Robots and Firms' Labour Search: the Role of Temporary Work Agencies

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Motivation

The adoption of new 'automation-oriented' technologies, such as robots, is transforming production and labour organization. Impacts on:

- Employment, wages

  (Acemoglu and Restrepo 2021; Aghion et al. 2020, 2021; Bessen et al. 2020)

- Skill composition of labour

  (Acemoglu 2022; Autor 2015; Aghion et al. 2021; Bonfiglioli et al. 2020; Humlum 2021; Kock et al. 2021)

- Sales, productivity, production scale

  (Stiebale et al. 2020; Kock et al. 2021)

In this paper

Technology & Firms' Labour Search

- New technologies increase performance only when combined with competent workers
  - ◇- New jobs → new combination of tasks → new workers
- Firms need to invest time/effort to find the workers that best complement the new technologies
  - ◇- the right worker/match for the job [quotation]

In this paper

- Robots increase the challenge
  - ◇- *McKensey Global Institute* (DP 2018, 2022): 5 EU countries + US
    - ⋆ the most automated functions: the largest skill mismatches (spc in production and manufacturing operations)
    - ⋆ need of advanced skills that are in short supply
    - ⋆ employees' skills as the factor with the biggest impact on automation outcomes
- Robots increase the stakes
  - ◇- bcs. entail large capital investments

In this paper

- Increased importance of efficient search and screening of workers
- Temporary Work Agencies:
  - save on searching costs, efficient screening, elicit info on skills difficult to observe (Autor, 2001)
  - improve matching (Neugart and Storrie, 2006)

[TWA advertising claims]

In this paper

We address 2 Research Questions:

- RQ1: How does automation technology (robot adoption) affect firms' labour search channels? Use of TWA?
- RQ2: If TWA is a more efficient search/screening channel $\rightarrow$ productivity effects?

What we do

- Theory: search model
  - to explain how new technology affects recruitment practices
- Empirics:
  - i) impact of robots on use of TWA
  - ii) impact of robots and TWA on firm productivity

Related literature and paper's contribution

- Literature line 1: Robots and employment
  - ◇- our contribution: robots and search strategy/channel
- Literature line 2: Search models with temp vs perm jobs
  - ◇- our contribution: distinction between directly-hired temps and TWA
- Literature line 3: Productivity
  - ◇- our contribution 1: productivity of TWA (as differentiated from regular temps)
  - ◇- our contribution 2: productivity of combining robots and TWA

- Theoretical model -

Model Overview

- Firms search workers who best match a new production technology
- Theory distinguishes 2 recruitment channels
  - ◇- regular market vs. TWA
- Recruitment channel matters for learning
  - ◇- TWA offer screening advantage before matching

A firm with a vacancy

- A firm has a vacant job of characteristics ξ and π determined by its production technology
  - ξ, labour efficiency, productivity of a job fully operational
  - π, share of competent workers ($\sim$ prior probability)
- New production technologies: $\xi \nearrow$ but $\pi \searrow$

  jobs are more productive but harder to fill

Agents' decisions: Recruitment channel and type of contract

- Firm chooses a recruitment channel
  - direct hiring on regular market
  - or TWA: firm pays a fee C but higher arrival rate of workers and info advantage
- When a firm and a worker meet, they jointly decide whether to match
  - based on available info
  - surplus-sharing rule $\rightarrow$ joint agreement
- When matched, the firm and the worker can separate at anytime or upgrade the contract from temp to perm
  - based on updated info
  - efficient contracting $\rightarrow$ joint agreement

Testable Implications: bringing model to data

- Implication 1:

$$\mathbb{P}(\text{`agency'}|\text{`new tech.'}) \geq \mathbb{P}(\text{` agency'}|\text{`no new tech.'})$$

