Carbon Prices and the Skill Premium

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Climate policies and Firms

Firms must comply with **climate policies** for the foreseeable future

- Which climate policy & at which intensity?
- Internalize negative externalities $\Rightarrow$ Lower carbon emissions
- Concerns: Economic activity, pass-through on **firms' stakeholders**

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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!

What we find

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3. STEM workers at firms with surplus enjoy the highest increase
   $\rightarrow$ Two channels interact with each other
4. No effects on hiring/separation
5. Carbon prices contributes to the wage differentials across workers and firms

What we know so far

- **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)
  Other climate policies & Labor markets: Restrictions on emissions may reduce labor demand (Walker 2013, Martin et al. 2014, Vona et al. 2018, Azevedo et al. 2023)
  $\rightarrow$ **Document the effects of carbon price on wages and underlying channels**
  $\rightarrow$ Market-based policies vs hard-cap regulations

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  → **Document the effects of carbon price on wages and underlying channels**
  → Market-based policies vs hard-cap regulations
- 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

European Union Emissions Trading System

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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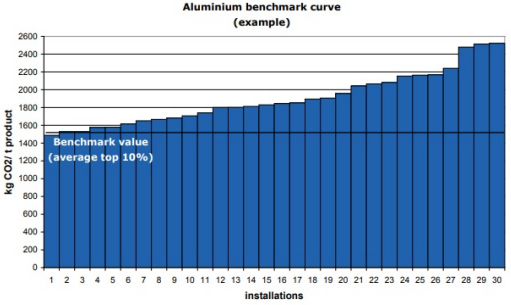
- Benchmark: Average emission of the best 10 percent installations in that product.



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- Benchmark: Average emission of the best 10 percent installations in that product.
- 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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- Historical activity: Median activity level of the installation in earlier phases.
- Benchmark: Average emission of the best 10 percent installations in that product.
- 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

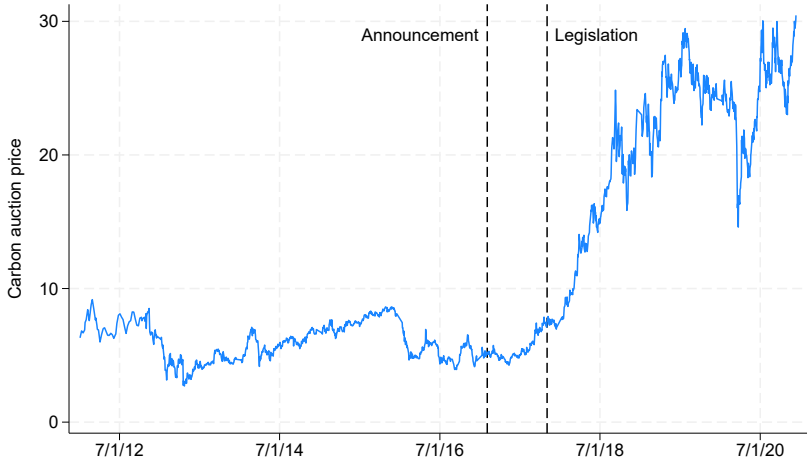
Data

- 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

New Rules in 2017

- The carbon price until 2017 was deemed to be too low to incentivize the firms (€5)
  → Weak 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



Conceptual Framework

- Firm's profit

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

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- 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

$$\frac{\partial w_i}{\partial V_j} > 0; \quad \frac{\partial w_i}{\partial V_i} > 0; \quad \frac{\partial^2 w_i}{\partial V_i \partial \omega_i} > 0$$

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1. p_c can increase OR decrease firm surplus, hence wages
2. Workers related to carbon efficiency can have higher wages
   $\rightarrow$Especially workers with better outside options

Empirical Strategy

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

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

Event-study version:

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

- ETS_i= 1 for firms/workers that participate into ETS program, ETS_i= 0 for matched units
- $Post_t$: =1 if year$\geq$2018
- y_{it}: log(hourly wages) (but also log(wages), earnings, and employment)

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Matching is done at two levels:

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

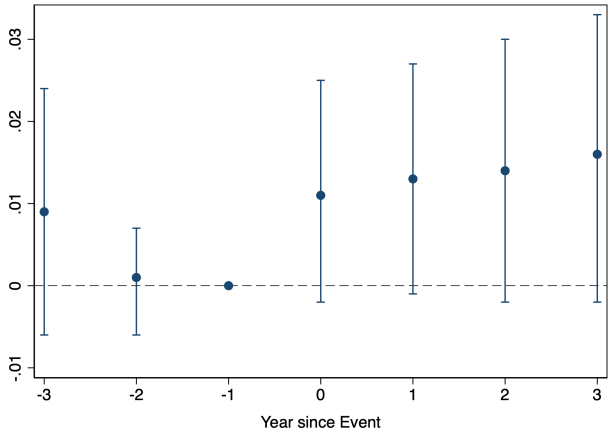
Balance Test

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

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

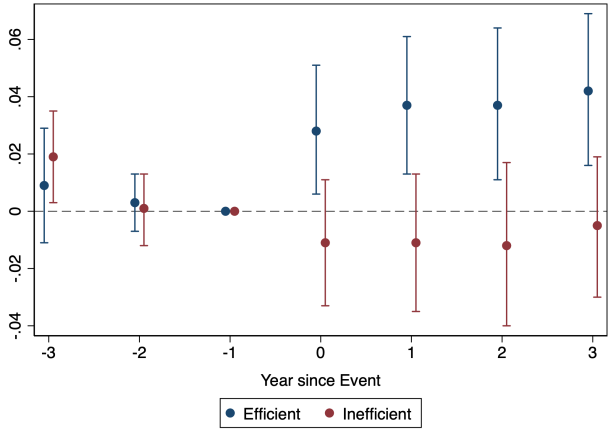
Baseline Effect

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



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

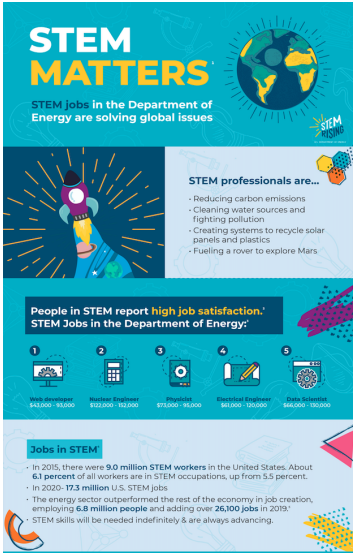
- Significant effects on wages and hourly wages; marginally significant for earnings
  $\rightarrow$ Only for efficient firms

Sample:	All				Efficient				Inefficient			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
ETS×Post	0.009	0.009	928.0*	0.006	0.029***	0.025**	1145.0*	0.001	-0.012	-0.024	-436.9	-0.001
	(0.006)	(0.008)	(525.3)	(0.004)	(0.010)	(0.010)	(623.7)	(0.007)	(0.010)	(0.017)	(1246.1)	(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(Wage)	Earnings	Employed	$\log(\frac{\text{Wage}}{\text{Hours}})$	log(Wage)	Earnings	Employed	$\log(\frac{\text{Wage}}{\text{Hours}})$	log(Wage)	Earnings	Employed

Worker-Level Match-Specific Surplus

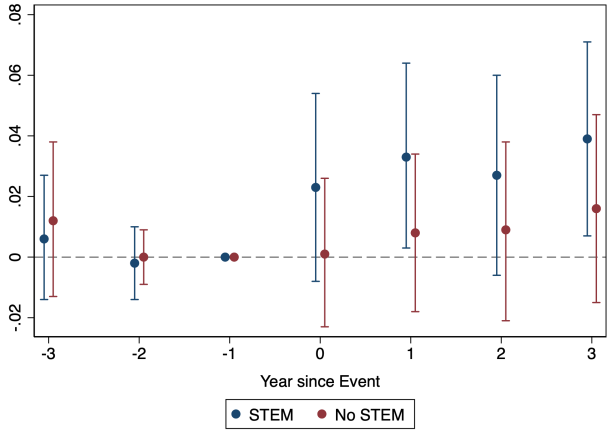
- In addition to firm-level cash flow (V_j), the carbon price shock is likely to affect *worker-level match-specific* surplus (V_i), and hence wages
- How does the carbon price shock affect *worker-level match-specific* surplus?
- An increase in carbon price can change the marginal revenue of certain workers
- If a worker is able to reduce emissions, her marginal revenue increases at ETS firms
- We hypothesize that STEM workers (engineering, math/physics, and computer science majors) are the most valuable to cut emissions (Vona et al. 2018, Saussay et al. 2023)
- Hence, the carbon price shock may increase the wages of STEM workers

