Labor Market Impacts of the Green Transition

Evidence from a Contraction in the Oil Industry

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Motivation

- The net-zero transition will require a contraction in fossil fuel extraction and an expansion of green industries
- Transitional costs and distributional consequences remain uncertain
- If displaced fossil fuel workers can reallocate to green jobs, this may ease the transition
- Limited empirical evidence on skill overlap, the extent of worker transitions to green, and the associated earnings implications

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This paper

1. What are the worker-level **transitional costs** of moving away from fossil fuel extraction?

2. How do these costs **vary** across worker types?

3. Are oil workers **moving into green jobs**, and what are the associated earnings effects?

4. What **explains** the (potential) earnings gaps across destination sectors?
   - Skill mismatch? Lower-paying employers? Worker sorting?

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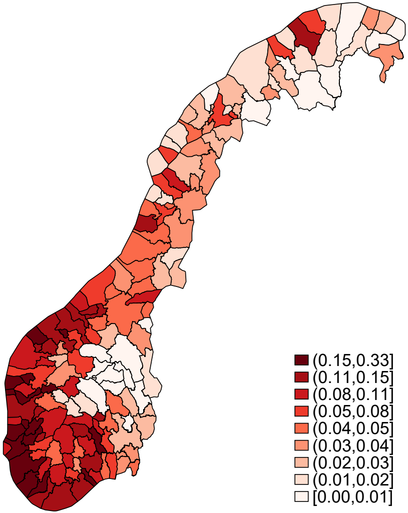
Petroleum-related employment in Norway

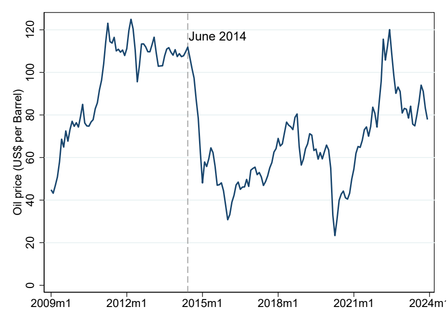
Figure 1: Oil workers as share of local labor market workforce. 2013



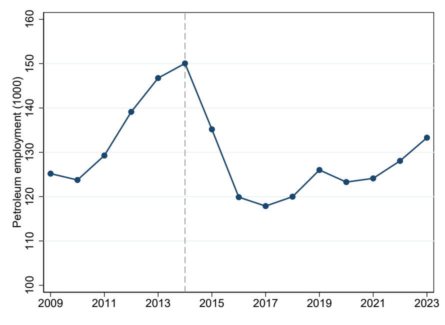
The 2014 oil price shock

- We use the 2014 oil price shock as a lens to study transitional costs for Norwegian petroleum workers

Oil price



Petroleum employment



Source: IndexMundi (a) and Statistics Norway (b).

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   - Skill mismatch? Lower-paying employers? Worker sorting?
     Employer premiums explain most; skill mismatch explains some.

Relevant literature

- **Worker-level transitional costs**
  - Trade (Autor et al., 2014; Balsvik et al., 2015), technology (Graetz and Michaels, 2017), offshoring (Hummels et al., 2014), mass-layoffs (Huttunen et al., 2018; Barreto et al., 2023, 2024; Salvanes et al., 2024), clean air act (Walker, 2013), carbon tax (Yip, 2018). Few studies on brown $\rightarrow$ green.
- **Resource booms and busts**
  - Oil, shale gas, coal (Morissette et al., 2015; Feyrer et al., 2017; Bartik et al., 2019; Katovich et al., 2022; Haywood et al., 2024; Rud et al., 2024). Geographical areas rather than workers. Mostly booms.
  - The 2014 oil price drop (Norway) (Juelsrud and Wold, 2019; Ellingsen et al., 2022; Lorentzen, 2023). Saving decisions, average effects, wage equilibrium effects.
- **Green jobs**
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Roadmap

1. Data and descriptives
2. Direct effects of the oil price shock
3. Transitional costs for displaced oil workers
4. From oil to green?

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Data

- **Linked employer-employee data** (2009-2023)
  - Job spells: start and end dates, earnings, occupation
- **Individual-level data**
  - Economic outcomes (income, wealth, transfers), demographics (age, gender, educational attainment)
- **Establishment- and firm-level data**
  - Industry code, patents, R&D, emissions, exports
  - Primarily used to classify jobs (oil, green, brown, other) - next slide
- **Key outcomes**
  1. Employment status
  2. Annual labor earnings
  3. Hourly wages*

Classification of oil, green, and brown

1. **Oil**
   - Petroleum-related industries (defined by Statistics Norway) ▸ Fig

2. **Green**
   - Renewable industries ++ (5 digit nace)
   - Green exports (env.goods) firm's green share ≥ 0.50
   - Green R&D firm's green share ≥ 0.50
   - Climate-related patents (Y02) firm's green share ≥ 0.50 ▸ Fig
   - Green skill share of occupation (ESCO) share ≥ 0.20 ▸ Fig

3. **Brown (non-oil)**
   - Firms reporting CO_2 emissions
   - EU ETS industries (5 digit nace)

- Employment shares in the overall economy:
  - Oil: 7.7%, Green: 7.9%, Brown: 3.4%, Other: 81%

▸ Maps

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Treatment and control group

- **Sample restrictions**: Full time, private sector workers aged 24-61 (measured in 2013)
- **Treatment group**: ‣ industries
  - Individuals employed in *petroleum-related* industries in 2013
- **Control group**: ‣ industries
  - Individuals employed in *non-petroleum related* industries in 2013
    - 5 digit industries with $\sim$ 0 deliveries to the oil sector (IRIS, 2015)
- **Propensity score matching** to improve pre-balance
  - 2013: labor earnings, wages, age, gender, education (1d), county
  - 2009-2013: employment status

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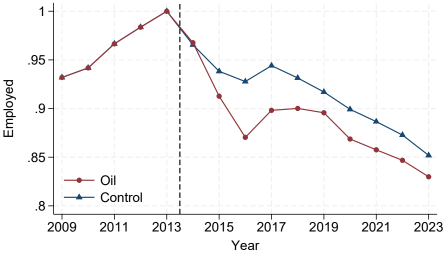
Table 1: Summary Statistics, 2013