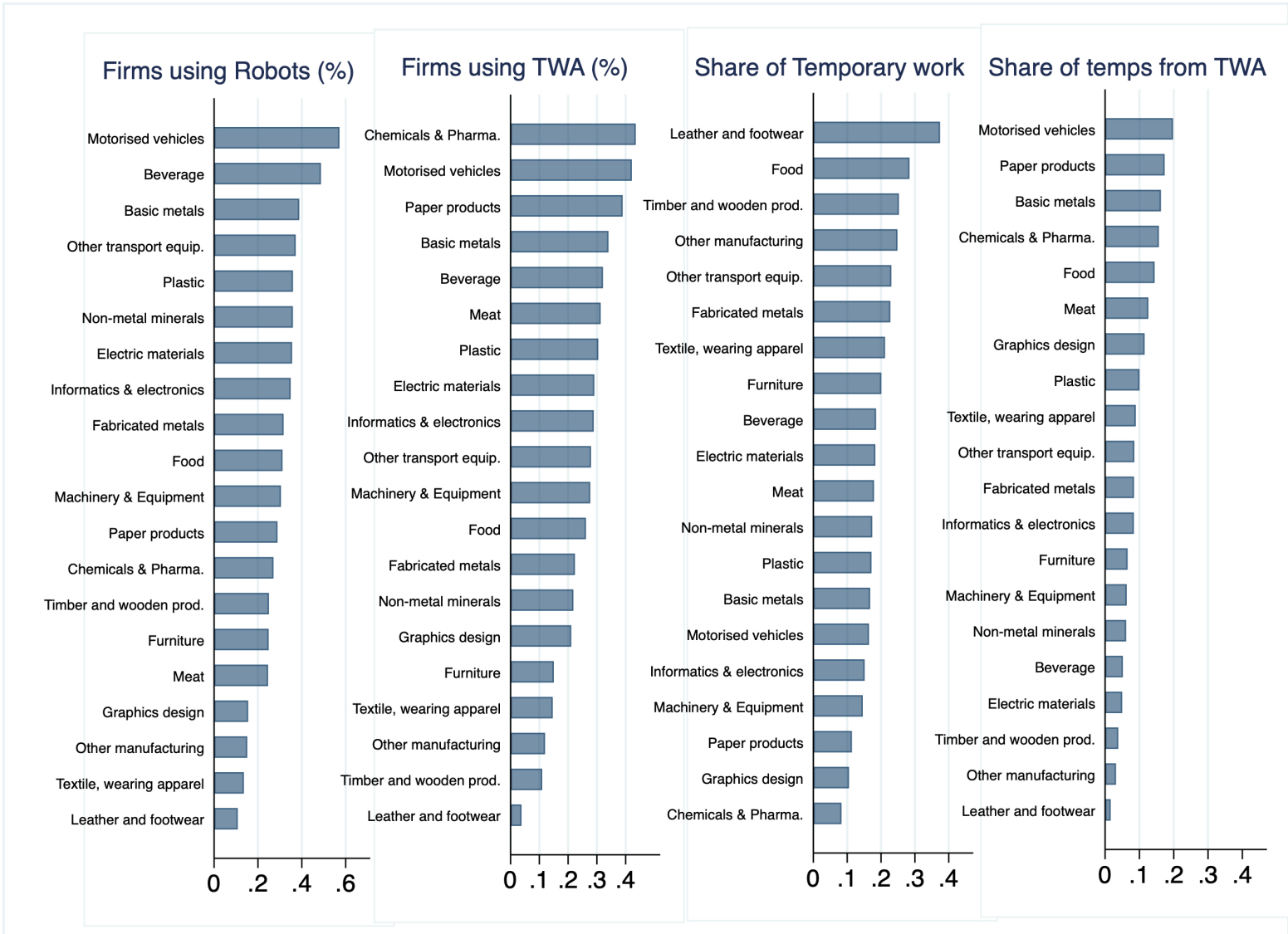
- Implication 2:

The gains from using TWA are higher when firms use new technologies. Model shows complementarity between TWA and tech.

