Are there no wage returns to compulsory schooling in Germany? A reassessment

– Online Appendix –

Kamila Cygan-Rehm*

(University of Erlangen-Nürnberg, CESifo, IZA, LASER)

January 2021

*Contact: Kamila Cygan-Rehm, Friedrich-Alexander University Erlangen-Nürnberg, Dept. of Economics, Lange Gasse 20, 90403 Nuremberg, Germany, Email: kamila.cygan-rehm@fau.de.

A Data and empirical strategy

The Qualification and Career Survey (QaC) is a repeated cross-section of the German labor force, and Pischke and von Wachter (2008) (henceforth PvW) use the first four survey waves collected in 1979, 1985/6, 1991/2, and 1998/9 (BIBB and IAB, various years).[1] They include individuals born between 1930 and 1960 who were between 19 and 65 years old when interviewed. Table A.1 shows the age structure in the data. Furthermore, they focus on German citizens living in the West German states (except for Berlin). They also exclude individuals with specific school degrees that could have been obtained only in socialist East Germany (GDR).

In the empirical approach, PvW exploit the regional variation in the timing of the compulsory schooling extensions from eight to nine years within an IV framework. While formally not presented in the original paper, the main outcome equation is

$$y_{ist} = \alpha \mathit{Educ}_{ist} + \chi_s + \delta_t + X'_{ist}\beta + \epsilon_{ist}, \tag{1}$$

where y corresponds to the log hourly wages of individual i from state s in year t. The outcome variable is calculated from the gross monthly earnings (in DM) and the actual number of hours worked per week. $Educ$ represents an individual's years of schooling. German data do not typically report the number of years of schooling because the educational system is structured by tracks rather than by highest attended grade. Thus, PvW impute the years spent in primary and secondary school by using the information on the year of graduation from secondary school, the year of birth, and the typical age of school enrollment (six). χ and δ are vectors of state and year-of-birth fixed effects (FE), respectively. X comprises a quartic in age, an indicator for gender, and three indicators for the survey year. The corresponding first-stage equation is

$$\mathit{Educ}_{ist} = \pi \mathit{C9}_{st} + \lambda_s + \theta_t + X'_{ist}\phi + \nu_{ist} \tag{2}$$

where λ captures state FE and θ year-of-birth FE. $C9$ represents a binary instrumental vari-

[1] More recently, the survey was collected in the years 2005/6 and 2011/2.

able that indicates whether an individual was required to attend nine instead of eight years of compulsory schooling. PvW construct this variable by using the information on an individual's year of birth, the current state of residence, and the timing of the reform in each state (as shown column 1 in Table B.1 in Online Appendix B). Given that geographical information is limited to the current state of residence, the instrument suffers from a measurement error due to regional mobility after schooling completion. PvW argue that this measurement error would be problematic only if it is systematically correlated with the reform and wages, which is rather unlikely.[2]

Generally, the instrument varies over time and across states. To mitigate the concern that other factors disproportionately affected states over time, PvW control for state-specific linear trends in year of birth, which are included in X throughout. These trends and the year-of-birth FE should also flexibly capture the generally increasing trend in educational attainment (see Figure B.1 in Online Appendix B), which might potentially introduce changes in the share of compliers over time. Finally, the standard errors are clustered to for potential correlation among individuals from the same state and birth cohort.

Panel A of Table C.1 in Online Appendix C simply reprints PvW's first-stage results obtained by estimating equation 2. Panel A of Table C.2 reprints PvW's main estimates for the wage regressions. They begin by estimating equation 1 using standard OLS regressions. The main IV estimate is in column 4. Panels B of these tables show my exact replication of PvW's results.

