

Occupational Vulnerability to Fossil Fuel Phaseouts and the Search for Suitable Outside Options

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Problem to be solved: transition to net zero greenhouse gases



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- **Technological** challenges
- **Economic** challenges
- **Political-economic challenges** (Aklin and Urpelainen 2013; Stokes 2015; Colantone et al. 2022; Egli, Schmid, and Schmidt 2022) **and solutions** (Gaikwad, Genovese, and Tingley 2022; Bolet, Green, and González-Eguino 2023)

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- Key role of **labor markets** (Blankenship et al. 2022; Lim, Aklin, and Frank 2023; Vona 2023; Bluedorn et al. 2023; Curtis, O'Kane, and Park 2024; Aklin 2025)

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- **Which occupations are at risk? And what are their suitable outside options?**

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2. Identify suitable **outside options**: set of realistic alternative occupations
 - Use LLM to generate hard-to-measure index of vulnerability
 - **Correlates of occupational vulnerability**: as much a story of skill as of sector
 - Danger of **unemployment traps** caused by limited low-risk outside options

Occupational vulnerability to fossil fuel phaseouts

- *Sectoral* versus *occupational* vulnerability (Clarke et al. 2024; Graham and Knittel 2024; Mayfield et al. 2020)
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$$\mathbb{P}(i \text{ beats } j) = \frac{e^{p_i}}{e^{p_i} + e^{p_j}} \quad \rightarrow p_i \text{ as latent vulnerability} \sim N(0, \sigma^2)$$

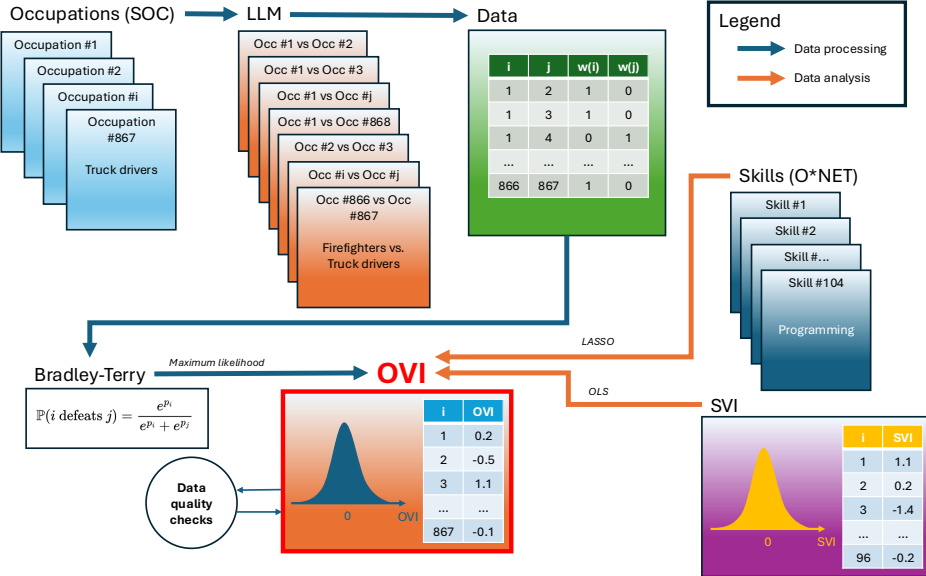
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- **Data:** collective wisdom via GPT (~375,000 comparisons)

Suppose that the United States were to phase out all fossil fuels (natural gas, coal, and oil). Which of these two occupations would be at greater risk of experiencing higher levels of job loss? '{occ1}' or '{occ2}'? Answer with '{occ1} is more at risk', '{occ2} is more at risk', or 'Both occupations are experiencing an equivalent risk.'