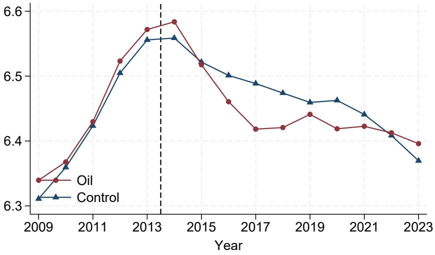
	Full sample		Matched sample	
	Oil	**Control**	**Oil**	**Control**
Female	0.18	0.36	0.19	0.19
	(0.38)	(0.48)	(0.39)	(0.39)
Age	42.92	42.43	43.35	43.43
Less than high school	0.16	0.27	0.21	0.21
	(0.37)	(0.44)	(0.40)	(0.40)
High school	0.48	0.44	0.44	0.44
	(0.50)	(0.50)	(0.50)	(0.50)
University (1-3 years)	0.20	0.21	0.22	0.22
	(0.40)	(0.41)	(0.41)	(0.41)
University (>3 years)	0.15	0.08	0.13	0.13
	(0.36)	(0.27)	(0.34)	(0.34)
Labor earnings (1000 NOK)	894	614	783	782
	(517)	(360)	(408)	(461)
Log labor earnings	6.68	6.32	6.57	6.56
	(0.47)	(0.46)	(0.42)	(0.43)
N (individuals)	108,687	578,820	70,389	70,389

Drop in employment and earnings for 2013 oil workers

Raw mean: employment



Raw mean: log labor earnings



- **Oil**: Individual employed in a petroleum-related job in 2013
- **Control**: Individual employed in a *non*-petroleum-related job in 2013

Difference-in-Differences

Dynamic DiD model:

$$Y_{it} = \beta_0 + \sum_{k=2009}^{2018} \beta_k \times 1\{t = k\} \times Oil_i + \mathbf{X}_{it}\beta + \gamma_{lt} + \lambda_i + \varepsilon_{it}$$

- Y_{it}: Labor market outcome for individual i in year t
- Oil_i: Employed in petroleum sector in 2013
- λ_i: Individual fixed effects
- γ_{lt}: Year $\times$ local labor market fixed effects
- $\mathbf{X}_{it}$: Year $\times$ age fixed effects

- s.e. clustered at the 2013 industry (5 digit)

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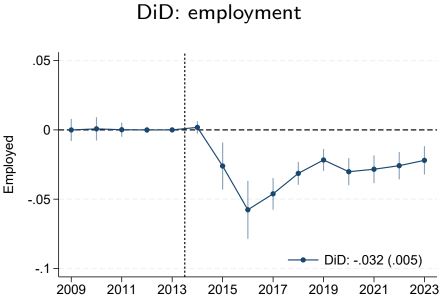
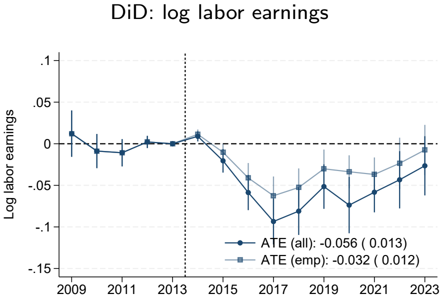
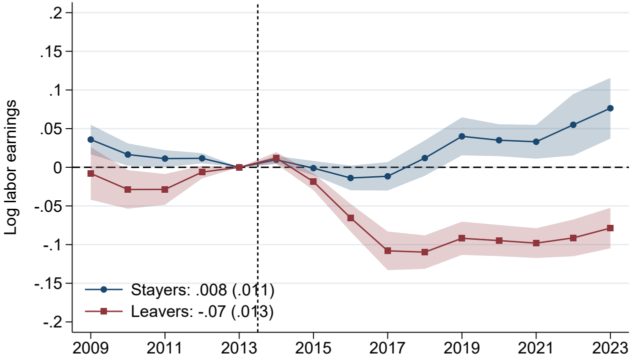




- Labor earnings drop to around -10% in 2017, but gradually recover.
- Oil workers that remain employed recover by 2023

Earnings loss for employed driven by **job change**

Figure 5: Effect on log labor earnings by wether workers stay with or leave their initial employer



- Average effects for **employed** oil workers mask substantial differences between stayers and leavers

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Event study of oil job separation

Staggered DiD around the year of **oil job separation**. Focus on workers aged 24-54 displaced between 2014 and 2018.

$$Y_{itc} = \sum_{k=-9}^{9} \delta_k \times 1\{t = c + k\} \times D_i +$$

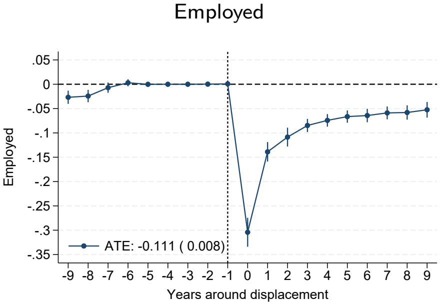
$$\sum_{k=-8}^{9} \omega_k \times 1\{t = c + k\} + \alpha_i + \pi_{tl} + \mathbf{X}_{it}\beta + \varepsilon_{itc}$$

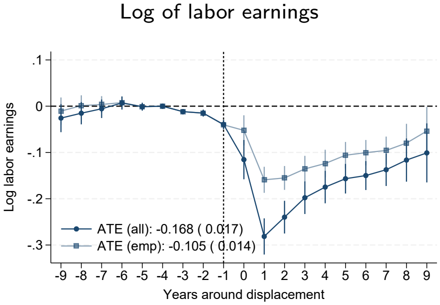
- Y_{itc}: Outcome for worker i in displacement cohort c in year t
- D_i: Indicates whether worker i is a displaced oil worker
- α_i: Individual fixed effects
- π_{tl}: Calender year $\times$ local labor market fixed effects
- $\mathbf{X}_{it}$: Calender year $\times$ age fixed effects

- Note: Each **displaced oil worker** is (re-)matched to a control worker.

▸ Summary statistics

Displacement effects on **employment** and **earnings**





- Workers separating from their 2013-oil employer (N=20,406) experience a large drop in employment probability and labor earnings
- Only partly recovery: 5% lower employment prob. and 10% lower earnings after 10 years (k=9)

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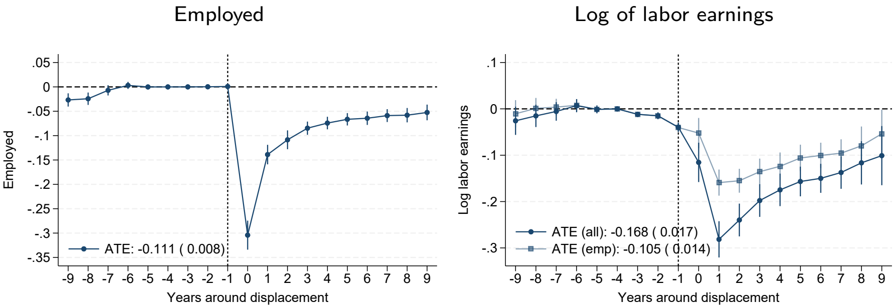

