

Labor Reallocation, Green Subsidies, and Unemployment

Gustav Fredriksson ¹

¹Trinity College Dublin

LSE

4 February 2026

Green subsidies are prevalent

- ▶ **Green subsidies** are a common climate policy instrument
- ▶ Green subsidies → Payments or tax credits to producers of green products and services
- ▶ Examples:
 - ▶ US IRA: Hundreds of billions of dollars of **production tax credits** to the wind power, solar power, hydrogen, CCS, and battery value chains (Bistline, Mehrotra and Wolfram, 2023)
 - ▶ EU: >€500 billion in **renewable electricity subsidies** since 2015 (European Commission, 2023, 2025)
 - ▶ China: >\$100 billion in **renewable electricity subsidies** since 2020 (IEA, 2024)

Green subsidies, the labor market, and welfare

- ▶ The prevalence of green subsidies raises (at least) two important questions
 1. How do green subsidies impact the labor market?
 - Not clear how the subsidies interact with **search frictions** that cause unemployment and prevent labor reallocation
 - **Welfare** implications?
 2. How do the subsidies **compare to carbon prices** in terms of labor market outcomes and welfare?
 - Relevant to know when carbon pricing is unavailable due to, for instance, public opposition (Douenne and Fabre, 2022; Dechezleprêtre et al., 2025)

This paper: Labor market and welfare impacts of green subsidies

- ▶ Main research question: How do green (output-based) subsidies affect:
 - ▶ **Labor market** outcomes across **green, fossil, and remaining "neutral"** jobs
 - ▶ **Welfare**
- ▶ Use U.S. microdata to provide new **empirical evidence** on worker **transitions** between green, fossil, and neutral jobs
- ▶ Develop an **empirically founded search model**
 - ▶ Compare green subsidies to carbon prices for various **financing mechanisms**

Literature (1)

1. Empirical estimates of worker transitions between jobs that are unevenly exposed to climate policy
 - ▶ “Fossil” jobs → Often tied to polluting industries
 - ▶ “Green” jobs → **No standard definition**
 - ▶ One approach: Jobs associated with **green products** are green (e.g., Curtis, O’Kane and Park, 2024; Colmer, Lyubich and Voorheis, 2025)
 - ▶ Alternatively: Jobs involving a high share of **green tasks** are green (e.g., Consoli et al., 2016; Bowen, Kuralbayeva and Tipoe, 2018; Vona et al., 2018; Vona, Marin and Consoli, 2019; Chen et al., 2020; Popp et al., 2021; Saussay et al., 2022; Elliott et al., 2024)

This paper: **Task-based approach** to empirically quantify green job transitions in the U.S.

Literature (2)

2. Employment impact of environmental regulation

- ▶ Econometric methods (e.g., Walker, 2013; Yip, 2018; Chen et al., 2020; Popp et al., 2021)
 - ▶ But: Endogenous employment in counterfactual (unregulated) industries due to labor reallocation (Hafstead and Williams, 2018)
- ▶ GE analyses
 - ▶ Carbon taxes (Hafstead and Williams, 2018; Aubert and Chiroleu-Assouline, 2019; Carbone et al., 2020; Fernández Intriago, 2021; Heutel and Zhang, 2021; Hafstead, Williams and Chen, 2022; Finkelstein Shapiro and Metcalf, 2023; Castellanos and Heutel, 2024)
 - ▶ Green subsidies (Shimer, 2013; Bistline, Mehrotra and Wolfram, 2023)

This paper: **GE analysis of green subsidies** in a microfounded model with **search frictions**

Literature (3)

3. Search literature

- ▶ Search models and environmental regulation (Hafstead and Williams, 2018; Aubert and Chiroleu-Assouline, 2019; Fernández Intriago, 2021; Hafstead, Williams and Chen, 2022; Finkelstein Shapiro and Metcalf, 2023)
- ▶ Matching function → Determines the number of hires
 - ▶ Hafstead and Williams (2018) develop a matching function that allows for frictions when workers switch jobs
 - ▶ Key parameter: ξ → Controls the degree of friction

This paper: **Estimate** ξ using the search model and account for an empirically relevant **neutral job type**

Outline

1. Empirical analysis
2. Model
3. Calibration
4. Employment and welfare impacts
5. Conclusion

Occupation data

- ▶ **Panel data on occupations** from the Survey of Income and Program Participation (SIPP)
 - ▶ SIPP: Representative survey of the U.S. population by the U.S. Census Bureau
 - ▶ Survey participants are asked each year about their monthly occupation
 - ▶ Two panels: 2013-2016 and 2017-2020 (8 years in total)

- ▶ Next step: **Classify** the occupations as green, fossil, or neutral

Classifying green jobs

- ▶ Define green jobs using a **task-based approach** (Vona et al., 2018)
 - ▶ Rooted in the labor economics literature (Autor, Levy and Murnane, 2003; Acemoglu and Autor, 2011; Autor, 2013)
 - ▶ Conceptualizes a job as a **collection of tasks**
 - ▶ Green job = Job involving many green tasks
 - ▶ Intuition: Jobs in which workers devote a lot of time to environmental activities are green
- ▶ **Green job := Job with $\geq 50\%$ of green tasks**, weighted by task importance

▶ Sensitivity

Task data

- ▶ Occupation-level task data from the U.S. Occupational Information Network (O*NET)
 - ▶ Main source of occupational information in the U.S.
 - ▶ Funded by the U.S. Department of Labor
- ▶ For 974 occupations (8-digit O*NET-SOC level):
 - ▶ **Task descriptions** (based on employee surveys, occupational experts, and desk research)
 - ▶ **Task importance scores** (based on employee surveys and occupational experts)
 - ▶ **Task classification as green or non-green**
 - ▶ Green task = Task associated with green economy activities and technologies

▶▶ Green job list

▶▶ Aggregating to 6-digit level

Examples of O*NET jobs with a weighted green task share $\geq 50\%$

O*NET code	Title	Total tasks	Green tasks	Weighted green task share (%)
17-2081.00	Environmental Engineers	28	28	100
17-2141.01	Fuel Cell Engineers	26	26	100
19-2041.01	Climate Change Analysts	14	14	100
19-2041.03	Industrial Ecologists	38	38	100
47-2231.00	Solar Photovoltaic Installers	26	26	100
47-4099.02	Solar Thermal Installers and Technicians	21	21	100
47-4099.03	Weatherization Installers and Technicians	18	18	100
49-9081.00	Wind Turbine Service Technicians	13	13	100
49-9099.01	Geothermal Technicians	24	24	100

Examples of O*NET jobs with a weighted green task share $\geq 50\%$

O*NET code	Title	Total tasks	Green tasks	Weighted green task share (%)
17-2081.00	Environmental Engineers	28	28	100
17-2141.01	Fuel Cell Engineers	26	26	100
19-2041.01	Climate Change Analysts	14	14	100
19-2041.03	Industrial Ecologists	38	38	100
47-2231.00	Solar Photovoltaic Installers	26	26	100
47-4099.02	Solar Thermal Installers and Technicians	21	21	100
47-4099.03	Weatherization Installers and Technicians	18	18	100
49-9081.00	Wind Turbine Service Technicians	13	13	100
49-9099.01	Geothermal Technicians	24	24	100

Green task examples of "47-2231.00 - Solar Photovoltaic Installers"

- ▶ "**Install photovoltaic (PV) systems** in accordance with codes and standards, using drawings, schematics, and instructions."
- ▶ "Perform routine photovoltaic (PV) **system maintenance** on modules, arrays, batteries, power conditioning equipment, safety systems, structural systems, weather sealing, or balance of systems equipment."
- ▶ "Visually **inspect and test** photovoltaic (PV) modules or systems."

Classifying fossil jobs

- ▶ No fossil task data → Define fossil jobs as jobs disproportionately found in emissions-intensive industries
- ▶ Procedure (that bears similarities to Vona et al. (2018)):
 1. Identify the 5% most **emissions-intensive industries**
 - ▶ Emissions data: EPA
 - ▶ Industry-level employment data: BLS
 2. **Fossil job** := Job \geq 8 times more likely to be found in one of these industries

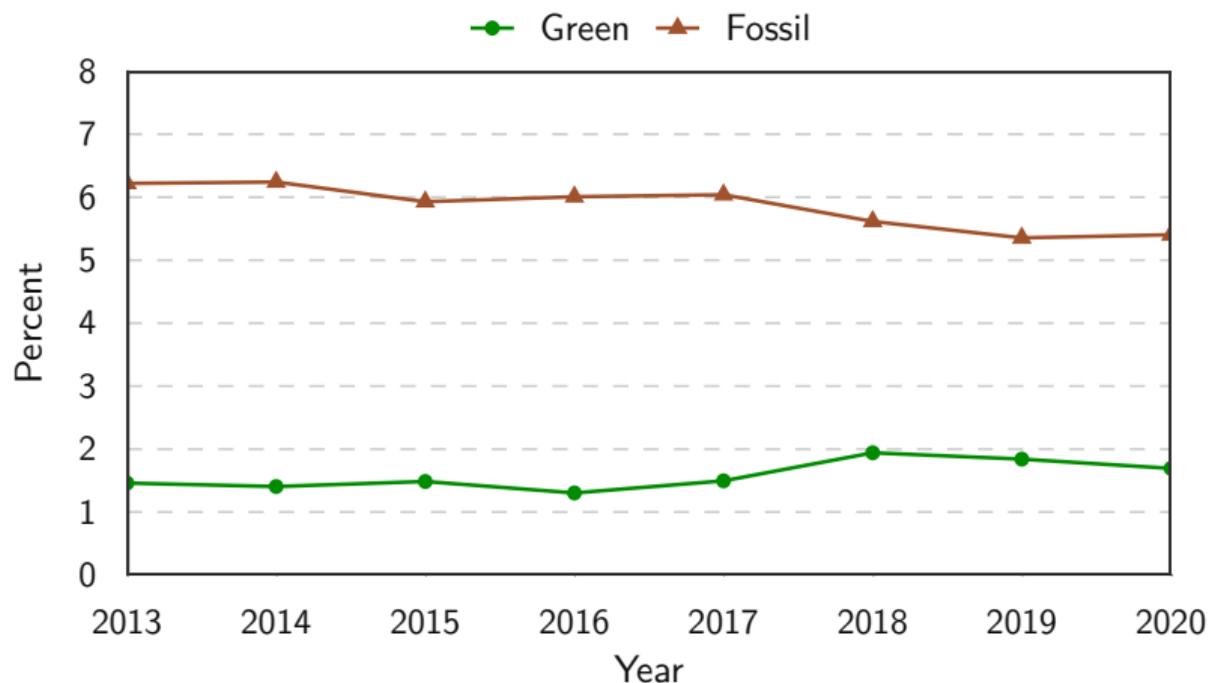
▶ Fossil jobs

▶ Overlapping jobs

▶ Emissions-intensive industries

▶ Sensitivity

Few jobs are green, most jobs are neutral



▶▶ Core tasks

▶▶ No green jobs in dirty industries

▶▶ Only fossil jobs in dirty industries

▶▶ Fossil job ≥ 10 times in dirty industry

▶▶ No fossil exemptions

▶▶ Neutral jobs in dirty industries \rightarrow fossil

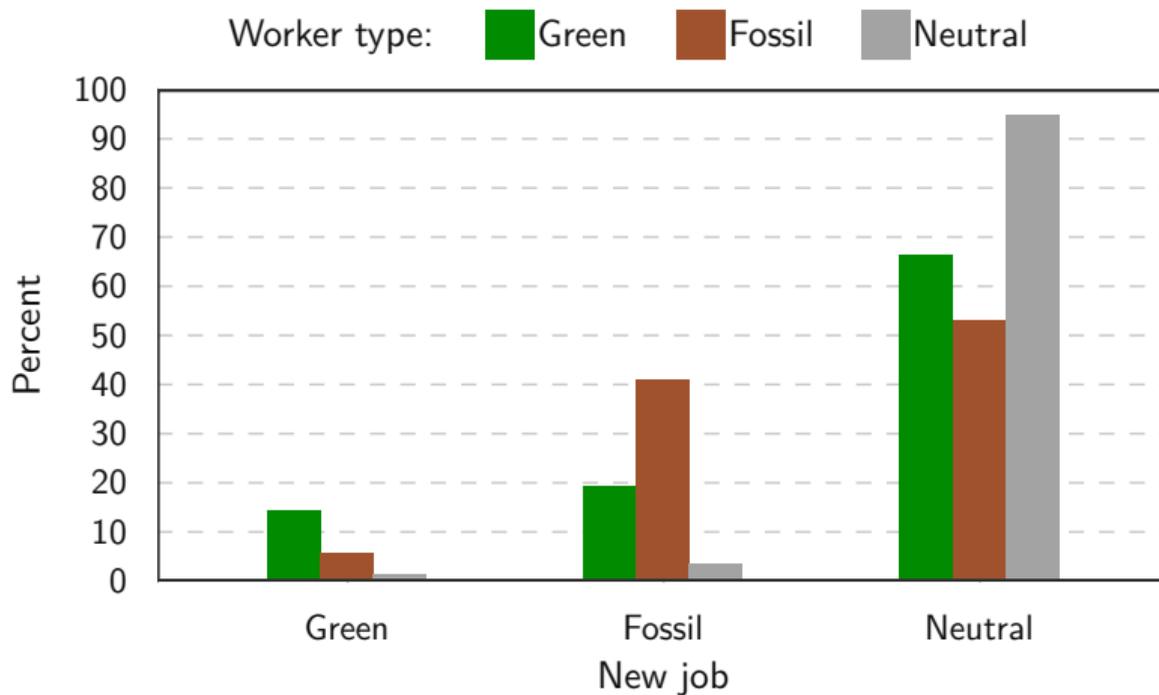
▶▶ Fossil job ≥ 6 times in dirty industry

