurance.
- In the simplest economic models of insurance, increasing risks would be met with commensurate premium increases.
- Real markets are more complicated. One reason is regulatory interventions intended to balance affordability, availability, and solvency. Escalating disaster losses are exacerbating tensions between these different goals.
- Understanding these markets is vital since well-functioning property insurance markets are critical to minimizing the welfare costs of climate change.

California insurers have seen large wildfire losses



Research Questions

1. How are private insurers in California responding to escalating wildfire risk?
2. Do regulations constrain firms' ability to adapt to escalating wildfire risk?
   - Do regulations constrain firms' ability to set prices equal to expected costs?
3. What are the implications for the distribution of wildfire costs and for efficiency?

Data

- California Department of Insurance (CDI) market data
- Insurer rate filings
- Proprietary structure-level modeled risk

Research Questions

1. **How are private insurers in California responding to escalating wildfire risk?**
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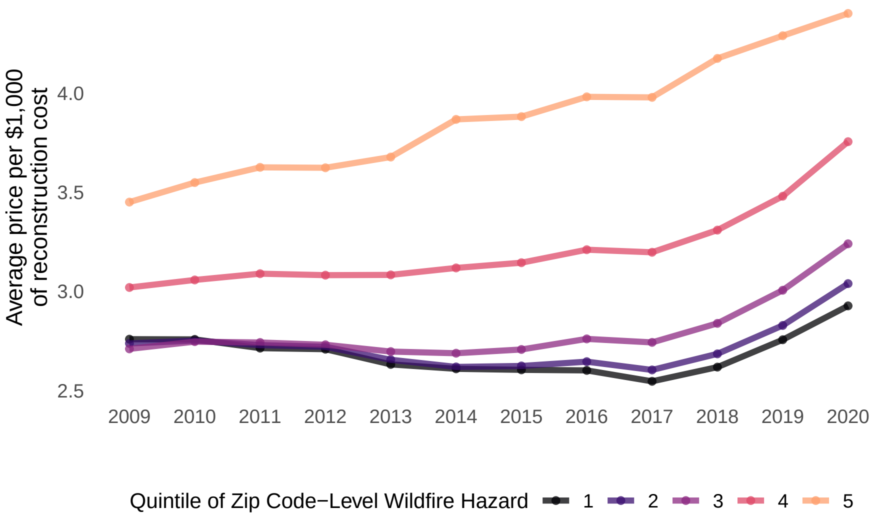
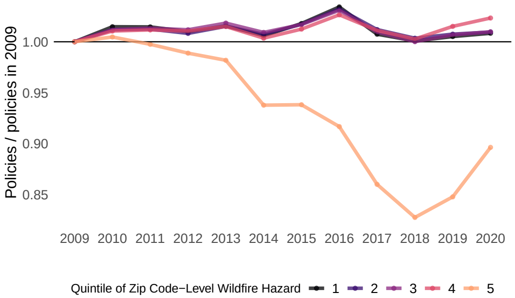
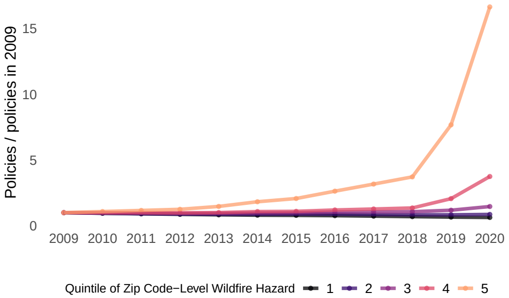
Industry response: Increased prices in high-hazard areas



Industry response: Reduced availability in high-hazard areas

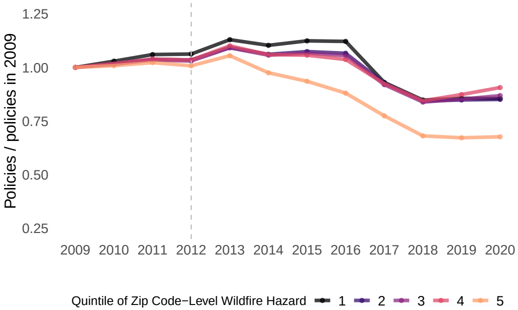


(a) Admitted Market

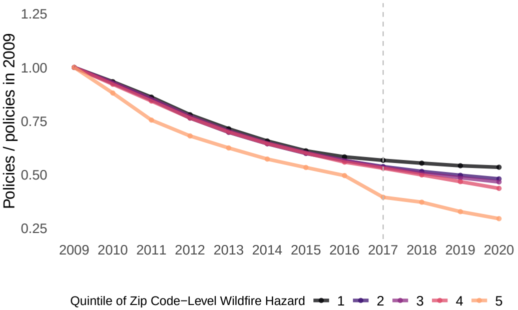


(b) FAIR Plan

Industry response: Innovation in risk modeling & selection



(a) State Farm



(b) AllState

Research Questions

1. How are private insurers in California responding to escalating wildfire risk?
2. **Do regulations constrain firms' ability to adapt to escalating wildfire risk?**
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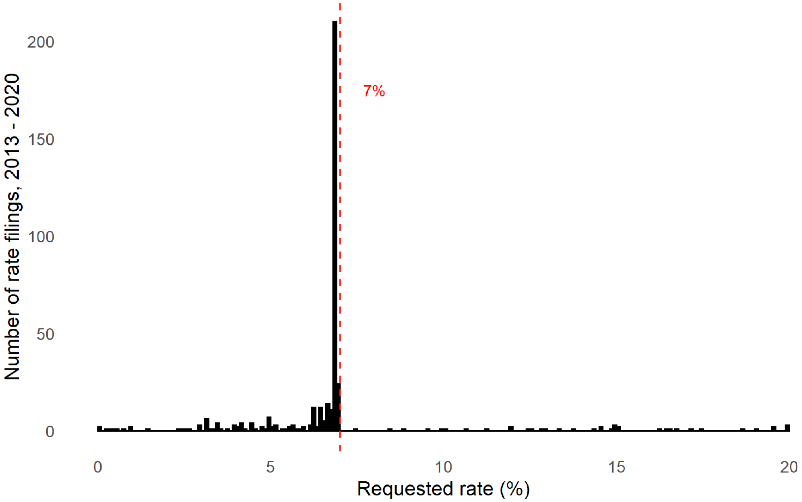
3. What are the implications for the distribution of wildfire costs and for efficiency?

Insurance prices in California are subject to regulatory approval

1. Premium increases in excess of 6.9% trigger costly administrative hearings.
2. Firms must justify loss projections using historical loss experience.
    - No CAT models.