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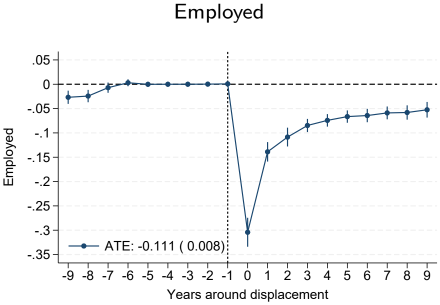

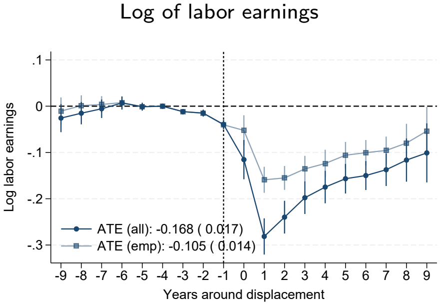

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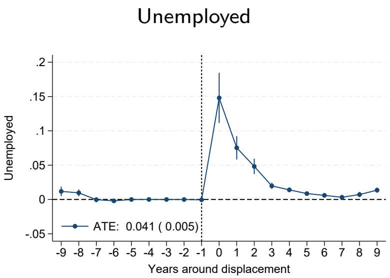
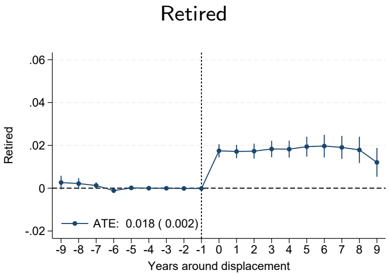
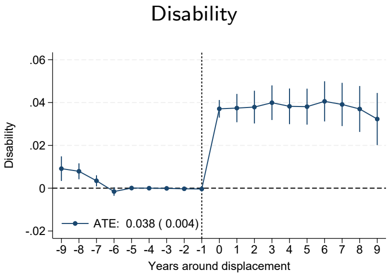
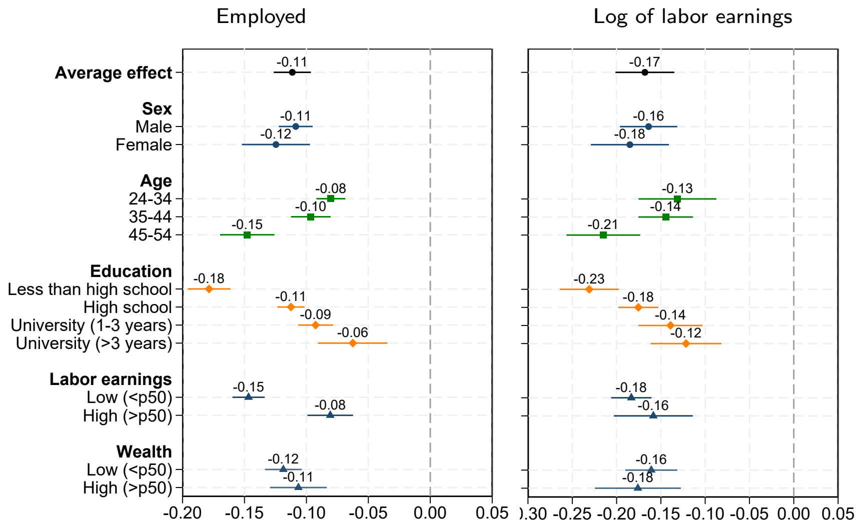
Unemployment, retirement, and disability







Older and less-educated workers worse off



Notes: Sample is restricted to individuals up to 54 years old in 2013 (64 in 2023) to mitigate the influence of early retirement

Direct effects
By occupation

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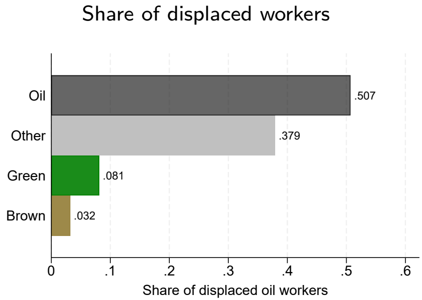
8% of displaced oil workers transition to a green job

Figure 9: Displaced Oil Workers, by Post Displacement Sector



- Most oil workers remain in oil ($\sim$ 50%)

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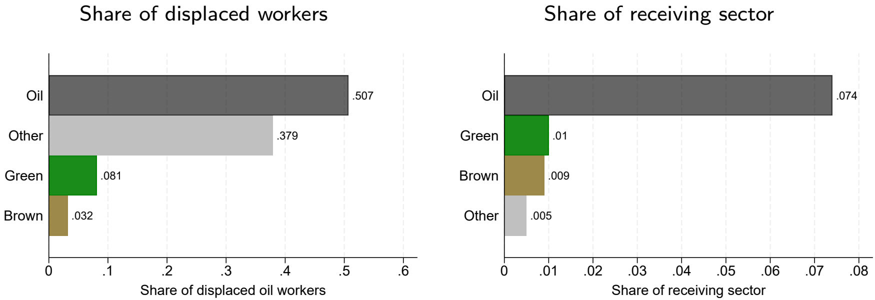
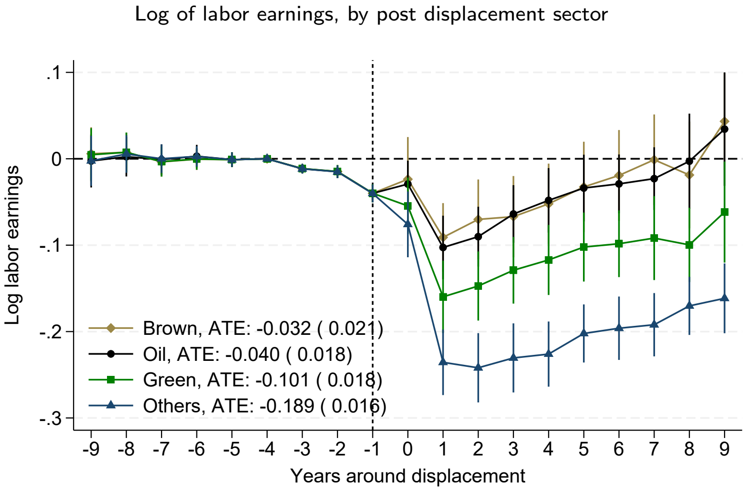


- Most oil workers remain in oil ($\sim$ 50%)
- After oil, green is the sector with the highest inflow of oil workers (scaled by sector size)