▶▶ Overlapping jobs \rightarrow fossil

▶▶ Dirty industry := Top 1% emissions-intensity

▶▶ Partly dirty industries \rightarrow not dirty

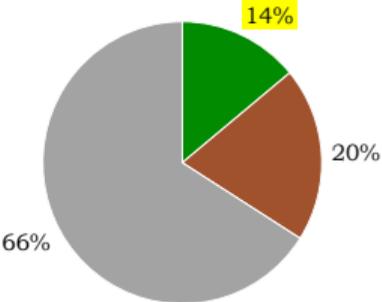
Fossil workers rarely start green jobs



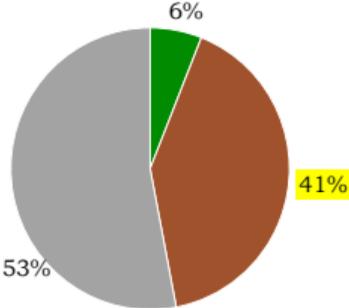
- ▶ Core tasks
- ▶ No green jobs in dirty industries
- ▶ Only fossil jobs in dirty industries
- ▶ Fossil job ≥ 10 times in dirty industry
- ▶ No fossil exemptions
- ▶ Neutral jobs in dirty industries \rightarrow fossil
- ▶ Fossil job ≥ 6 times in dirty industry
- ▶ Overlapping jobs \rightarrow fossil
- ▶ Dirty industry := Top 1% emissions-intensity
- ▶ Partly dirty industries \rightarrow not dirty
- ▶ With unemployment
- ▶ Same nr jobs

Distribution of workers starting each job

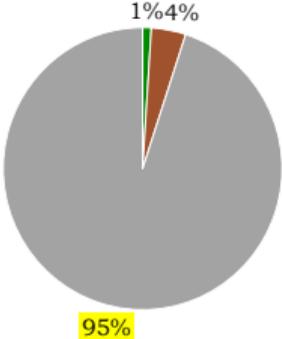
Worker type: ■ Green ■ Fossil ■ Neutral



Green jobs



Fossil jobs



Neutral jobs

Outline

1. Empirical analysis
- 2. Model**
3. Calibration
4. Employment and welfare impacts
5. Conclusion

Model overview

- ▶ Search model that builds on Shimer (2010) and Hafstead and Williams (2018)
- ▶ Month $t \in \{0, 1, 2, \dots\}$ (suppressed henceforth for legibility)
- ▶ Worker $i \in \{\text{green, fossil, neutral}\}$
- ▶ Firm $j \in \{\text{green, fossil, neutral}\}$

Firms

- ▶ Firms hire workers for **recruitment** and **production**
 - ▶ **Recruitment** allows the firm to hire more workers
 - ▶ **Production** generates **output** using a linear function of labor
- ▶ **Fossil firms generate emissions** in proportion to output

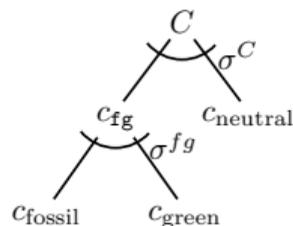
Workers

- ▶ Workers get utility from consumption C and disutility from working h_i hours:

$$U(C, h_i) = \log(C) - \psi \frac{\chi}{1 + \chi} h_i^{\frac{1+\chi}{\chi}},$$

where ψ is disutility from work and χ is the Frisch elasticity of labor supply

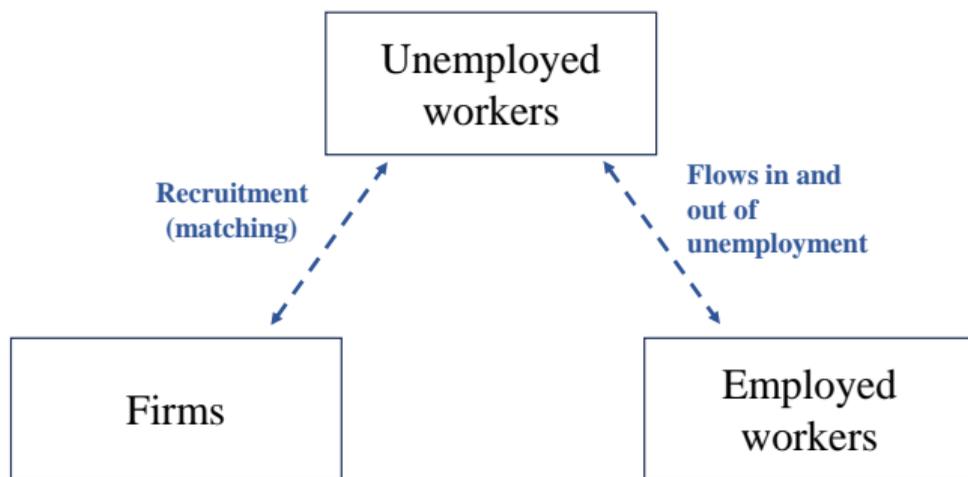
- ▶ Nested consumption to reflect different substitution possibilities across goods:



Government

- ▶ A government has access to an excise **emissions tax** and an excise **subsidy** on green firms' output
- ▶ The government collects revenue from a labor income tax, payroll tax and emissions tax, and returns it as transfers, unemployment benefits, and subsidy payments

Labor market



Matching and ξ_j

$$\# \text{ hires}_{ij} = f(r_j, \sum_j r_j, u_i, \sum_i u_i, \xi_j)$$

- ▶ $\# \text{ hires}_{ij}$ = Number of hired workers of type i by firm j
- ▶ r_j = Recruitment effort by firm j
- ▶ u_i = Number of unemployed workers of type i
- ▶ $\xi_j \in [0, 1]$ = **Friction associated with cross-type matching**

Matching and ξ_j

$$\# \text{ hires}_{ij} = f(r_j, \sum_j r_j, u_i, \sum_i u_i, \xi_j)$$

- ▶ $\xi_j = 0 \rightarrow$ Firm j can only recruit workers of type j (no cross-type matching)

Matching and ξ_j

$$\# \text{ hires}_{ij} = f(r_j, \sum_j r_j, u_i, \sum_i u_i, \xi_j)$$

- ▶ $\xi_j = 0 \rightarrow$ Firm j can only recruit workers of type j (no cross-type matching)
- ▶ $\xi_j = 1 \rightarrow$ Workers i and $j \neq i$ are equally likely to match with firm j (matching does not depend on a worker's type)

Matching and ξ_j

$$\# \text{ hires}_{ij} = f(r_j, \sum_j r_j, u_i, \sum_i u_i, \xi_j)$$

- ▶ $\xi_j = 0 \rightarrow$ Firm j can only recruit workers of type j (no cross-type matching)
- ▶ $\xi_j = 1 \rightarrow$ Workers i and $j \neq i$ are equally likely to match with firm j (matching does not depend on a worker's type)
- ▶ $\xi_j \in (0, 1) \rightarrow$ The share of cross-type matches for firm j is, all else constant, proportional to ξ_j

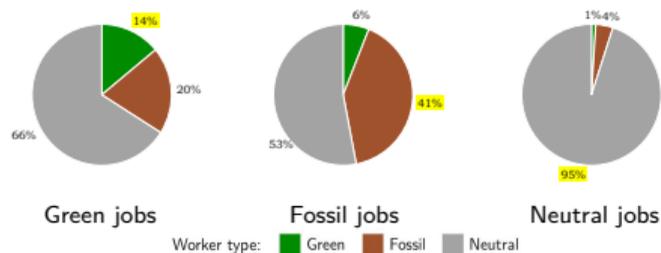
Outline

1. Empirical analysis
2. Model
- 3. Calibration**
4. Employment and welfare impacts
5. Conclusion

Solving for ξ_j

- ▶ Let ω_j be the **share of matches for firm j with workers of type j**
- ▶ From the empirical analysis,

$$\omega_j = \begin{cases} 0.14 & \text{for } j = \text{green,} \\ 0.41 & \text{for } j = \text{fossil,} \\ 0.95 & \text{for } j = \text{neutral} \end{cases}$$



- ▶ Solving for ξ_j to match moments in the initial equilibrium gives

$$\xi_j = \begin{cases} 0.87 & \text{for } j = \text{green,} \\ 0.56 & \text{for } j = \text{fossil,} \\ 1^* & \text{for } j = \text{neutral} \end{cases}$$

*Capped at 1

Remaining calibration

(a) Direct calibration

Parameter description	Symbol	Value	Source
Quit rate	π	0.037	BLS
Bargaining power of employer	η	0.5	Literature
Matching elasticity	γ	0.5	Literature
Discount factor	β	0.997	World Bank
Frisch elasticity of labor supply	χ	1	Literature
Elasticity in top consumption nest	σ^C	0.5	Literature
Elasticity in bottom consumption nest	σ^{fg}	0.75	Set relative to σ^C
Labor income tax	τ^L	0.29	OECD
Payroll tax	τ^P	0.15	OECD

(b) Calibration using the benchmark

Parameter description	Symbol	Value
Cross-type matching friction for firm $j \in \{f, g, z\}$	ξ_j	0.56, 0.87, 1
Matching efficiency for firm $j \in \{f, g, z\}$	μ_j	4.24, 3.87, 3.84
Labor productivity	ζ	3.20
Disutility of work	ψ	5.93
CES share of good $r \in \{f, g, z, fg\}$	ϱ_r	0.75, 0.25, 0.93, 0.07
Unemployment benefits for worker $i \in \{f, g, z\}$	b_i	0.25, 0.27, 0.28
Emissions factor	ϵ	0.00672

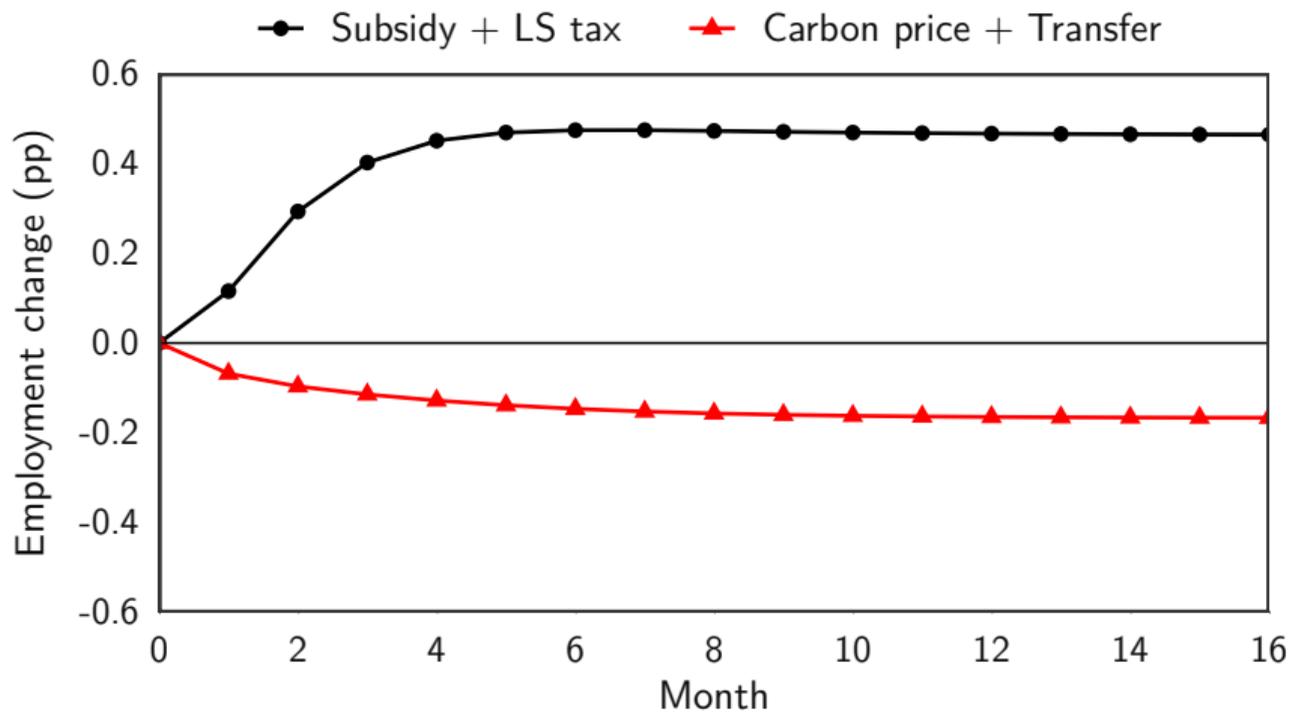
Outline

1. Empirical analysis
2. Model
3. Calibration
- 4. Employment and welfare impacts**
5. Conclusion

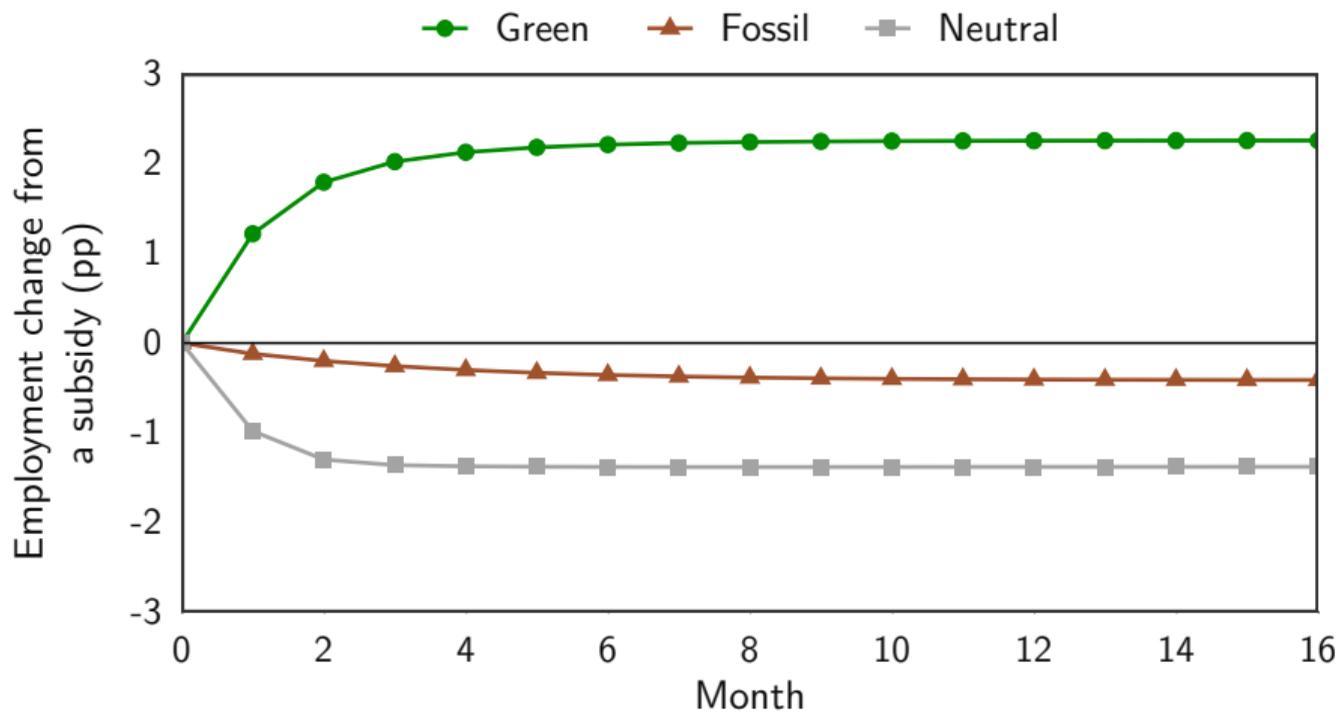
Policies

- ▶ Compare two policies:
 1. A subsidy on green firms' output
 2. A price on fossil firms' emissions
- ▶ 7% abatement → Estimated impact of the IRA tax credits (Bistline, Mehrotra and Wolfram, 2023)
- ▶ Compare outcomes to a business as usual benchmark

A green subsidy increases employment relative to a carbon price...