[2]I investigated this issue using the QaC survey collected in 2005/6, which reports both the current state of residence and the actual state of school attendance. On average, for approximately 18% of respondents born between 1930 and 1960, the state of schooling differed from the state of residence at the time of the interview. Nevertheless, I did not find any evidence that regional mobility is significantly correlated with the reform indicator. Moreover, extending PvW's original sample by the 2005/6 data and using the available information on state of schooling does not appreciably change the IV estimates of wage returns to schooling. This is in line with PvW's argument that measurement error due to regional mobility should not lead to bias.

Table A.1: Age structure in the data by birth cohort and survey year

Birth cohort	QaC 1979	QaC 1985/6	QaC 1991/2	QaC 1998/9
1930	49	56	62	
1931	48	55	61	
1932	47	54	60	
1933	46	53	59	
1934	45	52	58	65
1935	44	51	57	64
1936	43	50	56	63
1937	42	49	55	62
1938	41	48	54	61
1939	40	47	53	60
1940	39	46	52	59
1941	38	45	51	58
1942	37	44	50	57
1943	36	43	49	56
1944	35	42	48	55
1945	34	41	47	54
1946	33	40	46	53
1947	32	39	45	52
1948	31	38	44	51
1949	30	37	43	50
1950	29	36	42	49
1951	28	35	41	48
1952	27	34	40	47
1953	26	33	39	46
1954	25	32	38	45
1955	24	31	37	44
1956	23	30	36	43
1957	22	29	35	42
1958	21	28	34	41
1959	20	27	33	40
1960	19	26	32	39

Source: Own illustration.

B Institutional background

Given the existing description by PvW, this section outlines only the most relevant details and additional background work, which motivates some of my robustness tests in Table 1 in the paper.

While the responsibility for educational policies lies with the federal states, the states negotiate and establish framework agreements to ensure the comparability of school systems. The duration of compulsory schooling was a much-disputed and controversial topic in the (West-) German educational debate after World War II (e.g., Leschinsky and Roeder, 1980). The Nazi regime centralized the education system and required at least eight years of schooling. After the war, Hamburg and Schleswig-Holstein were the first states that introduced a compulsory ninth grade ($C9$), which had already been mandated there before the war. The final implementation in the remaining states was staggered. Column 1 of Table B.1 re-prints the information on first birth cohorts affected by the reform from Pischke and von Wachter (2005).

In the postwar period, a weak labor market, high youth unemployment, and a shortage of apprenticeship positions for school graduates became leading arguments for a nationwide extension of compulsory schooling (Petzold, 1981). Indeed, during the early 1950s, several states issued laws that allowed the authorities at local level to temporary prolong school attendance to 8.5 or nine years. The exact content of these laws differed across states. Most of them were limited to specific birth cohorts (see column 2 of Table B.1). Several of the laws were explicitly conditional on an insufficient number of apprenticeships relative to school graduates at the end of particular school years. In this case, each municipality could individually decide on the law's enforcement depending on the local labor market situation. The original legislation texts suggest that for students, the temporarily extensions were mandatory if their municipality actually made use of the law. Most of the laws also explicitly regulated at the state-level that the extensions should deepen general education and improve students' career choices.

Unfortunately, there is no systematic information on the actual implementation and enforcement of the temporary extensions at a local level. Nevertheless, official statistics on the ninth

grade attendance in basic track at the state level might shed some light on this issue. I summarize the available data Table B.1 below. The data are available starting from the school year 1952/53, so that they might only capture a potential exposure to temporary extensions for children born 1939 and later. Note that in some states, the temporary extensions already affected children born 1933 (see column 2). Nevertheless, using the available data, I computed a ratio of the number of students in their ninth year compared to the number of students in their eighth year but in previous school year (i.e., from the same birth cohort). The numbers are presented in column 3, and suggest that the temporary laws were hardly ever implemented in Bavaria. However, especially, in Rhineland-Palatinate and Baden-Wuerttemberg the temporary extensions were a notable phenomenon. For example, in Rhineland-Palatinate, up to 93% of basic track students from cohorts 1938-1942 attended a ninth school year due to the local temporary extensions. Note that the first birth cohort affected by the universal introduction of the compulsory ninth year in this state was 1953.

