Zero Returns to Compulsory Schooling in Germany: Evidence and Interpretation

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Research Question

What are the (wage) returns to (an additional year of compulsory) schooling in West Germany?

Length of Compulsory Schooling and Reforms

- In the 1950's to 1960's the West German Bundesländer (states) increased compulsory schooling.
- The implementation date varied across Bundesländer.

Hauptschule:	**8**	$\rightarrow$	**9**
Realschule:	10	$\rightarrow$	10
Gymnasium:	13	$\rightarrow$	13

Potential Outcomes - Notation

Variable Definition:

Y_i	log wages
D_i	years of schooling
X_i	gender, age, age^2, year fe, year of birth fe, state fe, state fe $\times$ linear trend
Z_i	$\mathbb{1}\{$9 years of compulsory schooling$\}$

Potential Outcomes:

$$
\begin{aligned}
Y_{1i} &= \mu_1 + X_i\gamma + U_{1i} \\
Y_{0i} &= \mu_0 + X_i\gamma + U_{0i}
\end{aligned}
\tag{1}
$$

Here pretend years of schooling is a dummy.

Potential Outcomes

Observed Outcome:

$$
\begin{aligned}
Y_i &= D_i Y_{1i} + (1 - D_i) Y_{0i} \\
&= \alpha + X_i \gamma + \beta_i D_i + \varepsilon_i
\end{aligned}
\tag{2}
$$

where

$$
\begin{aligned}
\alpha &= \mu_0 \\
\beta_i &= \mu_1 - \mu_0 + (U_{1i} - U_{0i}) \\
\varepsilon_i &= U_{0i}
\end{aligned}
$$

Potential treatment state:

$$
D_i = D_{0i} Z_i + D_{1i} (1 - Z_i) \tag{3}
$$

where D_{ji} is the potential treatment state if $Z_i = j$

(Additional) Identification Assumptions, IV

A1 Independence: $\{Y_{1i}, Y_{0i}, D_{1i}, D_{0i} \perp\!\!\!\perp Z_i | X_i\}$

A2 Existence of a first stage:
$E(D_i|Z_i = 1, X_i) \neq E(D_i|Z_i = 0, X_i)$

A3 Monotonicity: $D_{1i} \geq D_{0i}\ \forall i$

Under these assumptions, we can identify the LATE.

This slide heavily relies on: Cornelissen et al. (2016)

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How do these assumptions relate to the assumptions made in the generalized Roy model? (for equivalence proof see Vytlacil, 2002)

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The relationship between LATE and ATU

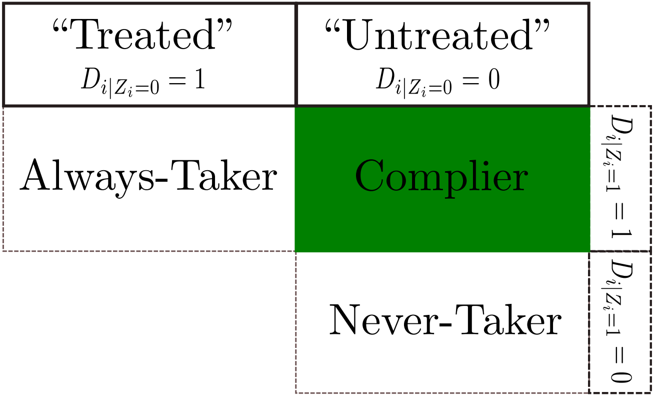
“Treated”	“Untreated”
$D_{i\|Z_i=0} = 1$	$D_{i\|Z_i=0} = 0$

The relationship between LATE and ATU

“Treated” $D_{i\mid Z_i=0} = 1$	“Untreated” $D_{i\mid Z_i=0} = 0$	
Always-Taker	Complier	$D_{i\mid Z_i=1} = 1$
Defier	Never-Taker	$D_{i\mid Z_i=1} = 0$

The relationship between LATE and ATU

+ Monotonicity assumption: no defier.



The relationship between LATE and ATU

- Monotonicity assumption: no defier.
- Perfect enforcement of reform: no never-taker

"Treated" $D_{i\|Z_i=0} = 1$	"Untreated" $D_{i\|Z_i=0} = 0$	
Always-Taker	Complier	$D_{i\|Z_i=1} = 1$

$$\Rightarrow \text{LATE} = \text{ATU} = (\text{PRTE})$$

Data (Constraints)

- Two data sets: Qualification and Career Survey (QaC) and Micro Census
- Main issue: neither data set includes years of education.

