Monetary returns to upper secondary schooling, the evolution of unobserved heterogeneity, and implications for employer learning

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Motivation

While a positive relationship between education and earnings in general is a fact in the literature, there is less convincing evidence on the returns to education beyond the compulsory level, such as upper secondary schooling and college education.

The literature has also shown that returns are individual-specific and correlate with individual preferences and abilities for education.

How this heterogeneity is shaped throughout the working career is unclear yet. This can give insights on the wage setting of employers.

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Research questions:

1. What are the monetary returns to academic track school education (*Abitur*) in Germany & when are these returns formed?
2. Is there unobserved heterogeneity in the effects & how does it evolve over working careers?

Literature & Contribution

Returns to academic track education

- No (long-run) effects or positive returns [Clark and Del Bono, 2016; Birkelund and van de Werfhorst, 2022; Matthewes and Ventura, 2022]
- Dustmann et al. [2017] find zero returns for Germany

Literature & Contribution

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Unobserved heterogeneity in monetary returns

- Selection into gains pattern for returns to collage education [Carneiro et al., 2011; Nybom, 2017; Kamhöfer et al., 2019] and upper secondary schooling [Carneiro et al., 2017]

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Employer learning literature

- Mainly evidence for employer learning [Farber and Gibbons, 1996; Altonji and Pierret, 2001; Lange, 2007]
- Aryal et al. [2022]: First using instrumental variables within an employer learning model finding that employers learn quickly

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- Aryal et al. [2022]: First using instrumental variables within an employer learning model finding that employers learn quickly

Contribution:

- Adding to Dustmann et al. [2017]: returns to academic track degree for different marginal individuals
- Showing evolution of heterogeneous effects over experience
- First to use marginal treatment effects to get insights on employer learning

Data

NEPS-SC6-ADIAB: Survey data linked to administrative data

- Combines information on educational trajectories of adults with data on labor earnings from 1975 to 2019
- Key: Information on residential history at local level & high-quality earnings data

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School opening data: Purpose-built data set on academic track school (Gymnasien) openings in West Germany

- Covering the years of the educational expansion from 1960 to 1980
- Information on location and opening year of 2,814 schools Map

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Assignment: Access to academic track education depends on entry cohort and municipality at time of track decision

$\Rightarrow$ Yearly panel on full-time working males born between 1950-1985

(N = 3496, unbalanced, earnings deflated by consumer price indices and imputed when exceeding assessment ceiling)

Descriptives

Baseline Empirical Strategy

We deal with the **endogeneity** of academic track education by separately estimating the following **two-stage least squares** (2SLS) model for each experience-level t:

$$
\begin{aligned}
D_i &= \pi_0 + \pi_1 Z_i + X_i'\gamma + \nu_i \\
Y_{it} &= \alpha_t + \beta_t \widehat{D}_i + X_i'\delta_t + \varepsilon_{it}.
\end{aligned}
$$

- D_i Abitur dummy
- Z_i Geographical access (Dummy and continuous index)
- Y_{it} Average monthly gross labor earnings p.a.
- X_i Entry cohort fixed-effects, district fixed-effects, birth month fixed-effects and state-specific trends

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$\Rightarrow$ **Identifying assumption**: The location and timing of academic track school openings is random within districts

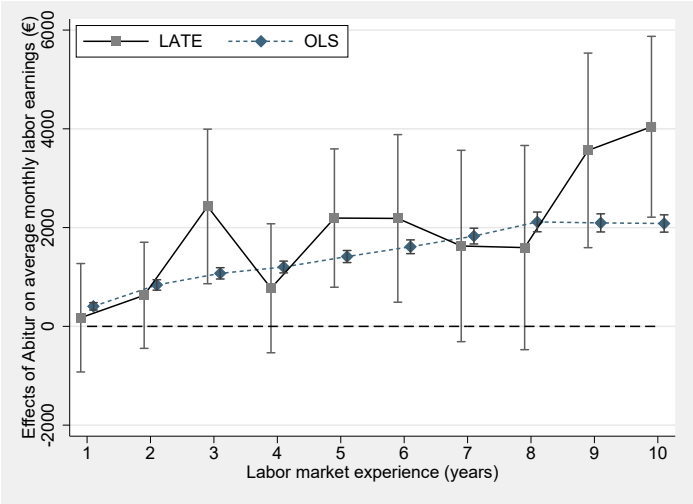
Results – LATE

	Abitur	Monthly labor earnings [∅ in first 10 years]	
	First Stage	OLS	IV
Acad. track school in municipality	0.0828***		
	(0.0241)		
Abitur		1,312.85***	1,927.52**
		(60.88)	(779.80)
F-statistic (instrument)	11.85		
Baseline earnings w/o Abitur		2,791.06	2,791.06
Observations	3,469	3,469	3,469

