

Carbon Prices and the Skill Premium

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The views expressed here are those of the authors, and not necessarily those of the Norges Bank.

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- Which climate policy & at which intensity?
- Internalize negative externalities \Rightarrow Lower carbon emissions
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We study how **higher EU ETS carbon price** affects **workers**

- Consequences for employees are important for the welfare and firm performance
- Being a market-based policy, ETS allows firms to use different margins of adjustment
- Ex ante, the effect is not obvious!

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→ Two channels interact with each other
4. No effects on hiring/separation

- **Climate policies:**

EU ETS & Firm behavior: Decline in emissions without a worsening in performance (Martin et al. 2014, Calel&Dechezlepretre 2016, Marin et al. 2018, Bolton et al. 2023, Dechezlepretre et al. 2023, Colmer et al. 2024)

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- Determinants of wage differences among workers and firms (Acemoglu 1998, Autor et al. 2003, Acemoglu et al. 2012)

→ Carbon prices may influence these differences due to skills and policy design

→ Importance of the design of the carbon market

The EU ETS is a cap-and-trade program

- The EU sets an annual emission amount and issues allowances accordingly
 - 40% of emissions in the EU
 - Phase 1 (2005-2007), Phase 2 (2008-2012), Phase 3 (2013-2020), Phase 4 (2021-2030)
- Phase 3: Single, EU-wide cap on emissions in place of the previous system of national caps
- Main participation criteria: Installation's thermal input capacity of more than 20 MW
- Firms submit their allowances by April 30 for the previous year
 - Participants can keep or sell their unused permits
 - Not submitting leads to a fine of 100 euros per tonne + allowance

European Union Emissions Trading System

Permits are distributed freely or via an auction

- In Phase 3, 43% of allowances are allocated for free. The rest is auctioned.
- Free allocation = Historical activity \times Benchmark \times Carbon leakage \times Linear reduction

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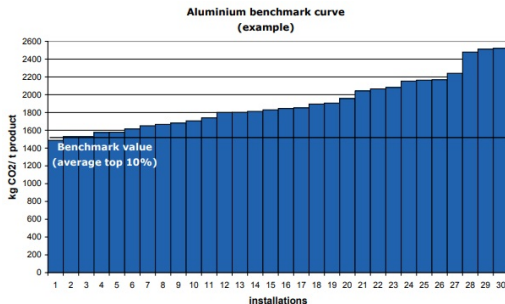
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- Carbon leakage: Sectors exposed to carbon leakage receive higher free allowances.

Share of free allocation calculated based on benchmarks per sector	2013	2014	2015	2016	2017	2018	2019	2020
Electricity production	0%	0%	0%	0%	0%	0%	0%	0%
Industry sectors	80%	72.9%	65.7%	58.6%	51.4%	44.2%	37.1%	30%
Industry sectors deemed exposed to carbon leakage	100%	100%	100%	100%	100%	100%	100%	100%

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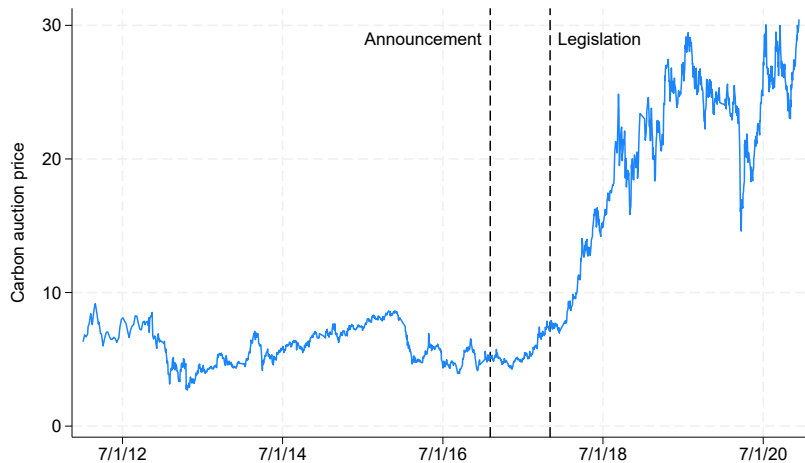
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- Carbon leakage: Sectors exposed to carbon leakage receive higher free allowances.
- Linear reduction reduces total allowances every year

Year	2013	2014	2015	2016	2017	2018	2019	2020
Linear reduction factor (electricity generators)	1	0.9826	0.9652	0.9478	0.9304	0.9130	0.8956	0.8782
Cross sectoral correction factor (non-electricity generators)	0.9427	0.9263	0.9098	0.8930	0.8761	0.8590	0.8417	0.8244