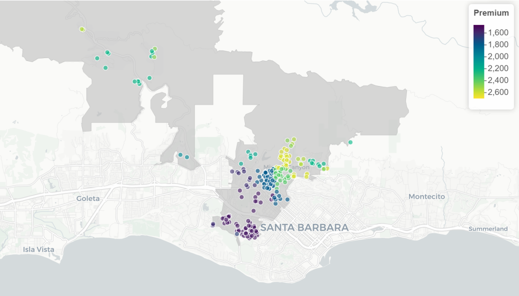
image license

There is clear bunching below the 7% threshold for rate increases

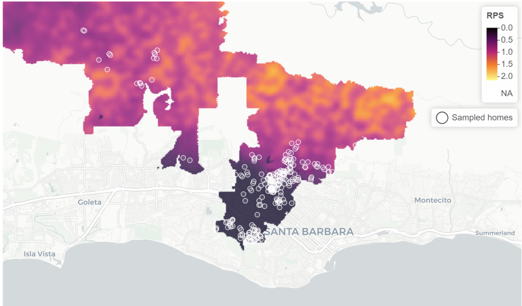


We investigate the relationship between premiums and expected losses

- *Necessary condition for actuarially fair pricing:* a $1 increase in expected wildfire losses implies a $1 increase in regulated premiums.
- We test for this using within-zip code variation in prices and modeled wildfire losses.



(a) Annual Premium for 1 Large Insurer



(b) USFS Wildfire Risk (Public Data)

The next step is to explain departures from actuarially fair pricing and understand market implications

- Binding price regulation
- Imperfect competition
- Other explanations

- Implications for distribution and efficiency

Free Trade and the Formation of Environmental Policy: Evidence from US Legislative Votes

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[†]Department of Economics
Carleton University

[‡]Ivey Business School
Western University

NBER SI, July 2022

The Big Picture:

- **Research Question:** Do governments alter environmental policy in response to trade liberalization?

- Question is central to the debate over the environmental consequences of globalization.
  - Key channel in theoretical literature.
    - Grossman and Krueger (1991); Copeland and Taylor (1994, 1995); Antweiler et al (2001)), etc.
  - Policy response often invoked in popular debates over "industrial flight."

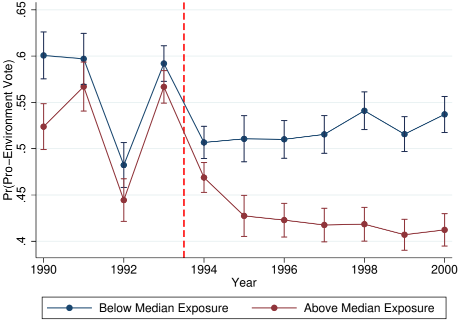
- Currently little empirical evidence of whether individual governments alter policy in response to trade.

This Paper:

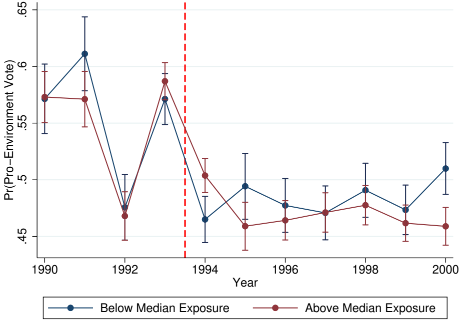
- Estimates effect of the NAFTA tariff reductions on support for federal environmental legislation in the US House of Representatives.
  - Examine support for policy at legislator level using data on roll-call votes on environmental bills from 1990-2000.

- Empirical approach:
  - Difference-in-difference research design.
  - Two sources of variation:
    1. Temporal variation in tariffs: Pre- vs. post-NAFTA.
    2. Cross-sectional variation: Differences in exposure to tariff reductions across congressional districts due to differences in pre-agreement industrial composition.

House Roll Call Votes Over Time:



(a) Votes by Size of US Tariff Reduction



(b) Votes by Size of Mexican Tariff Reduction

Notes: Figure shows share of all roll call votes on environmental bills in each year that are deemed pro-environment in the House of Representatives. Whiskers show 95% confidence intervals.

Main Finding:

- A **1 pp** $\searrow$ in a district's average US import tariff reduced the likelihood its representative casts a pro-environment vote by **14 pp**.
  - Reductions in Mexican tariffs had no effect.
- Result is **highly robust** and **economically significant.**
  - Estimates $\implies$ $\sim$36% of failed env. bills would have passed the House w/out NAFTA.

Mechanisms:

- Three competing explanations:
  1. Legislator concerns over potential post-NAFTA **industrial flight**.
  2. Trade-induced changes in **demand environmental policy** by voters.
  3. Trade-induced changes in **partisan representation** due to voter preferences for protectionism.

- We find:
  - No evidence to support the "**industrial flight**" hypothesis.
  - Effect of US tariff $\searrow$ appears to be due to (and in $\approx$ magnitudes):
    (i) Δ **Policy Demand:** incumbent Republican legislators $\searrow$ in support in response to trade-induced changes in constituent policy preferences.
    (ii) Δ **Partisan Representation:** Voters electing Republicans to replace pro-NAFTA Democrats.

Summary:

- Do governments alter environmental policy in response to trade liberalization?
  - **Evidence says yes,** at least in case of NAFTA.

- Why?
  1. Trade-induced changes in the **demand for environmental policy.**
  2. Trade-induced changes in **partisan representation.**

The ESG-Innovation Disconnect: Evidence from Green Patenting

Lauren Cohen
Harvard Business School and NBER

Umit Gurun
University of Texas at Dallas

Quoc Nguyen
DePaul University

Motivation: How prevalent is ESG Investing?

- As of 2020, sustainable investing represents more than 33 percent of the $51.4 trillion in U.S. assets under management. Compared to 2017, sustainable and impact investing has increased by more than 42% (USSIF 2020).

- A large contributor to this growth has been the 2015 guidance issued by the Department of Labor which allowed fiduciaries to incorporate environmental, social, and governance (ESG) factors into their investment decision.

- The implementation of ESG is often done by either avoiding certain categories categorically (such as Tobacco (27%), Weapons (16%), Fossil Fuel (11%), Gambling (11%)), or embracing certain industries (such as Local Economic Benefit (22%), Clean Tech (14%), Environment (11%), etc.).

Motivation: Arguments for/against ESG Investing

- Preferences: Investors willing to sacrifice an amount of risk-adjusted return in order to allow the fund to achieve returns with aligned ESG focus; or alternatively, pay more for a fund that promises the same ex-ante risk-return dynamics while delivering aligned ESG investment.

- Beliefs: A micro-founded, belief-based view of ESG investing could exist irrespective of the investor's actual preferences for ESG.

  - Customers: If consumers value products that are ESG compliant, they might be willing to pay a premium for these, or firms might collect a monopolistic rent on production if it were a salient product differentiation attribute.

  - Employees: If talented workers preferred companies following ESG principles, it could also be a mechanism to attract higher quality factors of production (such as human capital), or pay less for these factors. In these ways, good ESG behavior might be a source of comparative advantage that – if the market didn't fully impound – could result in favorable future return dynamics.

vs.

- Constrained portfolio maximization run by ESG-constrained fund managers is dominated by the unconstrained maximization run by other managers, resulting in likely underperformance in the risk-return space.

Motivation: Evidence on the Effect of ESG Investing

- Realized performance: The academic evidence on the realized performance of ESG-focused funds is decidedly mixed..
  - Eccles, Ioannous, and Serefaim (2014), Krüger (2015), Dimson and Karakas, and Li (2015), Khan, Serafaim, and Yoon (2016), Ferrell, Liang and Renneboog (2016), etc.