Due to the recovering labor market in the mid-1950s, the demand for apprentices increased, which virtually suspended the temporary schooling extensions. In the 1950s, the political discussion focused mostly on educational arguments such as improving students' physical and psychological readiness for the labor market and the quality and maturity of their occupational choices.

Finally, in 1964, the prime ministers of all states agreed that compulsory schooling should last nine years nationwide (*Hamburg Accord*). North Rhine-Westphalia, Hesse, Rhineland-Palatinate, and Baden-Wurttemberg eventually implemented the $C9$ reform in 1967, simultaneously with a shift in the starting date of the school year from spring to fall. The change in schedule was completed within two short school years ($SSYs$) that actually jointly lasted only 16 months (for details, see Pischke, 2007). Thus, individuals affected by both the $C9$ reform and $SSYs$ had to remain in school longer than pre-reform but not as long as students exposed solely to the $C9$ reform. Save Hamburg, Lower Saxony, and Bavaria, all school children attending school in April 1966 experienced compressed school years. Although the $SSYs$ shortened the instructional time in the attended grade, they did not affect the curriculum. Bavaria post-

poned the implementation of the grade $C9$ until 1969. Generally, the timing of the reform varied not only across states but also more locally, mainly because of challenges related to additional demand for teachers and classrooms (Leschinsky and Roeder, 1980).[3]

Generally, the $C9$ reform directly affected the duration of schooling among students who otherwise would have left school after eight years, which applies directly to the lowest secondary school track (basic track). However, the reform might also have obliged the potential dropouts from the other two tracks (middle and academic track) to remain in school longer because of extended compulsory schooling requirements. Figure B.1 shows the shares of students in each secondary school track across birth cohorts.

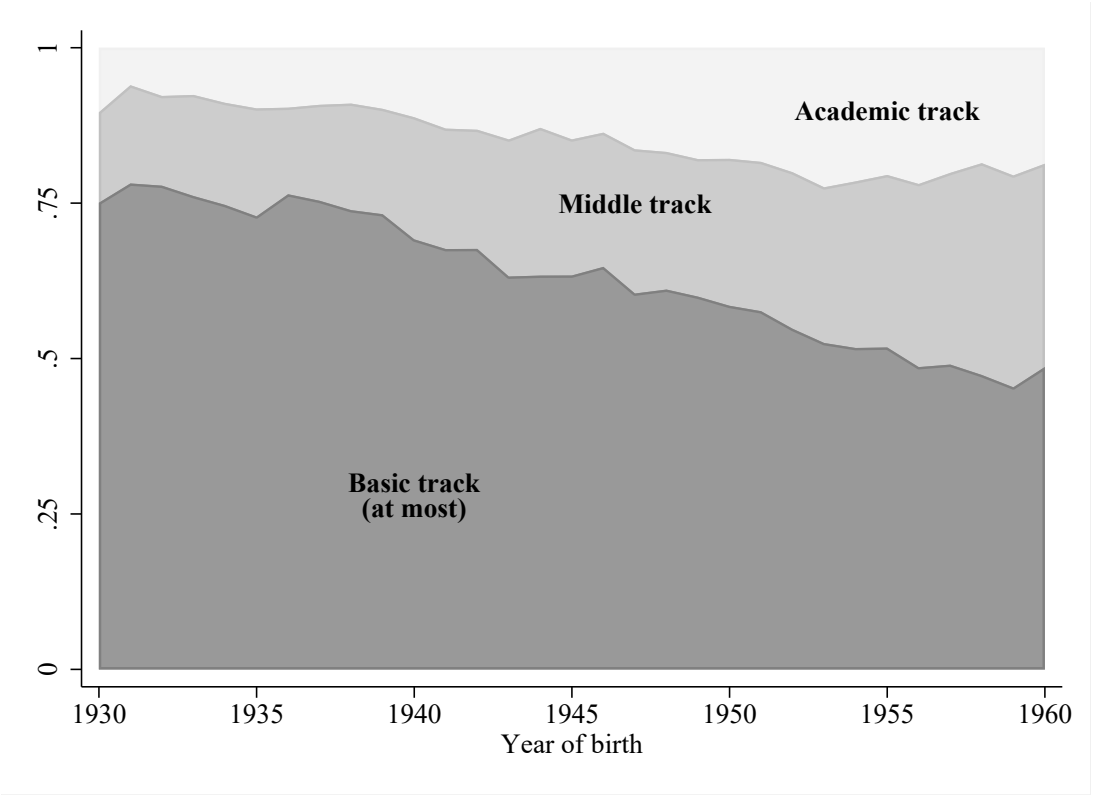
Table B.1: Final introduction of the ninth grade and earlier temporary extensions

