Missing Routine Work: Automation and the Life Cycle

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January 5, 2025

Motivation

Automation: Replacement of routine manual tasks by automatic machines

- Evidence that automation leads to reallocation across occupations
- Switching occupations more difficult for older workers

This paper: How does automation affect workers at different stages of the life cycle?

Reduced Form

What I do: Estimate earnings consequences of automation by age

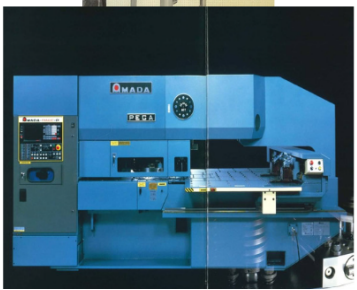
- Administrative and survey data from Germany
- Difference-in-difference exploiting variation in routine manual tasks by occupation

Finding: Young workers' earnings more negatively affected by machines

- Estimated earnings declines four-times larger for youngest vs oldest workers

Puzzle: Why are the earnings of young workers more negatively affected by machines?

Overview



Goal: Estimate effect of automation by age

Approach: Difference-in-difference design

Treatment: Expansion of automatic machines in 1980s

- Machines + computers
- Led to the replacement of routine manual tasks
- Declining opportunities for workers who performed these tasks

Sample: 2-percent German admin panel (SIAB)

- Sample period: 1975-1989
  - Pre-automation: 1970s
  - Post-automation: 1980s
- Treatment intensity: Determined by occupation in 1979

Treatment Intensity

Data: German employment survey (BIBB) from 1979

- Workers report which tasks they perform from a list of 84 tasks
- Categorize tasks into categories (Autor et al. (2003), Spitz-Oener (2006)): routine manual, non-routine manual, routine cognitive, non-routine cognitive, non-routine interpersonal
- Focus on routine manual (RM) tasks: precision cutting, forming metal, weaving

Treatment intensity: Routine manual task composition in 1979

$$D_j = \frac{\text{\# of RM tasks performed by workers in occupation j}}{\text{total \# of tasks performed by workers in occupation j}}$$

Merge this measure with the panel data at the occupation level

Treatment Intensity: Examples

Rank	Occupations	Share (D_j)
1	Drillers up to borers	.84
2	Metal producers, melters, other mold casting occupations	.81
3	Turners (metal parts fabrication)	.74
4	Welders, oxy-acetylene cutters	.71
5	Sheet metal pressers, drawers, stampers, metal molders	.67
	...	
113	Stenographers, typists	.05
114	Social workers, care workers	.05
115	Cost accountants	.05
116	Nursery teachers, pediatric nurses	.04
117	Technical draughtsperson	.04

Identification

Difference-in-difference with a continuous treatment

- Two-way Fixed Effect specification estimates the Average Causal Response (ACR)
  - The causal effect of a unit change in treatment intensity

Key Assumption: Parallel Trends

- Event study to examine parallel trends Event Study
- Relative earnings declines for high-exposure workers started in early 1980s

Heterogeneity across cohorts

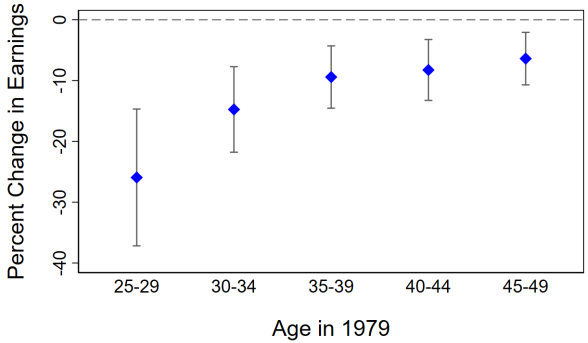
Two-way FE Specification: Estimate ACR (β) separately by 5-year cohort-gender group

$$Y_{it} = \beta \cdot D_{j(i)} \cdot Post_t + x_{it}'\gamma + \alpha_i + \theta_t + \varepsilon_{it} \tag{1}$$

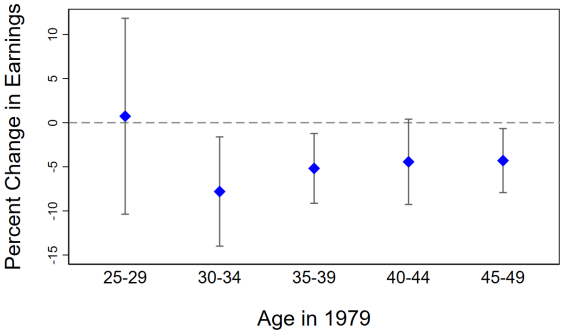
- Y_{it}: outcome log annual earnings in year t
- $D_{j(i)}$: a worker's treatment intensity determined by their occupation in 1979
- $Post_t$: Indicator equal to 0 for $t = 1975 - 1979$ and 1 for $t = 1980 - 1989$
- x_{it}: vector of individual level controls - exp, exp^2, education
- α_i: individual fixed effects
- θ_t: time fixed effects

Young men saw largest relative earnings declines

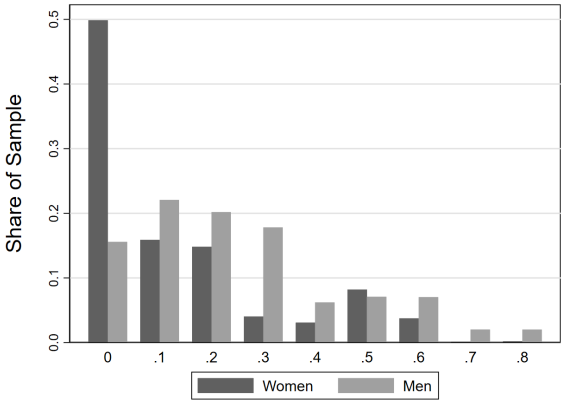
One SD higher treatment intensity $\rightarrow$ 1-4 percent lower average annual earnings