... because the subsidy generates large green job gains



The subsidy has three effects

1. **Substitution effect:** A subsidy shifts demand to green goods by making them cheaper

The subsidy has three effects

1. **Substitution effect:** A subsidy shifts demand to green goods by making them cheaper
2. **Match value effect:** A subsidy **increases the value of a match** for green firms
→ A green worker generates $p_{\text{green}} + s > p_{\text{green}}$ dollars per unit of output

The subsidy has three effects

1. **Substitution effect:** A subsidy shifts demand to green goods by making them cheaper
2. **Match value effect:** A subsidy **increases the value of a match** for green firms
→ A green worker generates $p_{\text{green}} + s > p_{\text{green}}$ dollars per unit of output
3. **Income effect:** Lump sum taxes reduce household income
→ BUT: **Recruitment is not distorted**

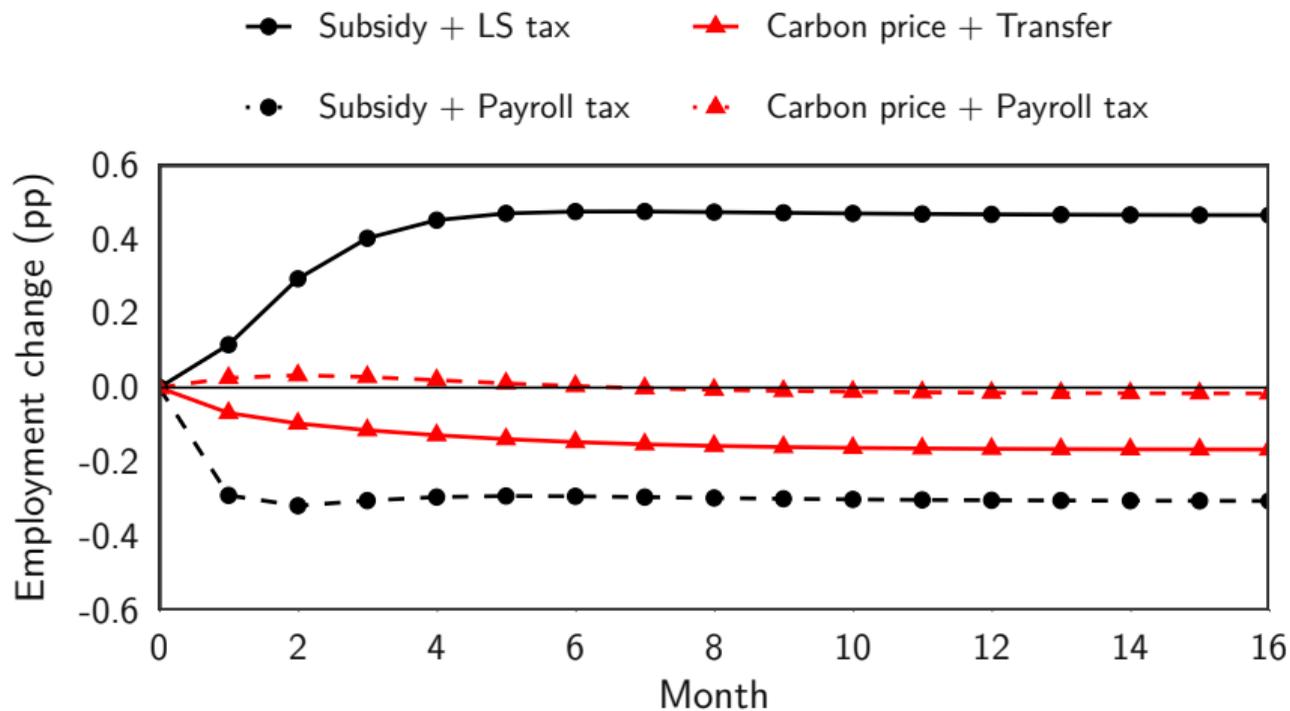
The subsidy has three effects

1. **Substitution effect:** A subsidy shifts demand to green goods by making them cheaper
2. **Match value effect:** A subsidy **increases the value of a match** for green firms
→ A green worker generates $p_{\text{green}} + s > p_{\text{green}}$ dollars per unit of output
3. **Income effect:** Lump sum taxes reduce household income
→ BUT: **Recruitment is not distorted**

⇒ The subsidy counteracts search frictions for green firms, without reducing the recruitment incentive for other firms

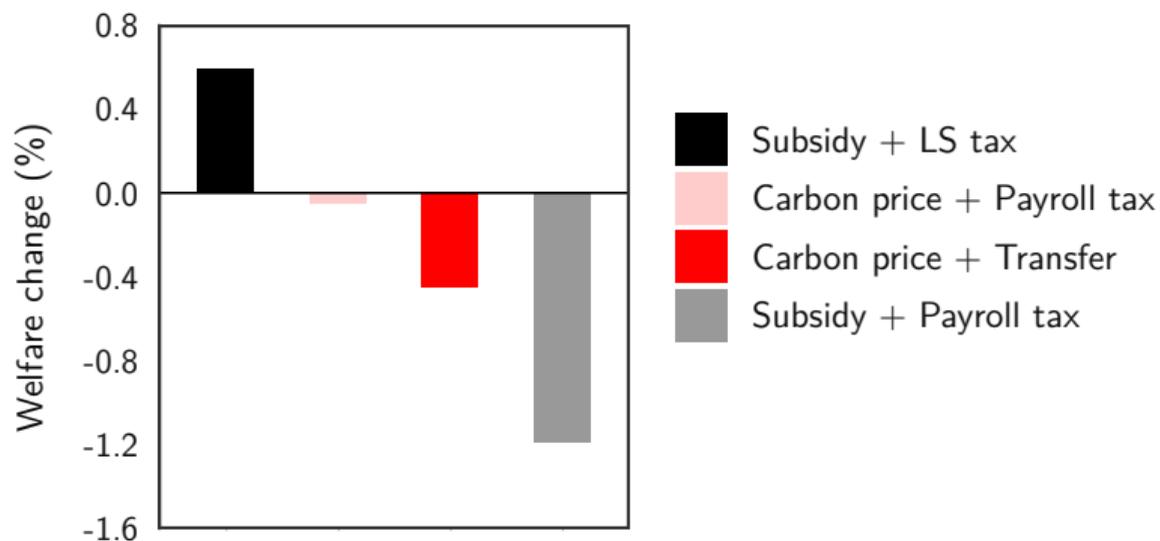
⇒ Net result: Large green job gains and higher overall employment

The job gains disappear if the subsidy is financed by payroll taxes

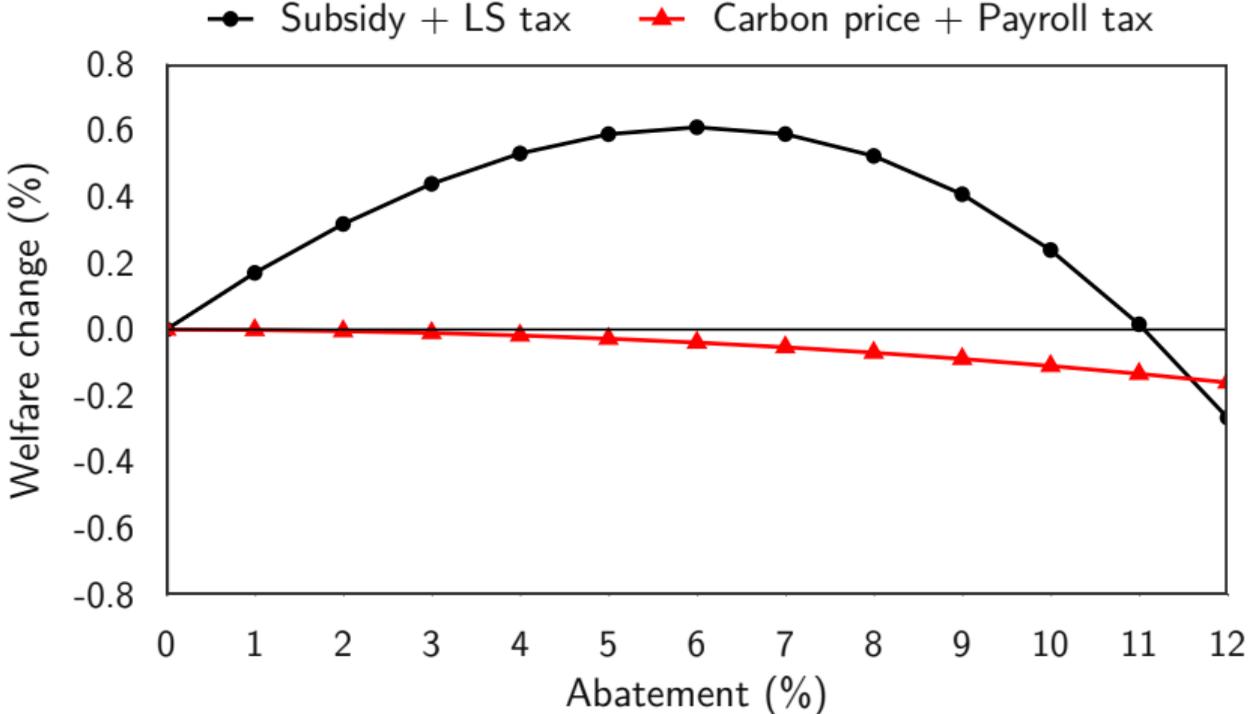


The financing mechanism matters for welfare

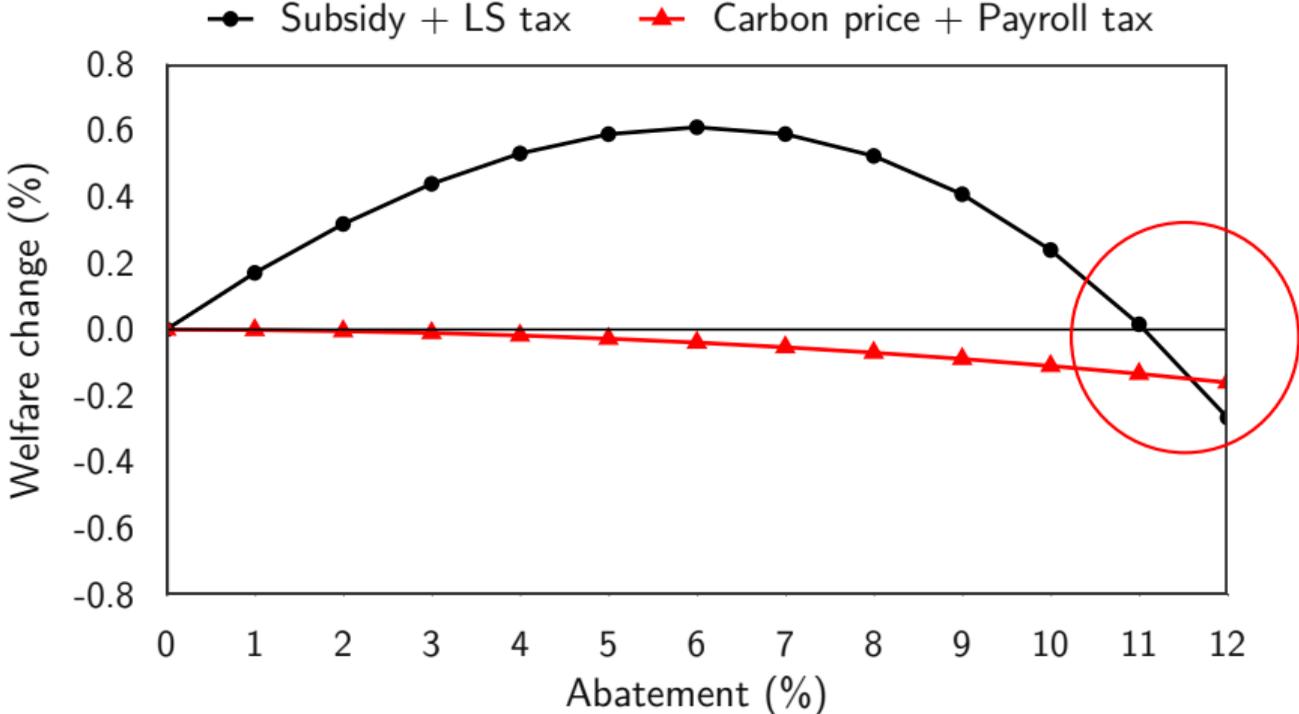
- ▶ Highest welfare from a green subsidy financed in a non-distortionary manner
- ▶ If payroll taxes are used for financing, a carbon price performs better



A green subsidy is less cost-efficient than a carbon price at high abatement levels



A green subsidy is less cost-efficient than a carbon price at high abatement levels



Outline

1. Empirical analysis
2. Model
3. Calibration
4. Employment and welfare impacts
5. Conclusion

Conclusion

- ▶ The financing mechanism is an important determinant of a green subsidy's performance
 - ▶ If the mechanism is non-distortionary, a subsidy increases:
 - ▶ Employment
 - ▶ Welfare vs. a carbon price at low abatement levels
- ▶ The subsidy increases overall employment by creating green jobs
 - ▶ Complementary labor market policies are needed for fossil workers to take advantage of these new job opportunities
 - ▶ Fossil workers rarely transition to green jobs
 - ▶ The addition of new green jobs is on its own unlikely enough

Thank you!