- Effect on firm behavior: There is limited systematic evidence that firms receiving disproportional amounts of capital from ESG funds have outperformed in any measurable way.

- Given this, our understanding of whether ESG investment flows impact innovation which can help us solve environmental problems is incomplete.

What do we do in this paper

- We investigate *who* produces green patents, or innovation that helps address climate change and other environmental challenges, and who are the most influential of these green patent producers.

- Whether the capital of investors who desire to allocate capital toward ESG objectives actually do end up investing in these producers.

Findings

1. A large fraction of this recent green patenting is not driven by highly rated ESG firms, firms that are commonly favored by ESG funds, but instead by firms that are explicitly excluded from ESG funds investment universe.

2. The energy sector has a large and growing percentage of their entirety of patenting activity dedicated to green research.

3. Energy firms allocate significantly more of their innovation efforts toward green innovation than other firms active in the green patenting space.
   - Significantly more than highly rated ESG firms.
   - Significantly more than other sectors that are in aggregate large green patent producers.

➢ Nearly three times the relative focus on green innovation in their innovation portfolio as the average industry, at 22.25% of patenting.

Findings

4. The green patents of energy producing firms are significantly higher quality:
   - In terms of being more highly cited.
   - More likely to produce "blockbuster" green patents than other firms.

5. Moreover, we do not find evidence that energy companies are restricting others from innovating in specific product areas (no evidence of patent thickets).
   - Traditional energy firms' green patents are predominantly cited by firms *outside* of the energy industry (74% of citations) – comparatively more outside influence than other green patentors (71%).

6. Moreover, in investigating whether energy firms simply purchase or acquire these innovative patents from outside firms and innovators, we find that the vast majority (over 97%) of their green patents are initiated and developed in-house (organically).
   - Further, traditional energy firms even appear over-represented amongst the top net green patenting firms in the economy.

7. On the intensive margin, energy firms even get less "credit" in terms of incremental ESG score increase for each (higher quality) green patent they produce.

Findings

8. These energy firms are explicitly excluded from many ESG funds, and the targets of many divestiture campaigns whose stated aims often include push forward green energy innovation.

9. We find initial evidence that energy firms seem to be making substantial follow-on investments support their innovation:
   - Energy firms were some of the earliest and foundational innovators in the green energy space.
   - Energy firms are significant global producers of alternative energy (electricity wattage) tied to their blockbuster patents and are central investors in some of the largest renewable projects worldwide (demonstrated by Shell's involvement in NoordzeeWind, the first wind farm with capacity to generate over 100MW, built in the Dutch North Sea).

What are Green Patents?

United States Patent [19]
Amick

[11] **4,235,643**
[45] **Nov. 25, 1980**

[54] **SOLAR CELL MODULE**

[75] Inventor: **James A. Amick**, Princeton, N.J.

[73] Assignee: **Exxon Research & Engineering Co.,** Florham Park, N.J.

[21] Appl. No.: **920,691**

[22] Filed: **Jun. 30, 1978**

[51] **Int. Cl.^{3}** **H01L 31/04**
[52] **U.S. Cl.** **136/246**; 136/251
[58] **Field of Search** .... 136/89 PC, 89 EP, 89 H

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,973,994	8/1976	Redfield	136/89
4,116,718	9/1978	Yerkes et al.	136/89 PC

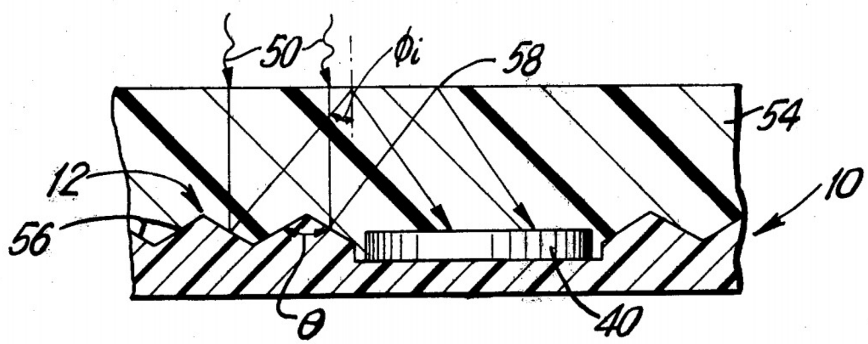
Primary Examiner—Aaron Weisstuch
Attorney, Agent, or Firm—Joseph J. Dvorak

[57] **ABSTRACT**

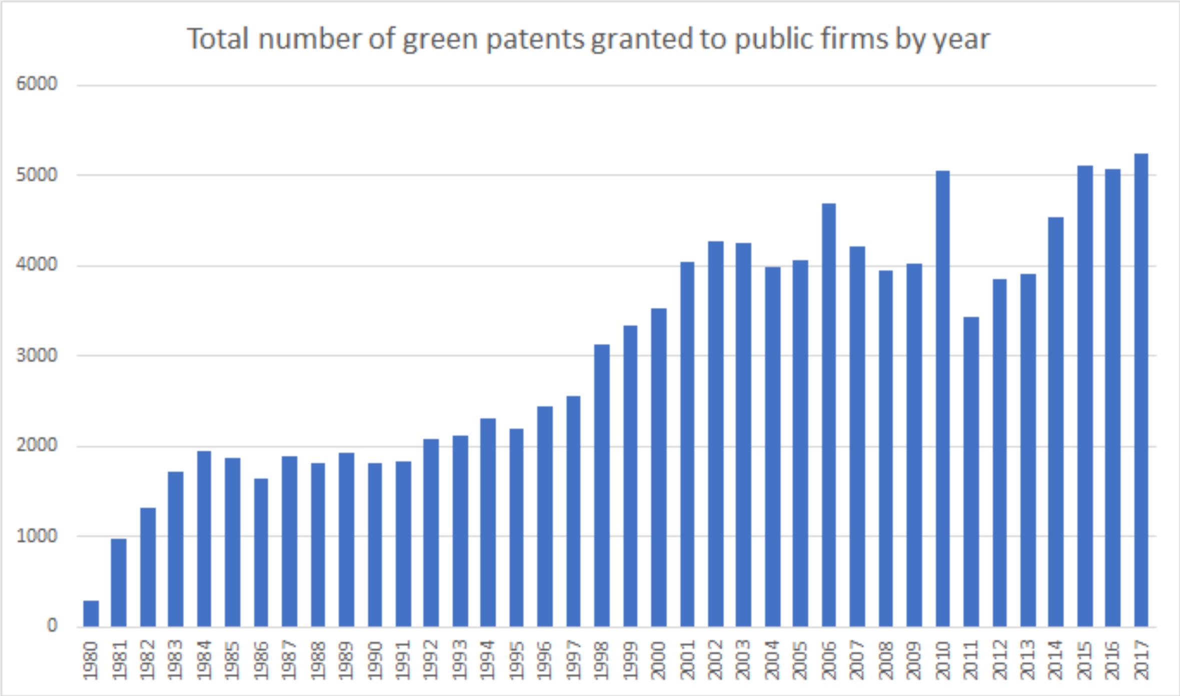
A solar cell module is provided having a plurality of circular solar cells arrayed on a support structure in which at least the land areas between the cells have facets with light reflecting surfaces. An optical cover medium couples the facets and the cells. Importantly the angular relationship of the facet surfaces is such that light impinging thereon will be reflected upwardly into the optical medium and then internally reflected downwardly toward an active cell area thereby effectively increasing the output of the module.

