The impact of the European Emission Trading Schemes on workers' careers and earnings trajectories: it is all about the rents, no troubles

Francesca De Matteis[*‡], Giovanni Marin[+‡], Michele Raitano[*] and Francesco Vona[§‡]

[*]University of Rome La Sapienza,
[+]University of Urbino, SEEDS,
[§]University of Milan,
[‡]Fondazione Eni Enrico Mattei

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UNIVERSITÀ DEGLI STUDI DI MILANO

FONDAZIONE ENI ENRICO MATTEI

Outline of the presentation

Distributional effects of climate policy

- **Distributional effects** of **climate policy** especially **salient** in the labour market (Vona, 2019).
- **"Job killing arguments"** fuel **green populistic backlash**, both in the US and recent EU elections (Bosetti et al., 2025).
- As for trade policy, previous research shows that, while the **"job killing argument"** is largely **over-stated**, muted or small employment effects may mask **large distributional effects** of **climate policies** across both workers and locations (Weber, 2020; Hanson, 2023; Carballo et al., 2025).
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- We study the **long-term impacts** of the **largest climate policy** worldwide (the **EU-ETS**) on the 2^{nd} **industrial economy** of Europe (**Italy**) at the **worker-level**.
- We do so using **matched employer-employee** administrative data from **social security** registers that cover the **universe** of private sector **employees** in Italy over the **period 2000-2019**.
- Our **identification strategy** combines standard **DiD** with a **two-stage matching procedure** on both firms and workers and leverage **decompositions** (on cumulative outcomes and AKM) to assess the importance of various channels.
  - We are able **uncover** the **channels** through which the EU-ETS affects **workers' well-being** along both an **intensive** (annual and weekly wages, hours worked) and an **extensive margin** (type of contract, mobility outcomes, unemployment risk, etc.).

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Preview of the results

- Differently from other structural shocks and mass lay-offs in polluting industries, the **EU-ETS** slightly **improves** the **long-term earning** and **career prospects** of **treated workers**.
  - The (undiscounted) **cumulative effect** on **annual earnings** after 15 years is +42.4%, but declines to +9.3% (**two-step matching**) and +7.2% (**two-step match + firm survival**) in our **favourite specifications**.

- Investigating the mechanisms, our findings indicate that the average effect is **driven** by the **quasi-rents** associated with the **ETS design** as it:
  - tends to **fade away** in the **last phase** (with less grandfathering) and for **firms entering** the ETS **in 2013**;
  - is **concentrated** in **trade-exposed sectors** where grandfathering is more prevalent;
  - is **appropriated** by **stayers**, while **movers experienced** substantial **losses** in terms of both weekly wages and weeks worked.

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  - **more likely** to **stay** in the same firms;
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  - **more likely** to work with **open-ended** and **full-time** contracts;
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- **Price effects** are also **important**:
  - ETS workers **earn** slightly **more per week**;
  - this effect is associated with an **increase** in the **AKM firm-level component** of wages.
- The **ETS** also **exacerbates** existing **labour market inequalities** favouring:
  - **Men** over **women**;
  - **White** over **blue collars**;
  - **Workers** with **high productivity** (high worker AKM) over workers with **low productivity** (low worker AKM).

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    - due to the lack of stringency of the policy and the implicit subsidy for incumbents through grandfathering;
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- **Cap-and-trade** system at the EU level for CO2 (and other greenhouse gases) emissions
- Approved in 2003, started in **2005**
- Covers about **11,000 industrial installations**, accounting for about **45%** of EU CO2 **emissions**
- **Phase I (2005-2007)** - trading (pilot) phase I
  - **Grandfathering** to mitigate **leakage risk** leak (Martin et al., 2014), no banking/borrowing, **price collapse** in 2006 due to **overallocation**, penalty 40€/ton CO2 for excess emissions
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- It **stimulates innovation** in **low-carbon** technologies, but the effect is quantitatively modest (Calel and Dechezlepretre, 2016; Martin et al., 2016; Teixidó et al., 2019).
- It has **muted** or slightly positive effects on **employment**, **value added** and **productivity** (Marin et al., 2018; Dechezleprêtre et al., 2023), while there is **no evidence on wages**.
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  - **Administrative data** from **social security records** on the universe of workers in Italy ⇒ largest **matched employer-employee** data in Europe.
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  - We consider both firms **exempted** and **not exempted** from auctioning.
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  - Thanks to the **longitudinal dimension** of the data and the coverage of the entire universe of firms, it is possible to **track workers' careers** across **different firms**.
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Cumulative outcomes

- Following Autor et al. (2014); Dauth et al. (2021b), we use **cumulative outcomes** to capture long-term effects, accounting for the full set of labour market outcomes, e.g., unemployment spells.
- In general, Y_{ij}^{T} for outcome y worker i of firm j up to year T as follows:

$$Y_{ij}^{T} = \sum_{t=2005}^{T} \frac{y_{ijt}}{y_{ij,t=2004}} \tag{1}$$

$\forall\, T = \{2000, ..., 2019\}$.

- Y can be **cumulative annual wages**(W), **cumulative weekly wages** (Ω) and **cumulative paid weeks** (H).
- We rescale annual and weekly wages by their **values** predating the ETS.
  - Weeks worked are not rescaled as our estimation samples **only** include **full-time workers** $(H_{ij}^{T} = \sum_{t=2000}^{2019} h_{ijt})$.
  - Weekly wages are also **divided by T** to facilitate interpretation $(\Omega_{ij}^{T} = \frac{1}{T} \sum_{t=2005}^{T} \frac{\omega_{ijt}}{\omega_{ij,t=2004}})$.

Cumulative outcomes

- Following Autor et al. (2014); Dauth et al. (2021b), we use **cumulative outcomes** to capture long-term effects, accounting for the full set of labour market outcomes, e.g., unemployment spells.
- In general, Y_{ij}^{T} for outcome y worker i of firm j up to year T as follows:

$$Y_{ij}^{T} = \sum_{t=2005}^{T} \frac{y_{ijt}}{y_{ij,t=2004}} \tag{1}$$

$\forall\, T = \{2000, ..., 2019\}$.

- Y can be **cumulative annual wages**(W), **cumulative weekly wages** (Ω) and **cumulative paid weeks** (H).
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Discrete outcomes

- To capture effects on **workers' transition** and **displacement risks**, we also consider the following (nested) **discrete outcomes**, which are also cumulated over time:
  - Remains **employed** in the **same firms**
  - **Not in private employment**
  - Employed in a **new firm**
    - **Same** 2-digit **sector**
    - **Other** 2-digit sector but in **manufacturing**
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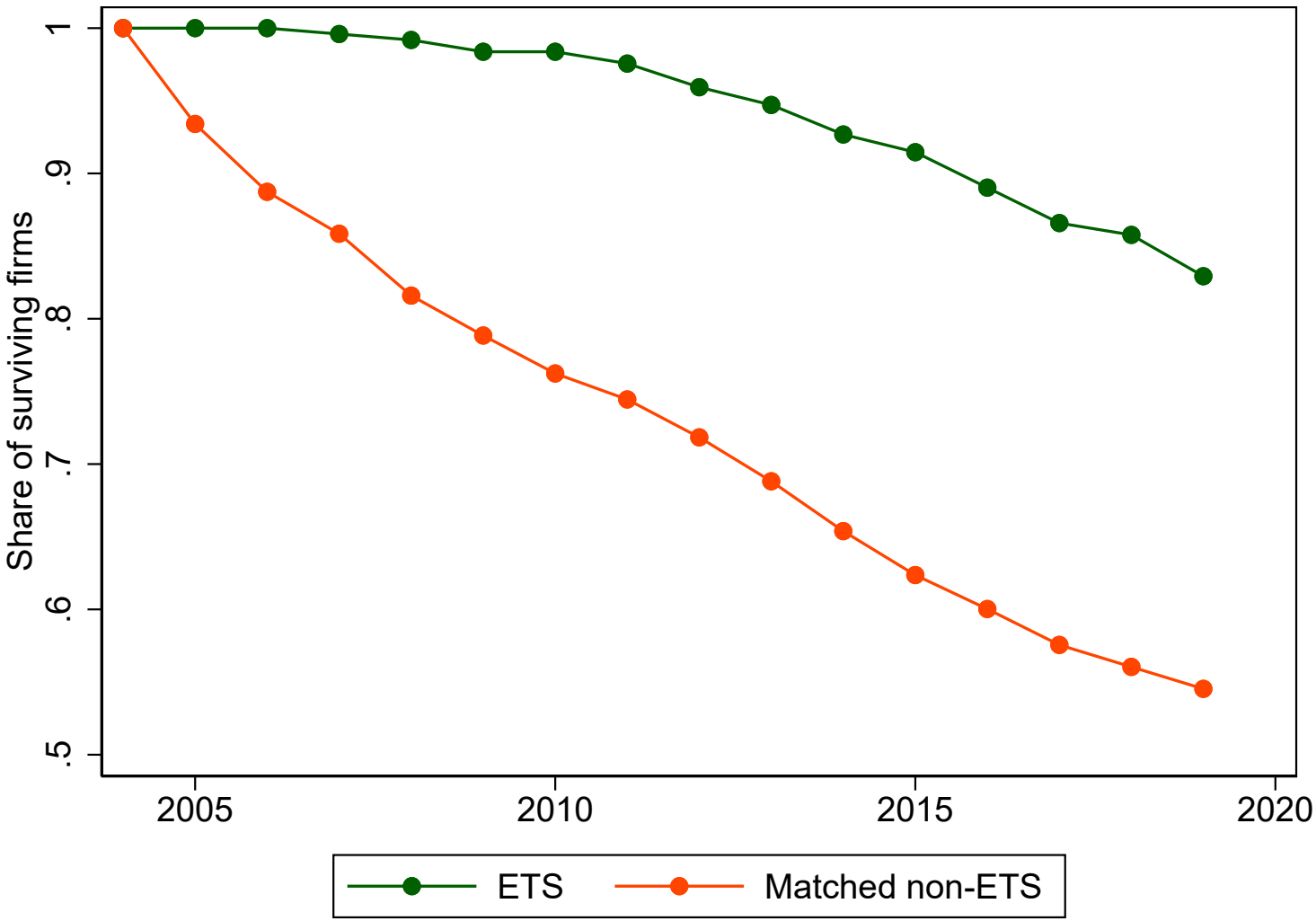
Firm survival: unconditional survival rates