fredrikg@tcd.ie

References I

- Acemoglu, Daron, and David Autor.** 2011. "Chapter 12 - Skills, Tasks and Technologies: Implications for Employment and Earnings." In Handbook of Labor Economics. Vol. 4, ed(s). David Card and Orley Ashenfelter, 1043–1171. Elsevier.
- Aubert, Diane, and Mireille Chiroleu-Assouline.** 2019. "Environmental tax reform and income distribution with imperfect heterogeneous labour markets." European Economic Review, 116: 60–82.
- Autor, David H.** 2013. "The "task approach" to labor markets: an overview." Journal for Labour Market Research, 46(3).
- Autor, David H., Frank Levy, and Richard J. Murnane.** 2003. "The Skill Content of Recent Technological Change: An Empirical Exploration." The Quarterly Journal of Economics, 118(4): 1279–1333.
- Bistline, John E. T., Neil R. Mehrotra, and Catherine Wolfram.** 2023. "Economic Implications of the Climate Provisions of the Inflation Reduction Act." Brookings Papers on Economic Activity, 54(1): 77–182.
- Bowen, Alex, Karlygash Kuralbayeva, and Eileen L. Tipoe.** 2018. "Characterising green employment: The impacts of 'greening' on workforce composition." Energy Economics, 72: 263–275.
- Carbone, Jared C., Nicholas Rivers, Akio Yamazaki, and Hidemichi Yonezawa.** 2020. "Comparing Applied General Equilibrium and Econometric Estimates of the Effect of an Environmental Policy Shock." Journal of the Association of Environmental and Resource Economists, 7(4): 687–719.
- Castellanos, Kenneth A, and Garth Heutel.** 2024. "Unemployment, Labor Mobility, and Climate Policy." Journal of the Association of Environmental and Resource Economists, 11(1): 1–40.
- Chen, Ziqiao, Giovanni Marin, David Popp, and Francesco Vona.** 2020. "Green Stimulus in a Post-pandemic Recovery: the Role of Skills for a Resilient Recovery." Environmental & Resource Economics, 76(4): 901–911.
- Colmer, Jonathan, Eva Lyubich, and John Voorheis.** 2025. "Nice Work if You Can Get It? The Distribution of Employment and Earnings During the Early Years of the Clean Energy Transition." Centre for Economic Performance, Discussion Paper No. 2127.
- Consoli, Davide, Giovanni Marin, Alberto Marzucchi, and Francesco Vona.** 2016. "Do green jobs differ from non-green jobs in terms of skills and human capital?" Research Policy, 45(5): 1046–1060.
- Curtis, E. Mark, Layla O’Kane, and R. Jisung Park.** 2024. "Workers and the Green-Energy Transition: Evidence from 300 Million Job Transitions." Environmental and Energy Policy and the Economy, 5: 127–161.
- Dechezleprêtre, Antoine, Adrien Fabre, Tobias Kruse, Bluebery Planterose, Ana Sanchez Chico, and Stefanie Stantcheva.** 2025. "Fighting Climate Change: International Attitudes toward Climate Policies." American Economic Review, 115(4): 1258–1300.

References II

- Douenne, Thomas, and Adrien Fabre.** 2022. "Yellow Vests, Pessimistic Beliefs, and Carbon Tax Aversion." American Economic Journal: Economic Policy, 14(1).
- Elliott, Robert J.R., Wenjing Kuai, David Maddison, and Ceren Ozgen.** 2024. "Eco-innovation and (green) employment: A task-based approach to measuring the composition of work in firms." Journal of Environmental Economics and Management, 127: 103015.
- European Commission.** 2023. Report from the European Commission to the European Parliament and the Council, 2023 Report on Energy Subsidies in the EU, COM/2023/651 final.
- European Commission.** 2025. Report from the European Commission to the European Parliament, the Council, the European Economics and Social Committee and the Committee of the Regions, 2024 Report on Energy Subsidies in the EU, COM(2025) 17 final.
- Fernández Intriago, Luis A.** 2021. "Carbon Taxation, Green Jobs, and Sectoral Human Capital." Working Paper.
- Finkelstein Shapiro, Alan, and Gilbert E. Metcalf.** 2023. "The macroeconomic effects of a carbon tax to meet the U.S. Paris agreement target: The role of firm creation and technology adoption." Journal of Public Economics, 218: 104800.
- Hafstead, Marc A.C., and Roberton C. Williams.** 2018. "Unemployment and environmental regulation in general equilibrium." Journal of Public Economics, 160: 50–65.
- Hafstead, Marc A. C., Roberton C. Williams, and Yunguang Chen.** 2022. "Environmental Policy, Full-Employment Models, and Employment: A Critical Analysis." Journal of the Association of Environmental and Resource Economists, 9(2): 199–234.
- Heutel, Garth, and Xin Zhang.** 2021. "Efficiency wages, unemployment, and environmental policy." Energy Economics, 104: 105639.
- IEA.** 2024. "Energy Policy Inventory." International Energy Agency, available at <https://www.iea.org/data-and-statistics/data-tools/energy-policy-inventory>.
- Marin, Giovanni, Marianna Marino, and Claudia Pellegrin.** 2018. "The Impact of the European Emission Trading Scheme on Multiple Measures of Economic Performance." Environmental and Resource Economics, 71(2): 551–582.
- Popp, David, Francesco Vona, Giovanni Marin, and Ziqiao Chen.** 2021. "The Employment Impact of a Green Fiscal Push: Evidence from the American Recovery and Reinvestment Act." Brookings Papers on Economic Activity, 1–49.
- Saussay, Aurélien, Misato Sato, Francesco Vona, and Layla O'Kane.** 2022. "Who's fit for the low-carbon transition? Emerging skills and wage gaps in job and data." FEEM Working Papers 329079, Fondazione Eni Enrico Mattei (FEEM).

References III

- Shimer, Robert.** 2010. Labor Markets and Business Cycles. Princeton University Press.
- Shimer, Robert.** 2013. "A Framework for Valuing the Employment Consequences of Environmental Regulation." Working Paper.
- Vona, Francesco, Giovanni Marin, and Davide Consoli.** 2019. "Measures, drivers and effects of green employment: evidence from US local labor markets, 2006–2014." Journal of Economic Geography, 19(5): 1021–1048.
- Vona, Francesco, Giovanni Marin, Davide Consoli, and David Popp.** 2018. "Environmental Regulation and Green Skills: An Empirical Exploration." Journal of the Association of Environmental and Resource Economists, 5(4): 713–753.
- Walker, W. Reed.** 2013. "The Transitional Costs of Sectoral Reallocation: Evidence from the Clean Air Act and the Workforce." The Quarterly Journal of Economics, 128(4): 1787–1836.
- Yip, Chi Man.** 2018. "On the labor market consequences of environmental taxes." Journal of Environmental Economics and Management, 89: 136–152.

O*NET code	Title	Total tasks	Green tasks	Weighted green task share
11-1011.03	Chief Sustainability Officers	18	18	1
11-3051.02	Geothermal Production Managers	17	17	1
11-3051.03	Biofuels Production Managers	14	14	1
11-3051.04	Biomass Power Plant Managers	18	18	1
11-3051.06	Hydroelectric Production Managers	19	19	1
11-9041.01	Biofuels/Biodiesel Technology and Product Development Managers	19	19	1
11-9121.02	Water Resource Specialists	21	21	1
11-9199.09	Wind Energy Operations Managers	16	16	1
11-9199.10	Wind Energy Project Managers	15	15	1
11-9199.11	Brownfield Redevelopment Specialists and Site Managers	22	22	1
13-1199.01	Energy Auditors	21	21	1
13-1199.05	Sustainability Specialists	14	14	1
17-2081.00	Environmental Engineers	28	28	1
17-2081.01	Water/Wastewater Engineers	27	27	1
17-2141.01	Fuel Cell Engineers	26	26	1
17-2199.03	Energy Engineers	21	21	1
17-2199.10	Wind Energy Engineers	16	16	1
17-2199.11	Solar Energy Systems Engineers	13	13	1
17-3025.00	Environmental Engineering Technicians	26	26	1
19-1013.00	Soil and Plant Scientists	27	17	0.62
19-1031.01	Soil and Water Conservationists	33	33	1
19-2041.01	Climate Change Analysts	14	14	1
19-2041.02	Environmental Restoration Planners	22	22	1
19-2041.03	Industrial Ecologists	38	38	1

Green jobs (continued)

O*NET code	Title	Total tasks	Green tasks	Weighted green task share
19-3011.01	Environmental Economists	19	19	1
19-4091.00	Environmental Science and Protection Technicians, Including Health	26	26	1
41-3099.01	Energy Brokers	16	16	1
41-4011.07	Solar Sales Representatives and Assessors	13	13	1
47-1011.03	Solar Energy Installation Managers	15	15	1
47-2231.00	Solar Photovoltaic Installers	26	26	1
47-4041.00	Hazardous Materials Removal Workers	21	21	1
47-4099.02	Solar Thermal Installers and Technicians	21	21	1
47-4099.03	Weatherization Installers and Technicians	18	18	1
49-9081.00	Wind Turbine Service Technicians	13	13	1
49-9099.01	Geothermal Technicians	24	24	1
51-8099.01	Biofuels Processing Technicians	19	19	1
51-8099.03	Biomass Plant Technicians	16	16	1
51-8099.04	Hydroelectric Plant Technicians	21	21	1
51-9199.01	Recycling and Reclamation Workers	18	18	1
53-1021.01	Recycling Coordinators	23	23	1
53-7081.00	Refuse and Recyclable Material Collectors	16	16	1

» Main text

Green jobs (SOC)

SOC code	Title	Weighted green task share
17-2081	Environmental Engineers	1
17-2141	Mechanical Engineers	0.53 [†]
19-2040	Environmental Scientists and Geoscientists	0.57
41-3099	Sales Representatives, Services, All Other	1
47-2231	Solar Photovoltaic Installers	1
47-4041	Hazardous Materials Removal Workers	1
47-4090	Miscellaneous Construction and Related Workers	0.67
49-9081	Wind Turbine Service Technicians	1
49-909X	Other installation, maintenance, and repair workers	0.5
51-9199	Production Workers, All Other	1 [†]
53-7081	Refuse and Recyclable Material Collectors	1

Note: [†] Jobs that were identified as both green and fossil.

► Green job description

Harmonizing O*NET with SIPP

- ▶ 41 occupations in O*NET have a green task share of at least 50%
- ▶ O*NET uses an 8-digit O*NET-SOC level while SIPP uses a 6-digit SOC level
- ▶ I aggregate the task shares to a 6-digit level using a procedure based on Marin, Marino and Pellegrin (2018):
 - ▶ If an occupation ending in “.00” has few green tasks, I assign a green task share of zero to the parent group
 - ▶ In all other cases, I average the green task shares across the occupations in the parent group

▶ Main text

SOC code	Title
11-3051	Industrial Production Managers
11-9041	Architectural and Engineering Managers
17-2041	Chemical Engineers
17-2070	Electrical and Electronics Engineers
17-2110	Industrial Engineers, Including Health and Safety
17-2121	Marine Engineers and Naval Architects
17-2131	Materials Engineers
17-2171	Petroleum Engineers
17-3020	Engineering Technicians, Except Drafters
19-2030	Chemists and Materials Scientists
19-4011	Agricultural and Food Science Technicians
19-4031	Chemical Technicians
43-5041	Meter Readers, Utilities
43-5061	Production, Planning, and Expediting Clerks
47-5010	Derrick, Rotary Drill, and Service Unit Operators, Oil, Gas, and Mining
47-5021	Earth Drillers, Except Oil and Gas
47-5040	Mining Machine Operators
47-50XX	Other Extraction Workers
49-2091	Avionics Technicians
49-209X	Electrical and electronics repairers, industrial and utility
49-9010	Control and Valve Installers and Repairers
49-9043	Maintenance Workers, Machinery
49-9044	Millwrights
49-904X	Industrial and Refractory Machinery Mechanics
49-9051	Electrical Power-Line Installers and Repairers
49-9096	Riggers
49-9098	Helpers—Installation, Maintenance, and Repair Workers

Fossil jobs (continued)

SOC code	Title
51-1011	First-Line Supervisors of Production and Operating Workers
51-2011	Aircraft Structure, Surfaces, Rigging, and Systems Assemblers
51-2020	Electrical, Electronics, and Electromechanical Assemblers
51-2031	Engine and Other Machine Assemblers
51-2041	Structural Metal Fabricators and Fitters
51-2090	Miscellaneous Assemblers and Fabricators
51-3020	Butchers and Other Meat, Poultry, and Fish Processing Workers
51-3091	Food and Tobacco Roasting, Baking, and Drying Machine Operators and Tenders
51-3093	Food Cooking Machine Operators and Tenders
51-3099	Food Processing Workers, All Other
51-4010	Computer Control Programmers and Operators
51-4021	Extruding and Drawing Machine Setters, Operators, and Tenders, Metal and Plastic
51-4022	Forging Machine Setters, Operators, and Tenders, Metal and Plastic
51-4031	Cutting, Punching, and Press Machine Setters, Operators, and Tenders, Metal and Plastic
51-4033	Grinding, Lapping, Polishing, and Buffing Machine Tool Setters, Operators, and Tenders, Metal and Plastic
51-4050	Metal Furnace Operators, Tenders, Pourers, and Casters
51-4070	Molders and Molding Machine Setters, Operators, and Tenders, Metal and Plastic
51-4111	Tool and Die Makers
51-4199	Metal Workers and Plastic Workers, All Other
51-6063	Textile Knitting and Weaving Machine Setters, Operators, and Tenders
51-6064	Textile Winding, Twisting, and Drawing Out Machine Setters, Operators, and Tenders
51-7041	Sawing Machine Setters, Operators, and Tenders, Wood
51-7042	Woodworking Machine Setters, Operators, and Tenders, Except Sawing
51-8010	Power Plant Operators, Distributors, and Dispatchers
51-8031	Water and Wastewater Treatment Plant and System Operators
51-8090	Miscellaneous Plant and System Operators

Fossil jobs (continued)

SOC code	Title
51-9010	Chemical Processing Machine Setters, Operators, and Tenders
51-9020	Crushing, Grinding, Polishing, Mixing, and Blending Workers
51-9041	Extruding, Forming, Pressing, and Compacting Machine Setters, Operators, and Tenders
51-9051	Furnace, Kiln, Oven, Drier, and Kettle Operators and Tenders
51-9061	Inspectors, Testers, Sorters, Samplers, and Weighers
51-9111	Packaging and Filling Machine Operators and Tenders
51-9191	Adhesive Bonding Machine Operators and Tenders
51-9195	Molders, Shapers, and Casters, Except Metal and Plastic
51-9196	Paper Goods Machine Setters, Operators, and Tenders
51-9197	Tire Builders
51-9198	Helpers—Production Workers
53-5011	Sailors and Marine Oilers
53-6031	Automotive and Watercraft Service Attendants
53-7021	Crane and Tower Operators
53-7051	Industrial Truck and Tractor Operators
53-7070	Pumping Station Operators
53-7199	Material Moving Workers, All Other

