Who Benefits from Privileged Peers?

Evidence from Siblings in Schools

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Summary

By comparing siblings attending the same school at different points of time, we investigate whether the effect of peer quality on long-term labor market outcomes varies with parental background. We find that exposure to better peers – who have higher mean parental education – increases lifetime earnings of disadvantaged students, coming from families with low parental education, but penalizes privileged students from better educated families. These results suggest that de-segregation policies that allocate disadvantaged students to schools with better peers produce long-term benefits. We discuss mechanisms and show that human capital accumulation, ordinal rank and network effects contribute to explain our findings.

Keywords: education peer effects, parental background, human capital production, long-term outcomes.

JEL codes: I21, J16, J24.

Appendix

Table A1. Distribution of individuals by number of siblings in the sample and attending the same school.

		# Siblings in same school				
		0	1	2	3 +	Total
# Sibs in sample	0	284,308	0	0	0	284,308
	1	114,376	353,034	0	0	467,410
	2	32,265	40,254	128,247	0	200,766
	3 +	6,408	6,896	8,976	33,175	55,455
	Total	437,357	400,184	137,223	33,175	1,007,939

Table A2. Summary statistics for the full and the school-by-family fixed effects. By parental education above and below the mean.

Variable	All individuals		Above average parental education		Below average parental education	
	Full sample	School-by-family sample	Full sample	School-by-family sample	Full sample	School-by-family sample
Female	0.49	0.49	0.49	0.49	0.50	0.50
Immigrant background	0.01	0.01	0.01	0.01	0.01	0.01
Birth order (top coded at 4)	1.70	1.87	1.58	1.75	1.80	1.97
Total number of siblings (excluding the individual)	1.44	1.76	1.30	1.58	1.58	1.93
Spacing from first born	1.78	2.38	1.58	2.18	1.97	2.57
Mean years of education of father and mother – PE – standardized	0	-0.04	0.88	0.89	-0.84	-0.86
Age of mother at birth	26.00	25.94	26.09	26.22	25.91	25.72
Age of father at birth	28.69	29.02	28.57	28.73	29.34	29.24
Lives in parish in top tertile of urbanicity at 15	0.27	0.25	0.33	0.32	0.22	0.20
Mean years of education of peers' parents - E(PE) – standardized	0	-0.11	0.36	0.25	-0.34	-0.43
Observations	1,007,939	596,468	490,128	265,637	517,811	303,831

Table A3a. Average effects of the mean years of education of peers' parents E(PE) on labor market outcomes measured for 3-year periods centred at age 31, 33, 35, 37, 39, and for age ranges 31-35 and 36-40.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Age:	31	33	35	37	39	31-35	36-40
Panel A. Dependent variable: average log real earning							
Mean years of education of peers' parents - E(PE)	-0.004	-0.000	0.003	0.005	0.002	-0.000	0.002
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Panel B. Dependent variable: years employed							
Mean years of education of peers' parents - E(PE)	0.005	0.008	0.006	0.007	0.012*	0.013	0.015
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.010)	(0.010)

Notes: the table reports the average effects of the mean years of education of peers' parents – E(PE) –on labor market outcomes measured in 3-year periods centered at age 31, 33, 35, 37, 39, and for age ranges 31-35 and 36-40. Peers are defined as pupils belonging to the same cohort of the individual, who attended the same school on the 31st of October of the year when they turned 15. The specification adopted is as in Table 5, Column 3. ***: p<0.01; **: p<0.05; *: p<0.10

Table A3b. Heterogeneous effects of the mean years of education of peers' parents E(PE) on labor market outcomes measured for 3-year periods centred at age 31, 33, 35, 37, 39, and for age ranges 31-35 and 36-40.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Age:	31	33	35	37	39	31-35	36-40
Panel A. Dependent variable: average log real earnings							
Mean years of education of peers' parents - E(PE)	-0.005	-0.001	0.003	0.004	0.001	-0.001	0.002
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Mean years of education of peers' parents – E(PE) x own parental education – PE	-0.010***	-0.010***	-0.007***	-0.008***	-0.010***	-0.008***	-0.009***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Panel B. Dependent variable: years employed							
Mean years of education of peers' parents - E(PE)	0.005	0.008	0.006	0.007	0.013*	0.012	0.015
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.010)	(0.010)
Mean years of education of peers' parents – E(PE) x own parental education – PE	-0.008**	-0.006	-0.003	0.003	0.006	-0.009	0.007
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.006)	(0.007)

Notes: the table reports the heterogeneous effects of the mean years of education of peers' parents – E(PE) – by own parental education – PE – on labor market outcomes measured in 3-year periods centered at age 31, 33, 35, 37, 39, and for age ranges 31-35 and 36-40. Peers are defined as pupils belonging to the same cohort of the individual, who attended the same school on the 31st of October of the year when they turned 15. The specification adopted is as in Table 6, Column 3. ***: p<0.01; **: p<0.05; *: p<0.10