	(1) First cohort with nine years (final reform)	(2) Birth cohorts affected by laws enabling temporary extensions	(3) Percentage of a cohort actually affected by temporary extensions
Schleswig-Holstein	1941		
Hamburg	1934		
Lower Saxony	1947	1935-1940	up to 15%
Bremen	1943		
North Rhine-Westphalia	1953	1935-1939	up to 20%
Hesse	1953	1933, 1936-1941	less than 5%
Rhineland-Palatinate	1953	1938-1942	up to 93%
Baden-Wuerttemberg	1953	1938-1941	up to 45%
Bavaria	1955	1938-1943	less than 1%
Saarland	1949		

Source: Column 1 from Pischke and von Wachter (2005). Column 2 based on original legislation from the state laws (further details available on request). Column 3 based on absolute numbers of basic track students in their eighth and ninth school year in school years 1952/53-1959/60 from *Statistisches Jahrbuch für die Bundesrepublik Deutschland* (various years). The digital version of the statistical yearbooks is available online at http://resolver.sub.uni-goettingen.de/purl?PPN514402342 [Last accessed: 25.09.2020]; own calculations.

[3]This might explain why I found some inconsistencies regarding the timing of the reform across various sources. However, this issue affects a limited number of cohorts from relatively small states and does not decisively drive PvW's findings. Thus, for comparability, I stick to their dates throughout.

Figure B.1: Shares of students by completed school track over time



Notes: This figure replicates Figure 1 from Pischke and von Wachter (2005) for birth cohorts 1930-1960.
Source: QaC 1979-1998/9, own calculations.

C Additional results

Table C.1: Replication: First-stage effect of the compulsory schooling reform on years in school

	Dependent Variable		
	Years in school (primary and secondary)		Attended basic track
	Full sample (1)	Basic track only (2)	Full sample (3)
Panel A: Pischke and von Wachter (2008)			
$C9$	0.190	0.285	-0.012
	(0.039)	(0.033)	(0.011)
Observations	54,126	32,970	54,126
Panel B: Replication			
$C9$	0.191	0.286	-0.012
	(0.040)	(0.033)	(0.011)
Observations	54,096	32,954	54,096

Notes: Sample restricted to (West-)German citizens born 1930-1960 and aged 19-65. Years in school are calculated as graduation year minus year of birth minus six. $C9$ is an indicator for exposure to a ninth compulsory school year. All regressions include a constant, indicators for state, year of birth, survey year, gender, and control for age (quartic). Robust standard errors clustered at state $\times$ year of birth cells in parentheses.
Sources: Panel A re-prints the top panel of Table 1 from Pischke and von Wachter (2008). Panel B based on own calculations using the QaC surveys 1979-1998/9.