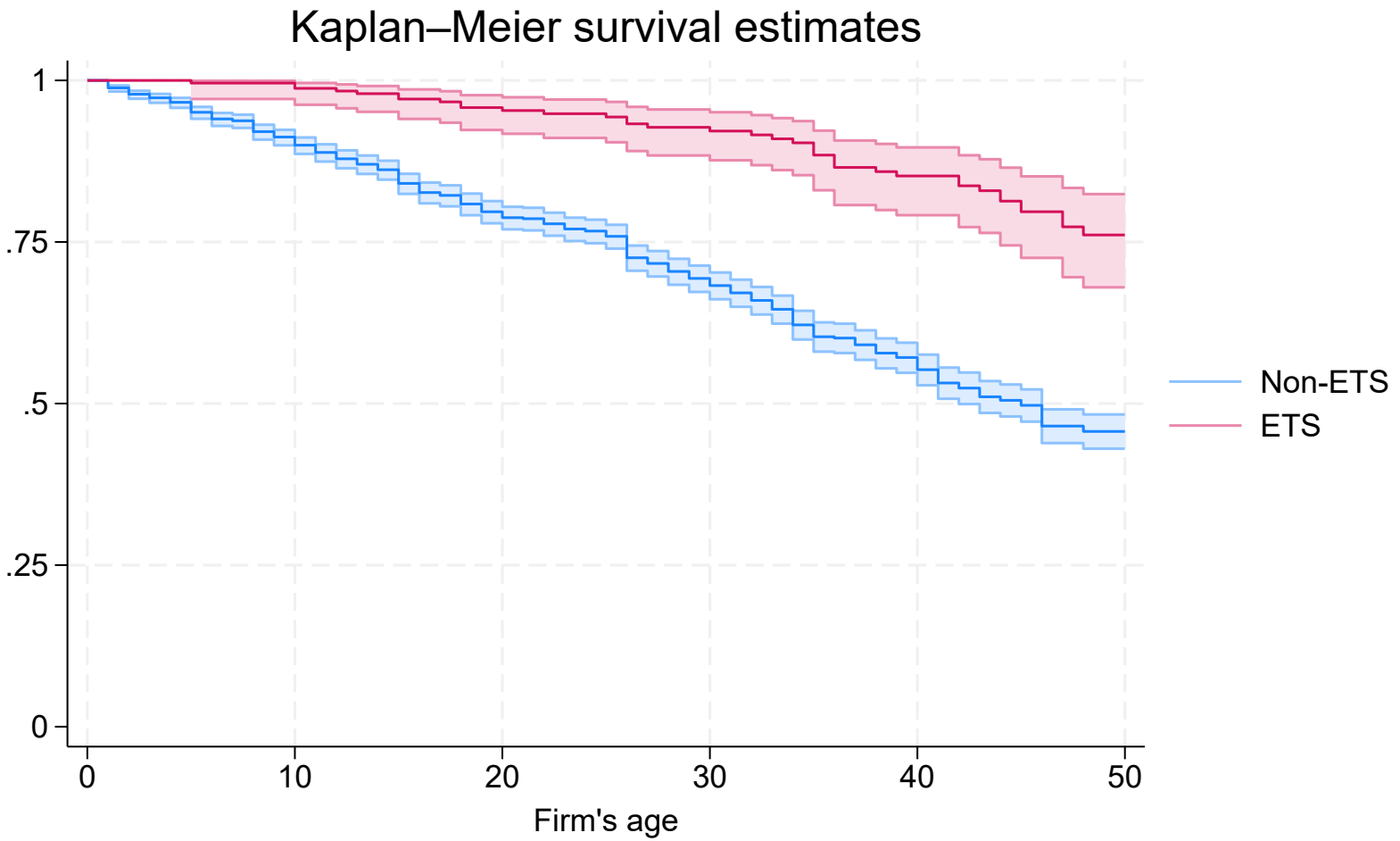
→ ETS and non-ETS firms are different along several dimensions, including survival rates.



Notes: Relative frequencies of in-sample ETS firms and matched non-ETS firms.

Firm survival: conditional survival rates

detail



Notes: Kaplan-Meier survival estimates by firm age of in-sample ETS firms and matched non-ETS firms.

Identifying a valid counterfactual

- Systematic **differences** of **labour market outcomes** and **individual characteristics** of workers in **ETS** vs **non-ETS firms** ⇒ ETS firms **larger**, more **carbon-intensive** and, as we just saw, **more likely to survive**.
- Previous works match on **firm characteristics** only (Calel and Dechezlepretre, 2016; Marin et al., 2018; Colmer et al., 2024), here we need to match on **workers' characteristics** as well.
- **Two-steps matching**:
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  - **Worker-level matching** to account for compositional differences and heterogeneous effects across workers.

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Matching: details

1. Step 1: **1:3 firm-level Mahalanobis distance matching**;
   - **Exact matching** on: 2-digit NACE sectors and, in a variant, firm survival.
   - **Mahalanobis distance** matching variables: number of **employees** (log), and **AKM** firm fixed effects (Abowd et al., 1999). akm
2. Step 2: **Considering** only **workers** in the selected **firms**: **1:3 worker-level Mahalanobis distance matching**:
   - We keep only workers employed full-time (52 weeks) and prime-age (25-39).
   - **Exact matching** on **matched firm** (from step 1), **age** (5-yr classes), **gender**, and **qualification** (white vs blue collars)
   - **Mahalanobis distance** matching on **tenure** (log), and **AKM** worker fixed effects (Abowd et al., 1999).

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Matching: adjustments

- Although the reservoir of untreated units is large in our case, there are well-known difficulties to find suitable matches in ETS evaluations.
- Hence, **few matched workers** serve as **counterfactual** of **many treated** ones ⇒ each worker in an non-ETS firm can serve as match to a non-ETS workers for a maximum of **7 times**.
- **Anti-SUTVA-violation**: we get rid of the whole match when one treated worker is reallocated to a matched control firm, or viceversa.

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Matching quality: firms' level

	Not matched sample			Matched sample		
	Not treated	Treated	t-test	Not treated	Treated	t-test
Panel A - All firms						
Firm AKM 00-04	-0.022	0.0254	40.38	0.025	0.0254	0.55
Size (log emp)	1.667	5.358	37.59	5.201	5.358	1.42
N firms	312,500	246		575	246	
Panel B - Surviving firms						
Firm AKM 00-04	-0.014	0.026	29.79	0.024	0.025	0.56
Size (log emp)	2.048	5.483	32.37	5.254	5.446	1.63
N firms	99,478	204		430	201	

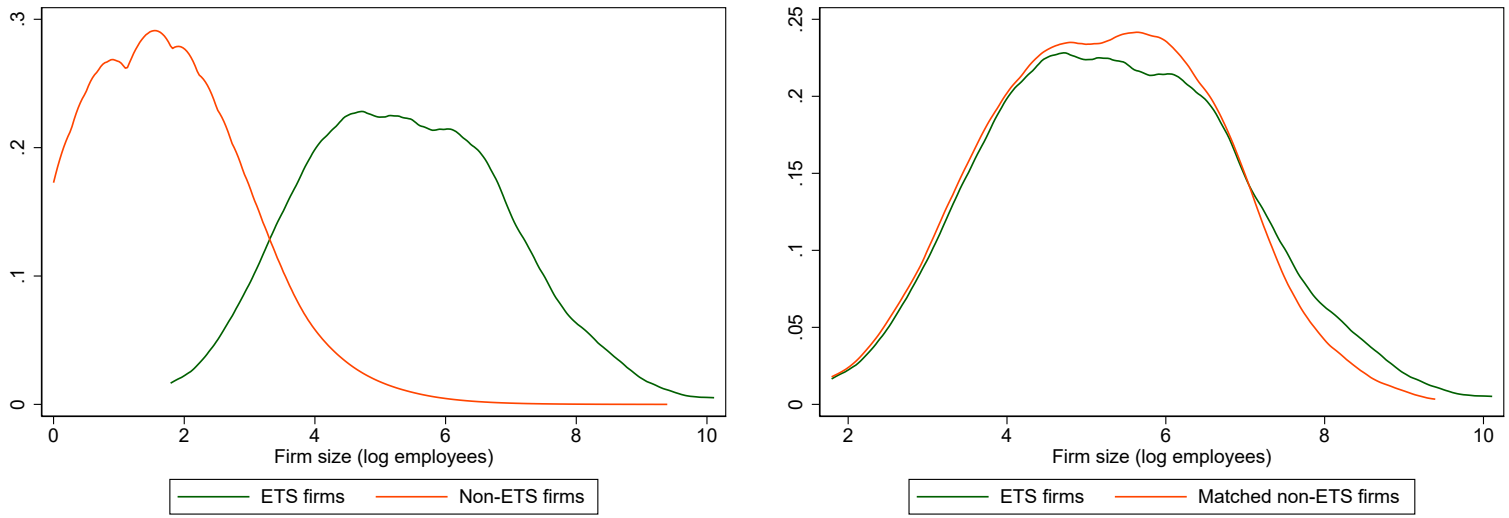
Notes: The first three columns of panel A consider all manufacturing companies with at least one employee in 2004, while the same columns of panel B consider all manufacturing companies that remained active (i.e. at least one employee) over the period 2004-2019. Firms with installations entering the EU-ETS after 2005 were excluded from the potential pool of controls. Firms are matched exactly (with reinmission) on the 2-digit NACE rev. 2 sector and on the Mahalanobis distance for firm size (log employees in 2004) and firm-level AKM (2000-2004). Up to three nearest neighbours are considered.

Matching quality: workers' level

	Not matched sample			Matched only firms			Matched sample		
Panel A - All firms	Not treat	Treat	t-stat	Not treat	Treat	t-stat	Not treat	Treat	t-stat
Age	34.35	35.44	55.66	35.24	35.44	9.74	35.38	35.47	3.89
Tenure	5.53	7.64	137.0	7.61	7.64	1.85	7.36	7.68	16.61
Worker AKM	0.075	0.120	45.66	0.133	0.120	-12.1	0.125	0.124	-1.40
N workers ('000)	2,323	95.4		510.8	95.4		42.2	59.3	
Panel B - Surviving firms	Not matched sample			Matched only firms			Matched sample		
	Not treat	Treat	t-stat	Not treat	Treat	t-stat	Not treat	Treat	t-stat
Age	34.44	35.37	42.18	35.18	35.37	8.17	35.27	35.37	4.19
Tenure	5.74	7.91	124.4	7.93	7.91	-1.36	7.86	7.89	1.72
Worker AKM	0.092	0.129	32.38	0.131	0.129	-1.77	0.130	0.130	-0.09
N workers ('000)	1,305	75.0		90.2	75.0		34.6	48.3	

Notes: The first three columns of panel A consider all employees in manufacturing companies with at least one employee in 2004, while the same columns of panel B consider all employees in all manufacturing companies that remained active (i.e. at least one employee) over the period 2004-2019. Columns 4-9 just consider as potential counterfactual workers employed in matched firms. In columns 7-9 employees are matched exactly on gender, occupation (white or blue collar) and 5-years age classes and the Mahalanobis distance for tenure in the firm in 2004 and employee-level AKM (2000-2004). Up to three nearest neighbours are considered.