Notes: Own calculations based on NEPS-SC6-ADIAB data. Regressions also include district and entry cohort fixed-effects, birth month dummies and state-specific trends. Standard errors in parentheses are clustered at the municipality level. Baseline: Average monthly earnings for individuals without Abitur. * ($p < 0.1$), ** ($p < 0.05$), *** ($p < 0.01$)

▸ Other outcomes

Results – LATE by experience



Notes: Own illustration based on NEPS-SC6-ADIAB data. The graph reports regression results for OLS and IV estimations of Abitur on monthly labor earnings over labor market experience. The regressions include district and entry cohort fixed-effects, birth month dummies, and state-specific trends. The vertical bars denote the 90% confidence interval based on standard errors clustered at the municipality level.

MTEs and Unobserved Heterogeneity

MTE-curve shows relationship between individual-specific returns and **unobserved resistance** to academic track education

- Identifies range of heterogeneity in returns to education (**extend of heterogeneity**)
- Detects **selection pattern** into upper secondary schooling

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Idea:

- Observed and unobserved components in gains and costs of education
- Individuals select into academic track education if *expected gains* $\geq$ *costs*

$\Rightarrow$ Rearranging yields: Individuals are indifferent if probability for having Abitur (based on observables) equals their unobserved resistance (restricted to unit interval)

$\Rightarrow$ With a marginal increase in this probability (induced by the instrument) additional marginal individuals choose academic track education

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Estimation: Joint approach with **linear MTE** specification

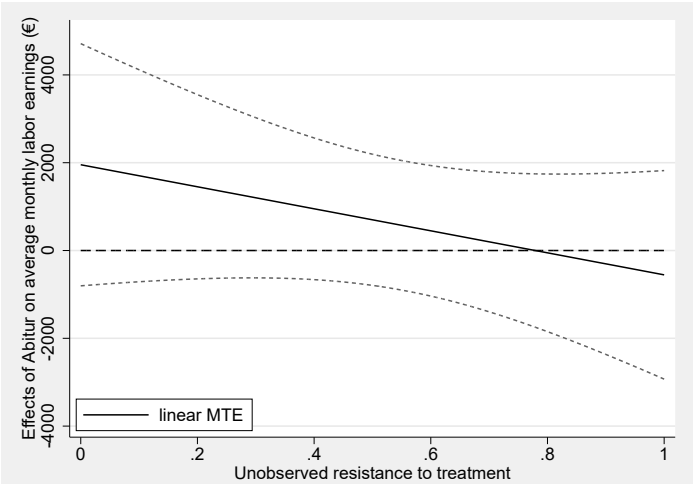
Results – MTE

	First Stage	**MTE**
	Abitur	Monthly labor earnings [∅ in first 10 years]
Index geographical access	0.1252***	
	(0.0394)	
Intercept		1,827.99
		(1,739.15)
Slope		-2,834.66
		(2,871.86)
χ^2-statistic (instrument)	9.05	
Observations	3,270	3,270

Notes: Own calculations based on NEPS-SC6-ADIAB data. Column 1 reports average marginal effects from a probit selection model. Regressions also include district and entry cohort fixed-effects, birth month dummies and state-specific trends. Standard errors in parentheses are clustered at the municipality level and in column 2, bootstrapped with 200 repetitions. * ($p < 0.1$), ** ($p < 0.05$), *** ($p < 0.01$)

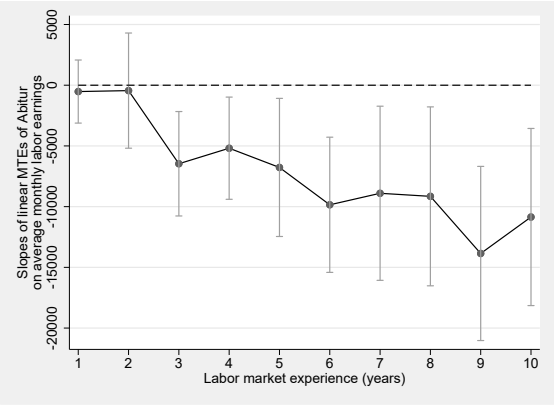
▸ Index definition ▸ Common support graph

Results – MTE



Notes: Own illustration based on NEPS-SC6-ADIAB data. The figure presents the regression results of a linear MTE estimation of Abitur on monthly labor earnings. Regressions also include district and entry cohort fixed-effects, birth month dummies and state-specific trends. The dashed lines give the 90% confidence interval based on bootstrapped standard errors with 200 repetitions clustered at the municipality level.