▶ Main text

Dirty industries

Census code	Census title
0370	Oil and Gas Extraction
0380	Coal Mining
0390	Metal Ore Mining
0470	Nonmetallic Mineral Mining and Quarrying
0480	Not Specified Type of Mining
0490	Support Activities for Mining
0570	Electric Power Generation, Transmission and Distribution
0580	Natural Gas Distribution
0590	Electric and Gas, and Other Combinations
0670	Water, Steam, Air-conditioning, and Irrigation Systems
0680	Sewage Treatment Facilities
0690	Not Specified Utilities
1070	Animal Food, Grain and Oilseed Milling
1080	Sugar and Confectionery Products
1090	Fruit and Vegetable Preserving and Specialty Food Manufacturing
1170	Dairy Product Manufacturing
1180	Animal Slaughtering and Processing
1280	Seafood and Other Miscellaneous Foods, n.e.c.
1290	Not Specified Food Industries
1370	Beverage Manufacturing
1390	Tobacco Manufacturing
1480	Fabric Mills, Except Knitting Mills
1490	Textile and Fabric Finishing and Fabric Coating Mills
1570	Carpet and Rug Mills
1870	Pulp, Paper, and Paperboard Mills

Dirty industries (continued)

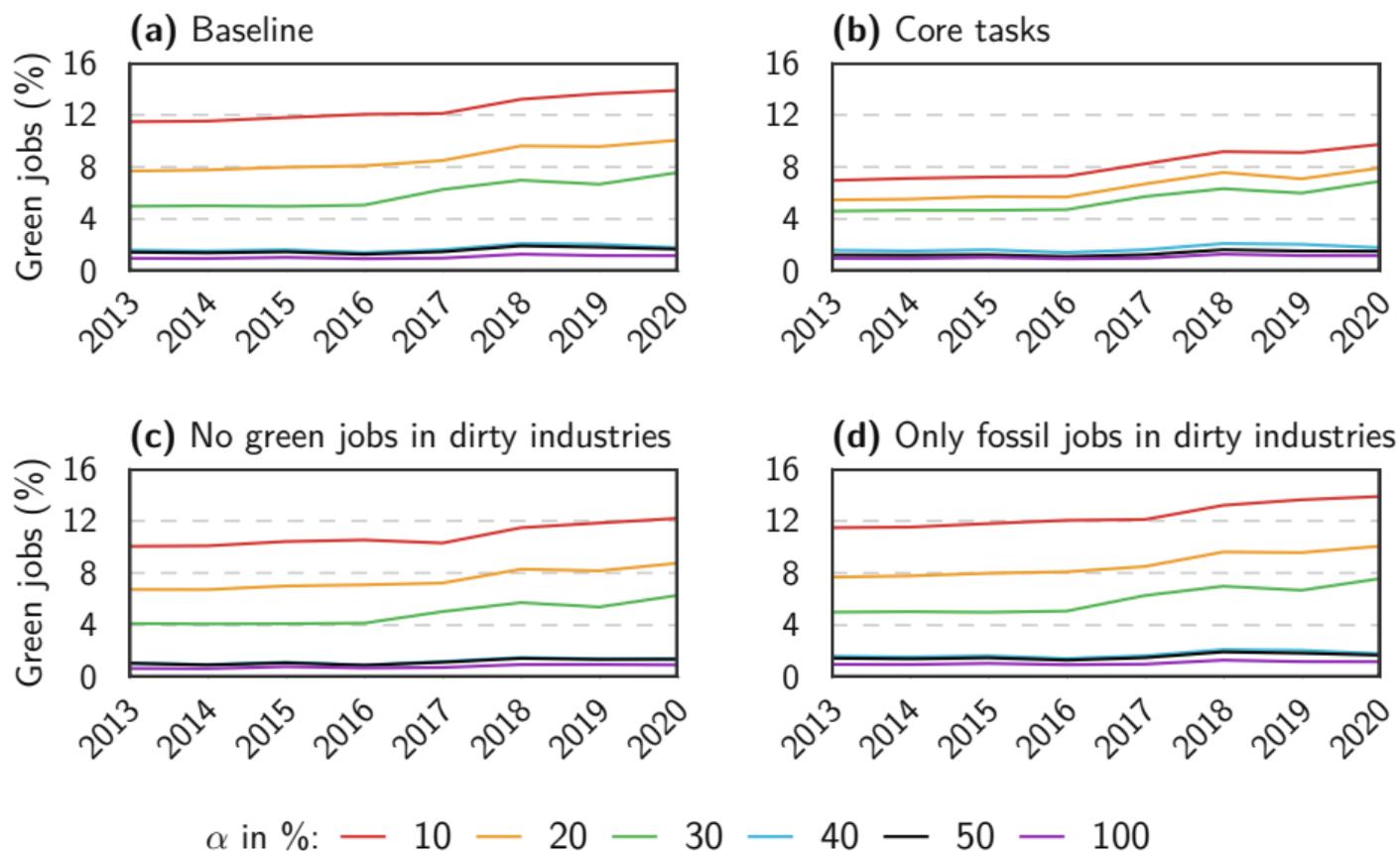
Census code	Census title
2070	Petroleum Refining
2090	Miscellaneous Petroleum and Coal Products
2170	Resin, Synthetic Rubber, and Fibers and Filaments Manufacturing
2180	Agricultural Chemical Manufacturing
2190	Pharmaceutical and Medicine Manufacturing
2270	Paint, Coating, and Adhesive Manufacturing
2280	Soap, Cleaning Compound, and Cosmetics Manufacturing
2290	Industrial and Miscellaneous Chemicals
2380	Tire Manufacturing
2390	Rubber Products, Except Tires, Manufacturing
2470	Pottery, Ceramics, and Plumbing Fixture Manufacturing
2480	Clay Building Material and Refractories Manufacturing
2490	Glass and Glass Product Manufacturing
2570	Cement, Concrete, Lime, and Gypsum Product Manufacturing
2590	Miscellaneous Nonmetallic Mineral Product Manufacturing
2670	Iron and Steel Mills and Steel Product Manufacturing
2680	Aluminum Production and Processing
2690	Nonferrous Metal (Except Aluminum) Production and Processing
2770	Foundries
2990	Not Specified Metal Industries
3180	Engine, Turbine, and Power Transmission Equipment Manufacturing
3390	Electronic Component and Product Manufacturing, n.e.c.
3490	Electric Lighting and Electrical Equipment Manufacturing, and Other Electrical Component Manufacturing, n.e.c.
3570	Motor Vehicles and Motor Vehicle Equipment Manufacturing
3580	Aircraft and Parts Manufacturing
3590	Aerospace Products and Parts Manufacturing

Dirty industries (continued)

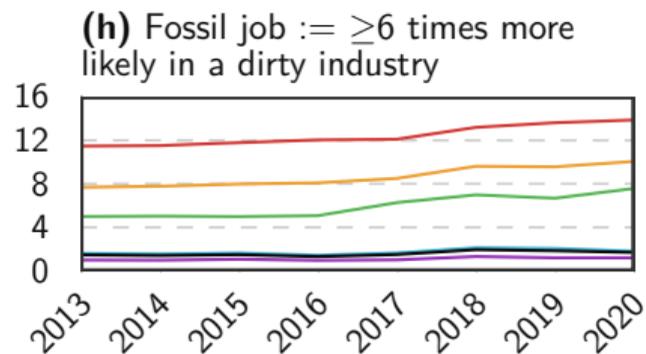
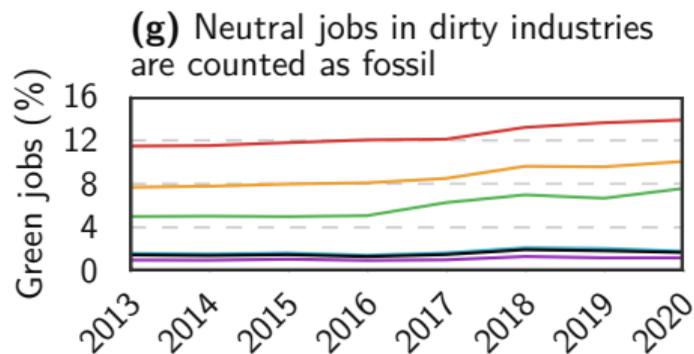
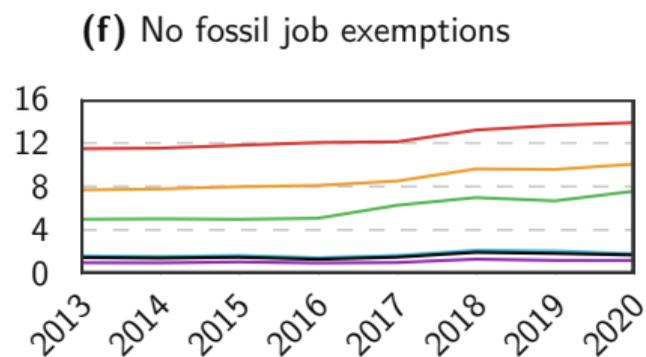
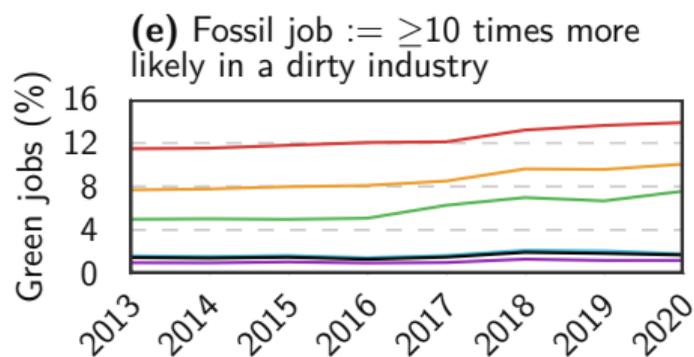
Census code	Census title
3670	Railroad Rolling Stock Manufacturing
3770	Sawmills and Wood Preservation
3780	Veneer, Plywood, and Engineered Wood Products
3990	Not Specified Manufacturing Industries
4490	Petroleum and Petroleum Products Merchant Wholesalers
5090	Gasoline Stations
5680	Fuel Dealers
6270	Pipeline Transportation

» Main text

Green job share by sensitivity test (panels) and α (lines)

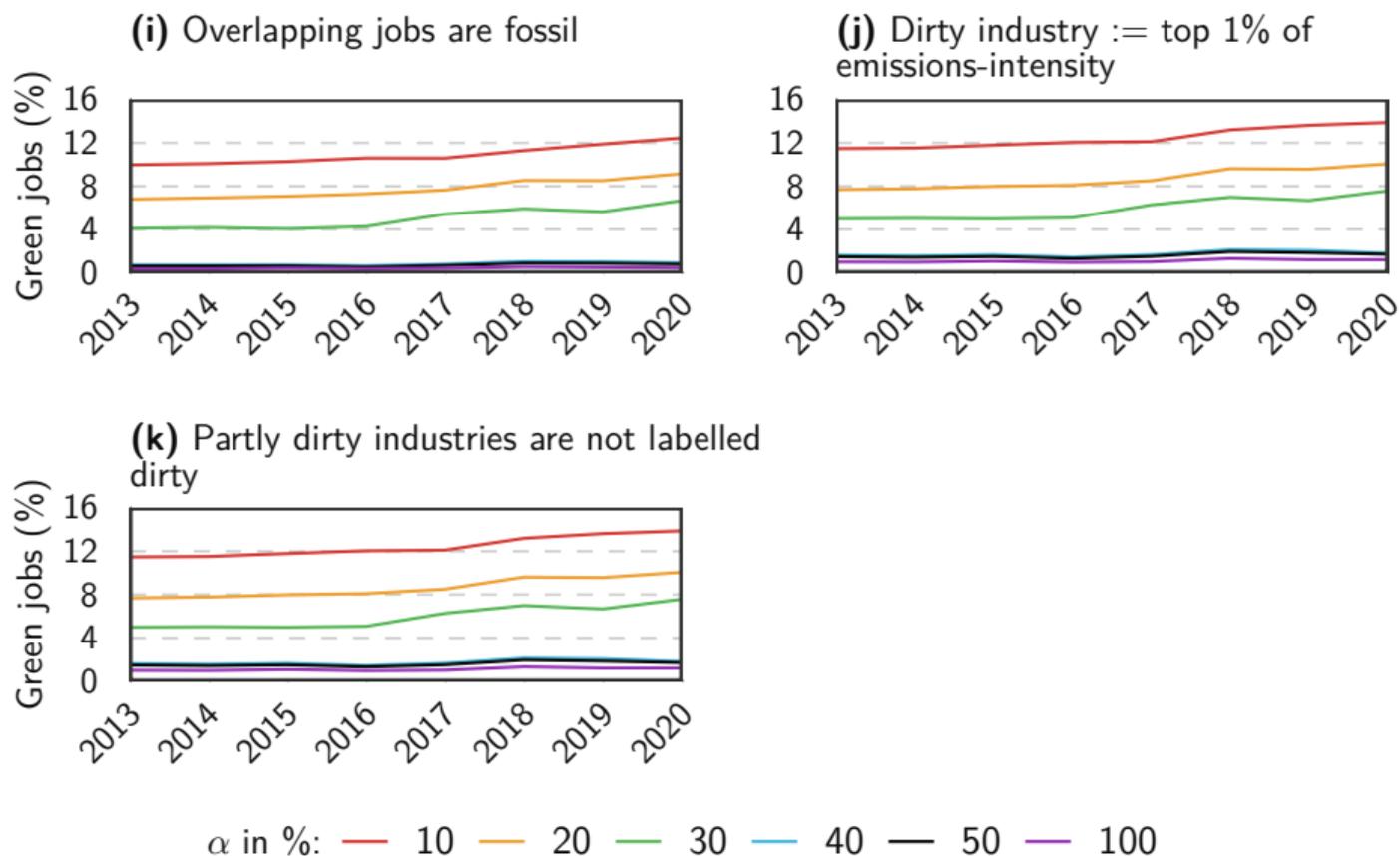


Green job share by sensitivity test (panels) and α (lines)