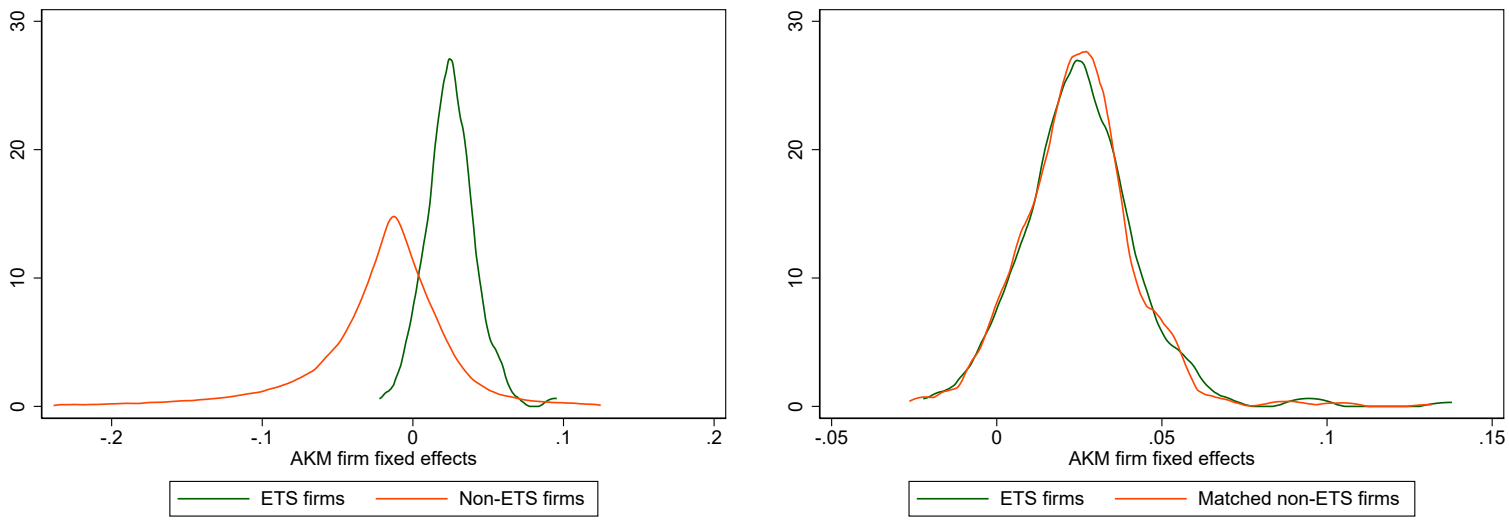
Figure: Firm size (log)



(a) Not matched

(b) Matched

Figure: Firm AKM

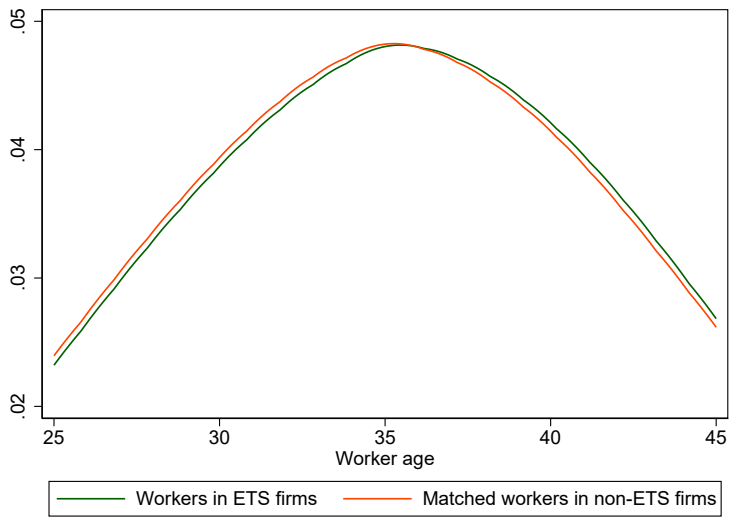


(a) Not matched

(b) Matched

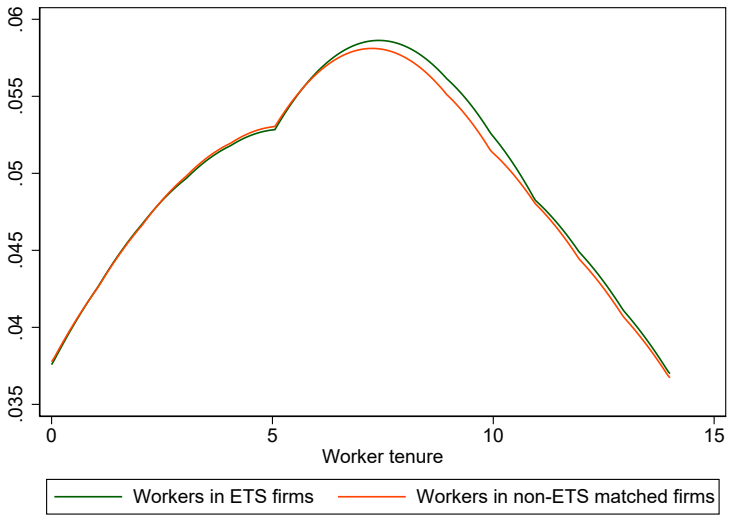
Figure: Worker age

(a) Not matched

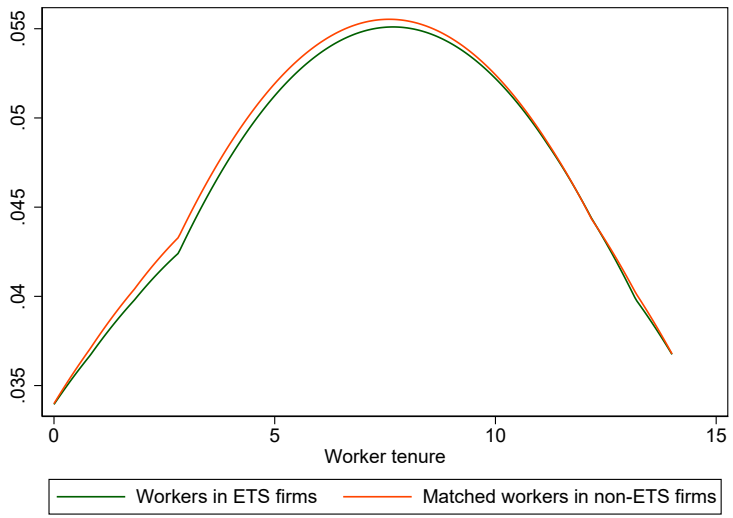


(b) Matched

Figure: Worker tenure

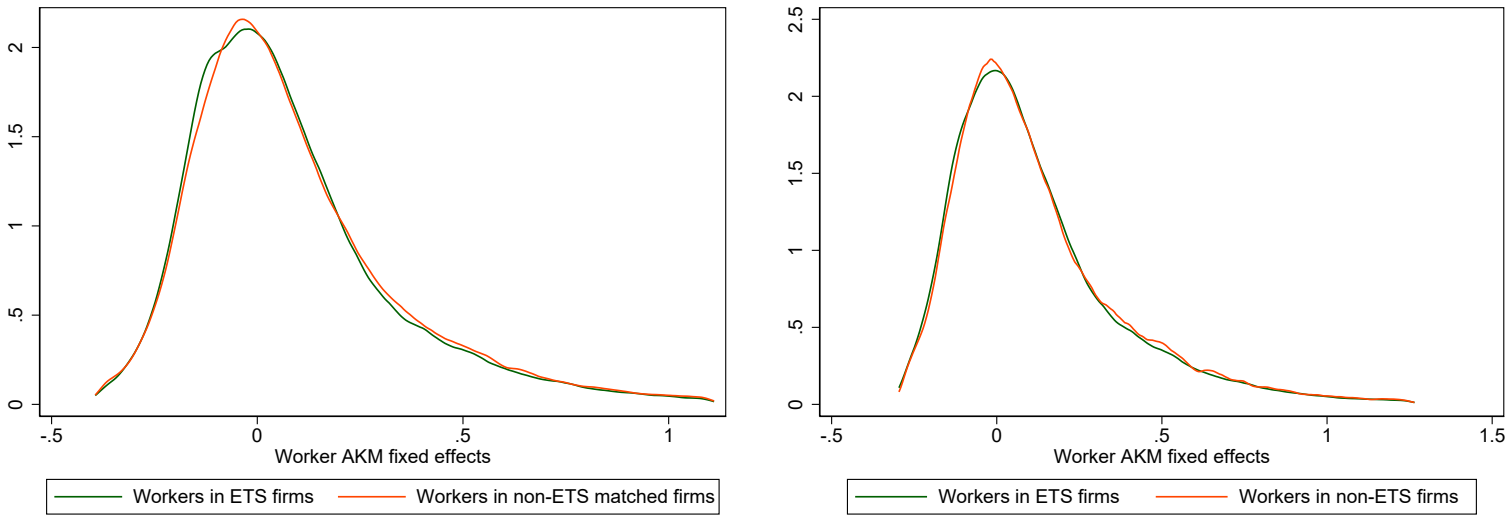


(a) Not matched



(b) Matched

Figure: Worker AKM



(a) Not matched

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Estimating equation with cumulative outcomes

We estimate the following equation **separately** by year on the **matched samples** of workers:

$$\begin{aligned} Y_{ij}^{T} &= \alpha + \beta^{T} \mathbb{1}_{i \in ETS(j)} + X_{ij}' \gamma^{T} + \varepsilon_{ijT} \\ \forall & \quad T = \{2000, ..., 2002, 2003, 2005, 2006, ..., 2019\} \end{aligned}$$

where:

- Y_{ij}^{T}: **cumulative outcome** for worker i in company j up to year T (w.r.t. 2004);
- $\mathbb{1}_{i \in ETS(j)}$: **treatment**=1 for workers i employed full-time in ETS firms j in 2004;
  - β^{T} is the cumulative **treatment effect** on the treated up to year T (provided parallel trend assumption is valid);
- X_{ij}' are **control variables** taken in **2004** to adjust for residual differences post-matching:
  - region (NUTS2), sector (2-digit NACE) dummies, firm-level AKM and log of employee,
  - a quadratic polynomial in worker's age and tenure, gender and blue collar dummies.
- **Two-way clustering** of standard errors: by workers id and worker matched set (Abadie and Spiess, 2022; Colmer et al., 2024).