Results – MTE



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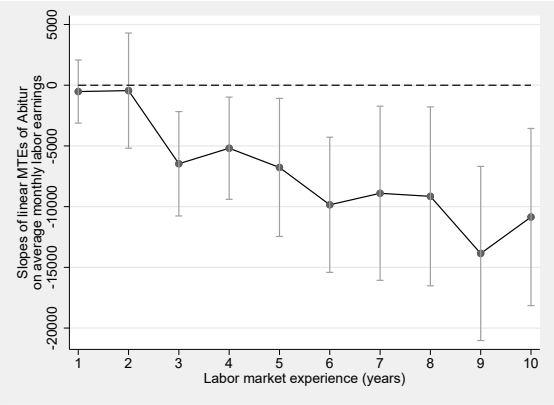

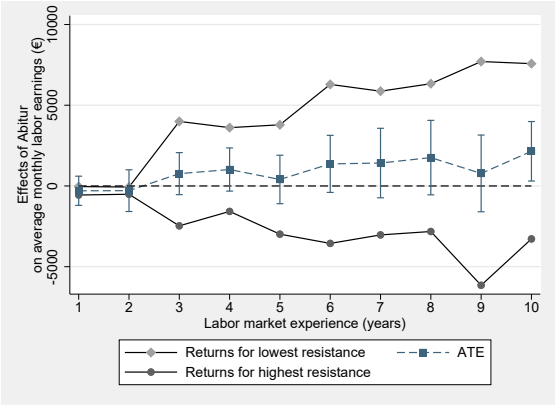

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Employer Learning Interpretation

Common employer learning model: Time-constant component of productivity, competitive labor markets and asymmetric information [Farber and Gibbons, 1996; Altonji and Pierret, 2001]

$\Rightarrow$ Employers learn about persistent productivity factors over time and adjust wages according to expected productivity

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Necessity: If low resistance individuals have higher (productivity enhancing) abilities than high resistance individuals, heterogeneity in returns to Abitur should also increase over experience

$\Rightarrow$ But **no sufficiency**: Different returns to skill and/or employer learning can be a driver

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Conditions to **proof employer learning** with MTEs:

- Assumptions: Productivity does not decrease with experience and no negative effect of Abitur on either skills or employer learning
- Decreasing returns for high resistance individuals over experience can only be driven by employer learning ▸ Returns for low resistance individuals

Conclusion

We find average **returns** to the highest German schooling degree (Abitur) of **over 70%** within the first 10 years after labor market entry (14% per additional year of education).

Positive returns first appear after 2 completed years in the labor market, revealing a **weak signaling valu**e of Abitur.

We document substantial heterogeneity in the returns from year 3 onwards, detecting **selection into gains**.

Zero or negative returns for parts of the distribution make **further incentives** for academic track education **unlikely to pay off**.

Increasing heterogeneity indicates that **employers learn** about their employees productivity (under certain assumptions).

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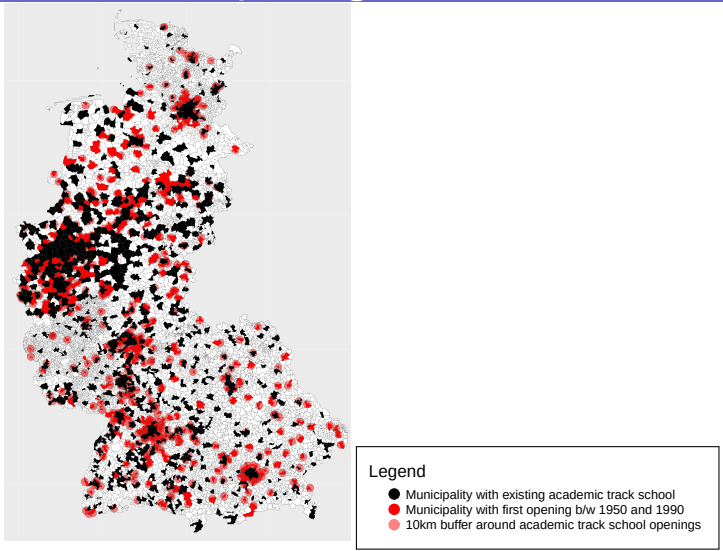
Academic track school openings



Own illustration based on self-collected school information.