- ETS, labor market, firm characteristics, individual characteristics
 1. ETS transactions log: Carbon emissions, free allowances (EUTL)
 2. Labor market: Wage components, hours obtained from employee-employer matched data (CBS)
 3. Firm characteristics: Balance sheet, income statement, sector (CBS)
 4. Individual characteristics: Education, age (CBS)
 5. We manually match EUTL variables with CBS variables
- 2014-2020 (Phase 3), annual

- The carbon price until 2017 was deemed to be too low to incentivize the firms (€5)
 - Low economic activity & structural oversupply
- In 2015, the Market Stability Reserve (MSR) is announced to start operations in 2019
 - MSR's main purpose is to absorb the oversupply of allowances
- In Feb 2017, the EU increases the MSR's absorption capacity significantly
 - Absorption of 24% of unused allowances instead of 12% if unused is above a threshold
 - Permanent cancellation of allowances
 - Legally introduced in Nov 2017
- These changes have increased the carbon prices in ETS substantially!

Carbon Prices



- Firm's profit

$$p \times f(A_f, L_{ft}, K_{ft}) - w_{ift} L_{ft} - p_c \times (C_{ft}(A_f) - F_s)$$

Conceptual Framework

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$$p \times f(A_f, L_{ft}, K_{ft}) - w_{ift} L_{ft} - p_c \times (C_{ft}(A_f) - F_s)$$

- Nash bargaining determines the wages, yielding:

$$\max_{w_i} (w_i - \omega_i)^\beta (V_j(p_c) + V_i(p_c) - w_i)^{(1-\beta)}$$

where w_i : salary; ω_i : outside option; V_j : Firm-level surplus; V_i : Worker-level surplus

- Straightforward to show that

$$\frac{\partial w_i}{\partial V_j} > 0; \quad \frac{\partial w_i}{\partial V_i} > 0; \quad \frac{\partial w_i}{\partial V_i} \Rightarrow \omega_i \uparrow$$

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- p_c can increase OR decrease firm surplus, hence wages
- Workers related to carbon efficiency can have higher wages
→ Especially workers with better outside options

Exploit the increase in carbon prices in a matched difference-in-differences setting:

$$y_{it} = \beta ETS_i \times Post_t + \gamma_i + \delta_t + \epsilon_{it}$$

Event-study version:

$$y_{it} = \sum_{\tau=-3}^3 \beta_{\tau} ETS_i \times \mathbb{1}(t = t^* + \tau) + \gamma_i + \delta_t + \epsilon_{it}$$

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- Worker level: matching on two lags of log(wage), age, part-time, tenure, and gender dummies
- Firm level: matching on industry, log(# employees), and profits per worker

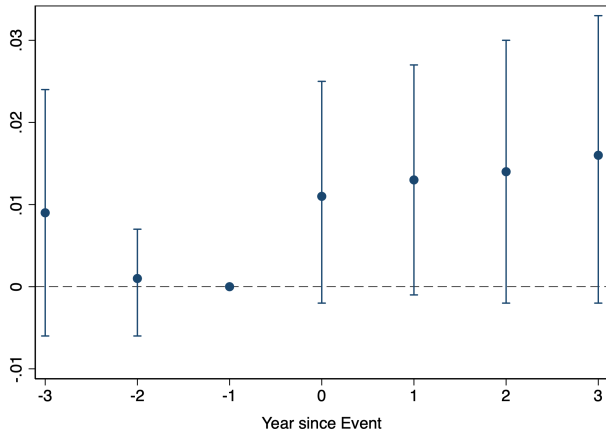
Balance Test

- ETS firms are larger and more profitable, workers are older and earn more
- Differences insignificant after matching

<i>Sample:</i> Variable	Full Sample			Matched Sample		
	Control	Treated	Difference	Control	Treated	Difference
Age _{t-1}	42.82 (0.125)	44.395 (0.408)	1.575 (0.426)	45.166 (0.218)	45.173 (0.272)	0.007 (0.348)
log(Wage _{t-1})	10.302 (0.020)	10.796 (0.040)	0.494 (0.045)	10.84 (0.035)	10.876 (0.026)	0.036 (0.044)
log(Wage _{t-2})	10.257 (0.020)	10.756 (0.037)	0.498 (0.042)	10.804 (0.032)	10.833 (0.025)	0.029 (0.040)
log(Size)	5.461 (0.133)	8.382 (0.330)	2.921 (0.355)	6.286 (0.152)	6.248 (0.127)	-0.038 (0.198)
Profits/Employment	20.33 (1.255)	48.759 (13.779)	28.429 (13.798)	79.800 (12.304)	68.625 (11.806)	-11.175 (17.028)
N	2,868,897	162,543	3,031,440	23,001	23,001	46,002