Decomposition

- Using **cumulative outcomes** allows to **decompose** the **causes of wages losses** (or gains), attributing a precise share of ATET to **mutually exclusive events** in a given time span (Autor et al., 2014; Dauth et al., 2021a).
- Notably, the effect of the EU-ETS on annual wages can be **perfectly decomposed** interacting the outcome variables with mutually exclusive mobility outcome dummies.

Alternative DiD

- **Unobservable workers**' characteristics accounted for by: i. **matching strategy**, ii. dividing by the **baseline value** of y.
- We consider a standard two-way fixed effect **event study/Difference-in-Difference design**, where we directly control for unobserved workers' heterogeneity using individual fixed effects.
- This alternative estimator is particularly useful to assess what happened to **stayers** and to set the stage for **AKM analyses**.

$$y_{ijt} = \sum_{t \neq 2004} \beta_t \mathbb{1}_{i \in ETS(j)} + X'_{ij}\gamma_t + \xi_t + \mu_i + \varepsilon_{ijt} \quad (2)$$

- We implement this approach also to assess the effect of the EU-ETS across policy phases.

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- We implement this approach also to assess the effect of the EU-ETS across policy phases.

Cumulative impacts on: annual/week wages, paid weeks

Panel A - Counterfactual: all manufacturing workers			
	Annual wages	Paid weeks	Weekly wages
2007 End phase I	0.0249***	0.0939	0.008***
	(0.00248)	(0.0996)	(0.0006)
2012 End phase II	0.244***	4.045***	0.023***
	(0.00906)	(0.331)	(0.0009)
2019 End phase III	0.424***	5.472***	0.026***
	(0.0224)	(0.755)	(0.001)
N of treated	63,414	63,414	63,414
N of non-treated	1,238,475	1,238,475	1,238,475

Panel B - Counterfactual: matched workers (favourite)			
	Annual wages	Paid weeks	Weekly wages
2007 End phase I	0.00216	0.0550	-0.0003
	(0.00301)	(0.120)	(0.0007)
2012 End phase II	0.0640***	1.043***	0.005***
	(0.0109)	(0.395)	(0.0009)
2019 End phase III	0.0928***	-1.222	0.007***
	(0.0273)	(0.900)	(0.0013)
N of treated	59,268	59,268	59,268
N of non-treated	42,156	42,156	42,156

Cumulative ETS impacts (cnt.)

more

Panel C - Counterfactual: matched workers in surviving firms			
	Annual wages	Paid weeks	Weekly wages
2007 End phase I	0.00838***	0.297**	-0.0001
	(0.00308)	(0.124)	(0.0007)
2012 End phase II	0.0387***	-0.126	0.004***
	(0.0111)	(0.409)	(0.0009)
2019 End phase III	0.0721***	-1.438	0.005***
	(0.0279)	(0.926)	(0.001)
N of treated	48,326	48,326	48,326
N of non-treated	34,604	34,604	34,604

Notes: Cross-section OLS regressions on cumulative outcomes (base year: 2004) for workers employed full-time for the whole year (52 weeks) in 2004. Regressions weighted with matching weights. Standard errors clustered two-way by worker-level matching group and individual worker (just individual worker for Panel A). * p<0.1, ** p<0.05, *** p<0.01. Additional control variables (measured in 2004): firm-level AKM, firm size (log of employees), white collar (dummy), gender, age (linear and squared), tenure (linear and squared), region dummy (NUTS2), sector dummy (2-digit NACE rev. 2).

Dynamics effects

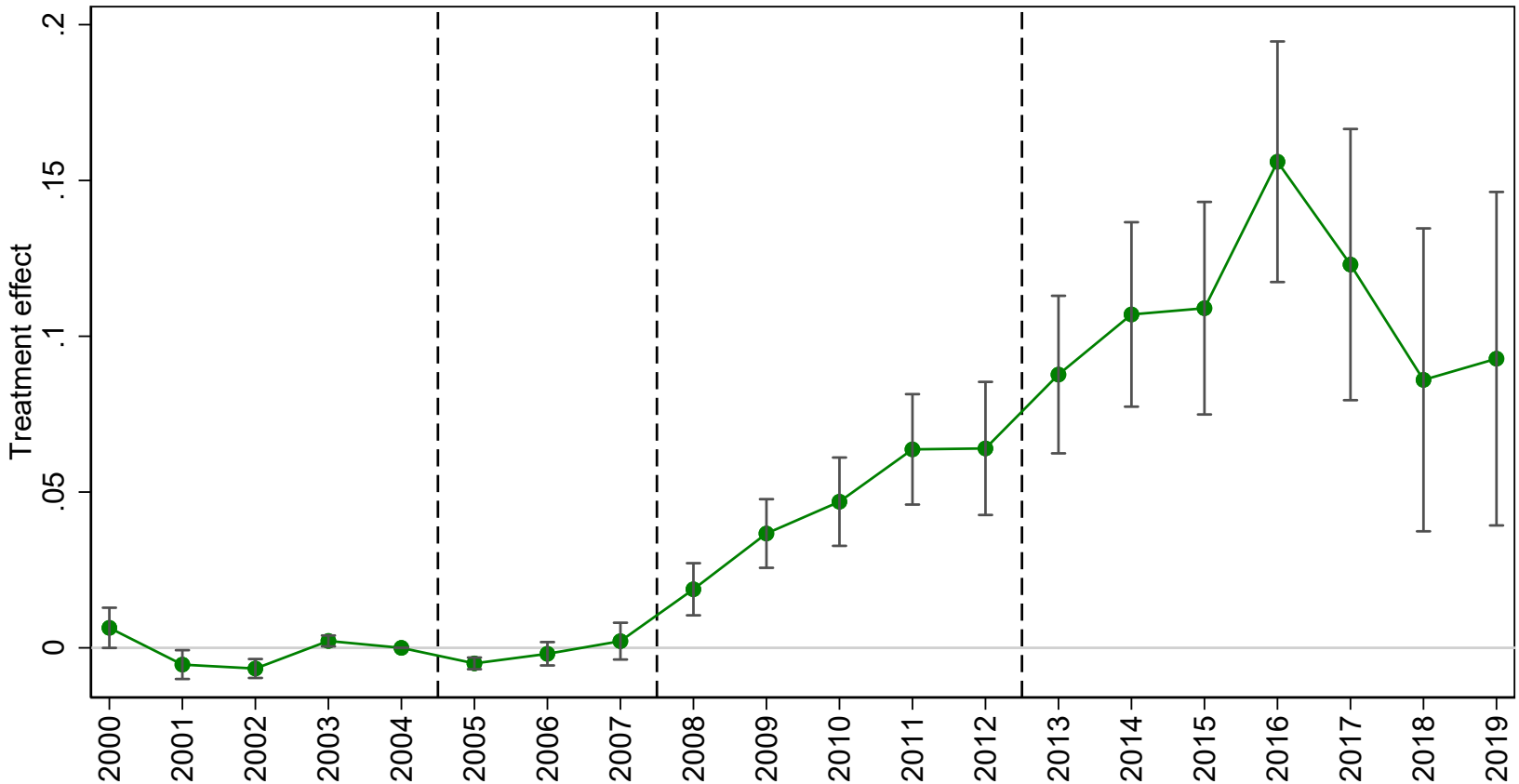
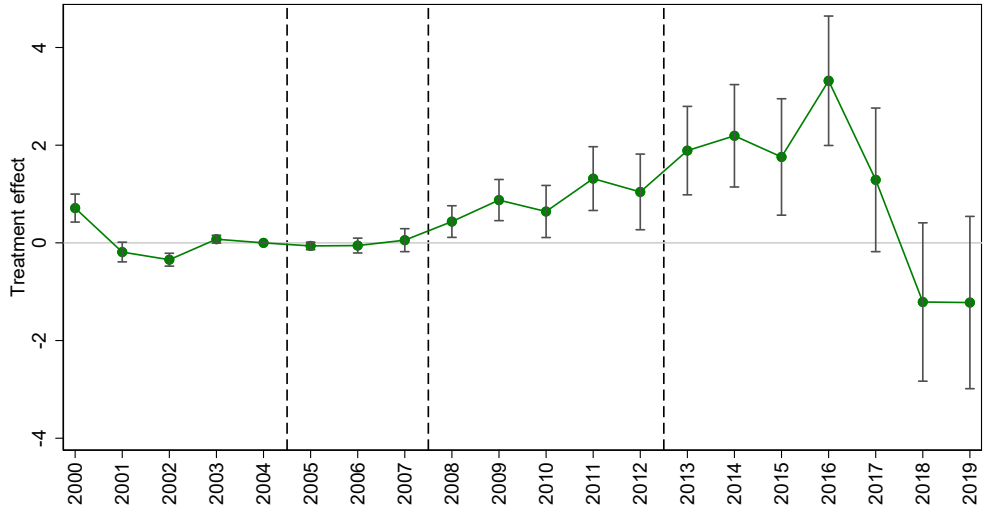
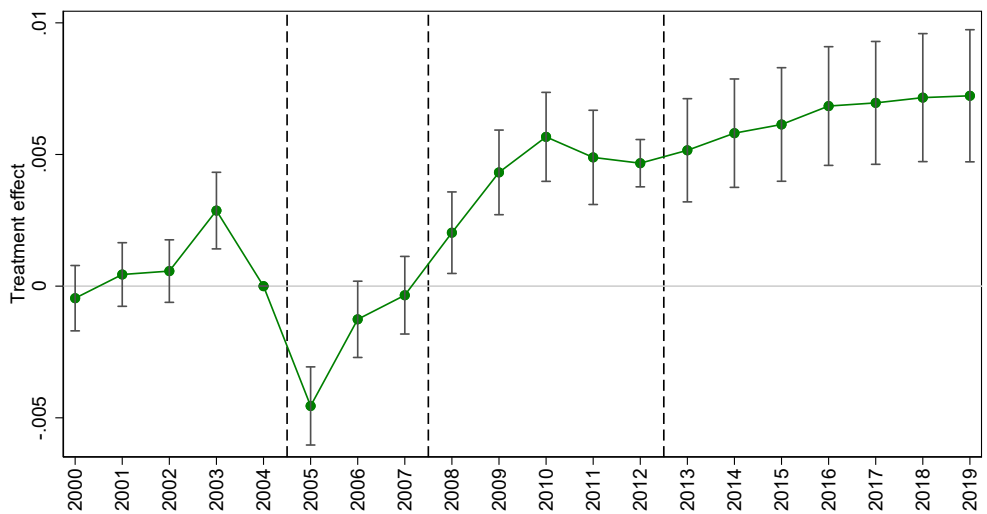