19 Claims, 6 Drawing Figures

Exxon published one of the first, and most influential, patents on solar cell technology



Number of Green Patents over Years



Takeaways

Elliot Berman (center, in patterned tie) and his team at Solar Power Corp. pose outside their office and manufacturing facility in Braintree, Mass., in 1973. John Perlin, author of *Let It Shine: The 6,000-Year Story of Solar Energy,* credits Berman, Solar Power Corp. and Exxon with "planting the flag of photovoltaics throughout the world."

Robert Willis/Solar Power Corp. via John Perlin

Strategic Innovation and Lobbying in Response to Regulatory Uncertainty

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Dept. of Ag and Consumer Economics
University of Illinois at Urbana-Champaign

NBER SI

July 2022

A bit about my past life

Before I was a researcher, I was a researcher (of a different type)

Innovation, lobbying and directed technical change

Firms face an uncertain future over regulation of their product.

- In response, affected firms might innovate
- Or, they might lobby

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- In response, affected firms might innovate
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- Lobbying affects:
  - A firm's own payoffs to innovation
  - Other firms' innovation payoffs

Innovation, lobbying and directed technical change

Firms face an uncertain future over regulation of their product.

- In response, affected firms might innovate
- Or, they might lobby
- Lobbying affects:
  - A firm's own payoffs to innovation
  - Other firms' innovation payoffs
- Effect signs: Whether lobbying and innovation are complements or substitutes in firm strategies

Research questions

1. What do firms do when faced with an uncertain regulatory future?
2. Specifically: What is the causal effect of the discovery of a new externality on the innovation and lobbying expenditures of affected firms?
3. And: Does the option to lobby induce substitution away from innovation, or into it?

Key contributions

- Recognizes the strategic tradeoffs in innovation vs. lobbying responses of firms to a regulatory threat

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- Novel identification strategy – random timing and content of scientific discoveries – identifies firms' strategic responses while avoiding bias from anticipation effects

Key contributions

- Recognizes the strategic tradeoffs in innovation vs. lobbying responses of firms to a regulatory threat
- Novel identification strategy – random timing and content of scientific discoveries – identifies firms' strategic responses while avoiding bias from anticipation effects
- Scrape and review over 7,000 scientific publications to construct a new dataset of over 100 first-time scientific discoveries affecting a range of sectors of the economy over multiple decades

Empirical models and identification

- The ideal experiment: firms are randomly shocked with the uncertain probability of regulation and allowed to respond over time

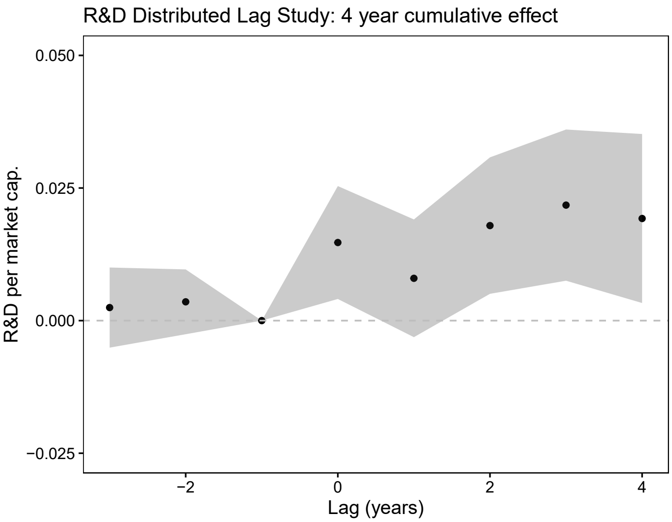
Empirical models and identification

- The ideal experiment: firms are randomly shocked with the uncertain probability of regulation and allowed to respond over time
- A natural experiment: first-time scientific discoveries of previously-unknown chemical harms
  - Different discoveries linked to different industry sectors at different times

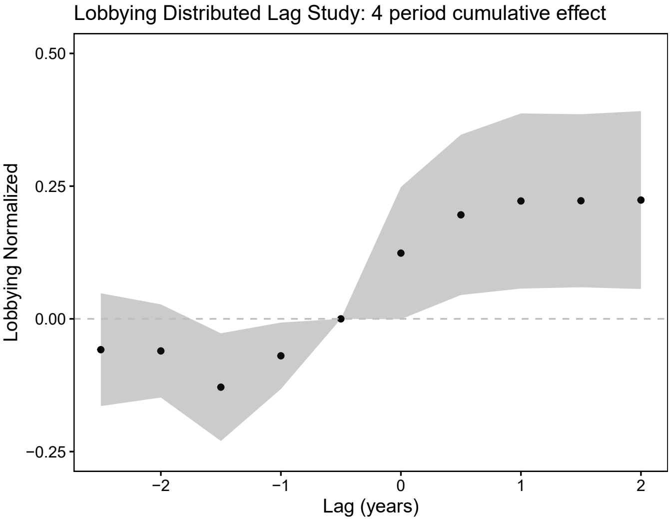
Building a dataset of discoveries

- Over 7,000 publications scraped and reviewed.
- Result:
  - 108 discoveries of previously-unknown chemical harms
  - Affecting 60 industries
  - Over 44 distinct years

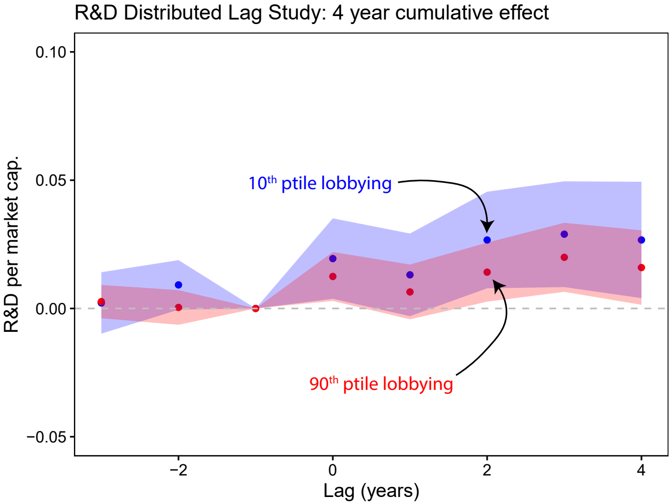
Innovation response



Lobbying response



Innovation response: lobbying interaction



Conclusion

- I **construct a new dataset** of initial scientific discoveries of low-dose harms, via scraping and reviewing over 7,000 scientific publications.
- Employing a **novel identification strategy**, I estimate total innovation spending increases by $\sim$ 2% of firm value over a 4-year period, and lobbying by $\sim$ 20% over a 1–1.5-year period.
- I find evidence consistent with the option to lobby inducing substitution away from innovation, with an estimated **economic loss of $\sim$\$174 billion** for treated firms in-sample.