- Data and descriptives -

Empirical section: Data

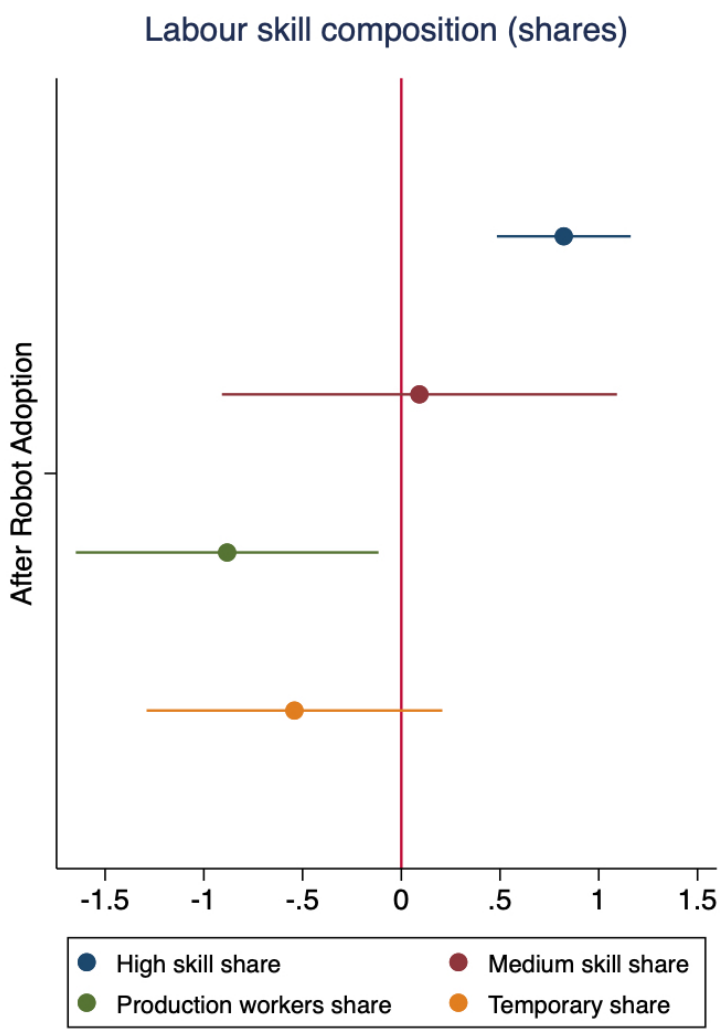
- ESEE (Encuestra Estrategias Empresariales, Fundación SEPI).
  - Survey (panel) data
  - Manufacturing Spanish firms
  - Sample: unbalanced panel, from 1997-2016, around 3,400 firms.
  - Temporary workers and TWA (yearly). TWA users: 27%
  - Use of robots (4-year basis). Robot users: 30%