Figure: cumulative annual wages



(a) cumulative paid weeks



(b) cumulative weekly wages

DiD on stayers - here both treated and matched are stayers

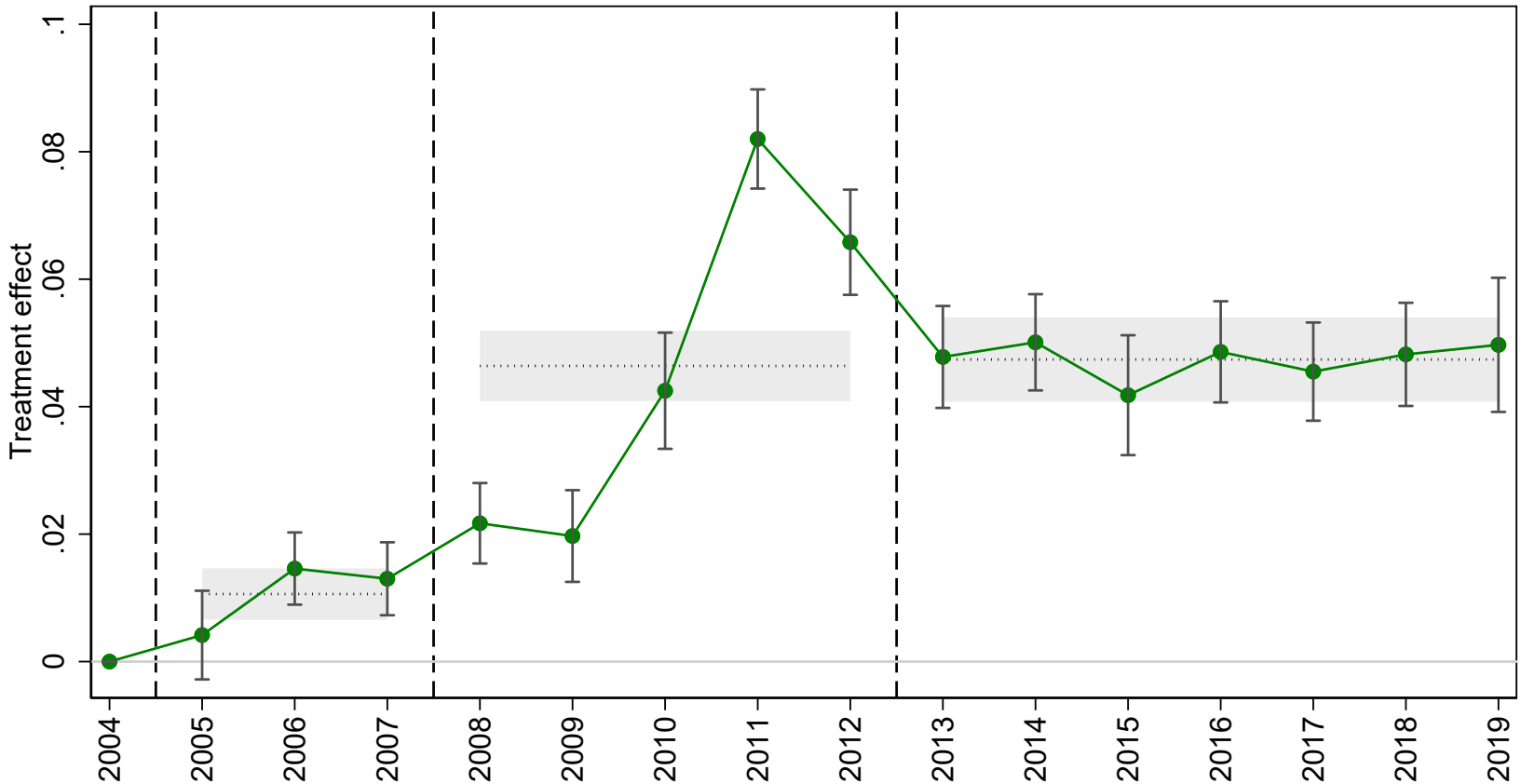
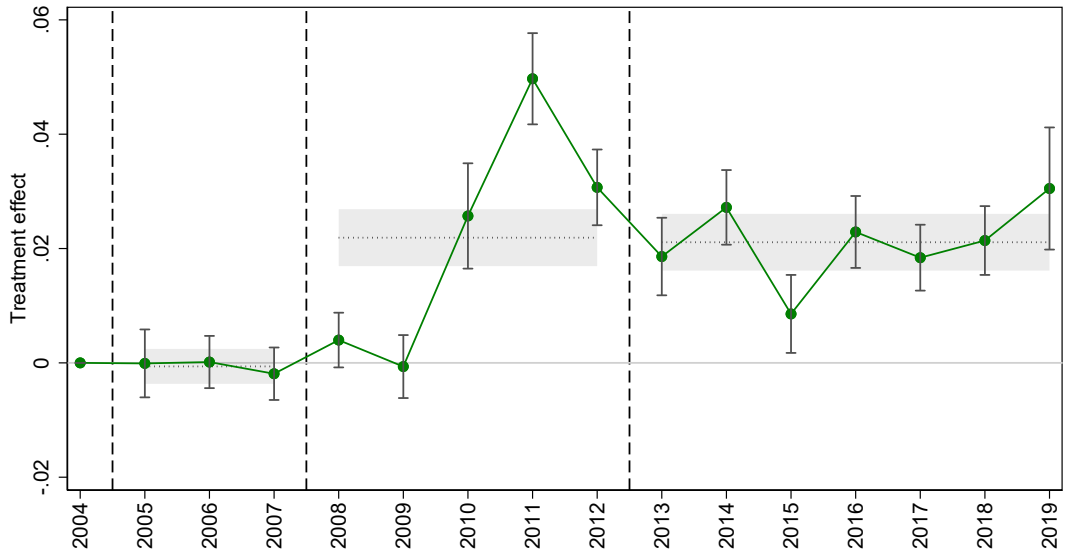
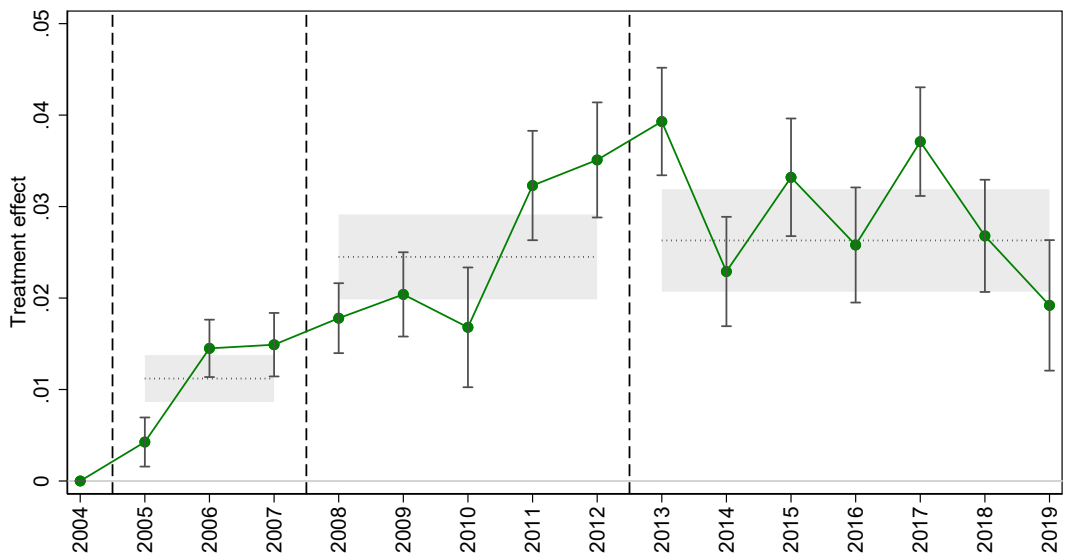


Figure: Annual wages (log)

Notes: OLS regressions on outcomes in log for workers employed FT for 52 weeks in 2004 and employed in the same firm throughout the period 2004-2019 (i.e. stayers). Counterfactual: matched workers. Number of treated: 18,010; number of non-treated: 11,499; number of observations: 1,004,640. Regressions weighted with matching weights. Additional control variables measured in 2004. Std errors clustered two-way by worker-level matching group and individual worker. 95% confidence intervals.



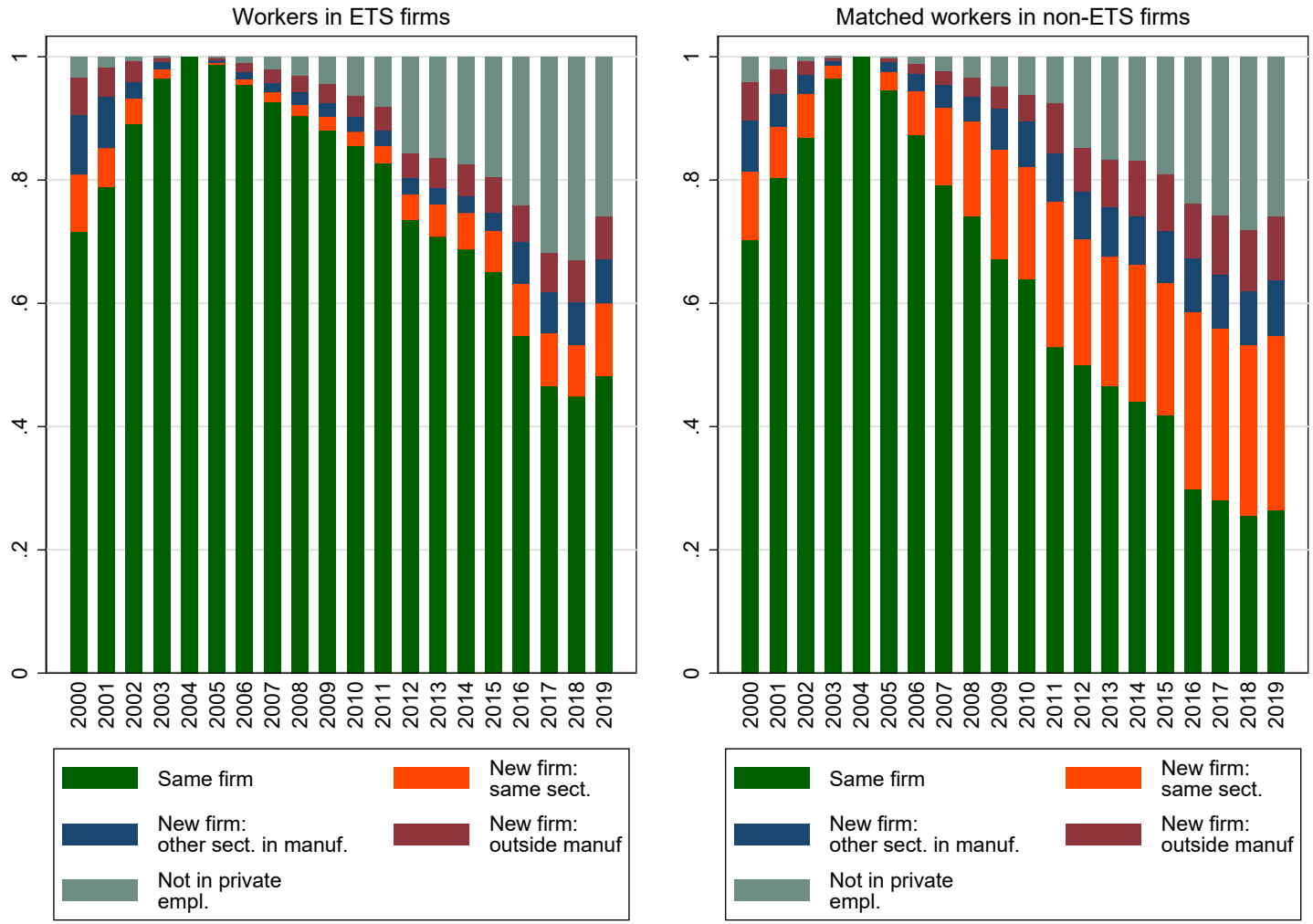
(a) Paid weeks (log)