A green earnings gap relative to oil and brown



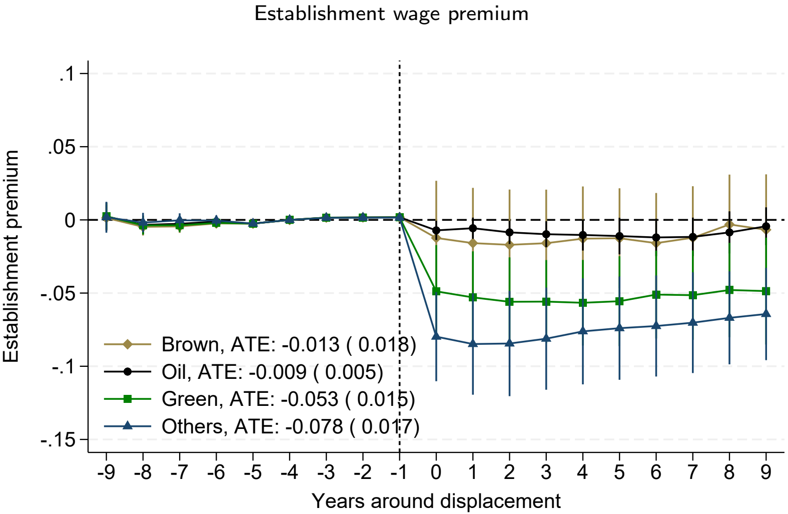
Notes: The treatment group is split into four groups based on destination sector (oil, brown, green, other) in a given post-displacement year. All four groups are compared to the same control group. Estimates are conditional on being employed in a given post-displacement year.

▸ Hourly wages

What explains the earnings gap across sectors?

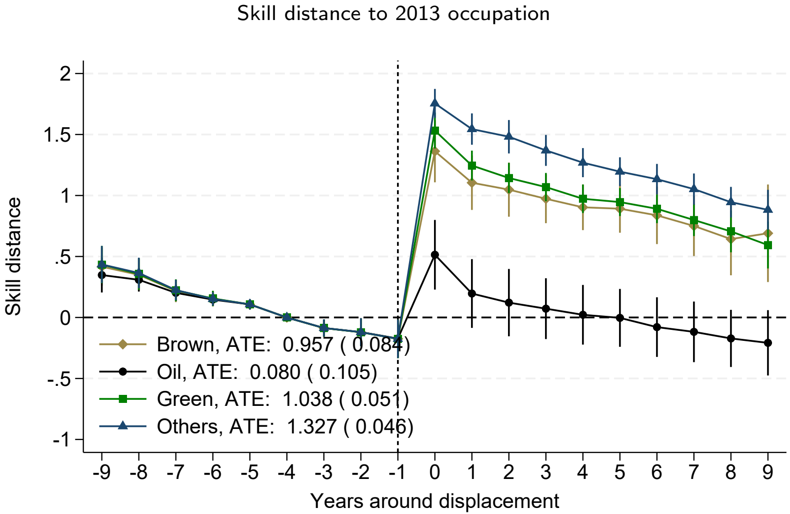
- Examine the role of two factors:
  1. **Better-paying employers** (employer wage premiums) ▸ Details
  2. **Skill distance** to 2013-oil job ▸ Details ▸ Average distance

Oil workers move to lower-paying employers



- Ranking of wage premiums: Oil > Brown > Green > Other

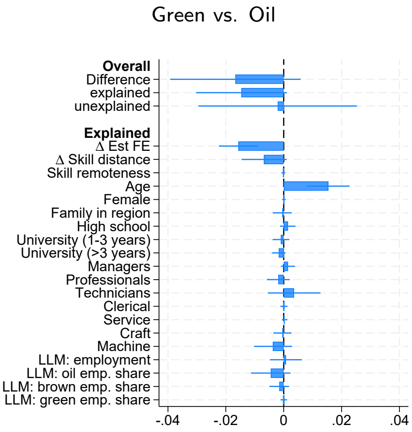
Oil workers move to jobs further away in the skill space



- Skill distance ranking: Oil > Brown > Green > Other

Explaining the earnings gap between oil and green

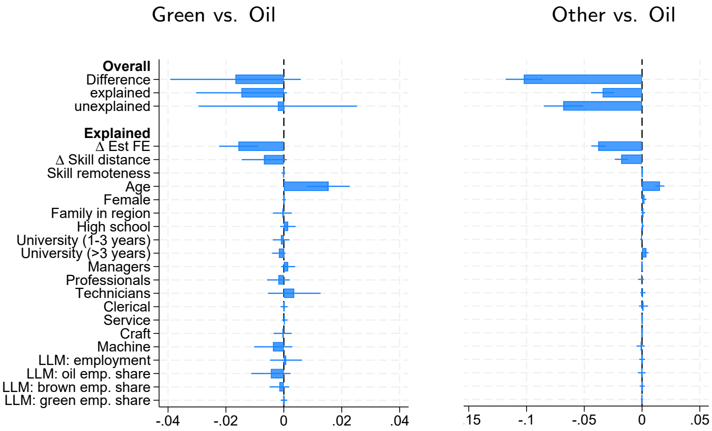
Figure 13: Oaxaca-Blinder Decomposition of log labor earnings ▸ Eq.



- **Employer premium** the single most important explanation
- **Skill distance** also plays a role (sensitive to spes.)

Explaining the earnings gap between oil and green

Figure 13: Oaxaca-Blinder Decomposition of log labor earnings ▸ Eq.



- **Employer premium** the single most important explanation
- **Skill distance** also plays a role (sensitive to spes.)

Summary

- **Displaced** oil workers experienced a substantial drop in labor earnings and employment, with only partial recovery after 10 years.
- Older, low-earning, and less-educated workers were worse off.
- Displaced oil workers transitioned disproportionately into green jobs rather than "generic" jobs – when accounting for sector size.
- Earnings losses were larger for workers switching to green jobs compared to brown jobs, but smaller compared to "generic" jobs.
- Employer wage premiums explain more of the earnings gap than skill distance.

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Conclusion

- Our findings suggest significant transitional costs for fossil fuel workers
- Targeted policies aimed at skill development alone will not fully restore prior earnings levels
- Expanding opportunities in green sectors (vs. generic) could help offset earnings losses and support labor market adjustment during the green transition.

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References I

Abowd, J. M., Kramarz, F., and Margolis, D. N. (1999). High wage workers and high wage firms. *Econometrica*, 67(2):251–333.

Autor, D. H., Dorn, D., Hanson, G. H., and Song, J. (2014). Trade adjustment: Worker-level evidence. *The Quarterly Journal of Economics*, 129(4):1799–1860.

Balsvik, R., Jensen, S., and Salvanes, K. G. (2015). Made in China, sold in Norway: Local labor market effects of an import shock. *Journal of Public Economics*, 127:137–144.

Barreto, C., Fluchtmann, J., Hijzen, A., and Puymoyen, A. (2024). *OECD Employment Outlook 2024: The Net-Zero Transition and the Labour Market*, chapter Job displacement in high-emission industries: Implications for the net-zero transition. OECD Publishing, Paris.