Table A4a. Controlling for sibling spillovers in the within-family estimation of the average effects of the mean years of education of peers' parents - E(PE) - on labor market outcomes

	(1)	(2)	(3)	(4)
Sample	2+ siblings	3+ siblings	3+ not firstborn	3+ not firstborn
Panel A. Dependent variable: average log real earnings, age 31-40. Mean: 12.63				
Mean years of education of peers' parents - E(PE)	0.001	0.000	0.002	-0.001
	(0.002)	(0.004)	(0.006)	(0.006)
Panel B. Dependent variable: years employed, age 31-40. Mean: 8.29				
Mean years of education of peers' parents - E(PE)	0.027	0.039	0.041	0.029
	(0.018)	(0.030)	(0.044)	(0.048)
Observations	569,468	169,888	116,280	116,280
Mean years of education of peers' parents - E(PE) – Average for older siblings	No	No	No	Yes

Notes: the table reports the average effects of peers' parental education on the outcome reported in the heading of each Panel for the sample described in the heading of each column. Peers are defined as pupils belonging to the same cohort of the individual, who attended the same school on the 31st of October of the year when they turned 15. The specification adopted is as in Table 5, Column 3. Column 4 includes as an additional control the mean years of education of peers' parents for an individual's older siblings. ***: p<.01; **: p<.05; *: p<.10

Table A4b. Controlling for sibling spillovers in the within-family estimation of the heterogeneous effects of the mean years of education of peers' parents - E(PE) - interacted with own parental education – PE – on labor market outcomes

	(1)	(2)	(3)	(4)
Sample	2+ siblings	3+ siblings	3+ not firstborn	3+ not firstborn
Panel A. Dependent variable: average log real earnings, age 31-40. Mean: 12.63				
Mean years of education of peers' parents - E(PE)	0.001	-0.001	0.001	-0.002
	(0.002)	(0.004)	(0.006)	(0.006)
Mean years of education of peers' parents – E(PE) x own parental education – PE	-0.009***	-0.007***	-0.002	-0.002
	(0.002)	(0.002)	(0.003)	(0.003)
Panel B. Dependent variable: years employed, age 31-40. Mean: 8.29				
Mean years of education of peers' parents - E(PE)	0.027	0.039	0.038	0.026
	(0.018)	(0.030)	(0.044)	(0.049)
Mean years of education of peers' parents – E(PE) x own parental education – PE	-0.002	-0.001	-0.007	-0.008
	(0.012)	(0.018)	(0.026)	(0.026)
Observations	569,468	169,888	116,280	116,280
Mean years of education of peers' parents - E(PE) – Average for older siblings	No	No	No	Yes

Notes: the table reports the effects of the mean years of education of peers' parents - E(PE) – and of its interaction with own parental education – PE - on the outcome reported in the heading of each Panel, for the sample described in the heading of each column. Peers are defined as pupils belonging to the same cohort of the individual, who attended the same school on the 31st of October of the year when they turned 15. The specification adopted is as in Table 6, Column 3. Column 4 includes as an additional control the mean years of education of peers' parents for an individual's older siblings. ***: p<.01; **: p<.05; *: p<.10

Table A5. Heterogeneous effects of the mean years of education of peers' parents - E(PE) - interacted with own parental education – PE – on educational outcomes

	(1)	(2)	(3)	(4)	(5)
Panel A. Dependent variable: has tertiary education degree. Mean: 0.35					
Mean years of education of peers' parents – E(PE)	0.003	0.004	0.001	0.003	0.005*
	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)
Mean years of education of peers' parents – E(PE) x own parental education – PE	-0.009***	-0.006***	-0.005***	-0.000	-0.005**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Panel B. Dependent variable: has tertiary degree in high-wage major. Mean: 0.14					
Mean years of education of peers' parents – E(PE)	0.002	0.002	0.002	0.002	0.003
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Mean years of education of peers' parents – E(PE) x own parental education – PE	-0.005***	-0.004***	-0.003***	-0.001	-0.003*
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
Panel C. Dependent variable: has tertiary degree in STEM major. Mean: 0.06					
Mean years of education of peers' parents – E(PE)	0.000	0.000	-0.001	0.000	-0.000
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
Mean years of education of peers' parents – E(PE) x own parental education – PE	-0.005***	-0.004***	-0.004***	-0.002	-0.004***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
School-by-family and cohort fixed effects	Yes	Yes	Yes	Yes	Yes
Individual-level controls	No	Yes	Yes	Yes	Yes
School-by-cohort controls	No	Yes	Yes	Yes	Yes
School specific cohort trends	No	No	Yes	Yes	Yes
Max (spacing)	17	17	17	5	17
Only family where all siblings attend the same school	No	No	No	No	Yes