- Quality checks: human coding, benchmarking



1. Occupational vulnerability

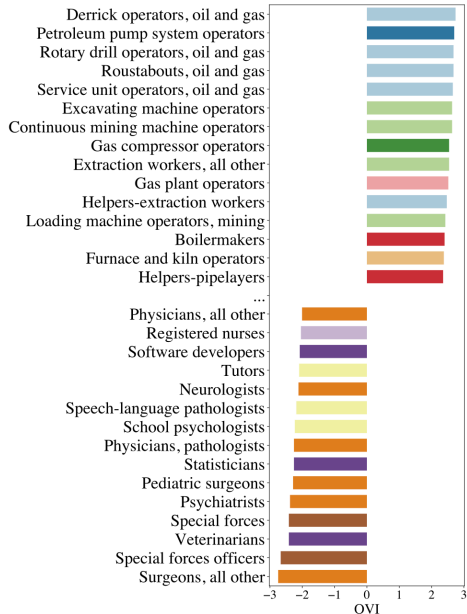


Figure 1: High and low risk occupations

Why occupations matter

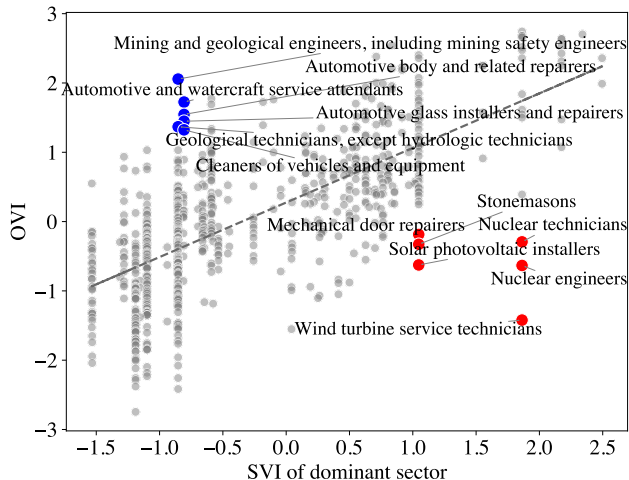


Figure 2: Why occupations matter: variability in vulnerability by sector (x-axis) et occupation (y-axis)

Not just a sectoral story

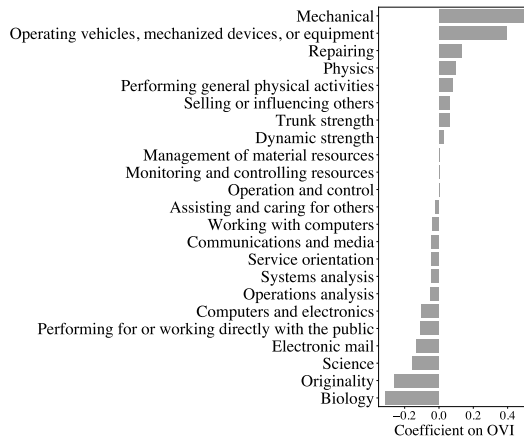


Figure 3: Skills \rightarrow Occupation (lasso). Occupational vulnerability is well explained by skills ($R^2 = 0.54$)

2. Search for suitable outside options

Where is help needed?

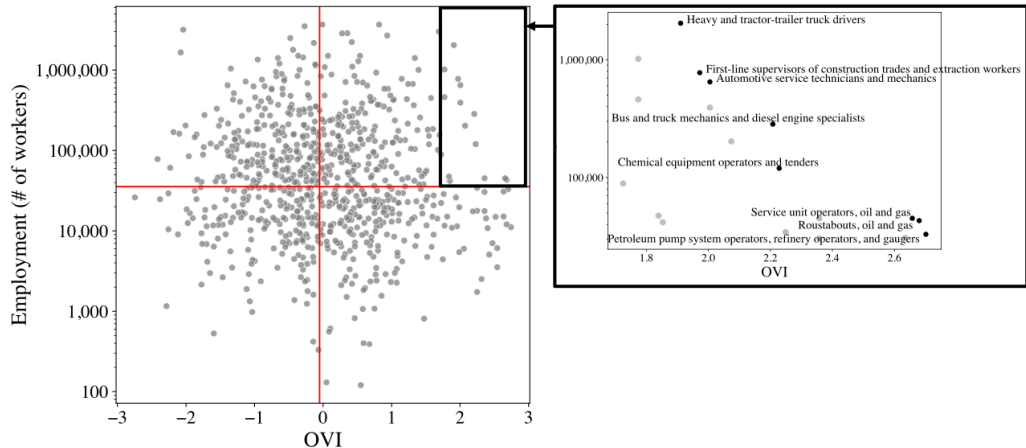
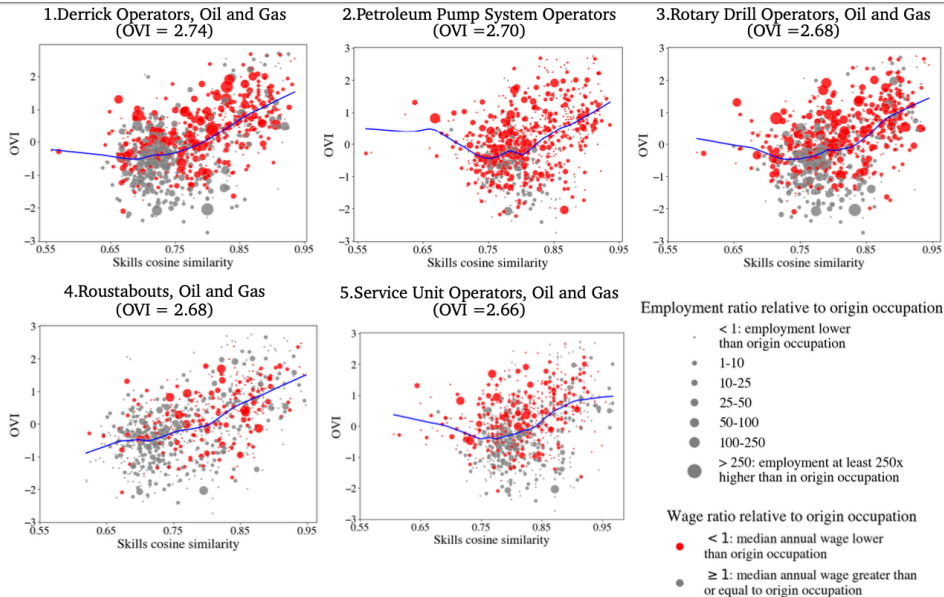