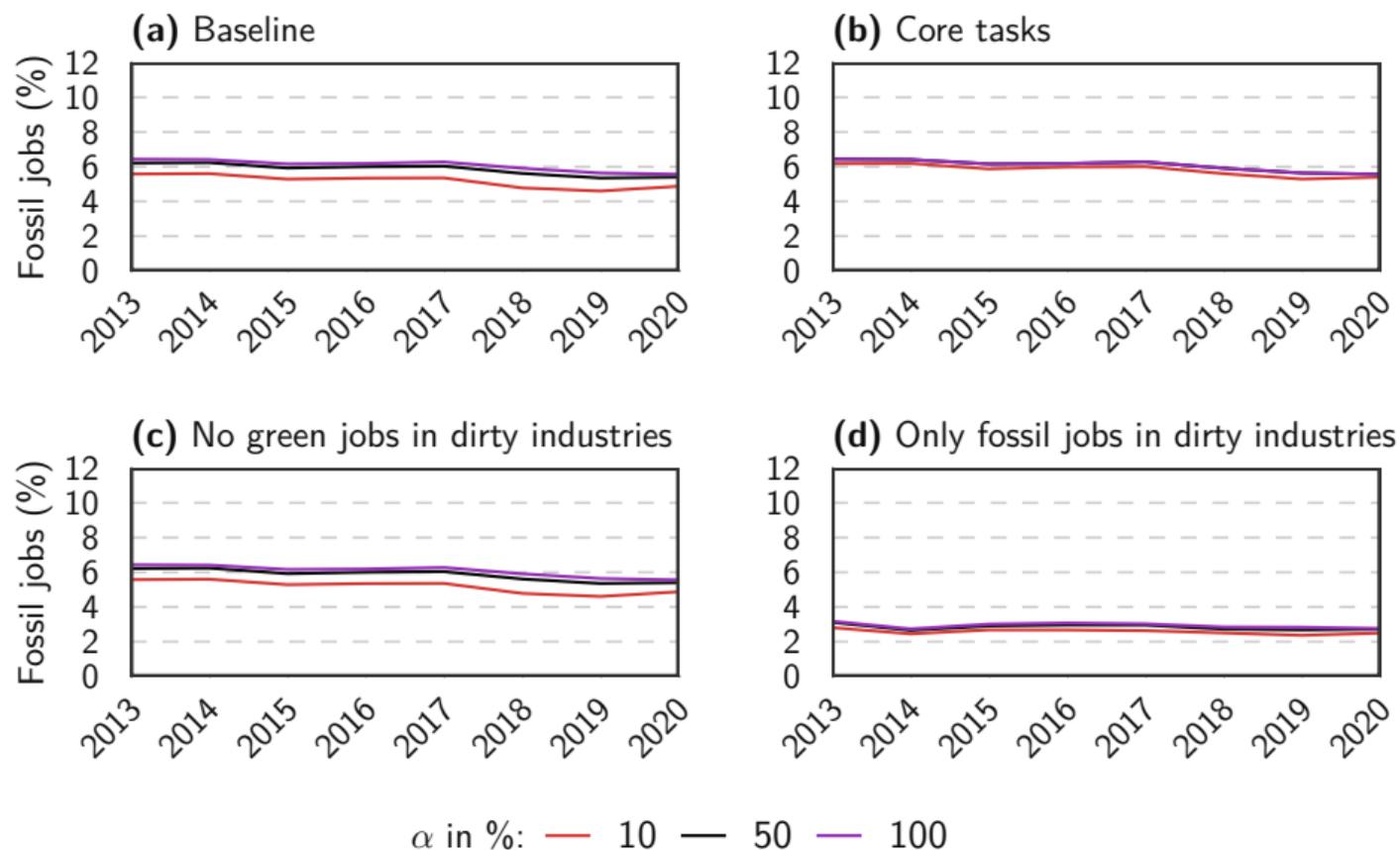


α in %: — 10 — 20 — 30 — 40 — 50 — 100

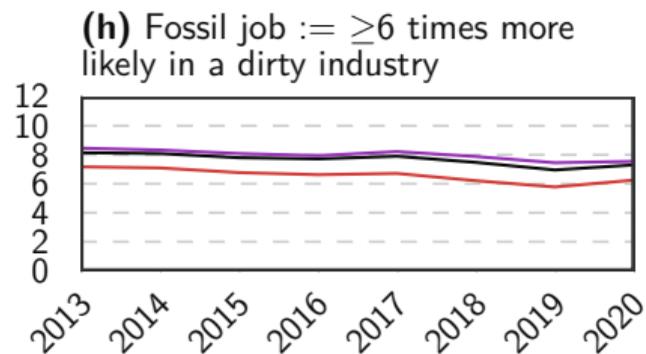
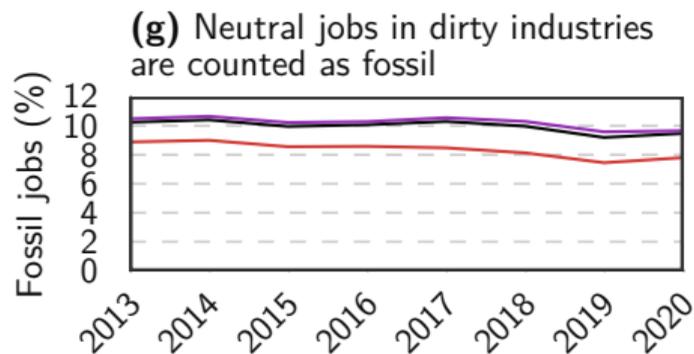
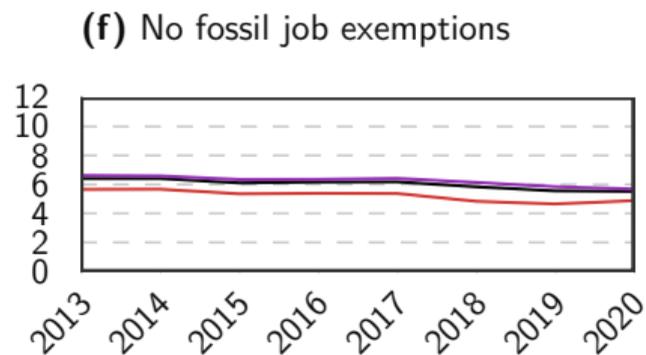
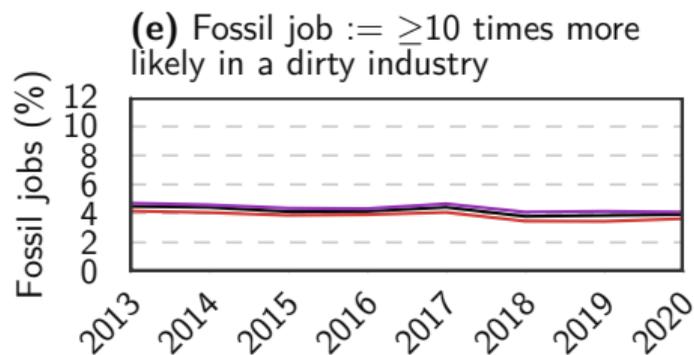
Green job share by sensitivity test (panels) and α (lines)



Fossil job share by sensitivity test (panels) and α (lines)

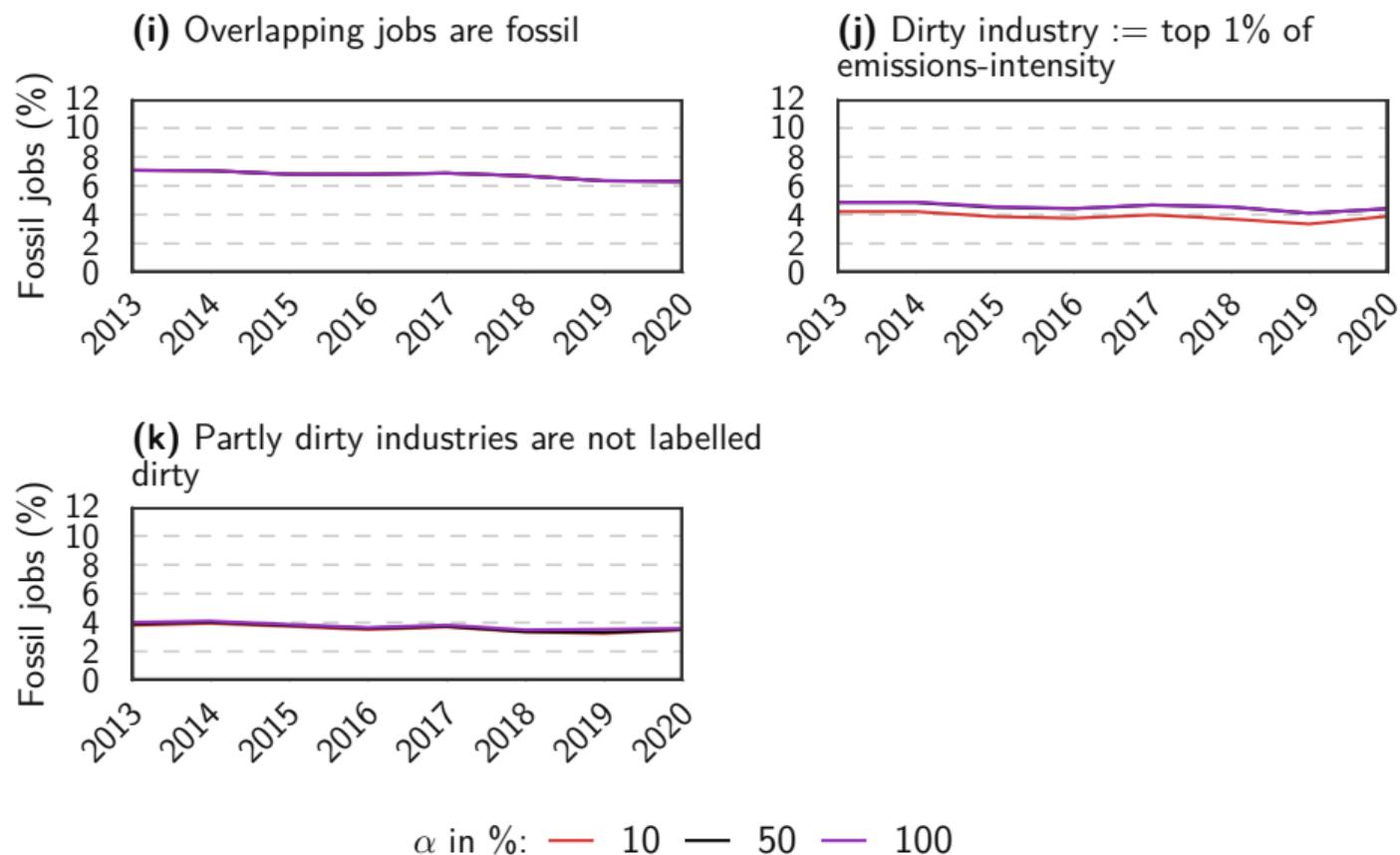


Fossil job share by sensitivity test (panels) and α (lines)

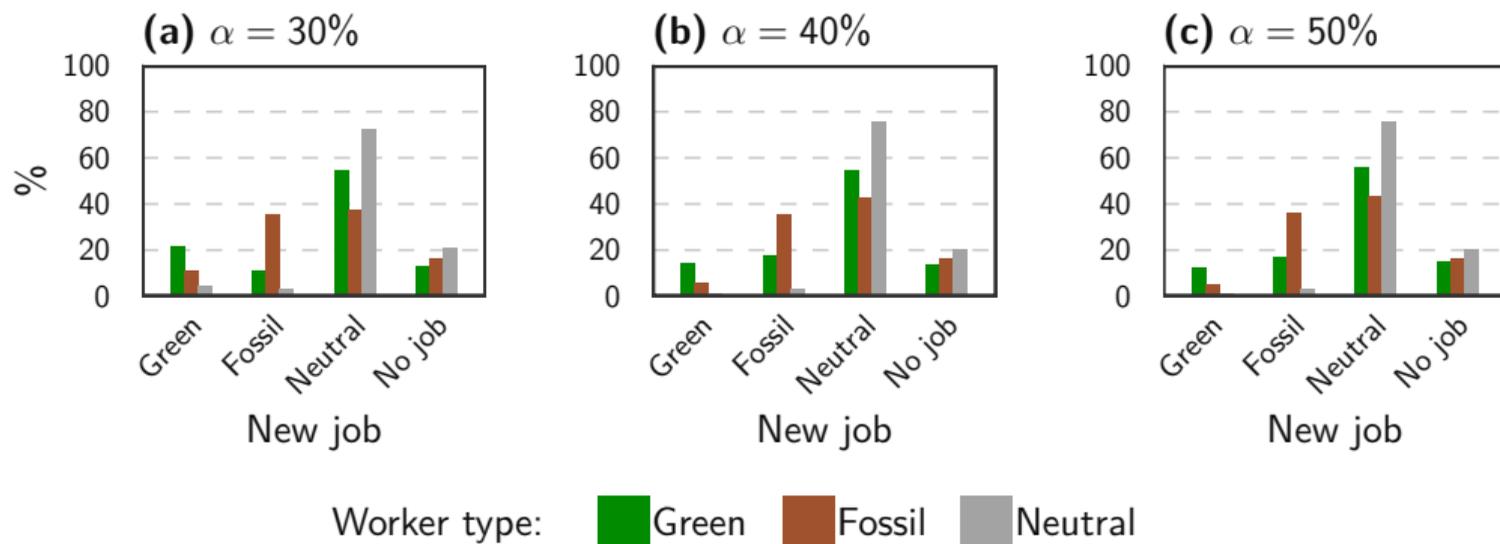


α in %: — 10 — 50 — 100

Fossil job share by sensitivity test (panels) and α (lines)

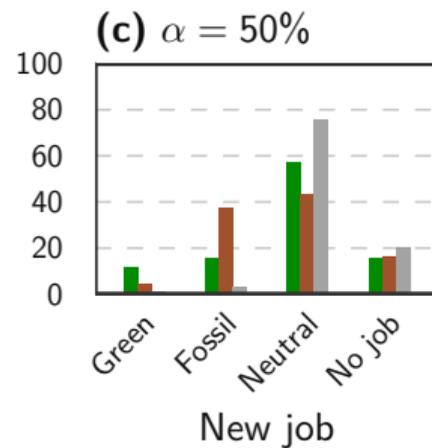
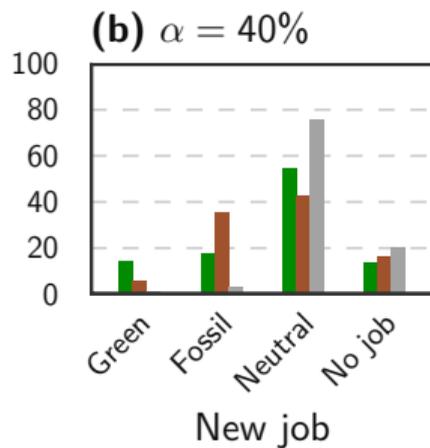
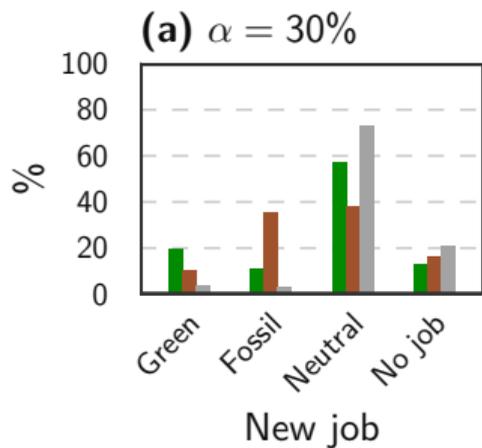