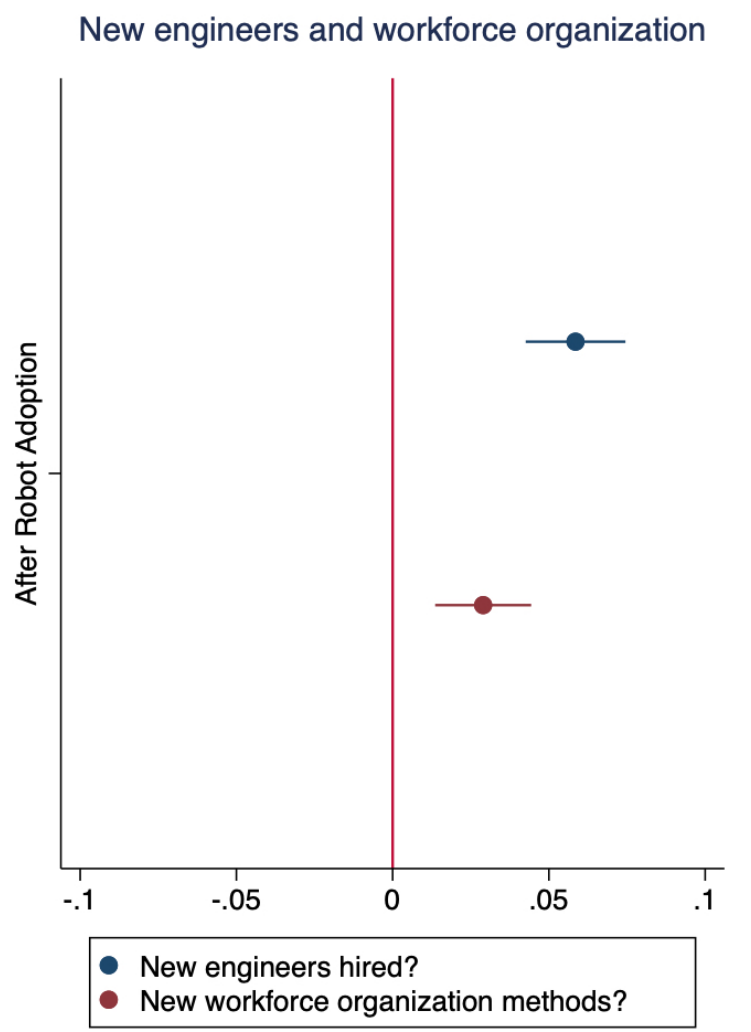

Firms using Robots (%)
Motorised vehicles
Beverage
Basic metals
Other transport equip.
Plastic
Non-metal minerals
Electric materials
Informatics & electronics
Fabricated metals
Food
Machinery & Equipment
Paper products
Chemicals & Pharma.
Timber and wooden prod.
Furniture
Meat
Graphics design
Other manufacturing
Textile, wearing apparel
Leather and footwear
0 .2 .4 .6
Firms using TWA (%)
Chemicals & Pharma.
Motorised vehicles
Paper products
Basic metals
Beverage
Meat
Plastic
Electric materials
Informatics & electronics
Other transport equip.
Machinery & Equipment
Food
Fabricated metals
Non-metal minerals
Graphics design
Furniture
Textile, wearing apparel
Other manufacturing
Timber and wooden prod.
Leather and footwear
0 .1 .2 .3 .4
Share of Temporary work
Leather and footwear
Food
Timber and wooden prod.
Other manufacturing
Other transport equip.
Fabricated metals
Textile, wearing apparel
Furniture
Beverage
Electric materials
Meat
Non-metal minerals
Plastic
Basic metals
Motorised vehicles
Informatics & electronics
Machinery & Equipment
Paper products
Graphics design
Chemicals & Pharma.
0 .1 .2 .3 .4
Share of temps from TWA
Motorised vehicles
Paper products
Basic metals
Chemicals & Pharma.
Food
Meat
Graphics design
Plastic
Textile, wearing apparel
Other transport equip.
Fabricated metals
Informatics & electronics
Furniture
Machinery & Equipment
Non-metal minerals
Beverage
Electric materials
Timber and wooden prod.
Other manufacturing
Leather and footwear
0 .1 .2 .3 .4

Firms' Labour Composition after Robot Adoption

(Basic DiD. - RA: Robot-Adopters -)

$$y_{it} = \alpha + \beta RA_i + \gamma\ RA_i \times Post_{it} + \eta_t + u_{it}$$





- Estimation Part I -

Probability of TWA after Robot Adoption

Methodology Part I. Robots and TWA use

Identification Strategy:

- Staggered DiD estimation, Callaway and Sant'Anna (2021)
- General and flexible framework for staggered DiD
  - firms variation in treatment timing (staggered adoption)
  - allows for 'conditional parallel pre-trends'
- Building block:
  - the group-time average treatment effect