Figure 4: Set of problematic cases. What else could they do?

- Suitable outside options as a constrained optimization problem
- What we look at...
 - ▶ High **skill similarity** (Autor 2013; Moro et al. 2021)
 - ▶ Same or larger **volume** of employment
 - ▶ Low **occupational vulnerability**
 - ▶ Unconstrained: same or higher **wages**
- What we don't look at: geography, supply-side pref, licensing, etc.

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Bad news (empty set...) and **good news** (wages)

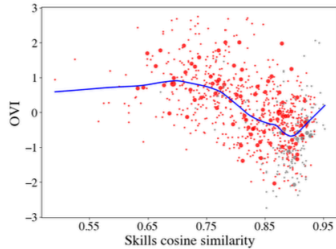


High OVI

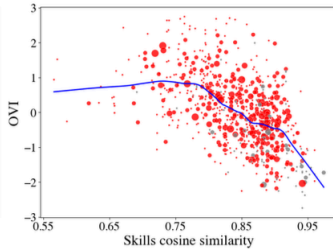
Figure 5: High risk jobs have high risk outside options

Middle and
low OVI

488.Industrial Engineers
(OVI = -0.19)



865.Veterinarians
(OVI = -2.42)



867.Surgeons, All Other
(OVI = -2.75)

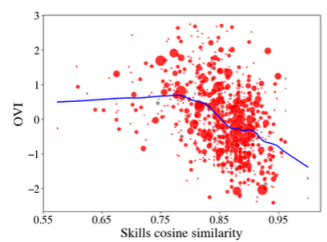


Figure 6: Low risk jobs have low risk outside options

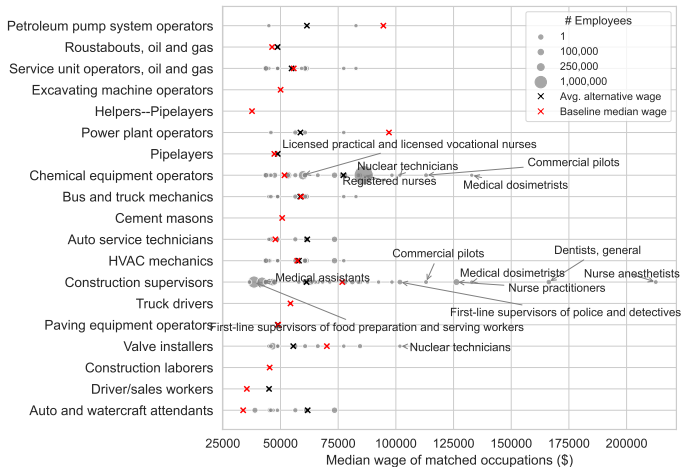


Figure 7: Good news: outside wages are generally okay

Conclusion

- **Labor markets** are key **political-economic chokepoints** for decarbonization
- **Challenge**: finding suitable new jobs for fossil-dependent workers
- This paper: (1) measures vulnerability and (2) searches for alternative occupations
- Bad news: risk of **unemployment traps** that could further fuel backlash
- How should we manage abrupt technological transitions?

Thank you!

Reference Touré, A. and M. Aklin. 2025. “Occupational Vulnerability to Fossil Fuel Phaseouts and the Search for Suitable Outside Options” *Working Paper*.