The Development-Biodiversity Tradeoff in India’s Forests

Raahil Madhok, UBC

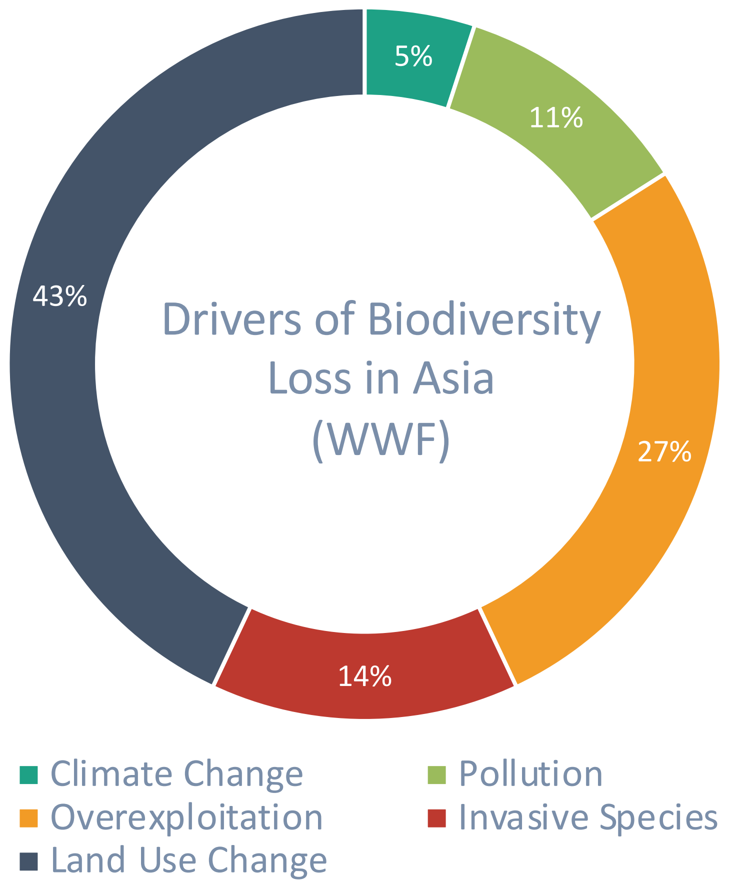
2022 NBER Summer Institute (Environmental & Energy Economics)

Development and Biodiversity Loss

- Biodiversity provides ecosystem services
  - But, it is rapidly declining
  - Anthropogenic pressures (esp. land use change)

- This Paper:
  1. Measure development-biodiversity tradeoff in India (2015-20)
  2. Identify institutions/policies that mitigate tradeoff

- Challenge: Very hard to measure biodiversity

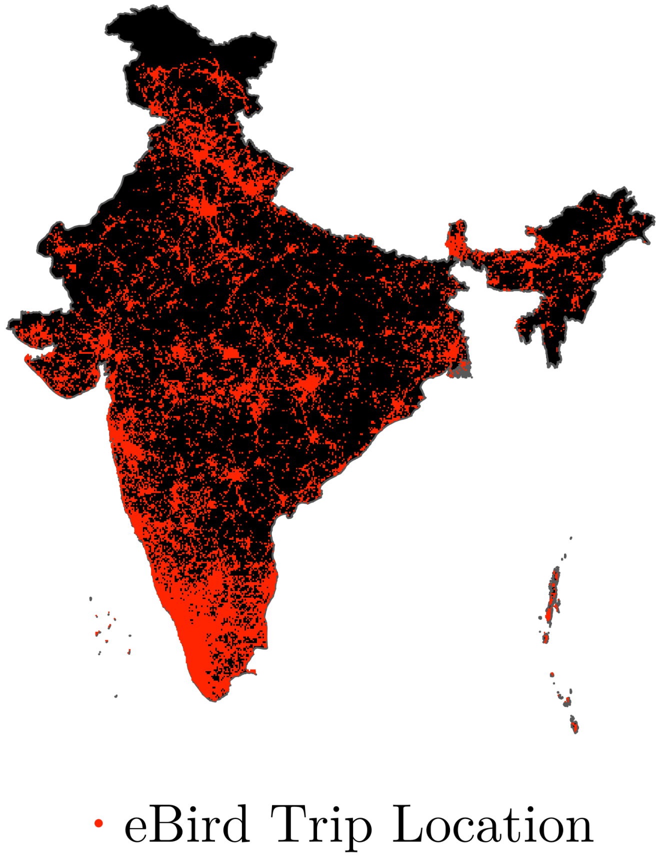


Research Design

- **Q:** How does infrastructure → biodiversity?
  - 1 million geotagged birdwatching diaries (eBird app)
  - 8000 permits for infrastructure encroachments
  - User x District x Month Panel (2015-2020)

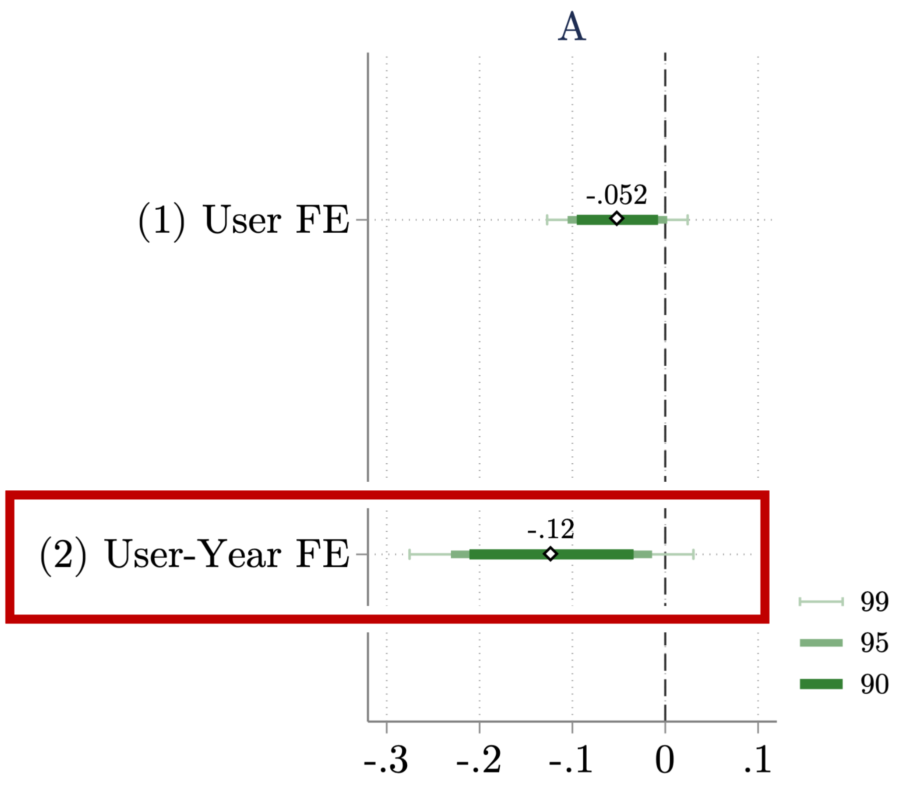
- **Outcome:** # of species on each notebook
  - Regress on cumulative km^2 of forest occupied by infrastructure