Barreto, C., Grundke, R., and Krill, Z. (2023). The cost of job loss in carbon-intensive sectors: Evidence from Germany. OECD Economics Department Working Papers No 1774.

Bartik, A. W., Currie, J., Greenstone, M., and Knittel, C. R. (2019). The local economic and welfare consequences of hydraulic fracturing. *American Economic Journal: Applied Economics*, 11(4):105–55.

Curtis, E. M. and Marinescu, I. (2022). Green energy jobs in the us: What are they, and where are they? Working Paper 30332, National Bureau of Economic Research.

Ellingsen, J., Espegren, C., et al. (2022). Lost in transition? Earnings losses of displaced petroleum workers. Centre for Applied Macroecomics and Commodity Prices (CAMP) Working Paper Series No 6/2022. Technical report.

References II

Feyrer, J., Mansur, E. T., and Sacerdote, B. (2017). Geographic dispersion of economic shocks: Evidence from the fracking revolution. *American Economic Review*, 107(4):1313–34.

Godøy, A. and Isaksen, E. (2025). A green wage premium? *Unpublished working paper*.

Graetz, G. and Michaels, G. (2017). Is modern technology responsible for jobless recoveries? *American Economic Review*, 107(5):168–73.

Haywood, L., Janser, M., and Koch, N. (2024). The welfare costs of job loss and decarbonization: Evidence from Germany's coal phaseout. *Journal of the Association of Environmental and Resource Economists*, 11(3):577–611.

Hummels, D., Jørgensen, R., Munch, J., and Xiang, C. (2014). The wage effects of offshoring: Evidence from Danish matched worker-firm data. *American Economic Review*, 104(6):1597–1629.

Huttunen, K., Møen, J., and Salvanes, K. G. (2018). Job loss and regional mobility. *Journal of Labor Economics*, 36(2):000–000.

IRIS (2015). Industribyggerne 2015. Available at: https://www.menon.no/wp-content/uploads/23industribyggerne-2015-rapport-iris-2015-031-230315.pdf.

Juelsrud, R. E. and Wold, E. G. (2019). The saving and employment effects of higher job loss risk. *Working paper*, (17/2019).

Katovich, E., Parker, D., and Poelhekke, S. (2022). Labor reallocation, human capital investment, and "stranded careers": Evidence from an oil boom and bust. Technical report, Working Paper.

References III

Lorentzen, L. (2023). The domino effects: Understanding sectoral reallocation and its wage implications. Technical report, BI Norwegian Business School.

Morissette, R., Chan, P. C. W., and Lu, Y. (2015). Wages, youth employment, and school enrollment recent evidence from increases in world oil prices. *Journal of Human Resources*, 50(1):222–253.

Rud, J.-P., Simmons, M., Toews, G., and Aragon, F. (2024). Job displacement costs of phasing out coal. *Journal of Public Economics*, 236:105167.

Salvanes, K. G., Willage, B., and Willén, A. (2024). The effect of labor market shocks across the life cycle. *Journal of Labor Economics*, 42(1):121–160.

Saussay, A., Sato, M., Vona, F., and O'Kane, L. (2022). Who's fit for the low-carbon transition? Emerging skills and wage gaps in job ad data.

Vona, F., Marin, G., Consoli, D., and Popp, D. (2018). Environmental regulation and green skills: An empirical exploration. *Journal of the Association of Environmental and Resource Economists*, 5(4):713–753.

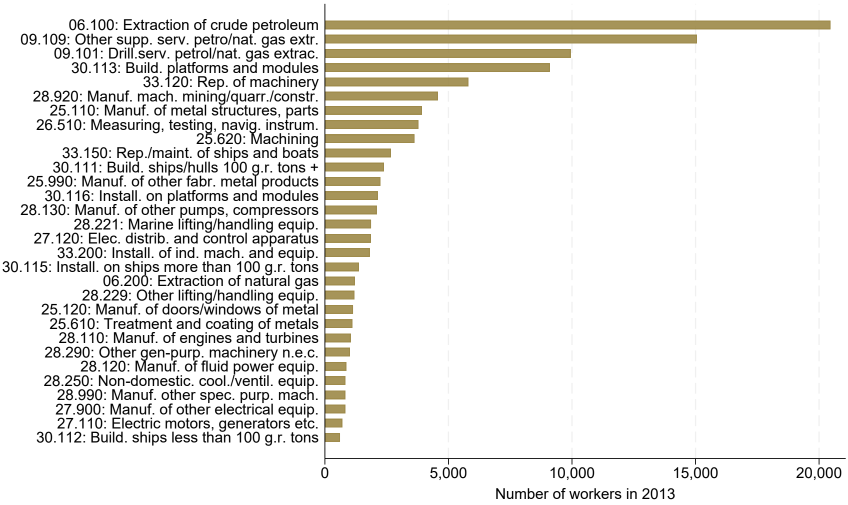
Walker, W. R. (2013). The transitional costs of sectoral reallocation: Evidence from the Clean Air Act and the workforce. *The Quarterly Journal of Economics*, 128(4):1787–1835.

Yip, C. M. (2018). On the labor market consequences of environmental taxes. *Journal of Environmental Economics and Management*, 89:136–152.

Appendix

Petroleum-related employment, by industry ▸ Back

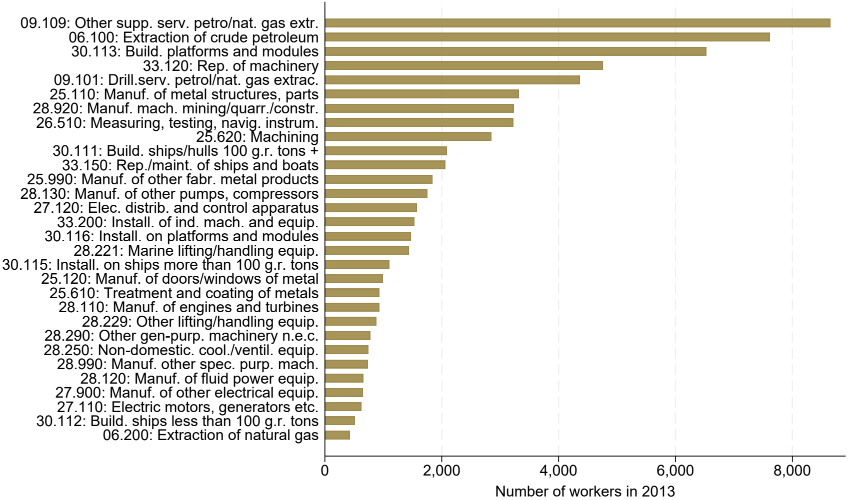
Figure 14: Number of workers in oil, by industry **Full sample**