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Appendix

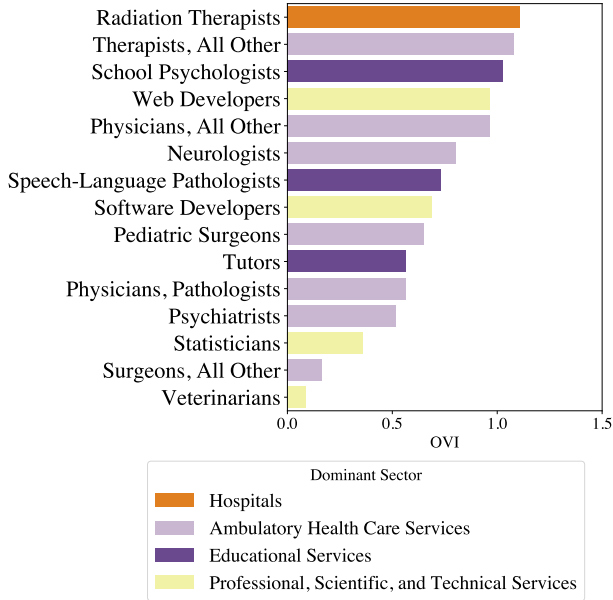


Figure 8: Low risk occupations

Macro level

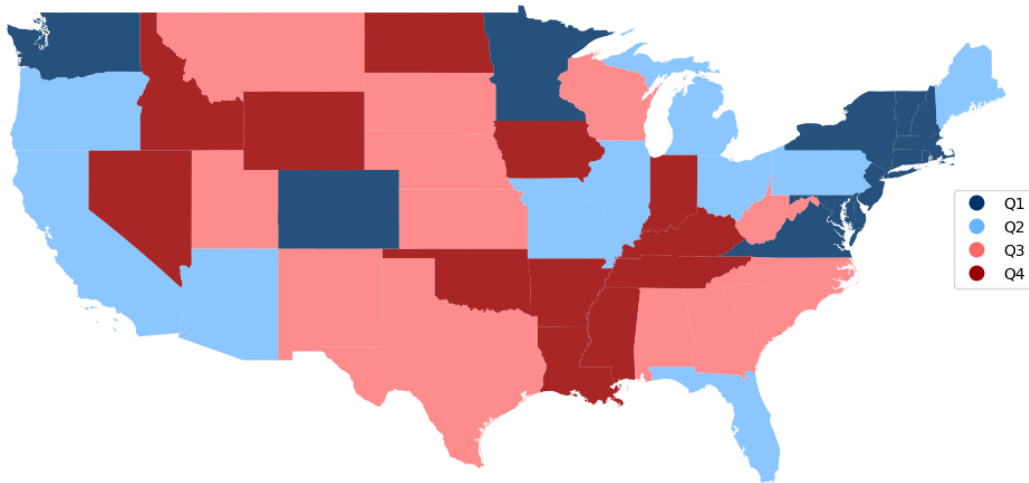
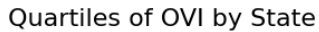


Figure 9: Why occupations matter: hidden vulnerabilities

Occupation	#Emp.	OVI	Annual median wage (\$)	Constrained match <i>Unconstrained match</i>	Skill sim.	OVI of match	#Emp. of match	Wage of match (\$)
Petroleum pump system operators	32,980	2.70	94,580	Firefighters <i>Machinists</i>	0.90 <i>0.94</i>	-0.05 <i>0.61</i>	314,960 <i>290,330</i>	57,120 <i>50,840</i>
Roustabouts, Oil and Gas	43,080	2.68	46,340	Janitors and cleaners <i>Highway maintenance workers</i>	0.88 <i>0.95</i>	-0.14 <i>0.71</i>	2,171,500 <i>150,240</i>	35,020 <i>47,360</i>
Service unit operators	45,120	2.66	55,750	Firefighters <i>HVAC mechanics</i>	0.96 <i>0.97</i>	-0.05 <i>2.01</i>	314,960 <i>393,090</i>	57,120 <i>57,300</i>
Excavating machine operators	30,770	2.64	50,050	Radiologic Tech. <i>Print binding and finishing workers</i>	0.87 <i>0.95</i>	-1.39 <i>0.47</i>	216,040 <i>38,480</i>	73,410 <i>38,100</i>
Helpers–Pipelayers	45,110	2.36	37,650	Lifeguards <i>Roofers</i>	0.87 <i>0.94</i>	-0.24 <i>1.20</i>	121,180 <i>134,860</i>	30,380 <i>50,030</i>
Power plant operators	30,400	2.36	97,010	Medical equipment repairers <i>Valve installers</i>	0.92 <i>0.95</i>	-0.88 <i>1.84</i>	63,490 <i>47,450</i>	60,670 <i>70,100</i>
Pipelayers	34,420	2.25	47,330	Telecom. equipment installers <i>Maintenance and repair workers</i>	0.88 <i>0.93</i>	-0.07 <i>0.54</i>	159,090 <i>1,501,130</i>	61,270 <i>46,700</i>
Chemical equipment operators	119,930	2.23	51,720	Veterinary technicians <i>Aircraft mechanics and service technicians</i>	0.93 <i>0.95</i>	-1.64 <i>0.66</i>	121,890 <i>137,090</i>	43,740 <i>75,020</i>

Figure 10: ‘Unconstrained’ matches are occupations with the closest skill requirements among all occupations with \geq nbr of employees. ‘Constrained’ additional limits to $OVI \leq 0$.