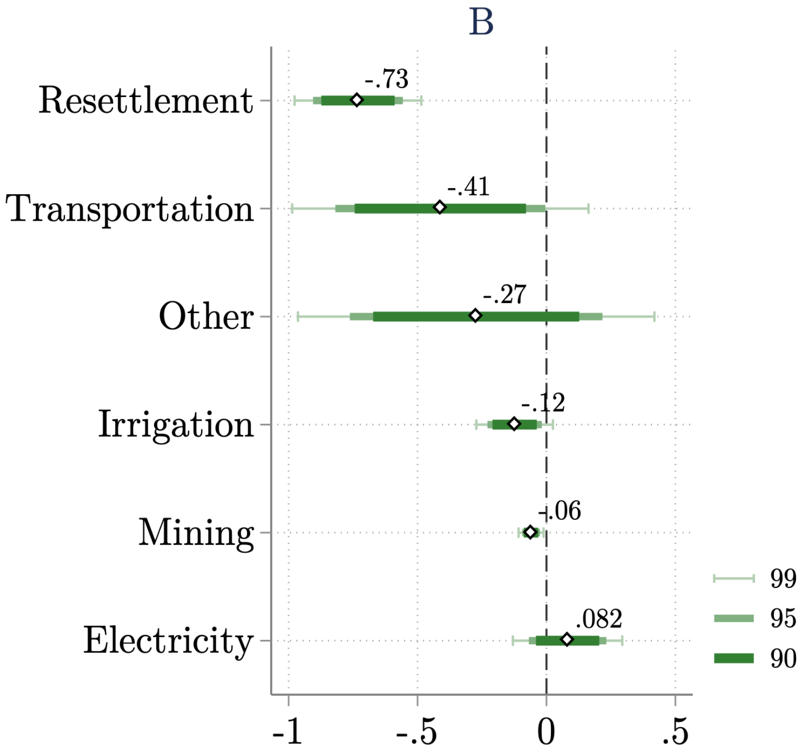
- **Variation:** Within-user travel across districts
  - User fixed effects (ability)
  - Control for location + seasonality + learning



Mining in Surajagadh, Gadchiroli. Photo by Shrishtee Bajpai

Development Triggers Species Loss





Result: 10 km² encroachment → loss of 1 species (4% of mean)

Result: Resettlement, transport, irrigation, mining are responsible

Institutions matter for conservation

- Q: Which policies minimize species loss?
- Data: Banerjee and Iyer (2005), N=163 districts
    - =0 if institutions favor economically advantaged
    - =1 if institutions are "inclusive"
- Result: Less species loss in "inclusive" districts

	(1)
Infrastructure (km^2)	-0.571***
	(0.058)
Infrastructure (km^2) × Inclusive (=1)	0.433**
	(0.126)
Infrastructure (km^2) × Tribal Pop. Share	0.037
	(0.272)
Baseline Forest Cover and Interactions	Yes
User × Year FEs	✓
District FEs	✓
State x Month FEs	✓
N	58760
R^2	0.709

Policy Mechanisms

- Why are projects more sustainable in inclusive districts?
- Data: Informed consent, cost-benefit analysis, proximity to protected area
- Regress permit data on institution (=1) + state-time FEs
  - Controls: Tribal share, forest cover, district area, project size

	(1) Informed Consent	(2) Cost-Benefit	(3) Protected Area
Inclusive (=1)	0.080***	0.072**	-0.006**
	(0.014)	(0.032)	(0.002)
Controls	Yes	Yes	Yes
Outcome Mean	0.234	0.156	0.007
State × Time FEs	✓	✓	✓
N	2282	2282	2277
R^2	0.541	0.505	0.236

Summary

- Biodiversity is declining
- My coefficients: 20% of India’s species loss from infrastructure
- “Inclusive” policies neutralize development-biodiversity tradeoff

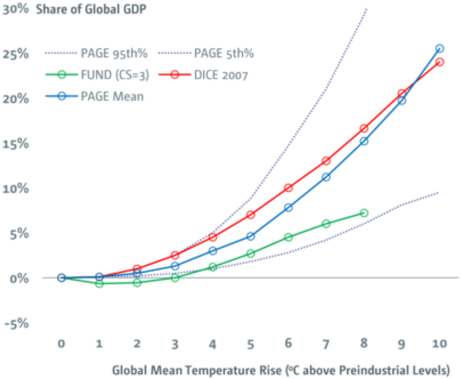
Labor Disutility in a Warmer World: The Impact of Climate Change on the Global Workforce

Ashwin Rode, Rachel E. Baker, Tamma Carleton,
Anthony Louis D'Agostino, Michael Delgado,
Timothy Foreman, Diana R. Gergel, Michael Greenstone,
Trevor Houser, Solomon Hsiang, Andrew Hultgren,
Amir Jina, Robert E. Kopp, Steven B. Malevich,
Kelly E. McCusker, Ishan Nath, Matthew Pecenco,
James Rising, & Jiacan Yuan

The Climate Impact Lab

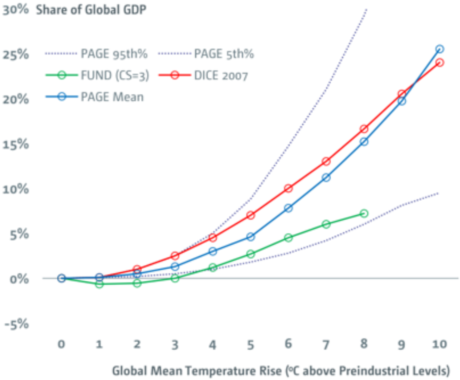
NBER Summer Institute 2022
Environmental and Energy Economics
July 26th, 2022

Climate damage & the Social Cost of Carbon (SCC)



Source: Interagency Working Group on Social Cost of Carbon, 2010

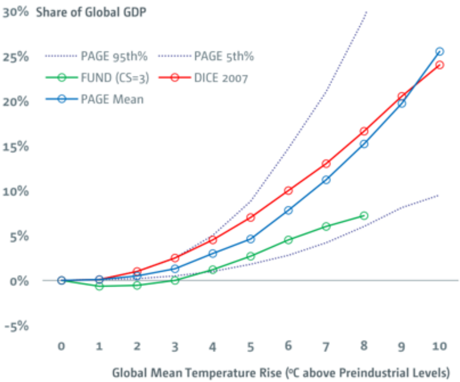
Climate damage & the Social Cost of Carbon (SCC)



Source: Interagency Working Group on Social Cost of Carbon, 2010

Estimating the Social Cost of Carbon: A "bottom-up" approach

Climate damage & the Social Cost of Carbon (SCC)



Source: Interagency Working Group on Social Cost of Carbon, 2010

Estimating the Social Cost of Carbon: A "bottom-up" approach

Mortality Energy Agriculture **Labor** Migration Coastal Conflict

This Analysis: Disutility from labor in the heat

→ **These welfare impacts are not currently modeled in any IAM**

World Cup stadium construction

Doha, Qatar

Avg summer temp: 97°F (36°C)