Baseline Effect

- Virtually no effect on wages
- Coefficients small in magnitude and insignificant



Carbon Price Shock, Cash Flows, and Wages

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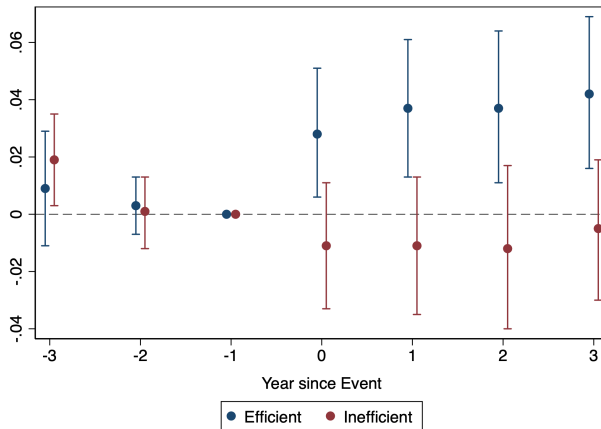
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- We sort firms in quartiles, going from the firms with highest surplus (efficient) to the firms with the highest deficit (inefficient)

Sorting by Efficiency – Event-Study Results

- Fairly large, positive effect on wages for efficient firms
- Conversely, inefficient firms experience negative effects (albeit insignificant)



Sorting by Efficiency – Results

- Significant effects on wages and hourly wages; marginally significant for earnings, but only for efficient firms

Sample:	All				Efficient				Inefficient			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
ETS×Post	0.009 (0.006)	0.009 (0.008)	928.0* (525.3)	0.006 (0.004)	0.029*** (0.010)	0.025** (0.010)	1145.0* (623.7)	0.001 (0.007)	-0.012 (0.010)	-0.024 (0.017)	-436.9 (1246.1)	-0.001 (0.007)
Observations	313,316	313,316	322,014	322,014	82,366	82,366	84,350	84,350	75,607	75,607	77,812	77,812
R ²	0.932	0.846	0.844	0.399	0.935	0.863	0.865	0.400	0.933	0.840	0.845	0.390
Dep. Var.	$\log(\frac{\text{Wage}}{\text{Hours}})$	$\log(\text{Wage})$	Earnings	Employed	$\log(\frac{\text{Wage}}{\text{Hours}})$	$\log(\text{Wage})$	Earnings	Employed	$\log(\frac{\text{Wage}}{\text{Hours}})$	$\log(\text{Wage})$	Earnings	Employed

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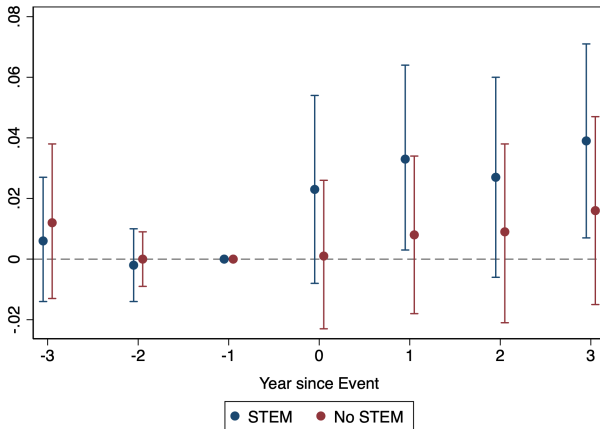
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- The increase in their “market value” is likely to be reflected in higher wages



Education – Event-Study Results

- Positive effect of shock on wages only for STEM workers
- Small and insignificant for all the others



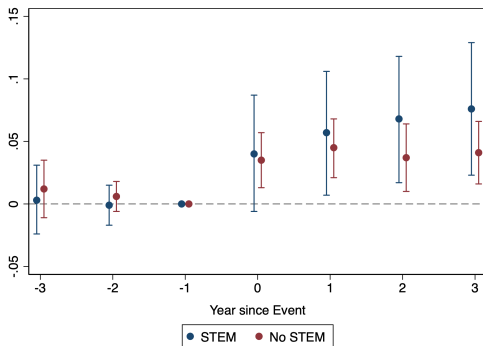
Education vs Firm Efficiency

- Are results driven by STEM workers being concentrated in efficient firms?