(b) Weekly wages (log)

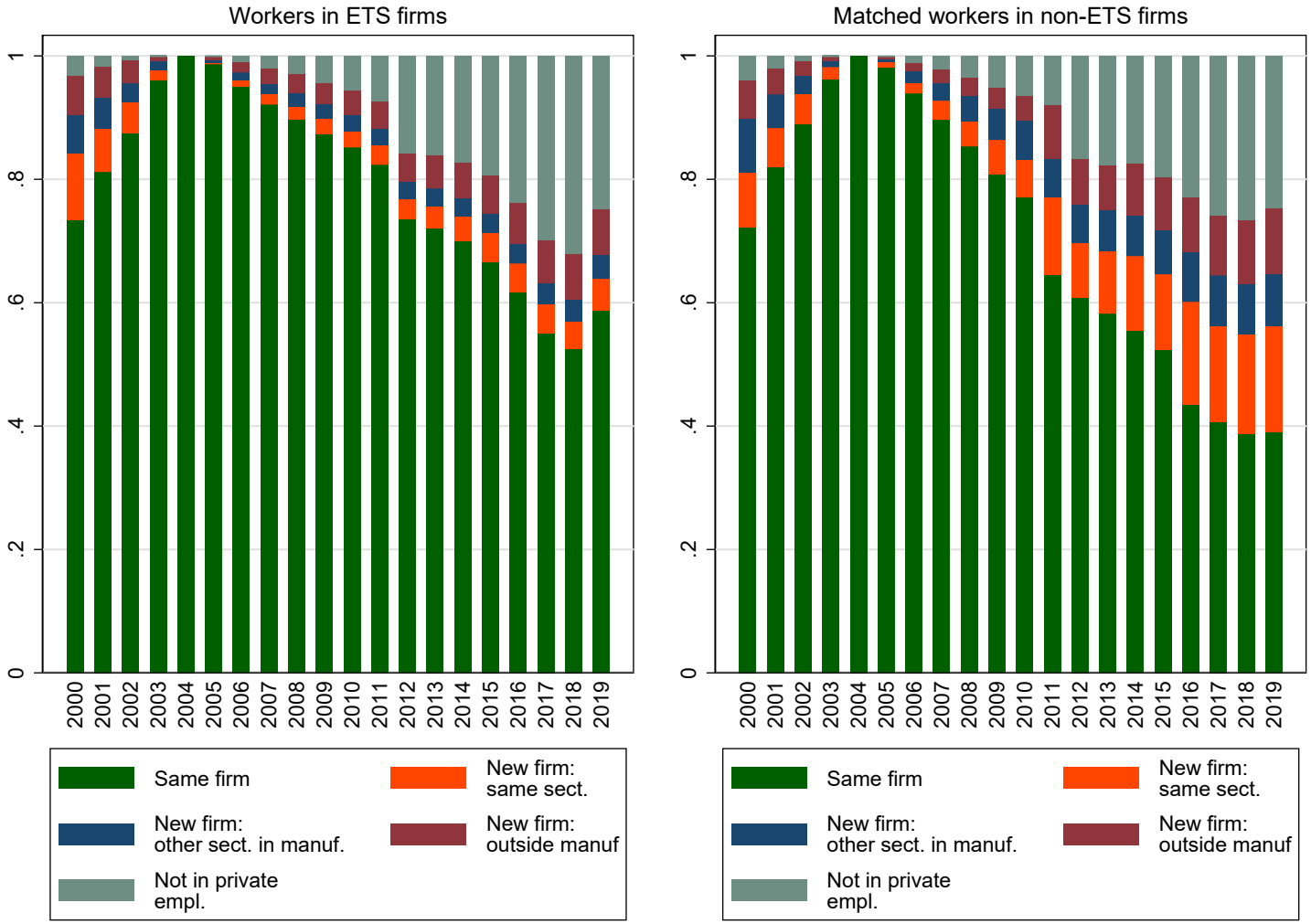
Workers' transitions: matched vs. treated

Figure: Workers' transitions: all firms



Workers' transitions in surviving firms: matched vs. treated

Figure: Workers' transitions: surviving firms



Workers' transitions visual

	Same firm	New firm	Not emp.	New firm (of which sector): Same	Oth man	Out man
Panel A - Counterfactual: matched workers						
2007	0.096***	-0.091***	-0.004***	-0.072***	-0.035***	0.016***
	(0.003)	(0.003)	(0.001)	(0.002)	(0.002)	(0.002)
2012	0.603***	-0.580***	-0.023***	-0.397***	-0.131***	-0.052***
	(0.012)	(0.011)	(0.006)	(0.007)	(0.006)	(0.007)
2019	1.987***	-2.020***	0.034**	-1.305***	-0.386***	-0.329***
	(0.027)	(0.025)	(0.015)	(0.017)	(0.012)	(0.015)
Panel B - Counterfactual: matched workers in surviving firms						
2007	0.035***	-0.032***	-0.003**	-0.029***	-0.019***	0.017***
	(0.003)	(0.003)	(0.001)	(0.002)	(0.002)	(0.002)
2012	0.515***	-0.487***	-0.028***	-0.287***	-0.162***	-0.037***
	(0.012)	(0.011)	(0.006)	(0.006)	(0.006)	(0.007)
2019	1.871***	-1.884***	0.013	-1.178***	-0.462***	-0.243***
	(0.028)	(0.025)	(0.015)	(0.016)	(0.013)	(0.016)

Notes: OLS regressions on cumulative outcomes (base year: 2004) for workers employed FT for 52 weeks in 2004. Additional controls as in the main. Std errors clustered two-way by worker-level matching group and individual worker. * p<0.1, ** p<0.05, *** p<0.01.

Type of contract

	Counterfactual: matched workers		Counterfactual: matched workers in surviving firms	
	Part-time	Fixed-term	Part-time	Fixed-term
2007	0.000516	-0.0139***	0.000403	-0.0161***
	(0.000686)	(0.00170)	(0.000728)	(0.00180)
2012	0.00158	-0.0690***	0.00140	-0.649***
	(0.00281)	(0.00667)	(0.00297)	(0.00698)
2019	-0.0155**	-0.0692***	-0.0121*	-0.0607***
	(0.00650)	(0.0161)	(0.00680)	(0.0166)
N of treated	59,268		48,326	
N of non-treated	42,156		34,604	
Observations	216,337		178,273	

Notes: OLS regressions on cumulative outcomes (base year: 2004) for workers employed FT for 52 weeks in 2004. Regressions weighted with matching weights. Standard errors clustered two-way by worker-level matching group and individual worker (just individual worker for Panel A). * p<0.1, ** p<0.05, *** p<0.01. Additional control variables measured in 2004.

Decomposition of cumulative outcomes

	Total	Same firm	New firm	New firm (of which sector): Same	Oth man	Out man
Panel A - Counterfactual: matched workers						
Ann. w	0.093***	2.266***	-2.173***	-1.430***	-0.415***	-0.328***
	(0.027)	(0.035)	(0.029)	(0.020)	(0.015)	(0.017)
Week	-1.222	94.77***	-95.99***	-62.97***	-18.06***	-14.97***
	(0.900)	(1.402)	(1.169)	(0.829)	(0.581)	(0.699)
Week w	0.007***	0.033***	-0.318***	-0.246***	-0.066***	-0.075***
	(0.001)	(0.001)	(0.004)	(0.003)	(0.002)	(0.002)
Panel B - Counterfactual: matched workers in surviving firms						
	Total	Same firm	New firm	New firm (of which sector): Same	Oth man	Out man
Ann. w	0.072***	2.165***	-2.093***	-1.325***	-0.503***	-0.265***
	(0.028)	(0.036)	(0.029)	(0.019)	(0.016)	(0.017)
Weeks	-1.438	89.11***	-90.55***	-57.36***	-21.75***	-11.44***
	(0.926)	(1.442)	(1.168)	(0.768)	(0.634)	(0.705)
Week w	0.005***	0.025***	-0.312***	-0.227***	-0.071***	-0.055***
	(0.001)	(0.001)	(0.003)	(0.003)	(0.002)	(0.002)

Notes: OLS regressions on cumulative outcomes (base year: 2004) for workers employed 52 weeks in 2004. Regressions weighted with matching weights. Standard errors clustered two-way by worker-level matching group and individual worker. * p<0.1, ** p<0.05, *** p<0.01. Additional control vars measured in 2004.

Heterogeneous effects

Panel A - Gender

	Male			Female		
	Annual wages	Paid weeks	Weekly wages	Annual wages	Paid weeks	Weekly wages
2007	0.001	0.191	0.0003	-0.017	-0.544	-0.003
	(0.002)	(0.125)	(0.0008)	(0.011)	(0.409)	(0.002)
2012	0.079***	1.391***	0.006***	0.020	0.565	0.00004
	(0.0115)	(0.415)	(0.001)	(0.035)	(1.289)	(0.003)
2019	0.141***	0.296	0.009***	-0.043	-5.502*	0.0006
	(0.029)	(0.952)	(0.001)	(0.085)	(2.849)	(0.004)

Panel B - Occupation

	Blue collar			White collar		
	Annual wages	Paid weeks	Weekly wages	Annual wages	Paid weeks	Weekly wages
2007	0.005	0.218	0.0005	-0.007	-0.282	-0.002
	(0.002)	(0.150)	(0.0008)	(0.005)	(0.205)	(0.001)
2012	0.043***	1.603***	0.0008	0.091***	0.262	0.011***
	(0.013)	(0.506)	(0.0009)	(0.0196)	(0.651)	(0.002)
2019	-0.032	-1.964*	-0.0009	0.301***	1.090	0.019***
	(0.031)	(1.165)	(0.001)	(0.051)	(1.459)	(0.003)

Heterogeneous effects (cnt.)