Job-finding probability by α , job, and worker



► Main text

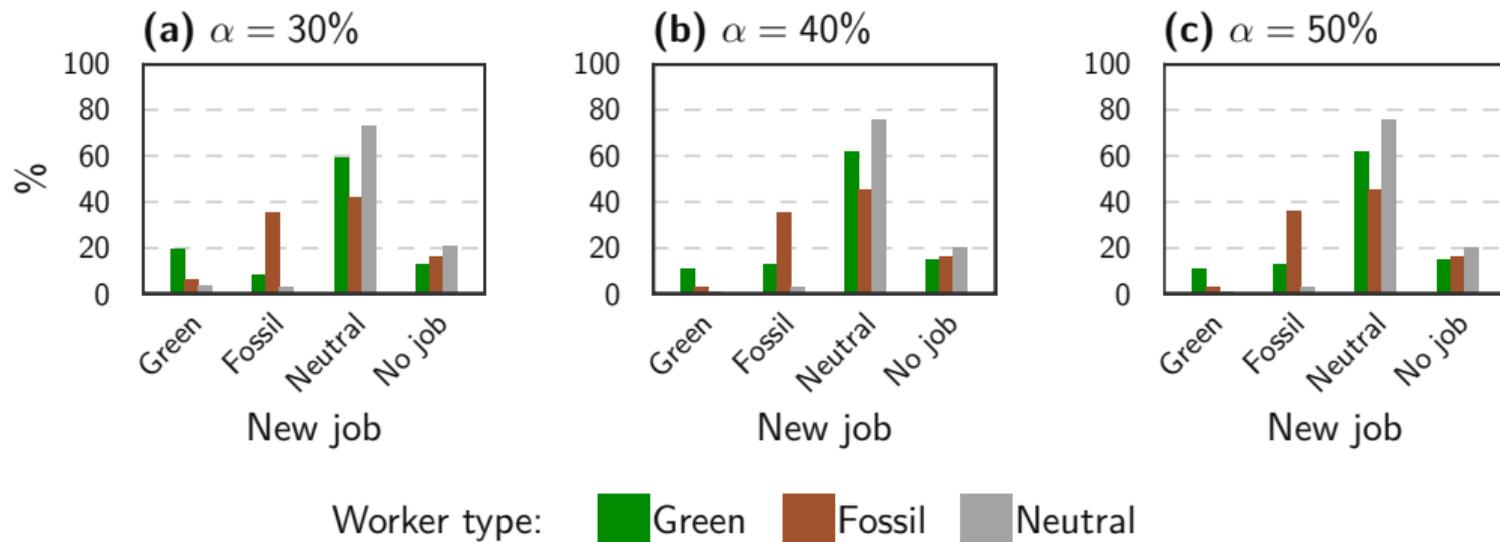
Job-finding probability by α , job, and worker (only core tasks)



Worker type: ■ Green ■ Fossil ■ Neutral

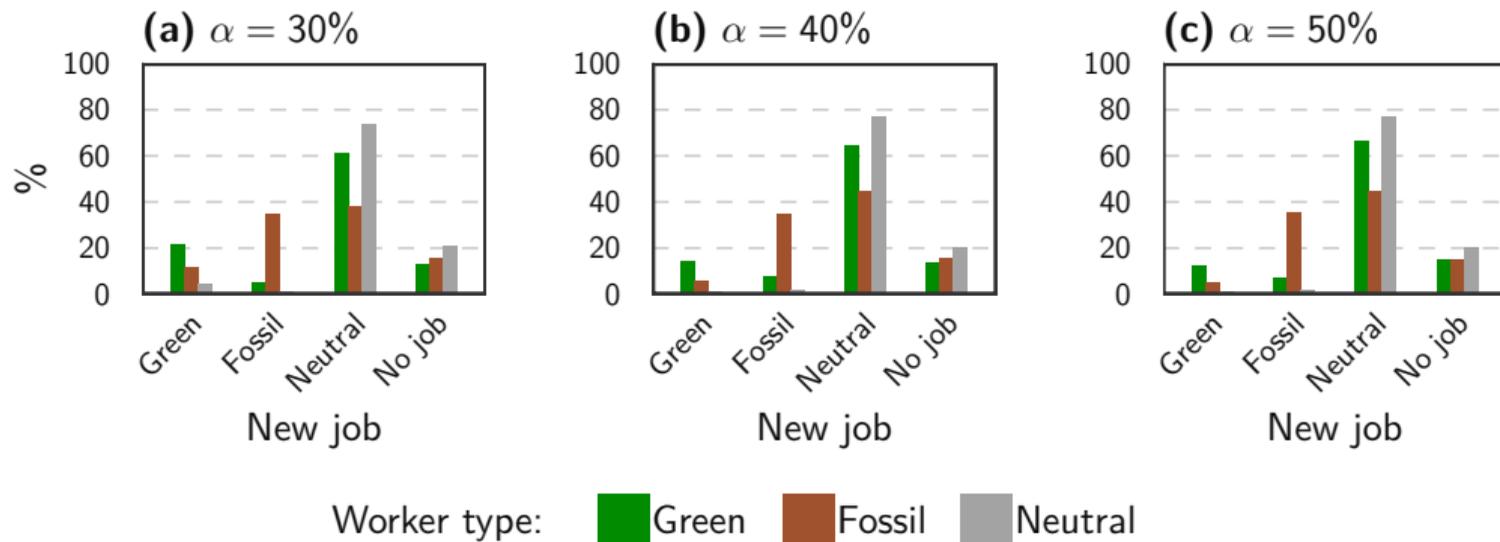
► Main text

Job-finding probability by α , job, and worker (no green jobs in dirty industries)



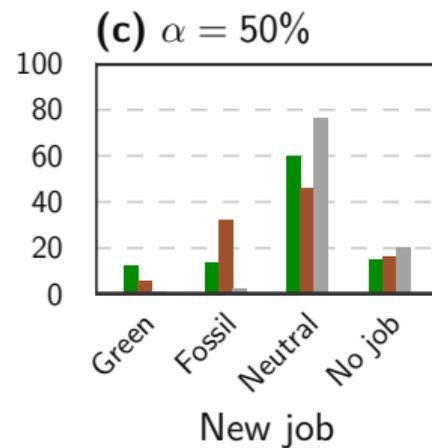
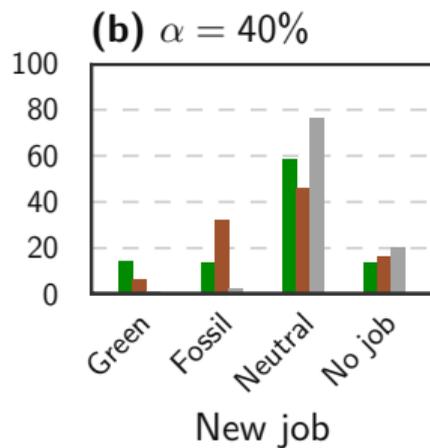
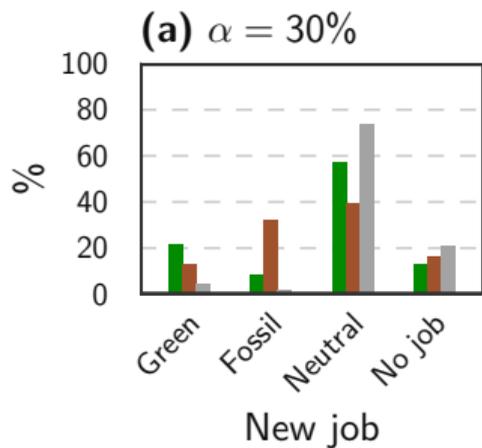
► Main text

Job-finding probability by α , job, and worker (only fossil jobs in dirty industries)



► Main text

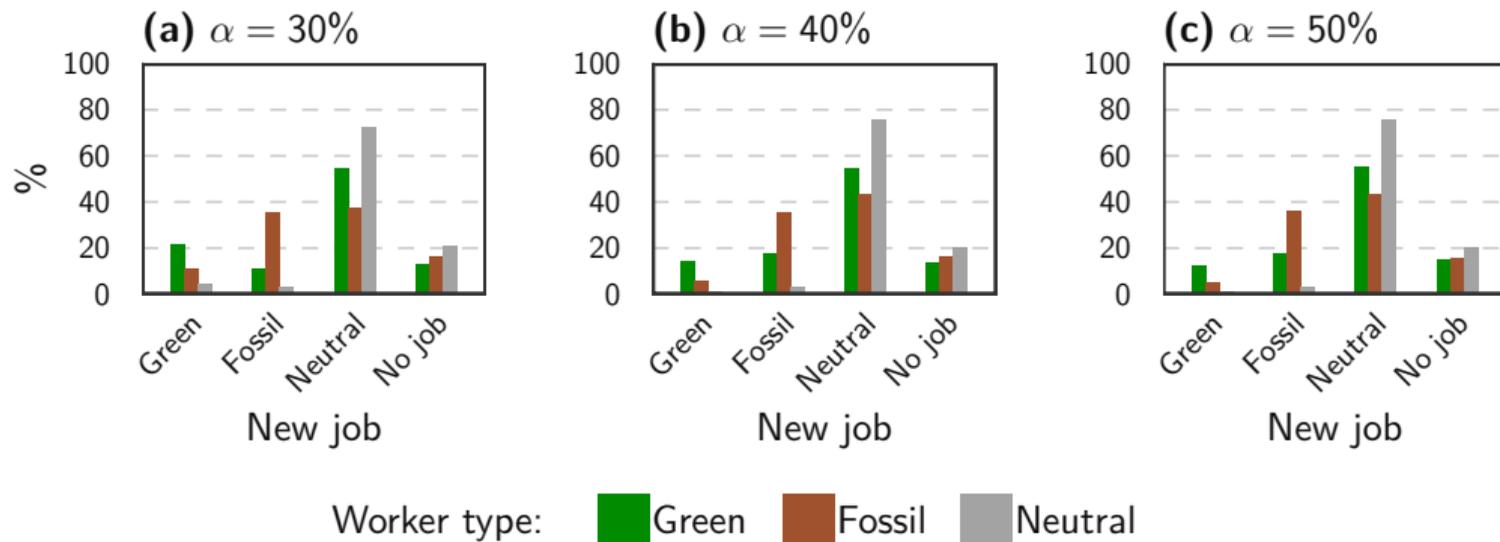
Job-finding probability by α , job, and worker (fossil job ≥ 10 times in dirty industries)



Worker type: ■ Green ■ Fossil ■ Neutral

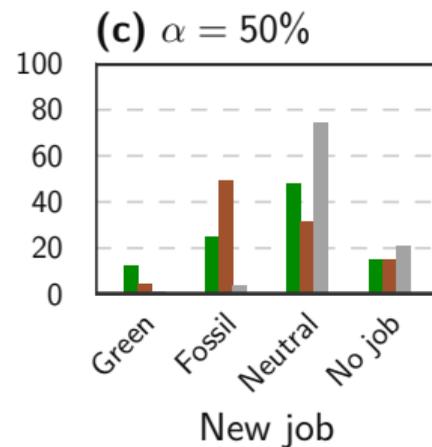
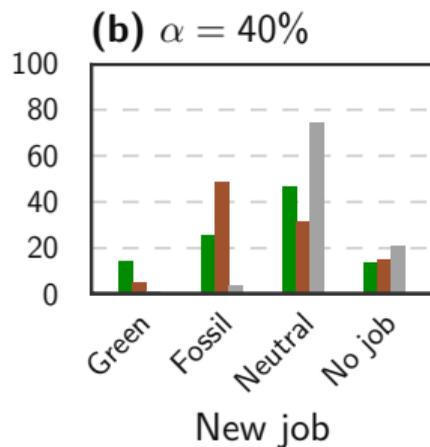
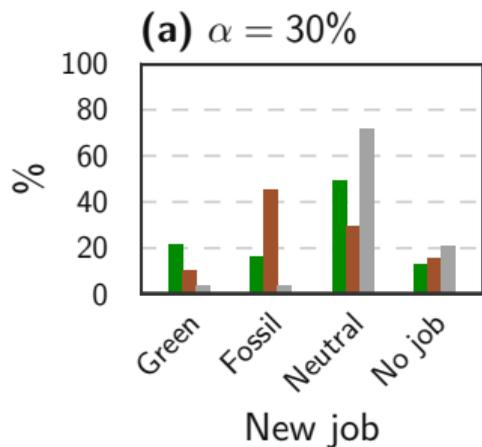
► Main text

Job-finding probability by α , job, and worker (no fossil job exemptions)



► Main text

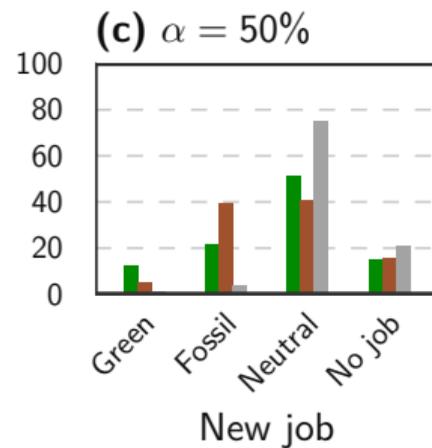
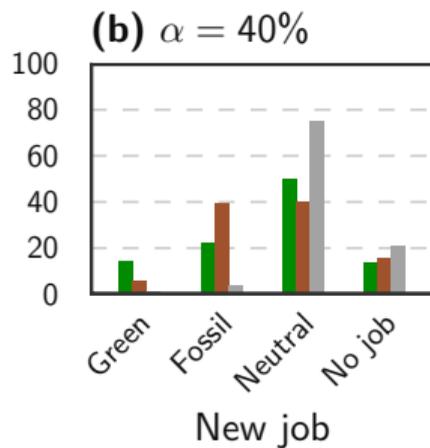
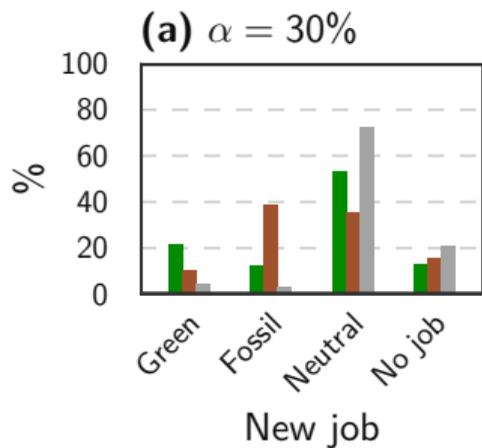
Job-finding probability by α , job, and worker (no neutral jobs in dirty industries)