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Descriptives– Means per degree

	Without Abitur	With Abitur
Secondary school entry	1975	1978
Month of birth	6	6
Age start working	20.798	24.396
University degree	0.018	0.489
Years of education	13.103	16.535
Repeated year in primary school	0.010	.
Raised by single parent	0.065	0.044
Raised by patchwork family	0.052	0.021
Firstborn	0.296	0.342
Nr siblings	1.995	1.458
Nr older siblings	1.430	1.178
Father born in Germany	0.923	0.916
Number of observations	2344	1125

Notes: Own calculations based on NEPS-SC6-ADIAB data. The table shows means of the variables for individuals with and without the academic track degree (Abitur). Values might be missing due to data protection rules.

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Descriptives– Descriptives of Instruments

	Statistics			
	Mean	SD	Min	Max
Background information				
Distance to 1st nearest school	3.427	4.339	0.1	35.3
Number of schools in municipality	5.2	10.283	0	65
Employed instruments:				
Academic track in municipality	0.633	0.482	0	1
Index (Z_I)	0.703	0.426	0	1.194

Notes: Own calculations based on NEPS-SC6-ADIAB data.

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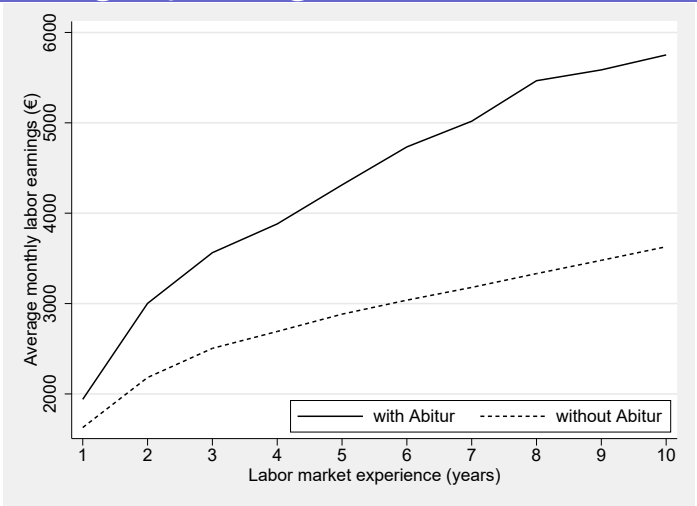
Descriptives – Wages per degree



Own illustration based on NEPS-SC6-ADIAB data. The figure shows means for individuals with and without the academic track degree (Abitur) over labor market experience.

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Variable Definition

$$Index = \sum_{i=1}^{3} f\left(\frac{x_{ji}}{5}\right)$$

with $f(\cdot)$ indicating the density function of $\mathcal{N}(0, 1)$ and x_{ji} the distance in km for individual i to its first, second and third ($j = 1, 2, 3$) nearest acad. track school. The denominator serves as a bandwidth of 5 km.

E.g.: Schools in 1km distance enter with 0.39, whereas schools that are 5km away are valued lower with 0.24. Schools that are 10 or more km away enter the equation with only a small value of 0.05 or less. (Individuals with more schools nearby have a greater index than those living farther away.)

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Results – Other Outcomes

	Outcome		
	Age start working	University degree	Years of education
IV			
Abitur	5.80***	0.55***	4.17***
	(2.01)	(0.18)	(0.99)
Baseline outcome w/o Abitur	20.80	0.02	13.10
N	3,469	3,467	3,446

Notes: Own calculations based on NEPS-SC6-ADIAB data. Regressions also include district and entry cohort fixed-effects, birth month dummies, and state-specific trends. Standard errors in parentheses are clustered on the municipality level. Baseline: Average outcome for individuals without Abitur. * ($p < 0.1$), ** ($p < 0.05$), *** ($p < 0.01$)