$$ATT(g,t) = \mathbb{E}[Y_t(g) - Y_t(0)|G_g = 1]$$

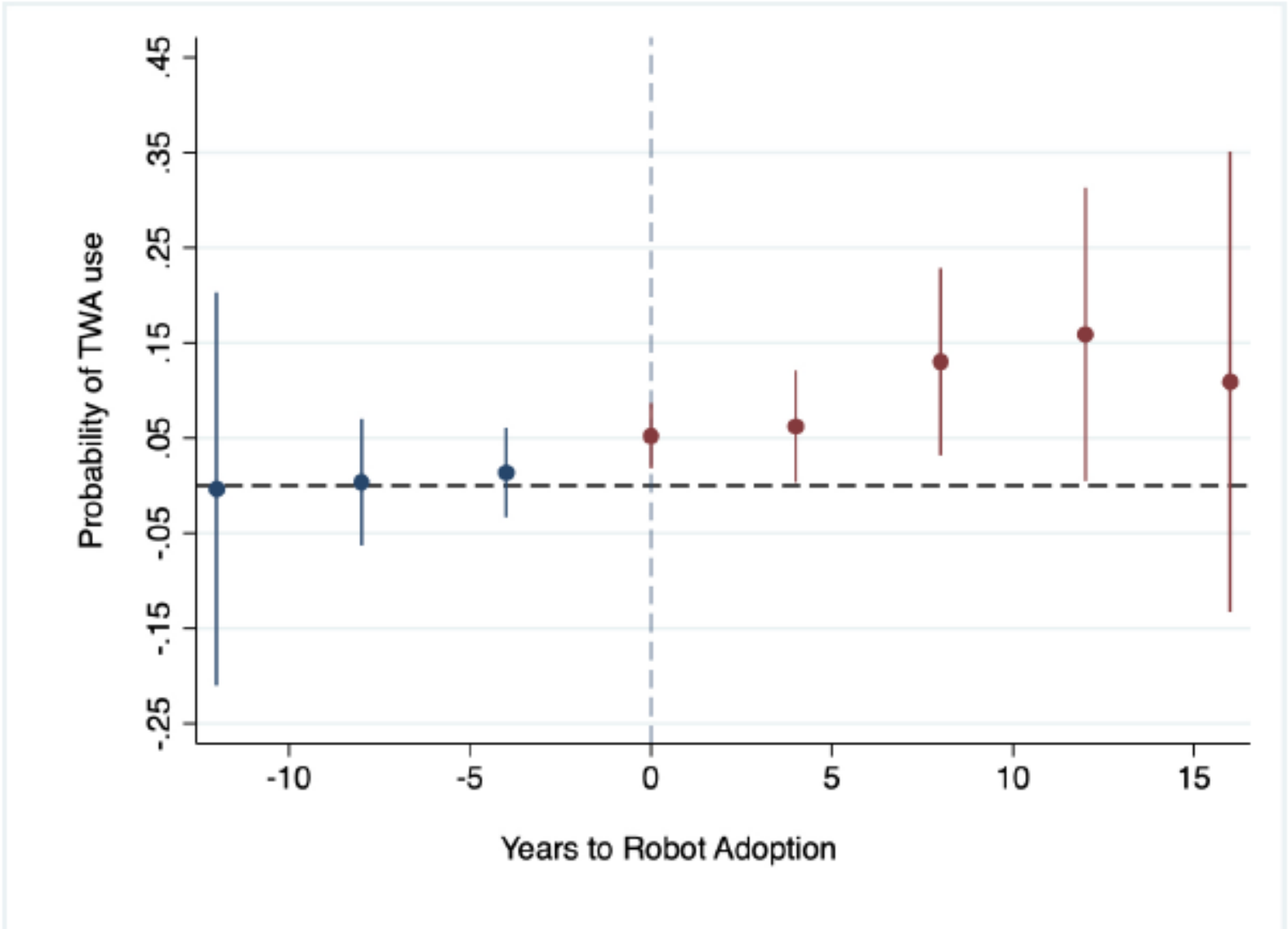
  - and weighted aggregation of the group-time ATTs to construct causal parameters

Probability of using TWA after robot adoption

	Uncond. PT sample 1	Cond. PT sample 1	Uncond. PT sample 2	Cond. PT sample 2
	(1)	(2)	(3)	(4)
Total ATT	0.058***	0.083***	0.062***	0.087***
	(0.020)	(0.021)	(0.023)	(0.023)
Event windows:				
-8, +4	0.026*	0.052***	0.020	0.042***
	(0.013)	(0.015)	(0.015)	(0.016)
-8, +8	0.035***	0.061***	0.032**	0.054***
	(0.015)	(0.017)	(0.016)	(0.017)
-8, +12	0.040***	0.066***	0.038**	0.061***
	(0.015)	(0.017)	(0.017)	(0.018)
-8, +16	0.042***	0.067***	0.039***	0.062***
	(0.015)	(0.017)	(0.017)	(0.018)
Pre-trends (Chi-sq)	0.775	1.207	0.775	1.061
(p-value)	[0.992]	[0.976]	[0.992]	[0.983]
N Obs.	6,851	6,851	6,447	6,447