Sugarcane farming

Karnataka, India

Avg summer temp: 93°F (34°C)

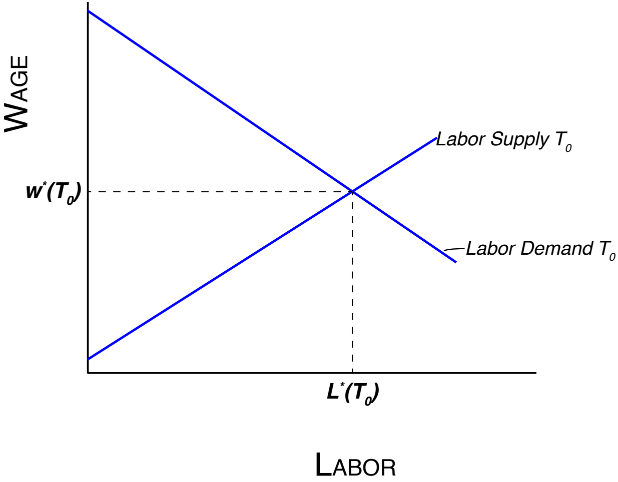
A global empirical SCC for labor disutility in the heat

→ **These welfare impacts are not currently modeled in any IAM**

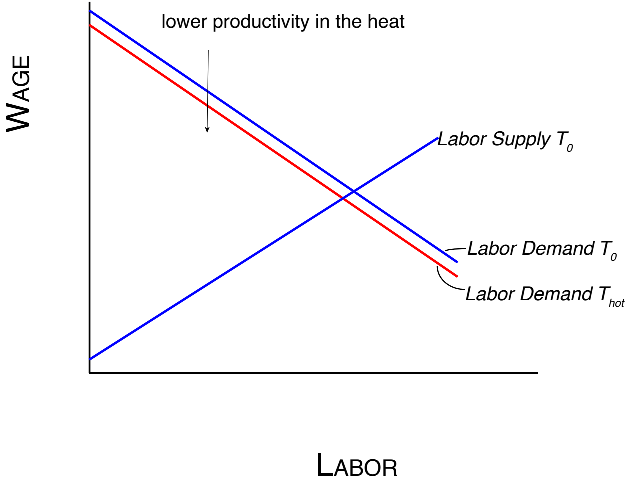
Contribution of this paper

- We provide the first estimate of the global impact of climate change on labor disutility.
- We infer disutility using temperature-induced changes in labor supply, estimated with worker-level data representing ∼1/3 of world's population.
- We compute the global labor disutility cost from an extra ton of CO_2 emissions – a "partial" social cost of carbon (SCC) for labor disutility.

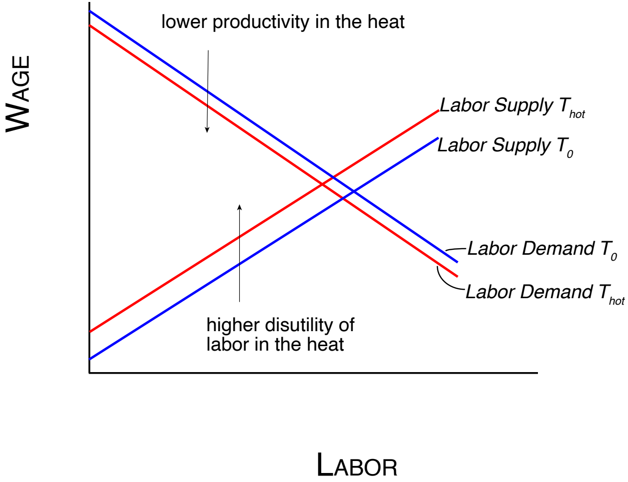
Equilibrium labor supply (temperature T_0)



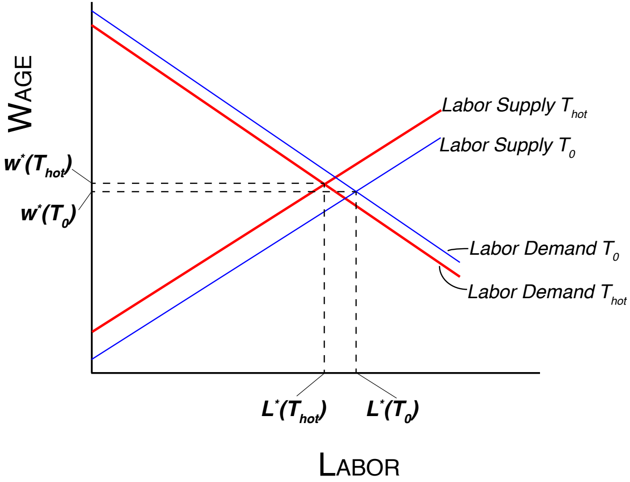
Labor supply in the heat ($T_0 \to T_{hot}$)



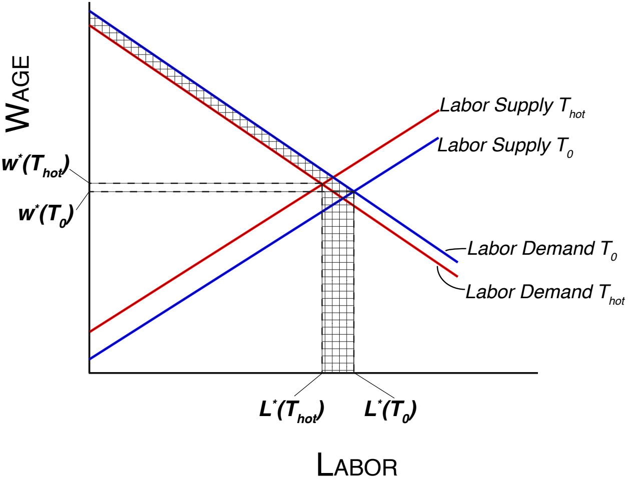
Labor supply in the heat ($T_0 \rightarrow T_{hot}$)



Labor supply in the heat ($T_0 \rightarrow T_{hot}$)

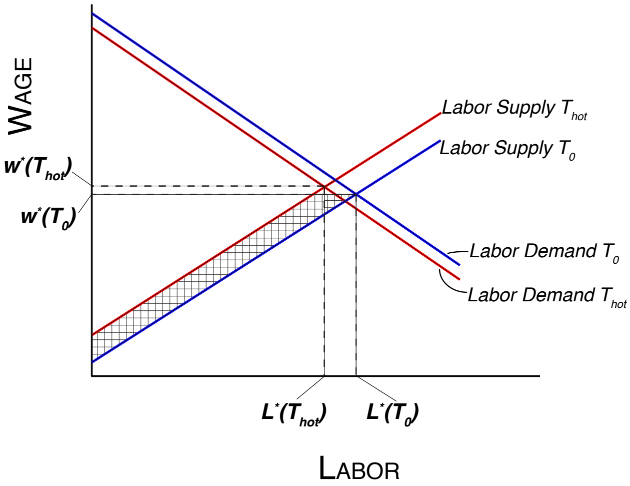


Welfare: prior work analyzes productivity effect



E.g. Hsiang (2010), Dell et al. (2012), Burke et al. (2015) capture total productivity effects.