	Panel C - Tenure					
	Tenure < 5 yrs			Tenure ≥ 5 yrs		
	Annual wages	Paid weeks	Weekly wages	Annual wages	Paid weeks	Weekly wages
2007	0.021**	-0.097	0.002	-0.002	0.961**	-0.001
	(0.010)	(0.125)	(0.003)	(0.003)	(0.412)	(0.001)
2012	0.041	0.879**	0.006*	0.060***	0.835	0.005***
	(0.038)	(0.411)	(0.003)	(0.011)	(1.352)	(0.001)
2019	0.212**	-2.444***	0.010**	0.062**	5.280*	0.006***
	(0.096)	(0.942)	(0.005)	(0.028)	(2.998)	(0.001)
	Panel D - Workers' productivity					
	Below-median worker AKM			Above-median worker AKM		
	Annual wages	Paid weeks	Weekly wages	Annual wages	Paid weeks	Weekly wages
2007	-0.009	-0.078	-0.002**	0.005	-.0.706	0.001
	(0.005)	(0.195)	(0.001)	(0.004)	(0.153)	(0.00105)
2012	0.010	-0.451	0.001	0.093***	1.282***	0.009***
	(0.017)	(0.653)	(0.001)	(0.014)	(0.497)	(0.001)
2019	-0.102**	-8.013***	0.001	0.221***	2.127*	0.013***
	(0.041)	(1.474)	(0.002)	(0.037)	(1.141)	(0.001)

Heterogeneous effects (cnt.)

Panel E - Leakage vs non-leakage sectors

	Leakage sectors (exempted)			Non-leakage sectors (not exempted)		
	Annual wages	Paid weeks	Weekly wages	Annual wages	Paid weeks	Weekly wages
2007	0.011***	0.002	0.003***	0.007	0.662**	-0.001
	(0.004)	(0.142)	(0.001)	(0.007)	(0.290)	(0.002)
2012	0.114***	1.398***	0.011***	-0.028	-0.688	-0.000532
	(0.013)	(0.466)	(0.001)	(0.027)	(0.994)	(0.002)
2019	0.204***	-0.907	0.015***	-0.034	-3.532	0.001
	(0.032)	(1.065)	(0.001)	(0.068)	(2.287)	(0.003)

Notes: OLS regressions on cumulative outcomes (base year: 2004) for workers employed 52 weeks in 2004. Counterfactual: matched workers. Regressions weighted with matching weights. Standard errors clustered two-way by worker-level matching group and individual worker. * p<0.1, ** p<0.05, *** p<0.01. Additional control variables measured in 2004.

AKM Results akm

	(1) AKM firm fe	(2) AKM workers fe of firm	(3) AKM firm fe of employees	(4) AKM fe of employees: movers	(5) AKM fe of employees: stayers
ETS	-0.020	0.018**	0.0006***	-0.000	0.001***
	(0.005)	(0.009)	(0.000)	(0.000)	(0.000)
ETS x Phase 1	0.004	0.000	0.0002***	0.001***	0.0001***
	(0.004)	(0.007)	(0.000)	(0.0005)	(0.000)
ETS x Phase 2	0.004	-0.006	0.0001**	0.0009**	0.0001*
	(0.006)	(0.007)	(0.000)	(0.000)	(0.000)
ETS x Phase 3	-0.005	0.002	-0.0001*	-0.0016***	0.000
	(0.006)	(0.002)	(0.000)	(0.000)	(0.000)
Unit of analysis	Firm	Firm	Worker	Worker	Worker

Notes: OLS regressions. Unit of observation in columns 1-2: firm by ETS phase (pre-ETS 2000-2004, Phase 1 2005-2007, Phase 2 2008-2012, Phase 3 2013-2019). Unit of observation in columns 3-5: worker by year. Standard errors clustered by firm-level matching group (columns 1-2) and by worker-level matching group (columns 3-5) in parenthesis. * p<0.1, ** p<0.05, *** p<0.01. Regressions weighted with matching weights. We define as movers in column 4 as the subset of treated workers (and their corresponding matched workers) that moved to a new company at least once in 2005-2019. Stayers (column 5) are defined, in complementary way, as the subset of treated workers (and their corresponding matched workers) that always remained in the same company throughout 2004-2019.

EU-ETS treatment in 2013: wages and paid weeks

	Annual wages	Paid weeks	Weekly wages
2019	0.009	-4.664***	0.011***
	(0.002)	(0.984)	(0.002)
N of treated	11,365 (110 firms)		
N of non-treated	9,945 (247 firms)		
Observations	44,451		

Notes: Cross-section OLS regressions on cumulative outcomes (base year: 2012) for workers employed full-time for the whole year (52 weeks) in 2012. Standard errors clustered two-way by worker-level matching group and individual worker (just individual worker for Panel A). * p<0.1, ** p<0.05, *** p<0.01. Additional control variables (measured in 2012): firm-level AKM, firm size (log of employees), white collar (dummy), gender, age (linear and squared), tenure (linear and squared), region dummy (NUTS2), sector dummy (2-digit NACE rev. 2).

EU-ETS treatment in 2013: workers' transitions

	Same firm	New firm	Not emp.	New firm (of which sector): Same	Oth man	Out man
2019	0.131***	-0.220***	0.010***	-0.057***	-0.086***	-0.077***
	(0.025)	(0.022)	(0.015)	(0.017)	(0.011)	(0.009)
N treat	11,365	11,365	11,365	11,365	11,365	11,365
N match	9,945	9,945	9,945	9,945	9,945	9,945
Obs	44,451	44,451	44,451	44,451	44,451	44,451

Notes: Cross-section OLS regressions on cumulative outcomes (base year: 2012) for workers employed full-time for the whole year (52 weeks) in 2012. Standard errors clustered two-way by worker-level matching group and individual worker (just individual worker for Panel A). * p<0.1, ** p<0.05, *** p<0.01. Additional control variables (measured in 2012): firm-level AKM, firm size (log of employees), white collar (dummy), gender, age (linear and squared), tenure (linear and squared), region dummy (NUTS2), sector dummy (2-digit NACE rev. 2).

Discussion

Differently from other recent structural shocks, we find that **workers** in **ETS** firms are **not penalized**, but **rather rewarded** in terms of **earnings**, **employability**, **hours worked** and **job security**.

- *Is this a good or a bad result for policymakers?*
  - It is good to gain **political support** from the **potential losers** without sacrificing decarbonization targets.
  - It is bad as it does **not create incentives** to **move** in other (greener and less paid) **sectors** within manufacturing and feed the **high-rents** in **energy-intensive industries**.
- We also find **distributional effects** that **exacerbate existing inequalities** (gender, skill).
  - This is something that needs to be addressed by targeted labour market, social and reskilling policies.

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THANK YOU

francesco.vona@unimi.it and
francesco.vona@feem.it

Why focus on manufacturing?

1. Historically strong in Italy (2^{nd} in Europe),
2. Yet, recently in decline worldwide.
3. Previous evidence of Italian manufacturing firms in buffering shocks (Citino and Linarello, 2021).

Firm **panel dimension**:

- 602 Italian firms with at least one installation in the EU-ETS;
- in 2004, 461 of them where operating;
- 397 of them operate in manufacturing;
- in 2005, 246 of them are treated for the first time.

back

Carbon leakage risk

- To **reduce windfall profits** arising from grandfathering of permits, the EC opted for allocating permits through **auctions** as the **default** rule from **phase III (2013-2020)** onwards
- To **limit** the risk of **carbon leakage** (i.e. offshoring of emission-intensive industrial processes) the EC decided to **exempt** from auctioning installations operating in **exposed sectors**
- With **Decision 2010/2/EU** (published on 24/12/2009) the EC approved the **list of sectors** (4-digit NACE) **exempted** from auctioning

Carbon leakage risk (cnt.)

- **3 quantitative criteria** + **1 qualitative criterion** ⇒ all at the **sector level** for EU
  - **Compliance costs** (direct+indirect) >30% of GVA
  - **Trade openness** extra-EU >30%
  - **Combination** of compliance costs (direct+indirect) >5% of GVA & trade openness extra-EU >10%
  - **Qualitative** criterion
- **Announcement** in late **2009**, but **negotiations** started in **early 2009** ⇒ **effective** from 1/1/**2013**

Qualitative criterion

The qualitative assessment was mainly applied to sectors not sufficiently represented in the quantitative assessment, and to sectors considered to be borderline cases or for which statistics were absent or of poor quality, and for which Member States or industry representatives had requested a qualitative analysis, based on plausible reasoning and substantiated requests. back

Survival analysis: background

In terms of survival probability, the increased import competition affected similarly large and small Italian manufacturing firms, but large firms have a much smaller death rate on average (Fiorio et al., 2023). So,

- Are ETS firms surviving longer than non-ETS firms?
- Does the participation to the ETS play a role in determining whether a firm shuts down or not?

Survival analysis: details

back

	Pooled sample (2005-19)	Phase 1 (2005-07)	Phase 2 (2008-12)	Phase 3 (2013-19)
ETS	-0.023***	-0.065***	-0.029***	-0.012*
	(0.004)	(0.014)	(0.006)	(0.006)
Firm AKM	0.242**	0.650***	-0.066	0.324*
	(0.097)	(0.181)	(0.134)	(0.173)
Size (log empl)	-0.013***	-0.006*	-0.011***	-0.018***
	(0.001)	(0.003)	(0.002)	(0.002)
Firm's age	-0.0004***	-0.001***	-0.0003	-0.0005***
	(0.0001)	(0.0003)	(0.0002)	(0.0002)
Pseudo R-sq	0.144	0.201	0.18	0.166
N of firms	799	726	704	617
N of observations	11553	2509	3906	4595

Notes: Probit regressions weighted by matching weights. Standard errors clustered by firms in parenthesis. * p<0.1, ** p<0.05; *** p<0.01. Coefficients represent average marginal effects. Additional control variables: 2-digit (NACE rev. 2) dummies, NUTS2 region dummies, year dummies.