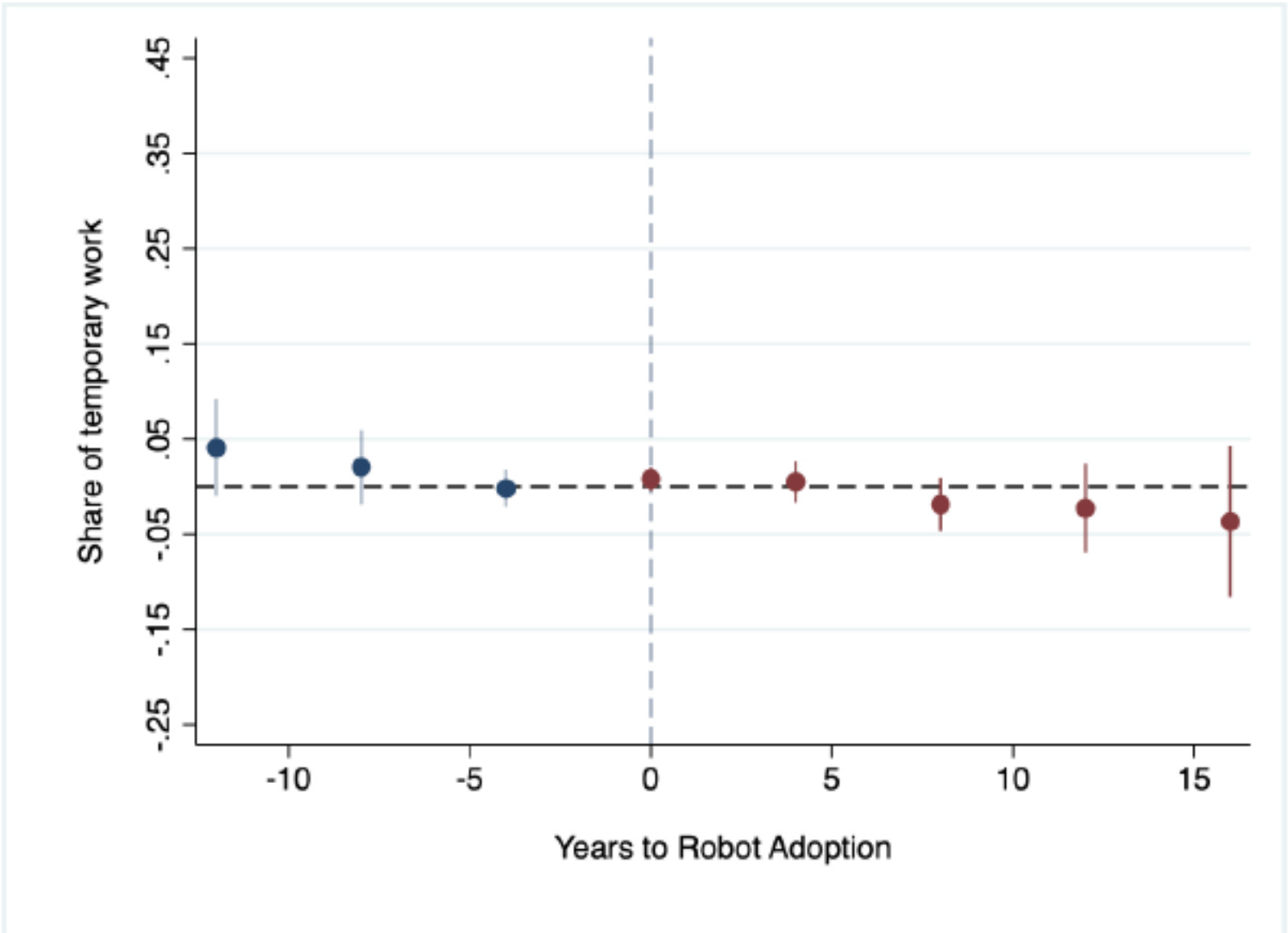
Notes: Uncond. PT refers to unconditional parallel trends estimation; Cond. PT: conditional parallel trends estimation (previous experience using TWA and firm's size interval). Sample 1 uses all observations from robot adopters until they stop using robots (around 5% of cases). Sample 2 discards all the observations coming from robot adopters that at some point stop using robots. Estimation method: Sant'Anna and Zhao (2020)'s improved doubly robust DiD estimator based on inverse probability of tilting and weighted least squares (drimp in csdid in Stata). Bootstrapped errors in parenthesis. * p-value<0.10 ** p-value<0.05 *** p-value<0.01.

Probability of using TWA after robot adoption



Share of temporary work after RA

Is it just an intensification of the use of temps?