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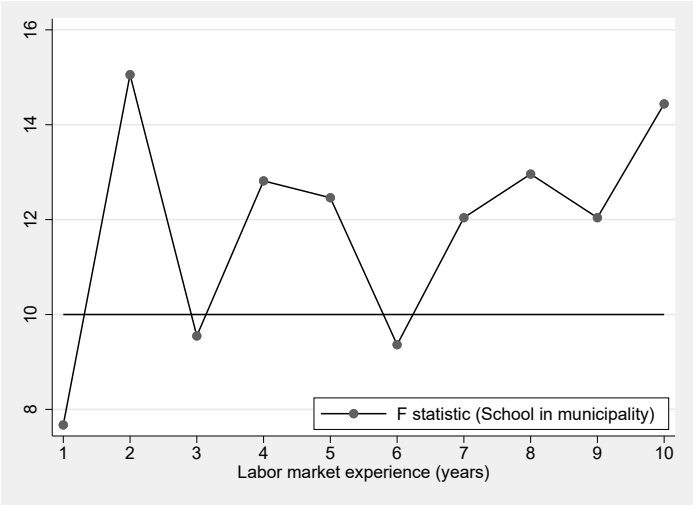
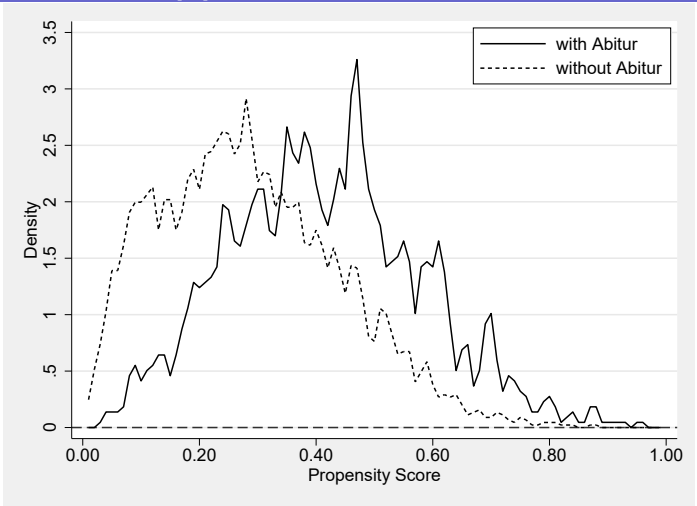
Results – First Stage F-statistic



Notes: Own illustrations based on NEPS-SC6-ADIAB data. The figure reports the F-statistic from a linear first stage regression of the instrument on the treatment (Abitur) over labor market experience. The regressions also include district and entry cohort fixed-effects, birth month dummies and state-specific trends.

Results – Common Support



Notes: Own illustration based on NEPS-SC6-ADIABAT data. This graph depicts the estimated density of the propensity score separately for individuals with and without Abitur.

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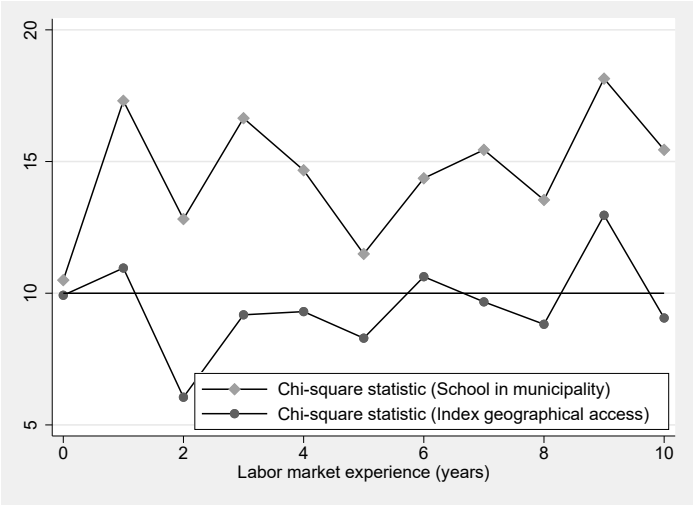
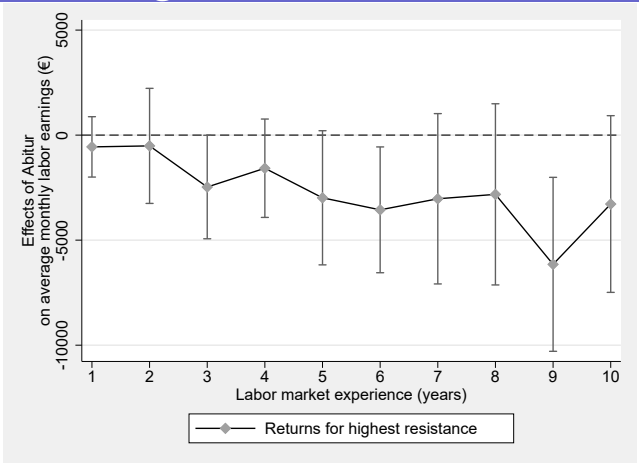
Results – First Stage Chi-square statistic