Petroleum-related employment, by industry

Back

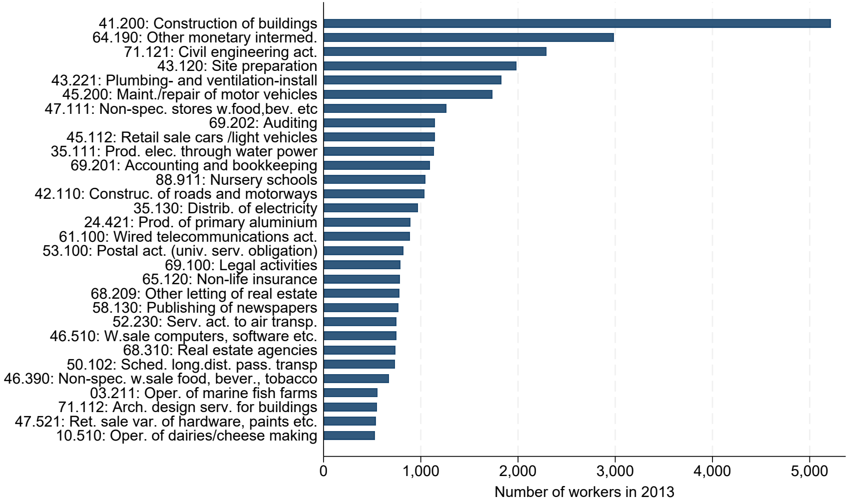
Figure 15: Number of workers in oil, by industry **Matched sample**



Non-petroleum related employment, by industry

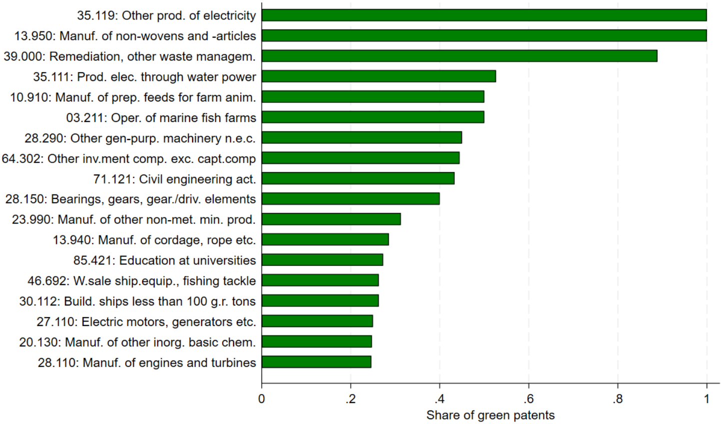
Back

Figure 16: Number of workers in non-oil, by industry **Matched sample**



Green patent share of industry ▸ Back

Figure 17: Green patent share, by industry.

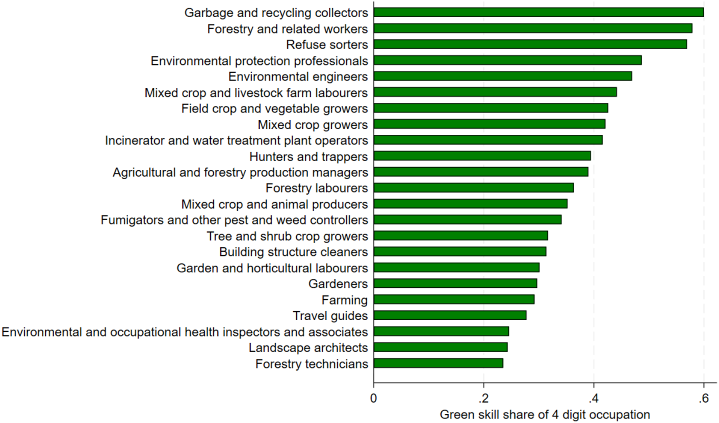


Notes: Figure only displays 5 digit industries with a green patent share larger than 20 percent. The green patent share is based on the average share of green patent applications 1990-2017. A patent is tagged as green if it has the Y02 tag.

Green skill share of occupation

▸ Back

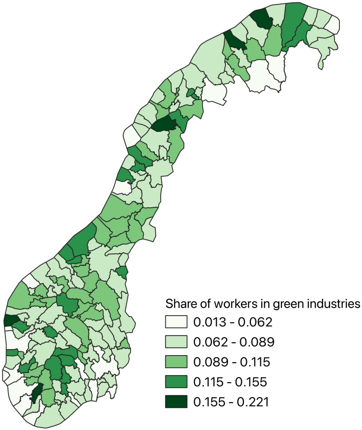
Figure 18: Green skill share, by 4 digit occupation.



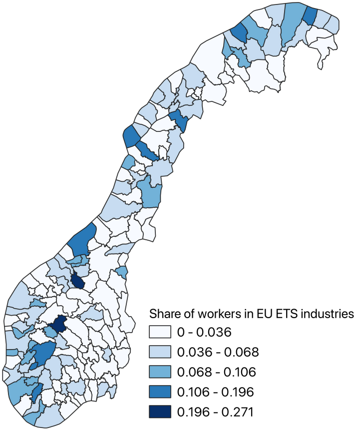
Notes:

Figure 19: Green and brown workers as share of local labor market workforce

(a) Green workers

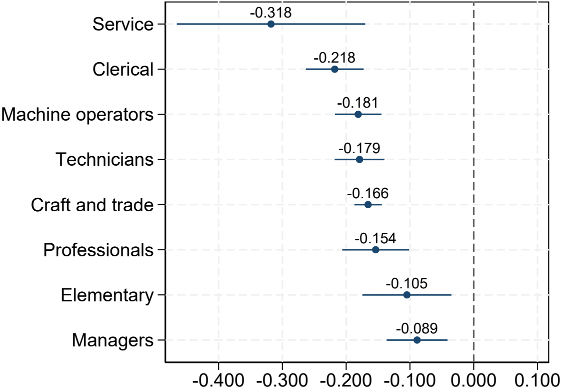


(b) Brown (non-oil) workers



Heterogeneous effects across occupation

Figure 20: Effect on log labor earnings, by occupation (in 2013)



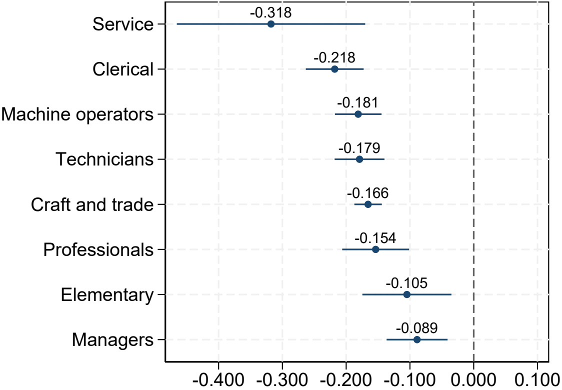
Notes: **Professionals** (university/academic): occupations that require a university degree. **Clerical** support workers: e.g., accounting, insurance, logistics. **Craft and trade**: e.g., carpenters, painters, mechanics. **Technicians** (college): occupations that require college degree. **Elementary**: e.g., cleaners, kitchen assistant.