More muted responses for women

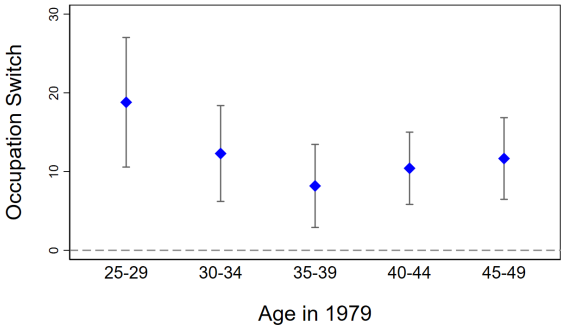


(a) Earnings Results for Women

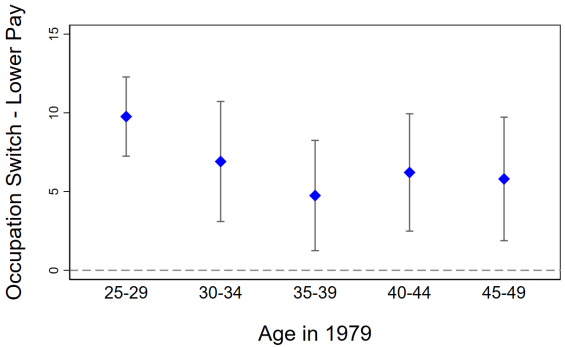


(b) Exposure distribution by gender

Additional Outcomes: Mobility



(a) Leave 1979 occupation



(b) Move to lower-wage occupation

Tasks by Age Early Retirement Unions

Conclusion

Summary:

- Provide evidence of heterogeneity in the effect of automatic machines on earnings by age
- Developed a life-cycle model of automation
- Find declining amenities play a quantitatively important role

Implications:

- Need to take a holistic approach to analyzing consequences of automation
- Policy decisions and analysis might miss unobserved consequences if only considering earnings

Appendix

Parallel Trends: Are the 1980s an appropriate treatment?

Event Study Specification:

$$Y_{it} = \sum_{1975, t \neq 1979}^{1989} \beta^t \cdot D_{j(i)}^t + x_{it}'\gamma + \alpha_i + \theta_t + \varepsilon_{it} \tag{2}$$

- Y_{it}: outcome log annual earnings in year t
- $D_{j(i)}$: workers treatment intensity determined by their occupation in 1979, equal to 0 for $t = 1975 - 1979$
- x_{it}: vector of individual level controls - exp, exp^2, education
- α_i are the individual fixed-effect and θ_t are the year fixed effects.

Run with all age groups combined but still separately for each gender group

Event Study Results

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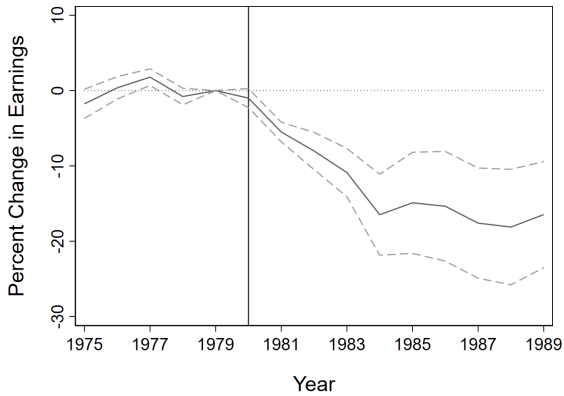

Figure 3: Event study results - men, all cohorts

German Labor Market Institutions: Unions

Age	45-49	40-44	35-39	30-34	25-29
Treatment (RM share)	-0.0748*	-0.0998**	-0.107**	-0.166***	-0.267***
	(0.0275)	(0.0329)	(0.0318)	(0.0383)	(0.0551)
Treatment*High Union	0.0188	0.0642	0.0954	0.0870	0.0315
	(0.0504)	(0.0625)	(0.0738)	(0.0651)	(0.102)
High Union	-0.0255	-0.0391	-0.0431	-0.0454*	-0.0376
	(0.0163)	(0.0196)	(0.0226)	(0.0179)	(0.0263)

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

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German Labor Market Institutions: Early Retirement

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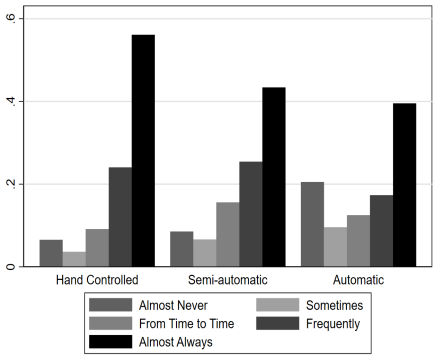
Cohort (age in 1979)	Share of Workers Observed in 1989
25-29	.81
30-34	.81
35-39	.82
40-44	.82
45-49	.72

Table 1: Attrition by cohort

Young workers perform more of the tasks replaced by machines



	(1)	(2)	(3)
Age	-0.0022***	-0.0014***	-0.00087**
	(0.00026)	(0.00024)	(0.00026)
Constant	0.55***	0.53***	0.48***
	(0.010)	(0.0093)	(0.012)
Occ. FE	No	No	Yes
Controls	No	Yes	Yes
Adj. R2	0.0024	0.22	0.24
N	27,359	27,359	23,666

Standard errors in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

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