Table C.2: Replication: Wage returns to schooling

	Full sample				Basic track only	
	OLS	OLS	Red. form	IV	Red. form	IV
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Pischke and von Wachter (2008)						
Years of education	0.061	-	-	-	-	-
	(0.001)					
Years in school	-	0.066	-	0.058		-0.005
		(0.002)		(0.038)		(0.034)
$C9$	-	-	0.010		-0.001	
			(0.008)		(0.010)	
Observations	54,126	54,126	54,126	54,126	32,970	32,970
Panel B: Replication						
Years of education	0.062	-	-	-	-	-
	(0.001)					
Years in school	-	0.066	-	0.059		-0.005
		(0.002)		(0.038)		(0.034)
$C9$	-	-	0.011		-0.002	
			(0.008)		(0.010)	
Observations	54,096	54,096	54,096	54,096	32,954	32,954

Notes: Sample restricted to (West-)German citizens born 1930-1960 and aged 19-65. The subsample of basic track students includes school dropouts. The dependent variable is log hourly wage. Years in school are calculated as graduation year minus year of birth minus six. Years of education (incl. postsecondary education and training) are constructed as the usual number of years spent in a particular educational route. $C9$ is an indicator for exposure to a ninth compulsory school year. All regressions include a constant, indicators for state, year of birth, survey year, gender, and control for age (quartic). Robust standard errors clustered at state $\times$ year of birth cells in parentheses.
Sources: Panel A re-prints the top panel of Table 2 from Pischke and von Wachter (2008). Panel B based on own calculations using the QaC surveys 1979-1998/9.

Table C.3: Replication: Sample means

	(1) Pischke and von Wachter (2005)	(2) Replication
Survey year	1986.9	1986.9
	(7.0)	(7.0)
Year of birth	1947.1	1947.1
	(8.5)	(8.5)
Age	40.1	40.1
	(10.0)	(10.0)
Female	0.36	0.36
Years of schooling (imputed from completed school track)	9.4	9.4
	(1.7)	(1.7)
Length of schooling (= year of graduation - year of birth - 6)	10.0	10.0
	(2.0)	(2.0)
Years of post-secondary training (imputed from completed vocational degree)	2.3	2.2
	(1.5)	(1.4)
Years of education (sum of imputed years of schooling and post-secondary training)	11.7	11.6
	(2.8)	(2.7)
Basic track: 8^{th} grade	0.40	0.40
Basic track: 9^{th} grade	0.21	0.21
Middle track: 10^{th} grade	0.23	0.23
Academic track: 12^{th} grade	0.03	0.03
Academic track: 13^{th} grade	0.13	0.13
Employed	1.00	1.00
Self-employed	-	0.07
Number of observations	54,126	54,096