STEM-Anecdotal Evidence



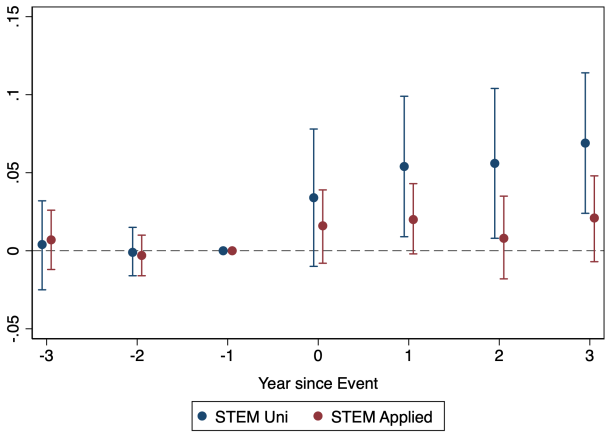
Education – Event-Study Results

- Positive effect of shock on wages only for STEM workers
- Small and insignificant for all the others (business, law, no degrees)



Education – Zooming in on STEM Workers

- Between STEM workers, we can also distinguish between graduates from research and applied universities
- Results are larger for research university graduates



Education – Results

- 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 × Post	0.010	0.014	0.028	0.006	0.008	0.026**	0.050**	0.012
	(0.006)	(0.011)	(0.015)	(0.010)	(0.011)	(0.012)	(0.018)	(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.

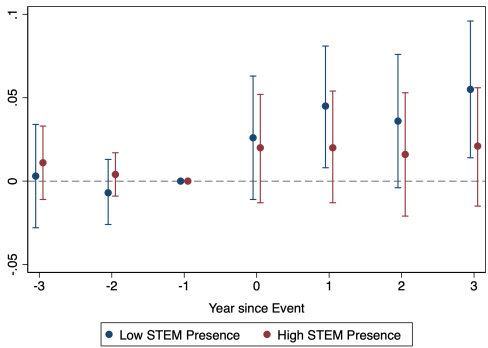
Outside Options

- Nash bargaining suggests that the effect of a worker-specific surplus on wage depends on the worker's outside options (ω_i)
- We use two proxies
  1. The fraction of STEM workers in the province
     - Intuition: A STEM worker should be in high demand if they leave the firm
  2. A dummy equal to one if the worker is a "switcher", i.e., has previously changed job
     - Intuition: Threat of quitting more credible

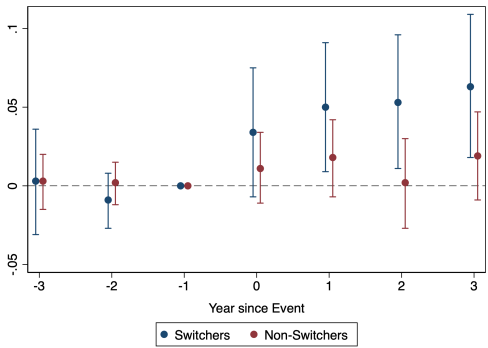
Outside Options – Results

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

A. Sorting by Density of STEM Graduates

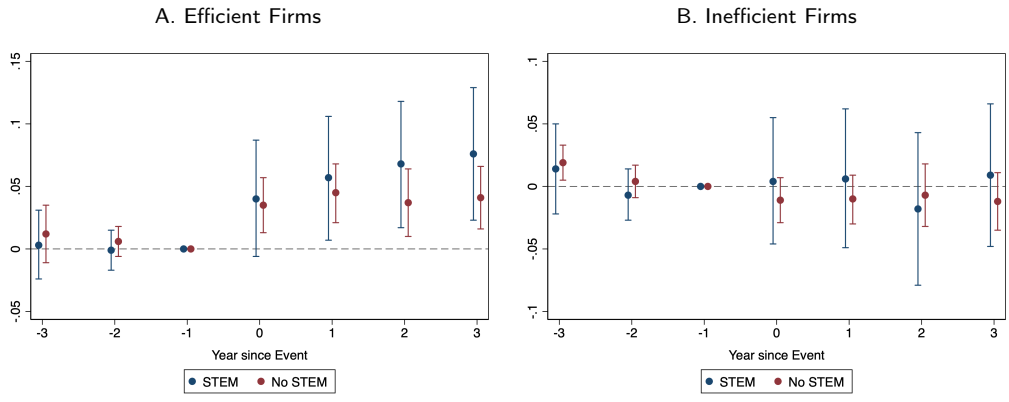


B. Job Switchers vs Non-Switchers



Education vs Firm Efficiency

- Do these two channels interact?
- Yes: Effects are stronger for STEM workers at efficient firms



Extensive Margin Results

- Two approaches to test whether the 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 the 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 $\rightarrow$ the price (not quantity) captures the effect

	(1)	(2)	(3)	(4)
ETS $\times$ Post	0.002	0.001	0.008	0.010
	(0.004)	(0.004)	(0.006)	(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.

Conclusion

- Policies aimed at curbing emissions can have significant labor market effects
- These effects depend on worker characteristics and policy-design choices
- Therefore, these policies may contribute to the wage differentials across workers and firms