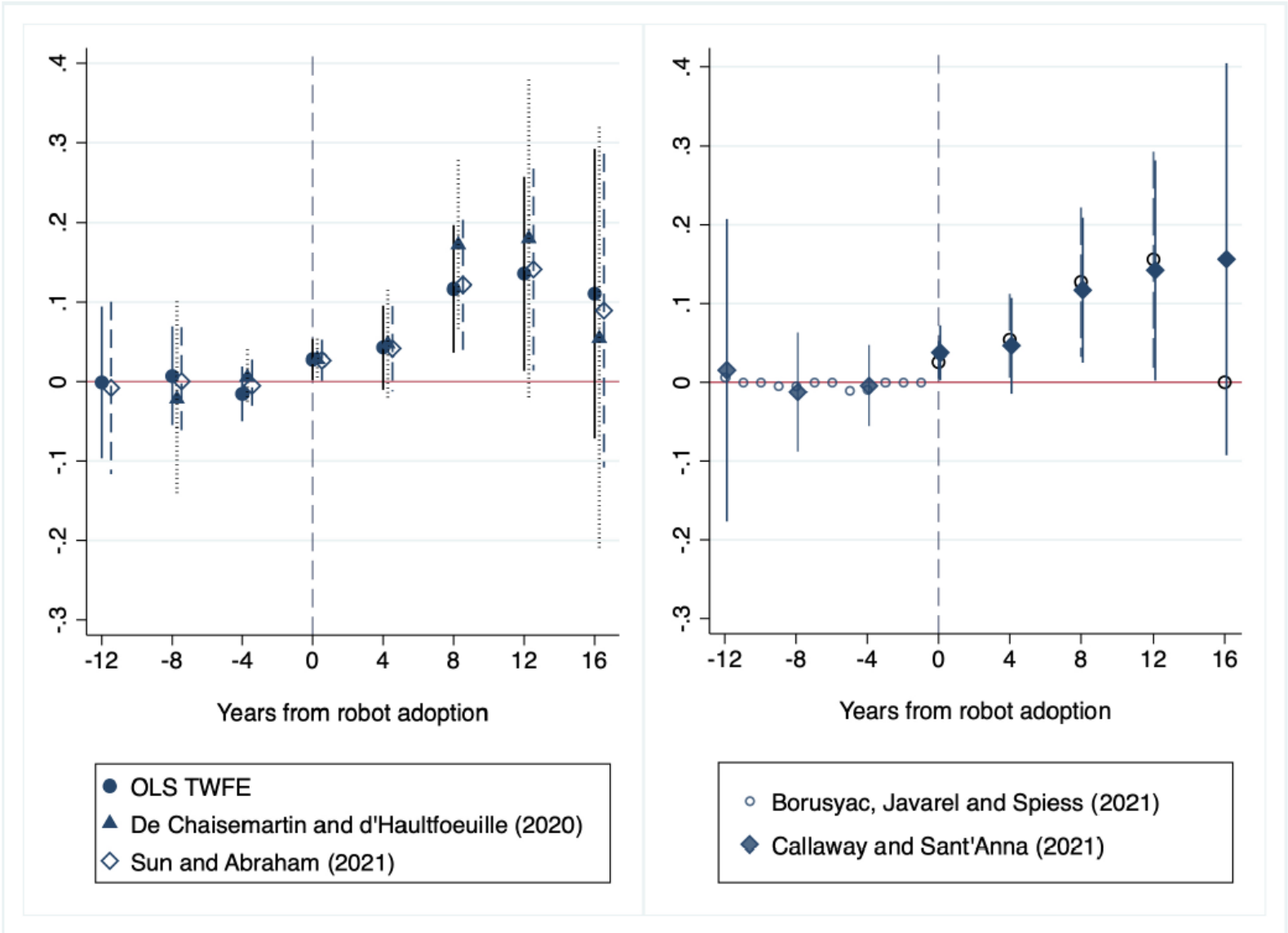


Excluding the years of the Great Recession (from 2008 to 2013)

	Uncond. PT sample 1 (1)	Cond. PT sample 1 (2)	Uncond. PT sample 2 (3)	Cond. PT sample 2 (4)
Total ATT	0.070***	0.073***	0.074***	0.087***
	(0.022)	(0.023)	(0.027)	(0.026)
Pre-trends (Chi-sq)	0.285	0.979	0.285	0.979
(p-value)	[0.997]	[0.964]	[0.997]	[0.964]
N Obs.	5,234	5,234	4,951	4,951

Notes: Years 2008 to 2013 - both included- are out of estimation. Notes: Uncond. PT refers to unconditional parallel trends estimation; Cond. PT: conditional parallel trends estimation (previous experience using TWA and firm's size interval). Sample 1 uses all observations from robot adopters until they stop using robots (around 5% of cases). Sample 2 discards all the observations coming from robot adopters that at some point stop using robots. Estimation method: Sant'Anna and Zhao (2020)'s improved doubly robust DiD estimator based on inverse probability of tilting and weighted least squares (drimp in csdid in Stata). Bootstrapped errors in parenthesis. * p-value<0.10 ** p-value<0.05 *** p-value<0.01.