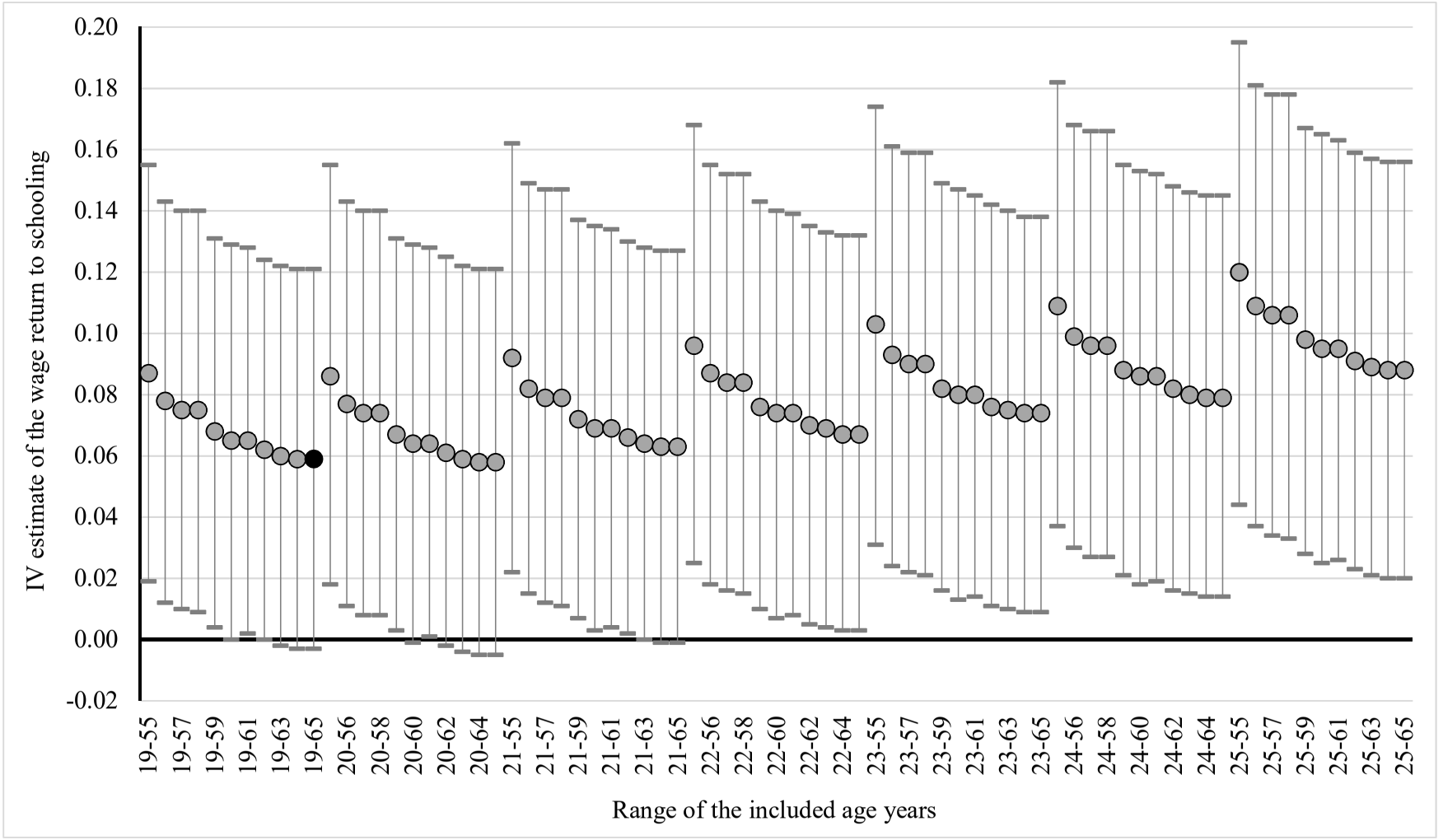
Notes: Sample restricted to (West-)German citizens born 1930-1960 aged 19-65. Track refers to completed school degree. Basic track includes school dropouts. Standard deviations in parentheses.
Source: Column 1 re-prints summary statistics from Appendix Table 1 in Pischke and von Wachter (2005). Column 2 based on own calculations using the QaC surveys 1979-1998/9.

Table C.4: PvW's reduced-form estimate of the effect of the ninth compulsory school year on completed school track: replication and sensitivity tests