- No clear pattern. Managers and Elementary best off

Direct effects Back

Heterogeneous effects across occupation

Figure 20: Effect on log labor earnings, by occupation (in 2013)



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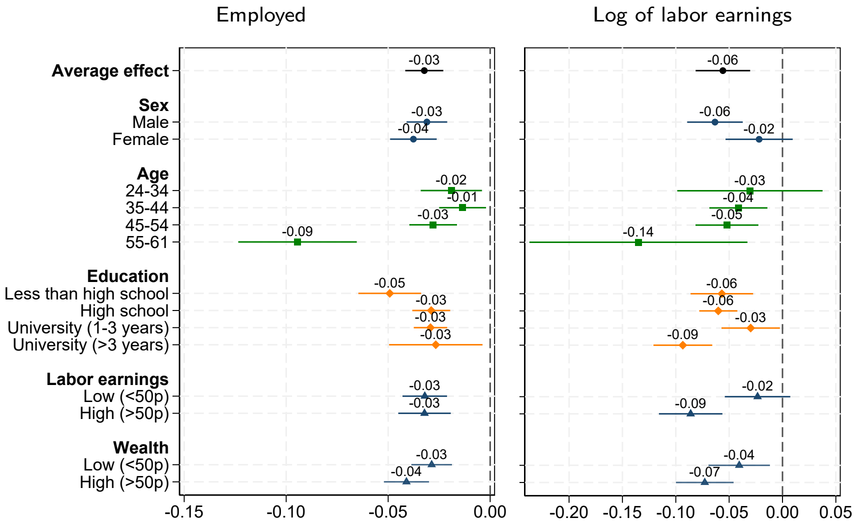
- No clear pattern. Managers and Elementary best off

Direct effects Back

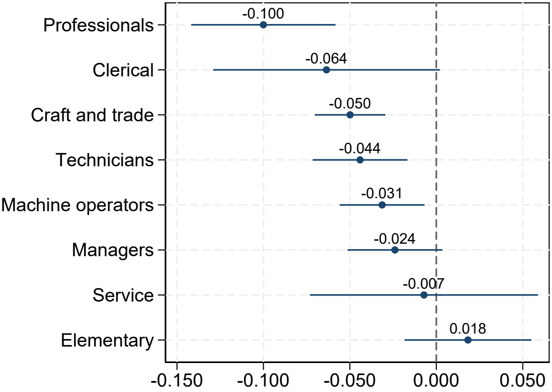
Older and Univ 3+ workers worse off

Baxk



Heterogeneous effects across occupation ▸ Back

Figure 22: Effect on log labor earnings, by occupation (in 2013)

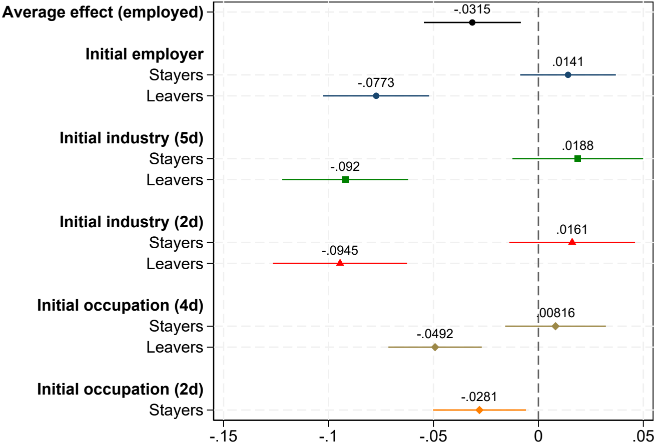


Notes: **Professionals** (university/academic): occupations that require a university degree. **Clerical** support workers: e.g., accounting, insurance, logistics. **Craft and trade**: e.g., carpenters, painters, mechanics. **Technicians** (college): occupations that require college degree. **Elementary**: e.g., cleaners, kitchen assistant.

- Some indication of high-skilled occupations (Professionals) worse off

Stayers vs. leavers: industry matters more than occ

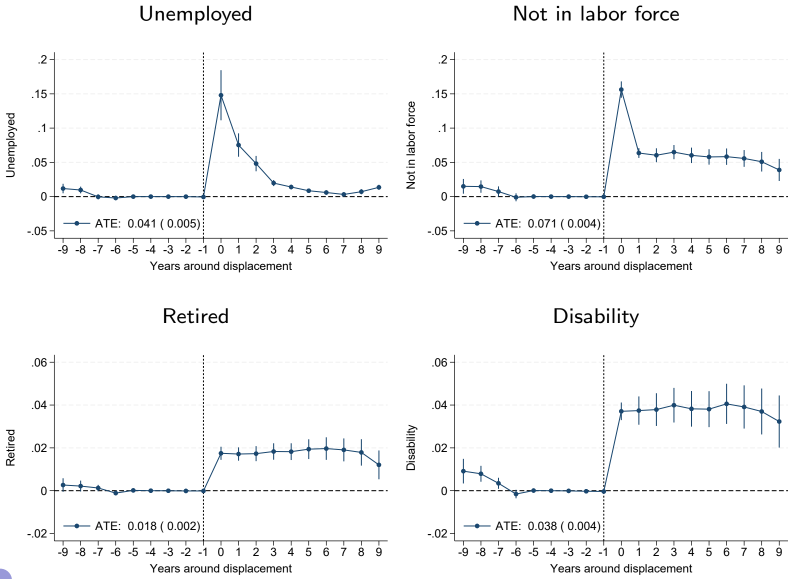
Figure 23: Effect on log labor earnings.



Notes: Effects are conditional on employment 2014-2018. Treatment group is split in two (stayers, leavers) based on employment in the post period. Stayers and leavers are compared to the same control group.