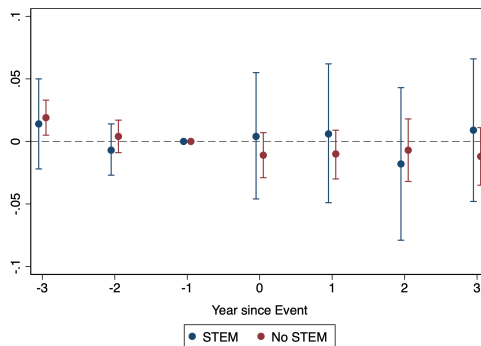
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- No: Effects are distinct

A. Efficient Firms



B. Inefficient Firms

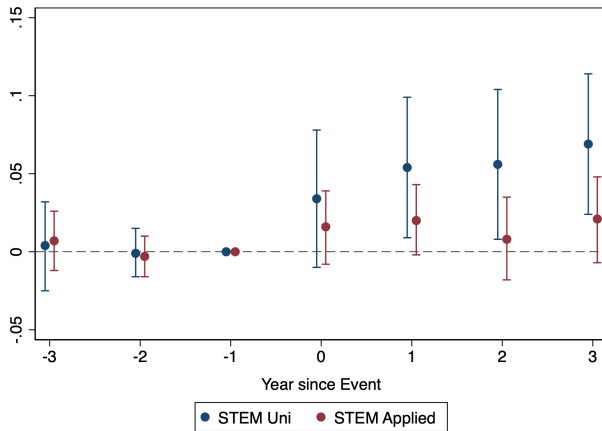


Education – Zooming in on STEM Workers

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- Between STEM workers, we can also distinguish between graduates from research and technical universities
- Results larger for the former



- Null effects for Non-STEM graduates, similar to workers with no degrees at all
- Only STEM workers benefit from increase in carbon price

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ETS \times Post	0.010 (0.006)	0.014 (0.011)	0.028 (0.015)	0.006 (0.010)	0.008 (0.011)	0.026** (0.012)	0.050** (0.018)	0.012 (0.010)
Observations	98,779	80,167	32,435	47,732	49,332	30,835	12,261	18,574
R ²	0.905	0.912	0.907	0.906	0.911	0.916	0.912	0.908
Sample	No Degrees	Some Uni	Uni	Appl. Sc.	No STEM	STEM	STEM Uni	STEM Appl.

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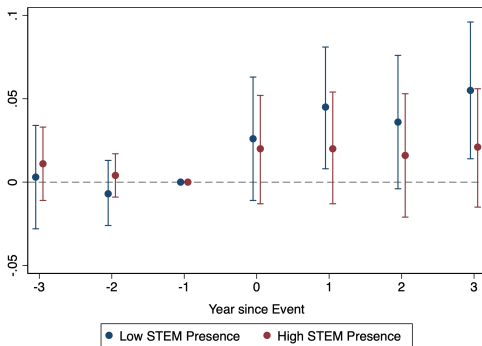
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 - Intuition: Threat of quitting more credible

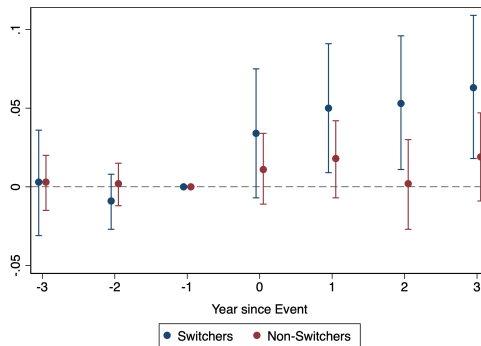
Outside Options – Results

- Distinguish workers between:
 - A. High vs low density of STEM graduates
 - B. Switchers vs non-switchers

A. Sorting by Density of STEM Graduates



B. Job Switchers vs Non-Switchers



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- Two approaches to test whether increase in carbon price leads to changes in the extensive margin:
 1. Look at changes in the fraction of STEM workers (columns 1 and 2)
 2. Look at likelihood that a hired/separated worker is STEM (columns 3 and 4)
- No significant effects
- Suggests that, in the short run, labor supply is quite inelastic → large wage effects

	(1)	(2)	(3)	(4)
ETS × Post	0.002 (0.004)	0.001 (0.004)	0.008 (0.006)	0.010 (0.008)
Observations	1,926	1,926	294,174	278,496
R ²	0.944	0.952	0.101	0.144
Dep. Var.	$\frac{\text{STEM}}{\text{Total}}$	$\frac{\text{STEM Hr.}}{\text{Total Hr.}}$	STEM Hire	STEM Sep.

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- As a result, high-skill workers reap all the benefits → increase in the skill premium