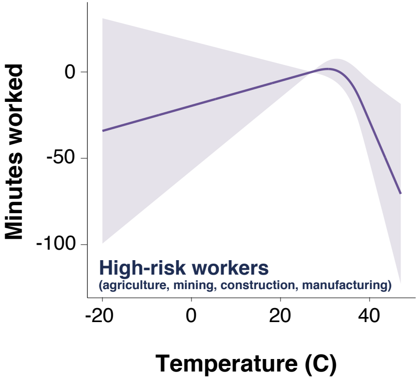
Welfare: this study is first to estimate disutility



Compensating Variation: $\frac{\partial \mathit{Disutility}}{\partial \mathit{Temperature}} = L\partial w = \frac{w\partial L}{\epsilon}$ where ϵ denotes Frisch elasticity of labor supply. We follow Chetty et al. (2011) and use $\epsilon = 0.5$.

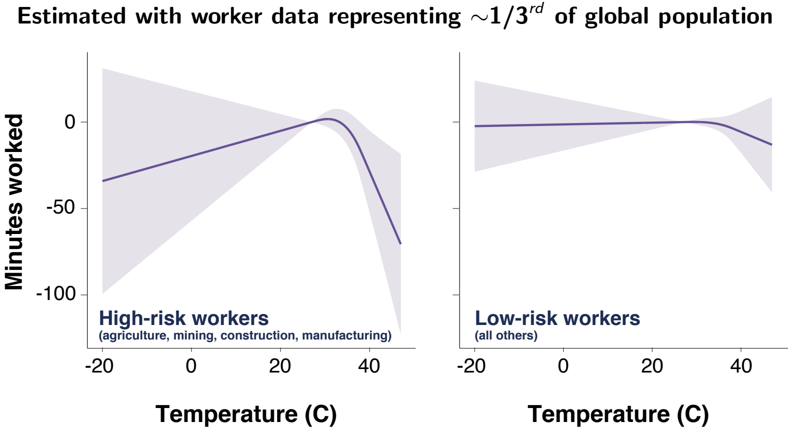
Change in weekly minutes worked per person due to daily temperature

Estimated with worker data representing $\sim 1/3^{rd}$ of global population



High risk $N = 2,423,958$

Change in weekly minutes worked per person due to daily temperature

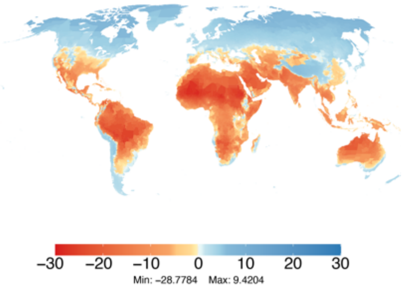


High risk $N = 2,423,958$; Low risk $N = 4,175,377$.

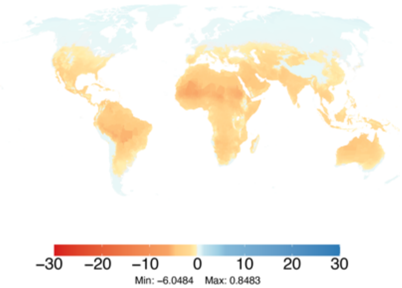
△ Labor supply due to warming: 2100

25,000 regions

High Risk Workers



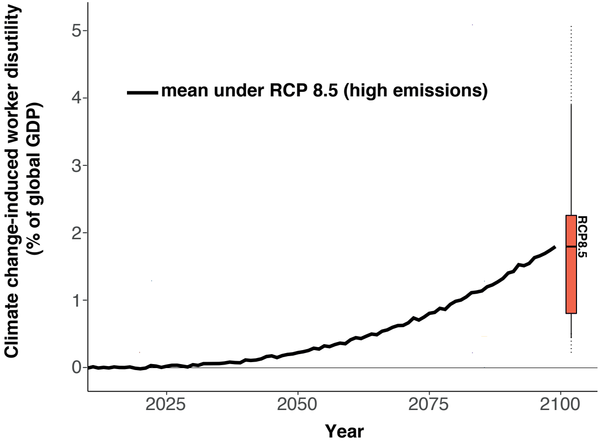
Low Risk Workers



Units are mins./worker/day.
Scenario: RCP 8.5 (high emissions)

Monetized Δ global disutility of working in the heat

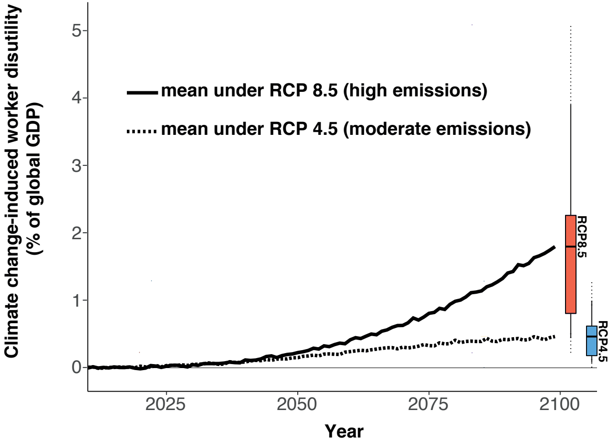
Increased disutility equal to 1.8% of global GDP in 2100 (RCP 8.5)



Elasticity of labor supply = 0.5 (Chetty et al., 2011).
Labor share of income = 0.6 (Karabarbounis and Neiman, 2014).

Large benefits of mitigation

Increased disutility equal to 0.5% of global GDP in 2100 (RCP 4.5)



Elasticity of labor supply = 0.5 (Chetty et al., 2011).
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Partial SCC for labor disutility (2019 USD)

Discount rate:	$\delta = 2\%$
RCP 8.5	\$17.0 [-\$1.4,\$137.8]

[Brackets] indicate 1-99% uncertainty ranges.

Partial SCC for labor disutility (2019 USD)

Discount rate:	$\delta = 2\%$	$\delta = 2.5\%$	$\delta = 3\%$
RCP 8.5	\$17.0 [-\$1.4,\$137.8]	\$10.9 [-\$1.7,\$86.4]	\$7.4 [-\$1.9,\$57.5]
RCP 4.5	\$10.8 [-\$3.9,\$109.4]	\$7.2 [-\$3.8,\$67.8]	\$5.1 [-\$3.7,\$45.2]

[Brackets] indicate 1-99% uncertainty ranges.

Partial SCC for labor disutility (2019 USD)

Discount rate:	$\delta = 2\%$	$\delta = 2.5\%$	$\delta = 3\%$
RCP 8.5	$17.0 [-$1.4,$137.8]	$10.9 [-$1.7,$86.4]	$7.4 [-$1.9,$57.5]
RCP 4.5	$10.8 [-$3.9,$109.4]	$7.2 [-$3.8,$67.8]	$5.1 [-$3.7,$45.2]

[Brackets] indicate 1-99% uncertainty ranges.

Current US federal government's total SCC: \$51 (RCP 8.5, $\delta = 3\%$).

Current partial SCC for labor: \$0.

Thank you!

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