Quantification

back

- To connect our estimation of the effects on the three main outcome variables (*CAW*, *CPW* and *CWW*), it is useful to note that:

$$W_{ij}^{T} = \sum_{t=2005}^{T} \frac{\omega_{ijt} h_{ijt}}{\omega_{ij,t=2004} h_{ij,t=2004}} = (T - 2004) \times \Omega_{ij}^{T} + \frac{H_{ij}^{T}}{52} + G(\omega_{ijt}, h_{ijt}), \quad (3)$$

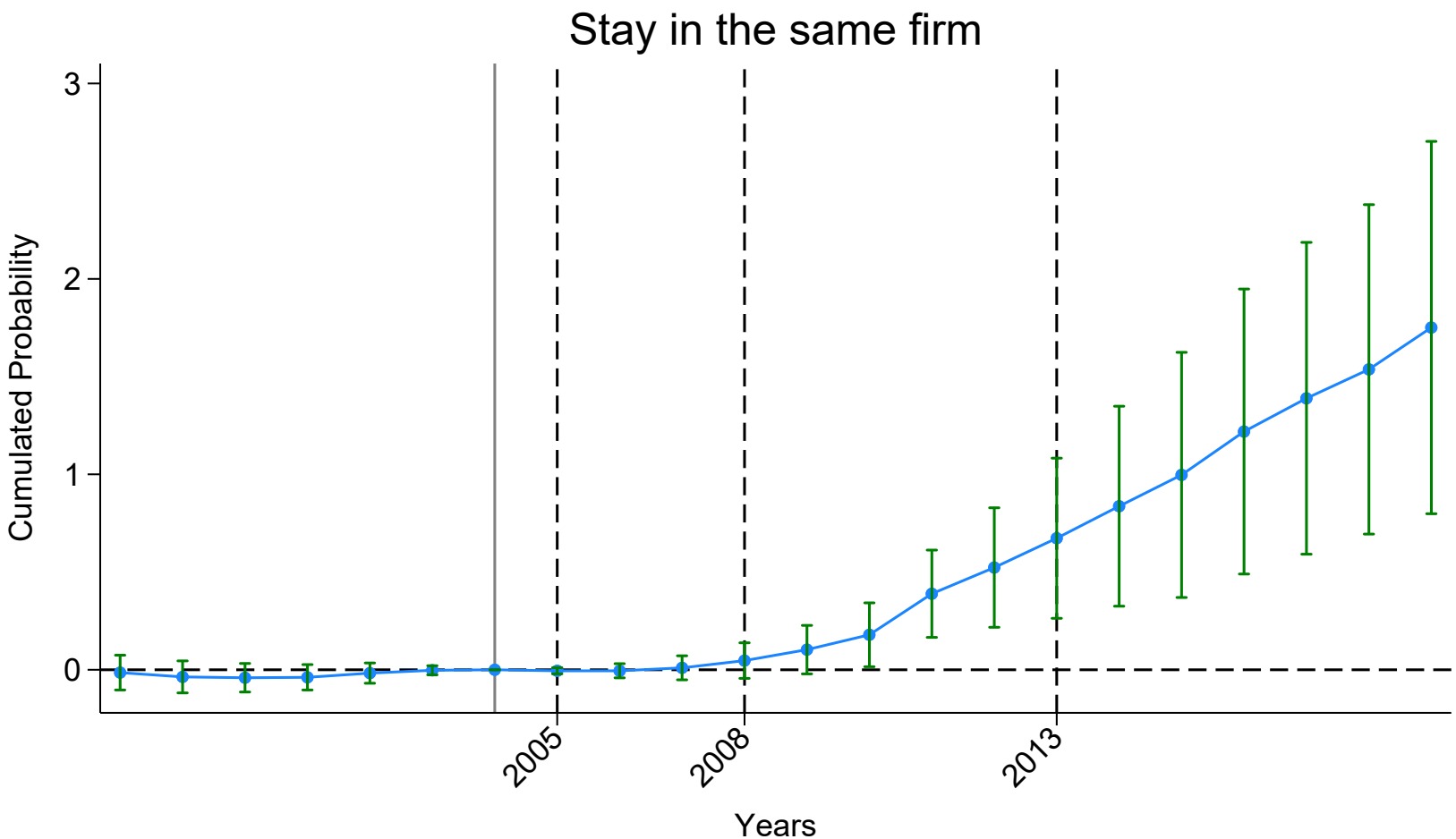
where ω_{ijt} (resp. Ω_{ijt}) are weekly wages (resp. cumulative weekly wages) and $_{ijt}$ (resp. H_{ijt}) weeks worked (resp. cumulative weeks worked), while $G(\omega_{ijt}, h_{ijt})$ is a residual terms that depends on the interaction between the two.

- This decomposition holds also for the ATET at time T (2019 in our case):

$$\hat{\beta}_{W}^{19} = 0.093 \approx 15 \times \hat{\beta}_{\Omega}^{19} + \frac{\hat{\beta}_{H}^{19}}{52} + res =$$

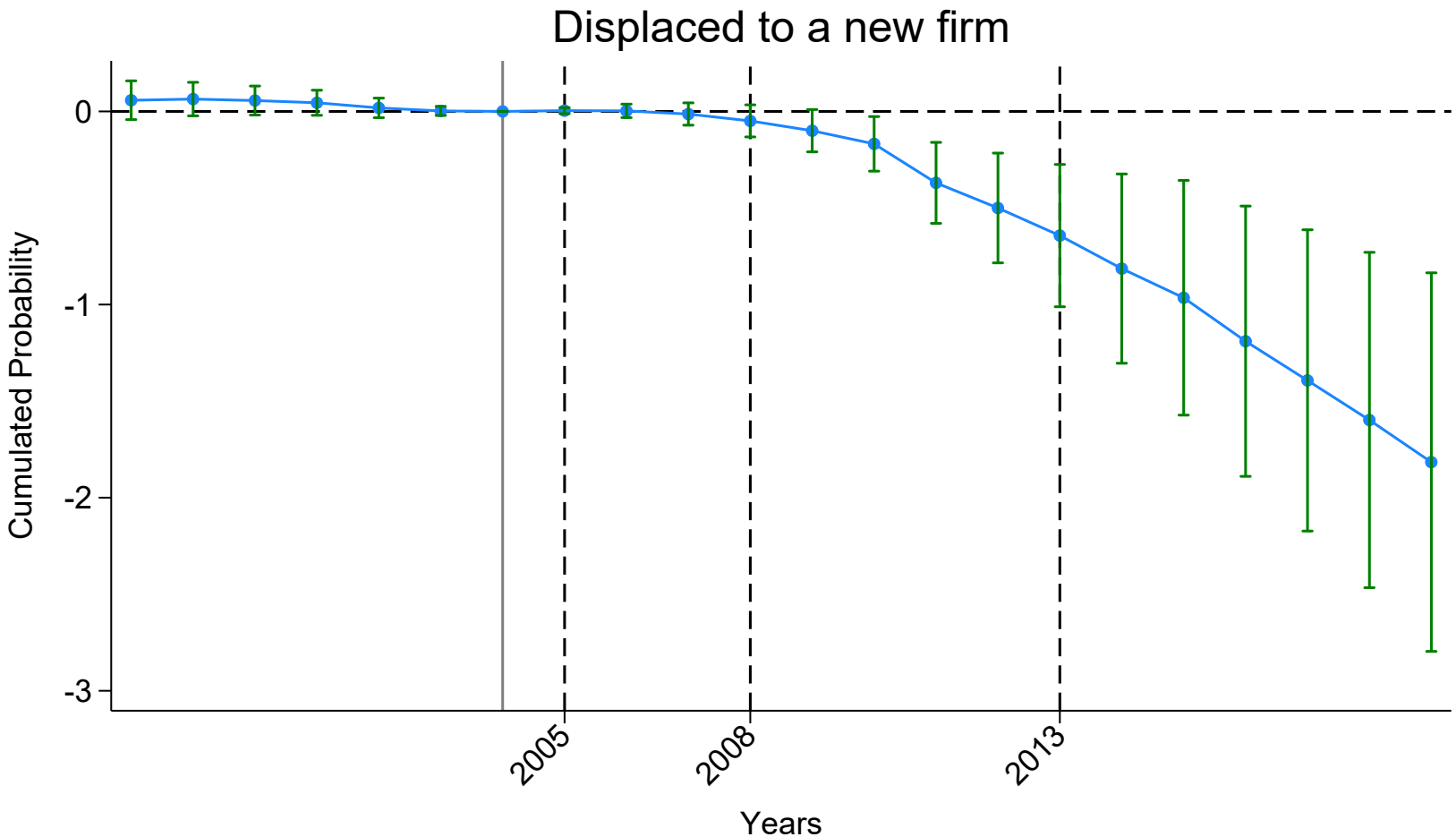
$$15 \times 0.007 - \frac{1.223}{52} + res = 0.082$$

More on mobility



More on mobility (cnt.)

back



AKM

- **AKM** approach Abowd et al. (1999): **decompose individual wages** into **firm-specific** components and **worker-specific** components (akm):
  - **Worker-level**: unobserved ability, skills, experience
  - **Firm-level**: rents, productivity improvements
- For the **universe** of the **non-farm private sector workers**, we estimate worker- and firm-specific premia for each period τ (EU-ETS phases: 2000-2004, 2005-2007, 2008-2012, 2013-2019) by means of the following equation:

$$log(w_{i\epsilon j,t\epsilon\tau}) = \gamma_{j,\tau} + \delta_{i,\tau} + X'_{i,2004}\eta + \phi_{t\epsilon\tau} + \varepsilon_{i\epsilon j,t\epsilon\tau} \quad (4)$$

- where $log(w_{i\epsilon j,t\epsilon\tau})$ is the weekly wage of worker i when employed in firm j in year t for the phase τ, $\gamma_{j,\tau}$ is the firm-specific wage premium and $\delta_{i,\tau}$ is the worker-specific wage premium.
- Both components can be **identified** for those **firms** experiencing **at least one entry/exit** of workers in the considered period back

AKM (cnt.)

- We **augment** the standard AKM setting by controlling for **age** (linear and squared), **gender** and **year** fixed effects (Bloom et al., 2021).

- We estimate the standard **diff-in-diff** model at the **firm level** for **treated** and **matched** firms for the selected time intervals (2000-2004, 2005-2008, 2009-2012, 2013-2016, 2017-2019)
- Next: back to the estimation for each EU-ETS phase (2000-2004, 2005-2007, 2008-2012, 2013-2019).

- At the **firm level**, we consider both the estimated **firm-specific component** $\hat{\gamma}_j$ and the **average worker-specific component** of workers employed in firm j $\sum_{i \epsilon j=1}^{N_j} \hat{\delta}_{i \epsilon j}/N_j$ (i.e. firms employing 'good' employees) weighted for the week worked;
- Next: at the **worker level**, we consider the estimated **firm-specific component** $\hat{\gamma}_j$, for workers sorting between employers.

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