	(1) Basic track (at most)	(2) Middle track	(3) Academic track	(4) Observations
Panel A: Pischke and von Wachter (2008)				
Original results	-0.012	n.a.	n.a.	54,126
	(0.011)			
Replication	-0.012	0.014	-0.002	54,096
	(0.011)	(0.009)	(0.008)	
Panel B: Sensitivity tests				
S1: Birth cohorts 1931-1960	-0.013	0.015 *	-0.002	53,230
	(0.011)	(0.009)	(0.008)	
S2: Birth cohorts 1945-1960	-0.029 *	0.026 *	0.004	32,647
	(0.015)	(0.013)	(0.010)	
S3: Temporary extensions as	-0.011	0.014	-0.003	54,096
additional instrument	(0.011)	(0.009)	(0.008)	
S4: Instrument comprises both	-0.015 **	0.012 **	0.002	54,096
temp. and final extensions	(0.007)	(0.006)	(0.004)	
S5: Age 19-60	-0.012	0.015	-0.003	53,381
	(0.011)	(0.009)	(0.008)	
S6: Age 19-55	-0.013	0.016 *	-0.003	50,293
	(0.011)	(0.009)	(0.008)	
S7: Age 25-65	-0.009	0.011	-0.002	50,680
	(0.012	(0.010)	(0.008)	
S8: Excl. bottom and top	-0.012	0.015 *	-0.003	53,818
earners (0.5% each year)	(0.011)	(0.009)	(0.008)	
S9: Control for $SSYs$	-0.008	0.011	-0.003	54,096
	(0.011)	(0.010)	(0.008)	
S10: Control for squared trends	-0.021	0.020 *	0.001	54,096
	(0.013)	(0.011)	(0.009)	
S11: Men only	-0.007	0.018 *	-0.011	34,562
	(0.012)	(0.011)	(0.010)	
S12: Incl. missings on years	-0.014	0.016 *	-0.002	56,895
of education	(0.010)	(0.009)	(0.007)	
S13: Years in school from 6 to 21	-0.010	0.016 *	-0.005	59,702
	(0.011)	(0.009)	(0.007)	

Notes: See Table 1 in the paper. The three outcome variables (in columns) correspond to indicators for mutually exclusive school tracks. Following Pischke and von Wachter (2008), basic track includes school dropouts.
Source: QaC 1979-1998/9, own calculations.

Figure C.1: Effect of years of schooling on log wages across alternative ranges of included age years



Notes: Each dot shows the IV point estimate of the effect of years in school on log wages and the corresponding 90% confidence interval. The black dot highlights the age restrictions from Pischke and von Wachter (2008) (i.e., ages 19-65) . All regressions include a constant, indicators for state, year of birth, survey year, gender, and control for age (quartic), and state-specific linear trends in year of birth. Robust standard errors are clustered at state × year of birth cells. All samples are restricted to (West-)German citizens born 1930-1960.
Source: QaC 1979-1998/9, own calculations.

References

BIBB and IAB (various years). Bundesinstitut für Berufsbildung (BIBB), Berlin; Institut für Arbeitsmarkt- und Berufsforschung (IAB) der Bundesanstalt für Arbeit, Nürnberg: Qualifikation und Berufsverlauf 1979-1985/86. GESIS Datenarchiv, Köln. doi:10.4232/1.1243 (1979), doi:10.4232/1.12563 (1985/86), doi:10.4232/1.2565 (1991/92), doi:10.4232/1.12247 (1998/99)

Leschinsky, A. and P. M. Roeder (1980). Didaktik und Unterricht in der Sekundarschule I seit 1950 - Entwicklung der Rahmenbedingungen. In J. Baumert, A. Leschinsky, J. Naumann, J. Raschert, and P. Siewert (Eds.), Bildung in der Bundesrepublik Deutschland - Daten und Analysen, Band 1: Entwicklungen seit 1950, Chapter 4, pp. 283-392. Stuttgart: Klett-Cotta.

Petzold, H.-J. (1981). Schulzeitverlängerung: Parkplatz oder Bildungschance? Die Funktion des 9. und 10. Schuljahres. Bensheim: Päd.-Extra-Buchverlag.

Pischke, J.-S. (2007). The impact of length of the school year on student performance and earnings: Evidence from the German short school years. *Economic Journal* 117(523), 1216-1242.

Pischke, J.-S. and T. von Wachter (2005). Zero returns to compulsory schooling in Germany: Evidence and interpretation. NBER Working Paper 11414, Cambridge, MA.

Pischke, J.-S. and T. von Wachter (2008). Zero returns to compulsory schooling in Germany: Evidence and interpretation. *Review of Economics and Statistics* 90(3), 592-598.