Notes: Own illustrations based on NEPS-SC6-ADIAB data. The figure reports the chi-squared statistics from seperate probit regressions of both instruments on the treatment (Abitur) over labor market experience. The regressions also include district and entry cohort fixed-effects, birth month dummies and state-specific trends.

Results – Returns of high resistance individuals



Notes: Own illustration based on NEPS-SC6-ADIAB data. The figure shows monetary returns to academic track education for individuals with low resistance to treatment, i.e. with propensity score of 1. Regressions include district and entry cohort fixed-effects, birth month dummies and state-specific trends. 90% confidence intervals are based on bootstrapped standard errors with 200 repetitions clustered at the municipality level.

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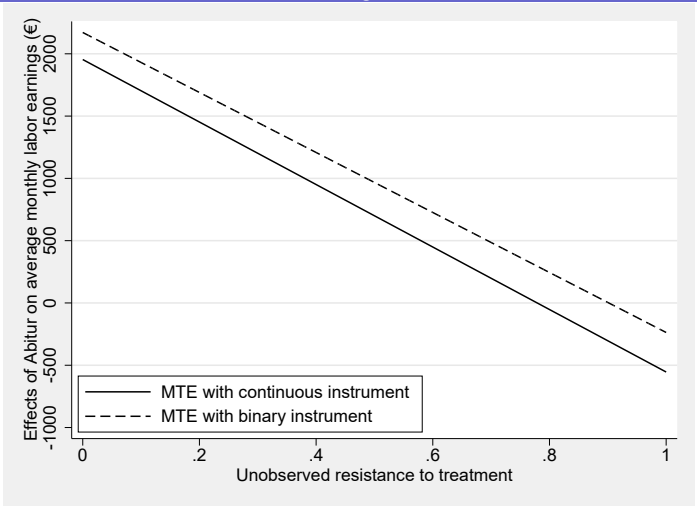
Robustness Checks

- Additionally control for ex ante differences in municipalities within districts (dummy for academic track availability in birth municipality before 1940)
  - Weaker first stage but increased credibility of exogeneity assumption
  - Very similar results
- We show that the parametric estimation of the MTE outcome regression can approximate a nonparametric fit by applying Härdle & Mammen's (1993) specification test
- MTE estimation with binary instrument yields similar results with a slightly stronger first stage ▸ Comparison graph

Robustness Checks – MTE Binary Instrument



Notes: Own illustration based on NEPS-SC6-ADIAB data. The figure presents the regression results of linear MTE estimations of Abitur on monthly labor earnings. Regressions also include district and entry cohort fixed-effects, birth month dummies and state-specific trends.

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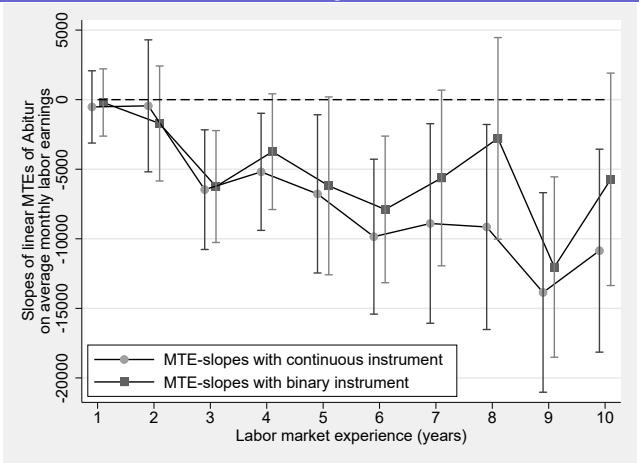
Robustness Checks – MTE Binary Instrument



Notes: Own illustration based on NEPS-SC6-ADIAB data. The figure presents the estimated slope parameters of linear MTE estimations of Abitur on monthly labor earnings over labor market experience. Regressions also include district and entry cohort fixed-effects, birth month dummies, and state-specific trends. 90% confidence intervals are based on bootstrapped standard errors with 200 repetitions clustered at the municipality level.

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