# The effect of automation technology on workers' training participation

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# Motivation and Literature

- Automation technology alters the wage and employment structure (e.g., Acemoglu and Restrepo, 2017, 2018; Dauth et al., 2021; Acemoglu and Autor, 2011; Autor, 2013; Autor et al., 2003; Bresnahan et al., 2002; Goos and Manning, 2007; Goos et al., 2014; Michaels et al., 2014)
- Public discussion on the importance of life-long learning and further training.
- Policies to promote further training (e.g., in 2019, the German government spent approximately 2.1 billion Euros to subsidize further training)

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# Motivation and Literature

- Why should workers train when they are exposed to automation?
  - Learn new tasks
  - Remain employable
- Why should firms' train workers who are exposed to automation?

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- Retain specific human capital; motivate workers
- Forgone investments in workers who will be automated

- Evidence on the relationship between automation and training is scarce and mixed
- Workers who fear automation have a larger intention to train (Innocenti and Golin, 2022)
  - Firms provide and finance between 85 and 90 percent of all training (Booth and Bryan, 2007)
- Nedelkoska and Quintini (2018) find large negative training gap for workers who are exposed to automation.

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But why?

# Contribution

- Workers who are exposed to automation train approximately 12 percent less than the average worker.
- Conditional automation-training gap is almost as large as education-training gap (Görlitz and Tamm, 2016)
- Education, worker and firm characteristics explain little of the training gap.
- Firms' financial and non-financial training support explains more than 50 percent of the automation-training gap.

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# Data: National Educational Panel Study

- Starting cohort 6.
- 10,000 adults between 2009 and 2017.
- Between 25 and 60.
- 43779 of 9594 adults.
- Detailed variables on training participation.
  - Frequency, duration, training content.
  - Detailed worker and firm characteristics: industry, occupation, part-time etc.

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Information about firms' training support

# Data: Exposure to Automation Technology (Webb Measure)

- Combination of information from patent texts with job descriptions from O\*Net
- Verb-noun pairs indicate overlap between tasks and the capabilities of new automation technologies according to patents
- Many studies validate Webb measure (e.g., Acemoglu et al., 2020)
- Crosswalk between the Standard Occupational Classification (SOC) from the U.S. and the German classification of occupations from 2010.

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# Data: Exposure to Automation Technology



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# Descriptive statistics technology and training



Figure: Relationship between robot exposure and training.

# Methods: regular fixed effects estimation

 $T_{it} = \delta \cdot Robot_{it} + Educ_i \cdot \beta_1 + Individual_i \cdot \beta_2 + Job_{it} \cdot \beta_3 + Firm_{it} \cdot \beta_4 + \mu_i + \lambda_t + \epsilon_{it}$ 

- T<sub>it</sub>: Training measures
- Robot<sub>it</sub>: Automation exposure
- Educi: 3 education categories
- Individual<sub>i</sub>: gender, migration status, birth year
- Job<sub>it</sub>: experience, working hours, part time, public employment

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- Firm<sub>it</sub>: firm size, industry
- μ<sub>i</sub>: individual fixed effects
- $\lambda_t$ : time fixed effects

## Methods: decomposition

 $E(T_{LE}) - E(T_{HE}) = (E(X_{LE}) - E(X_{HE}))'\beta_{LE} + E(X_{HE})'(\beta_{LE} - \beta_{HE})$ 

- LE: Low exposure; HE: High exposure
- $(E(X_{LE}) E(X_{HE}))'\beta_{LE}$ : explained part
- $E(X_{HE})'(eta_{LE}-eta_{HE})$ : unexplained part
- Focus on firms' financial and non-financial support
- Restriction on waves 2011/12, 2018/19 and 2019/20

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	I	II	Ш	IV	V
Robot exposure	-0.028*** (0.001)	-0.022*** (0.001)	-0.021*** (0.001)	-0.010*** (0.002)	-0.006** (0.003)
High robot exposure	-0.153*** (0.007)	-0.121*** (0.007)	-0.109 <sup>***</sup> (0.008)	-0.060 <sup>***</sup> (0.014)	-0.042 <sup>***</sup> (0.014)
Education	No	Yes	Yes	No	No
Individual controls	No	No	Yes	No	No
Individual FE	No	No	No	Yes	Yes
Job Characteristics	No	No	No	No	Yes
Firm Characteristics	No	No	No	No	Yes
R <sup>2</sup> Observations	0.033 43779	0.039 43779	0.041 43779	0.015 43779	0.019 43779

### Table: Effect of robot exposure on training participation

# Data: Exposure to Automation Technology



Figure: Switchers and stayers

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#### Table: Intensive and Extensive Margin of Training Intensity

	Ext. Hours	Int. Hours	Ext. Number	Int. Number
High robot exposure	-2.266	-2.721	-0.111***	-0.158
	(1.415)	(5.840)	(0.043)	(0.203)
R <sup>2</sup>	0.009	0.014	0.017	0.023
Observations	43779	13344	43779	13344

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### Table: Heterogeneity Analysis

	Low	Education <i>Medium</i>	High	Male	Female
High robot exposure	-0.026	-0.050***	-0.024	-0.068***	-0.021
	(0.038)	(0.016)	(0.039)	(0.021)	(0.019)
R <sup>2</sup>	0.026	0.019	0.029	0.021	0.021
Observations	2661	28124	12994	21170	22609

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	IT	Production	Soft/Business	Other
High robot exposure	-0.016**	-0.004	-0.031***	0.027
	(0.007)	(0.009)	(0.010)	(0.056)
R <sup>2</sup>	0.009	0.006	0.013	0.008
Observations	32659	32061	35109	13344

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## Table: Effect of robot exposure on training content

	I	II	III	IV	V
High robot exposure	-0.002***	-0.001*	-0.001	-0.002	-0.000
	(0.001)	(0.001)	(0.001)	(0.004)	(0.004)
Education Individual controls Individual FE Job Characteristics Firm Characteristics	No No No No	Yes No No No	Yes Yes No No	No No Yes No No	No No Yes Yes Yes
R <sup>2</sup>	0.0011	0.0014	0.0056	0.00087	0.0027
Observations	43779	43779	43779	43779	43779

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Table: Effect of robot exposure on formal further training participation

Table: Oaxaca	blinder	decomposition
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	Overall training	Production	ICT	Soft/business
Raw difference	-0.188***	-0.019***	-0.083***	-0.136***
Explained	-0.133***	-0.013***	-0.045***	-0.093***
Unexplained	-0.055***	-0.006	-0.037***	-0.043***
Detailed decon	nposition of explain	ed part in perc	cent of the c	overall gap
Education	12% ***	16%	1%	10%***
Ind. characteristics	3%*	-5%	4%	7%***
Job characteristics	-2%	-5%	-1%	-7%**
Firm characteristics	<b>5%</b> *	-37%***	10%**	10%***
General support	19%***	52%***	11%***	16%***
Individual support	36%***	84%***	30%***	33%***
Observations	10983	7801	7978	8780

# Conclusion

Firms' do not invest in training of workers' whom they substitute

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- Impact on the key training fields (IT, soft and business skills)
- Firms training support explains largest share of training gap

# Firm support

Firms' general training support

- Does your company have a shop agreement governing continuing education?
- Is there continuing education planning on a regular basis for the employees there?
- Does your company finance or provide classes or training courses?
- Is there a staff member, unit or department responsible for training or continuing education?

Firms' individual support for further training.

- Has your current employer offered to release you from work to attend training sessions and courses?
- Has your current employer offered to pay for you to attend courses and training sessions, give you aid or other kinds of financial support?

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