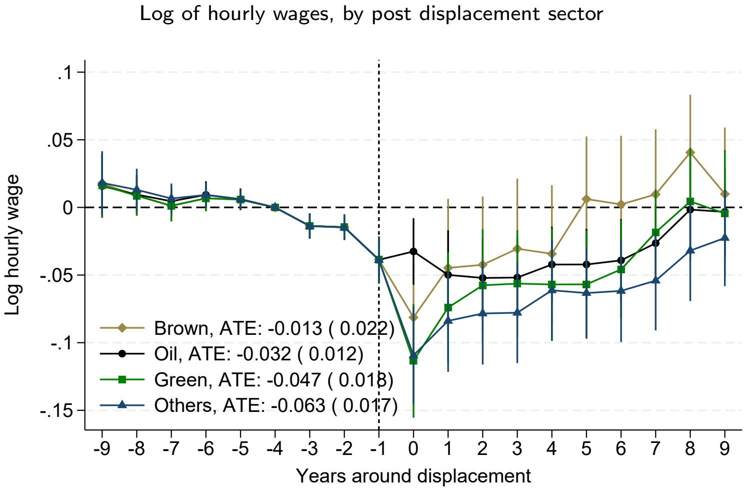
Back

Unemployment and labor market exit



▸ Back

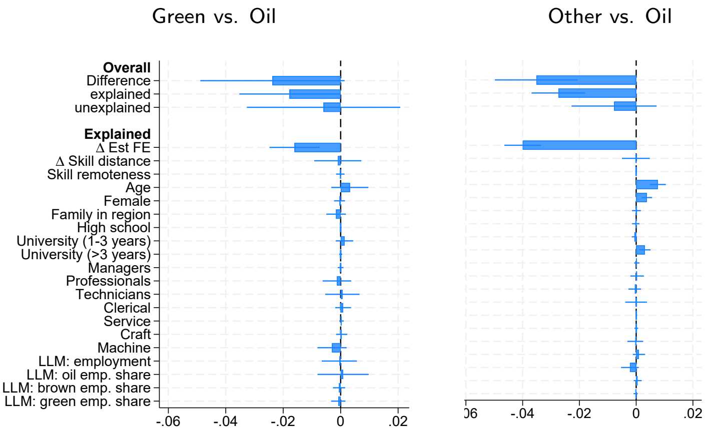
A green wage gap relative to brown ▸ Back



Notes: The treatment group is split into four groups based on destination sector (oil, brown, green, other) in a given post-displacement year. All four groups are compared to the same control group. Estimates are conditional on being employed in a given year 2014-2018.

Explaining the hourly wage gap between green and oil

Figure 26: Oaxaca-Blinder Decomposition of Log Hourly Wages ▸ Back



- Employer premium accounts for 68% of the green-oil earnings gap
- Skill distance has little explanatory power

Oaxaca-Blinder decomposition ▸ Back

$$\Delta\bar{y}_i^{\text{Oil}} - \Delta\bar{y}_i^{\text{Non-oil}} = \underbrace{(X^{\text{Oil}} - X^{\text{Non-oil}})\hat{\beta}^{\text{Non-oil}}}_{\textit{Explained}} + \underbrace{X^{\text{Oil}}(\hat{\beta}^{\text{Oil}} - \hat{\beta}^{\text{Non-oil}})}_{\textit{Unexplained}}$$

- The first term on the RHS ("explained") measures the part of the gap that can be accounted for by observable differences in worker and job characteristics across the groups.
- The second term on the RHS represents the part of the gap that cannot be attributed to observable differences in characteristics.

Table 2: Summary Statistics (2013) ▸ Back

	Full sample DiD		Matched sample DiD		Matched sample Event	
	Oil	Control	Oil	Control	Oil	Control
Female	0.18	0.36	0.19	0.19	0.18	0.18
	(0.38)	(0.48)	(0.39)	(0.39)	(0.39)	(0.39)
Age	42.92	42.43	43.35	43.43	42.31	42.32
	(9.99)	(10.21)	(9.98)	(9.94)	(8.18)	(8.29)
Less than high school	0.16	0.27	0.21	0.21	0.15	0.15
	(0.37)	(0.44)	(0.40)	(0.40)	(0.36)	(0.36)
High school	0.48	0.44	0.44	0.44	0.51	0.51
	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)
University (1-3 years)	0.20	0.21	0.22	0.22	0.22	0.22
	(0.40)	(0.41)	(0.41)	(0.41)	(0.41)	(0.41)
University (>3 years)	0.15	0.08	0.13	0.13	0.13	0.13
	(0.36)	(0.27)	(0.34)	(0.34)	(0.33)	(0.33)
Employed	1.00	1.00	1.00	1.00	1.00	1.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Labor earnings (1000 NOK)	894	614	783	782	803	820
	(517)	(360)	(408)	(461)	(449)	(517)
N (individuals)	108,687	578,820	70,389	70,389	20,406	20,406

Employer wage premiums ▸ Back

- We estimate the AKM-model (Abowd et al., 1999) using the **universe** of full-time employees in 2009–2023.

$$ln(w_{it}) = \alpha_i + \psi_{j(i,t)} + X'_{it}\beta + \theta_t + \varepsilon_{it} \quad (1)$$

- $ln(w_{it})$ is log of hourly wages
- $\psi_{J(i,t)}$ is a vector of establishment fixed effects, capturing the wage premium paid by establishment j

Skill distance to 2013 oil job ▸ Back

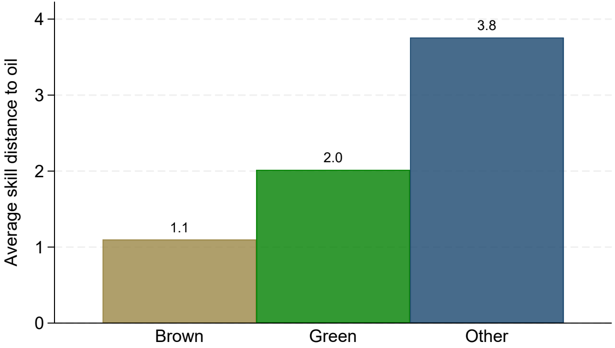
- $s = 1, ..., S$ denotes skills , $j = 1, ..., J$ index jobs.
- l_{js} denotes the level of skill s demanded by job j.
- $job_j = [l_{j1}, ..., l_{jS}]$: job as a vector of length S:
- The (Euclidean) skill distance between two jobs, j and j':

$$d_{jj'} = \sqrt{\sum_{s=1}^{S}(l_{js} - l_{j's})^2} \tag{2}$$

- Here: skill distance between occupations
- Data: the Occupational Information Network (O*NET)
- For each occ, 35 skills are assigned an importance score [1,5]

Average skill distance to oil (2013) ▸ Back

Figure 27: Skill distance between oil jobs and brown, green, and other jobs



Notes: Figure shows the average, employment-weighted skill distance between workers in oil jobs and workers in brown, green, and other jobs using employer-employee data from 2013. Skills are based on the 35 skills defined by O*NET. Occupations are based on the STYRK-08 classification, which again is based in the ISCO-08 classification. Skill distance is calculated as the Euclidean distance.

▸ Distribution of skill distance

Histogram of skill distance ▸ Back

Figure 28: Histogram of skill distance

Notes: Figure shows the distribution of the skill distance between 349 occupations. Skills are based on the 35 skills defined by O*NET. Occupations are based on the STYRK-08 classification, which again is based in the ISCO-08 classification. Skill distance is calculated as the Euclidean distance.