Imputation based on:

	QaC	Micro Census
year of birth	X	X
state of residence	X	X
year second. school graduation	X	
highest secondary degree	X	X
postsecondary education	detailed	not detailed

⇒ Only use imputed values for QaC.

The two-sample two-staged least square estimator (TSTSLS) - Intuition

- IV estimation of treatment effects relies on two moments/conditional means:
  1. GMM: Cov(Z, y),
     Wald-estimator: $E[Y_i|Z=1]-E[Y_i|Z=0]$
  2. GMM: Cov(Z, D),
     Wald-estimator: $E[D_i|Z=1]-E[D_i|Z=0]$

Zhao et al. (2017), Angrist & Krueger (1992), Inoue & Solon (2010)

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     Wald-estimator: $E[D_i|Z=1] - E[D_i|Z=0]$
- Use the first stage of the QaC sample to estimate (2)
- and use the reduced form effect of the instrument on wages of the Micro Census to estimate (1)
- (here) the division of these two coefficients yields the TSTSLS estimator

Zhao et al. (2017), Angrist & Krueger (1992), Inoue & Solon (2010)

The two-sample two-staged least square estimator (TSTSLS)

A4 the data generating process of the samples is the same among the relevant dimensions (see Angrist & Krueger 1992, Zhao et al. 2017, for details)

A5 sample moments are independent

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A5 sample moments are independent

, The TSTSLS consistently estimates:

$$LATE^{MC,QaC} = \frac{E[Y_i^{MC}|Z_i^{MC}=1] - E[Y_i^{MC}|Z_i^{MC}=0]}{E[D_i^{QaC}|Z_i^{QaC}=1] - E[D_i^{QaC}|Z^{QaC}=0]} \tag{4}$$

$$\overset{A4}{=} \frac{E[Y_i|Z_i=1] - E[Y_i|Z_i=0]}{E[D_i|Z_i=1] - E[D_i|Z_i=0]} = LATE \tag{5}$$

Results

Independent Variable	Full Sample (1)
	Qualification and Career Survey
Dummy for cohort with ninth grade in basic track	0.190 (0.039)
Number of observations	54,126

	Dependent Variable: Log Wage			
	Full Sample			
Independent Variable	OLS (1)	OLS (2)	OLS (RF) (3)	IV (4)
	Micro Census			
Years of education	0.074 (0.001)	—	—	—
Imputed number of years in school	—	—	—	0.016 (0.015)
Dummy for cohort with ninth grade in basic track	—	—	0.003 (0.003)	—
Number of observations	939,736	939,736	939,736	939,736

Results

	Dependent Variable: Log Wage			
	Full Sample			
Independent Variable	OLS (1)	OLS (2)	OLS (RF) (3)	IV (4)
	Qualification and Career Survey			
Years of education	0.061 (0.001)	—	—	—
Imputed number of years in school	—	0.066 (0.002)	—	0.058 (0.038)
Dummy for cohort with ninth grade in basic track	—	—	−0.010 (0.008)	—
Number of observations	54,126	54,126	54,126	54,126

Discussion

- Results suggests that there are no wage returns to one additional year of schooling at the lower end of the schooling distribution in West Germany.
- Problem: according to my own research some of the reforms are incorrectly dated.

Discussion

State	Pivotal Cohort	
	Pischke & von Wachter	Laws
Schleswig-Holstein	1941	1940
Hamburg	1934	1934
Niedersachsen	1947	1947
Bremen	1943	1943
NRW	1953	1952
Hessen	1953	1947
Rheinland-Pfalz	1953	1951
BaWü	1953	1949
Bavaria	1955	1955
Saarland	1949	1952

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Institutional Background

- Germany's secondary schooling system consists of three main tracks:
  - Hauptschule (basic track),
  - Realschule
  - Gymnasium (academic track).
- Children who graduate from Hauptschule or Realschule usually continue with an 3-year apprenticeship including part-time vocational education.
- Children who graduate from Gymnasium take part in a university entrance exam (Abitur)

Identified Parameters of IV with Covariates

- As discussed in the lecture, IV estimator without covariates yields the LATE. This is not generally true if we add additional covariates. (Cornelissen et al. 2016)
- If we partition the sample in subsamples s.t. for all $X_i = x$, then we obtain, the covariate specific LATE:

$$LATE(x) = E(Y_{1i} - Y_{0i} | D_{1i} > D_{0i}, X_i = x)$$

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- Applying the 2SLS with a **fully saturated 1st and 2nd stage** yields a **variance-weighted average of covariate specific LATEs.**
- Less saturated models seem to yield tolerable approximation (Angrist & Pischke 2009).

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