Worker type: ■ Green ■ Fossil ■ Neutral

► Main text

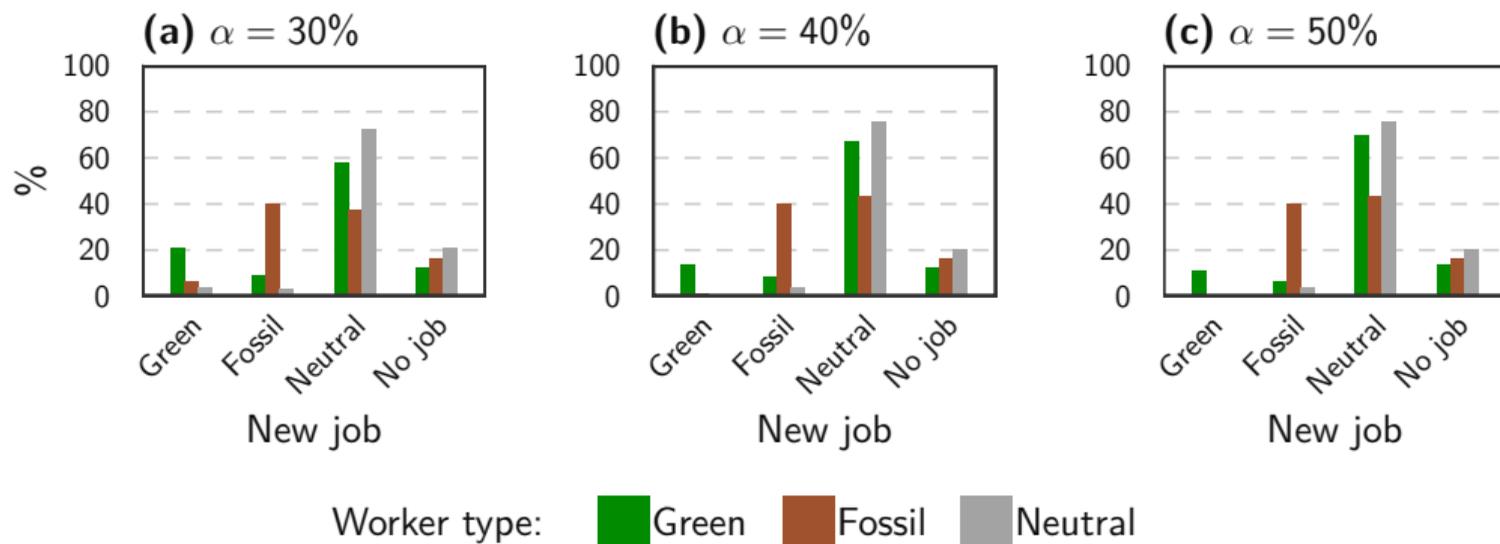
Job-finding probability by α , job, and worker (fossil job ≥ 6 times in dirty industries)



Worker type: ■ Green ■ Fossil ■ Neutral

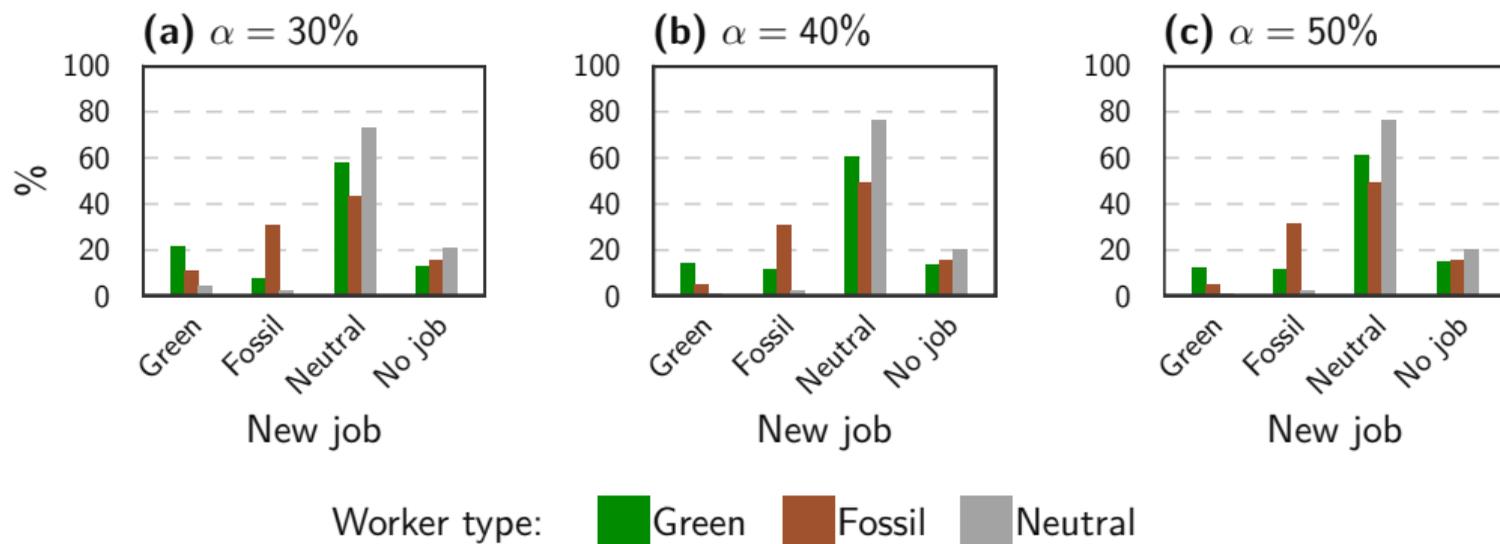
► Main text

Job-finding probability by α , job, and worker (overlapping jobs are fossil)



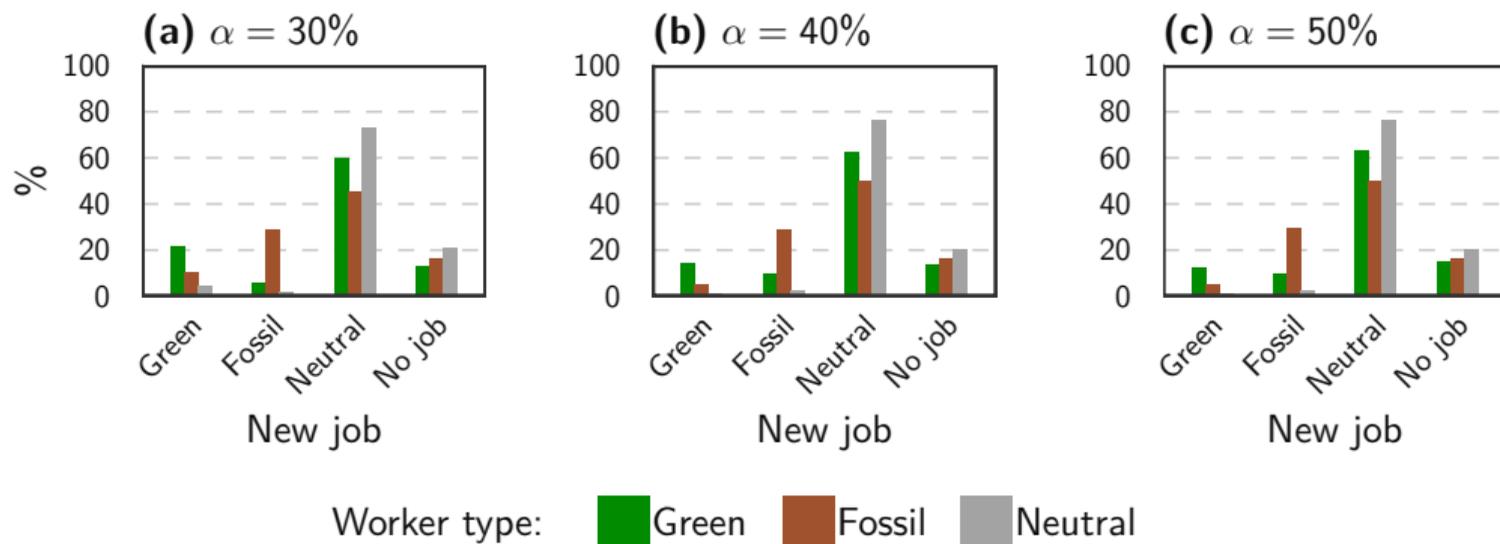
► Main text

Job-finding probability by α , job, and worker (1% emissions-intensity cutoff)



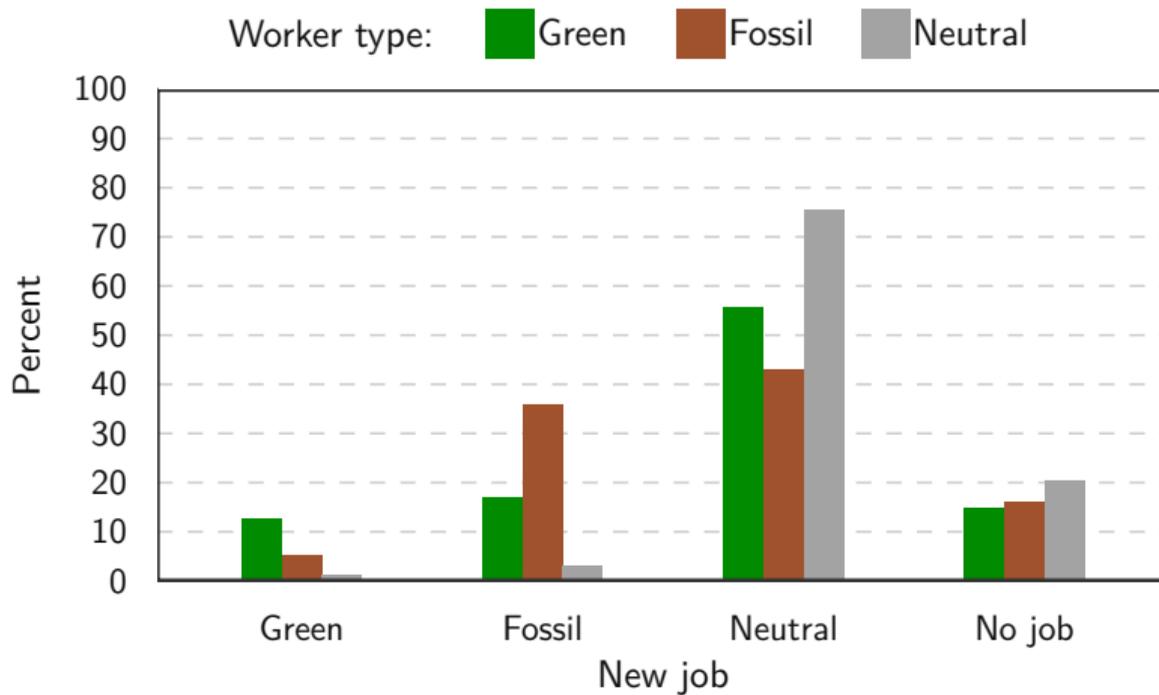
► Main text

Job-finding probability by α , job, and worker (partly dirty industries are not called dirty)

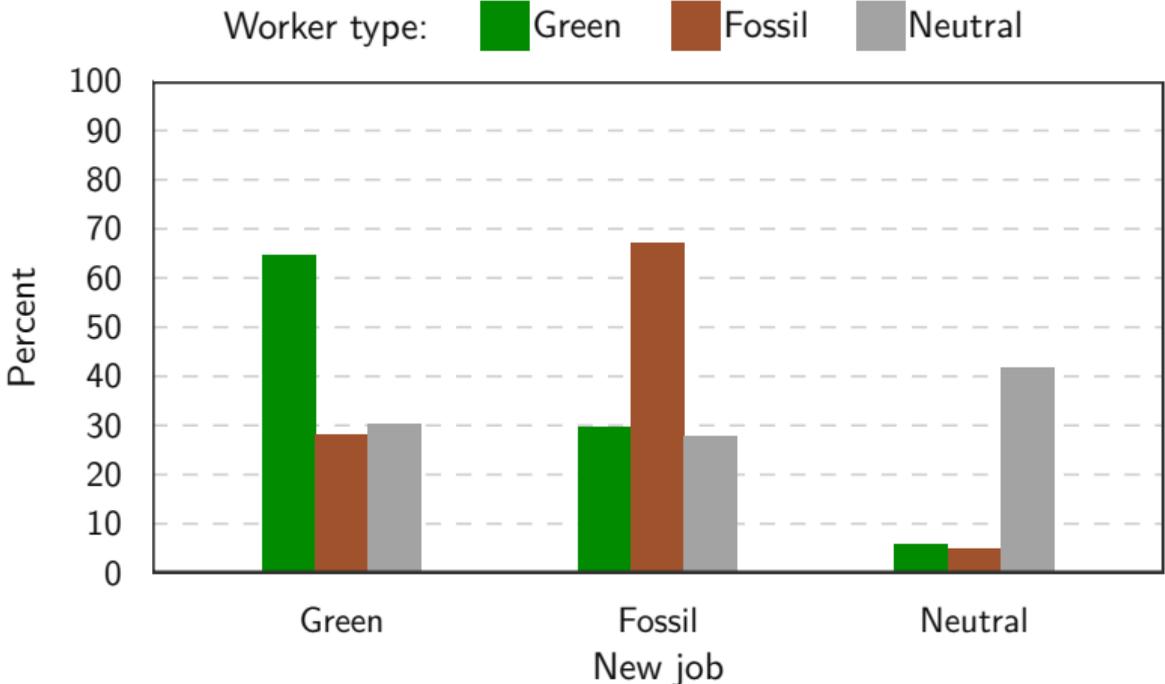


► Main text

Job finding probabilities with unemployment



Fossil workers are the least likely to start a green job if the job numbers are equalized



▶ Main text