Comparing CS-DiD with 4 alternative DiD



- Estimation Part II -

Productivity of TWA and robots

Methods Part II. Productivity of Robots and TWA.

Endogeneity of robot adoption:

- TWFE DiD estimation with propensity score reweighting (Guadalupe, et al. 2012; DiNardo et al. 1996; Koch et al. 2021).

$$y_{it} = \alpha + \gamma\ Robots_{it_a} + \delta\ TWA_{it} + \theta\ TWA_{it} \times Robots_{it_a} + \\ + \lambda\ Temps_{it} + \eta_t + \eta_i + \eta_{jt} + \eta_{rt} + u_{it}$$

where y_{it} is (log of) the firm's value added divided by (effective) labour-hours and deflated with ESEE firm-level deflators; and where we check $t_a = t$ and/or $t_a = t - 4$.

(matching and weigthing based on lagged sales, sales growth, labour productivity, labour productivity growth, capital-,skill- and R&D intensity, indicators for exporter, importer and foreign ownership, and year dummies)

- Entropy balancing: we balance the treated and control samples in terms of both the mean and the variance.

Productivity of Robots and TWA

	p-score matching				entropy balancing		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$Robots_{t_0}$	-0.001						
	(0.022)						
$Robots_{t_{-4}}$	0.162***	0.162***	0.155***	0.141***	0.104***	0.100***	0.077***
	(0.028)	(0.019)	(0.019)	(0.020)	(0.013)	(0.013)	(0.015)
TWA			0.178***	0.137***		0.088***	0.053***
			(0.014)	(0.016)		(0.009)	(0.011)
$Robots_{t_{-4}} \times TWA$				0.190***			0.137***
				(0.040)			(0.031)
$Temps$			0.003	-0.009		-0.202***	-0.197***
			(0.029)	(0.032)		(0.020)	(0.021)
Observations	2,584	2,584	2,584	2,584	2,368	2,368	2,368
R-squared	0.833	0.833	0.835	0.836	0.828	0.829	0.830
p-score weights	Yes	Yes	Yes	Yes	No	No	No
Entropy weights	No	No	No	No	Yes	Yes	Yes
Industry-year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional-year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: outcome variable is labour productivity of firm i in period t, and it is constructed as the (log of) firm's value added deflated with ESEE firm-level deflators and divided by (effective) labour-hours; the outcome variable is averaged over the years between two consecutive ESEE response years, including the last one. $Robots_{t_0}$ is a dummy variable that takes the value of one in all post-robot adoption periods for robot adopters that report for the first time using robots in the current ESEE response year; $Robots_{t_{(-4)}}$ is similarly defined for firms reporting robot use for the first time in the previous ESEE response year - that is, 4 years before; TWA is the average of the binary indicator of TWA-use in period t comprised between two ESEE response years; $Temps$ stands for the firm's share of temporary workers during that period. Bootstrapped standard errors clustered by firm in parenthesis.* p-value<0.10 ** p-value<0.05 *** p-value<0.01.

Conclusion

- Complementarity between firms' adoption of modern technologies and labour recruitment strategy
- Evidence that automation-oriented technologies
  - push firms to use TWA
  - increase productivity even more when combined with TWA
  - not a story of temps vs. perms
- A theoretical mechanism
  - New technologies create more specific jobs...
  - ...which raise the stakes of recruiting the right workers
  - TWA fulfil this need for better screened workers

Thank you for your attention!!!

New jobs and new workers

'It is essential to have good tools, but it is also essential that the tools should be used the right way.' [to the Intro]

Wallace D. Wattles, *The Science of Getting Rich* (1910).

Advertising claims of TWA (see also Autor, 2003)

"*Randstad brings people closer to the job they are looking for and companies closer to the talent they need*" [to the Intro].