Notes: each cell reports the coefficient associated with E(PE) - the mean years of education of peers' parents –and its interaction with own parental education PE in OLS regressions where the dependent variable is the outcome reported in the heading of each panel and the explanatory variables include the controls, fixed effects and trends listed at the bottom of each column. Peers are defined as pupils belonging to the same cohort of the individual, who attended the same school on the 31st of October of the year when they turned 15. Individual-level controls are: gender, birth order dummies, a dummy for whether the individual lives in a parish in the top tertile of urbanicity at age 15. School-by-cohort controls are: % girls, enrolment, average number of siblings, average age of mother and father at birth, % living in a parish in top tertile of urbanicity at 15, % first-born, % second-born, % third-born, % immigrant. Standard errors are clustered by school and family (two-way). The estimation sample includes 1,435 schools, 252,121 families and 253,398 school-by-family groups. E(PE) is standardized (zero mean and unit standard deviation in the full sample). Total number of observations: 569,468, except for Column (4), where it is 402,158, and Column (5), where it is 391,369. ***: p<0.01; **: p<0.05; *: p<0.10.

Table A6a. Gender-specific average effects of the mean years of education of peers' parents - E(PE) - labor market outcomes

Dependent variable:	Average log real earnings, age 31-40		Average years employed, age 31-40	
	Males	Females	Males	Females
	(2a)	(2b)	(3a)	(3b)
Mean years of education of peers' parents – E(PE)	-0.004 (0.003)	0.007*** (0.003)	0.031 (0.019)	0.023 (0.019)
Equality of males vs females - p-value	0.000		0.533	

Notes: the table reports the gender-specific effects of the mean years of education of peers' parents - E(PE) – on the outcome reported in the heading of each column. The specification adopted is as in Table 5, Column 3, and includes also the interaction term E(PE)*female. P-values of tests for equality in the effects of E(PE) across genders are also reported. Peers are defined as pupils belonging to the same cohort of the individual, who attended the same school on the 31st of October of the year when they turned 15. ***: p<0.01; **: p<0.05; *: p<0.10.

Table A6b. Gender-specific heterogeneous effects of the mean years of education of peers' parents - E(PE) - interacted with own parental education – PE – on labor market outcomes

Dependent variable:	Average log real earnings, age 31-40		Average years employed, age 31-40	
	Males	Females	Males	Females
	(2a)	(2b)	(1a)	(1b)
Mean years of education of peers' parents – E(PE)	-0.006** (0.003)	0.007** (0.003)	0.030 (0.019)	0.025 (0.019)
Equality of males vs females - p-value	0.000		0.690	
Mean years of education of peers' parents – E(PE) x own parental education – PE	-0.008*** (0.002)	-0.009*** (0.002)	-0.014 (0.013)	0.010 (0.013)
Equality of males vs females- p-value	0.634		0.042	

Notes: the table reports the gender-specific effects of the mean years of education of peers' parents - E(PE) – and of its interaction with own parental education – PE - on the outcome reported in the heading of each Column. The specification adopted is as in Table 6, Column 3, and includes also the interaction terms E(PE) x female, PE x female, and E(PE) x PE x female. P-values of tests for equality in the effects of E(PE) and E(PE) x PE across genders are also reported. Peers are defined as pupils belonging to the same cohort of the individual, who attended the same school on the 31st of October of the year when they turned 15. ***: p<0.01; **: p<0.05; *: p<0.10.

Table A7. Average and heterogeneous effects of mean years of education of peers' parents - E(PE) – on labor market outcomes. Comparing different identification strategies.

	(1)		(2)	
Dependent variable:	Average log real earnings, age 31-40		Average years employed, age 31-40	
	(a)	(b)	(a)	(b)
Identification strategy:	Within school, across cohorts	Within School-by-family, across cohorts	Within school, across cohorts	Within School-by-family, across cohorts
Panel A:. average effect of peers' parental education				
Mean years of education of peers' parents - E(PE)	0.005***	0.001	0.012	0.027
	(0.001)	(0.002)	(0.011)	(0.018)
Panel B: heterogeneous effects of peers' parental education interacted with own parental education				
Mean years of education of peers' parents - E(PE)	0.005***	0.001	0.012	0.027
	(0.001)	(0.002)	(0.011)	(0.018)
Mean years of education of peers' parents – E(PE)	0.002***	-0.009***	0.012***	-0.002
x own parental education – PE	(0.001)	(0.002)	(0.004)	(0.012)
School and cohort fixed effects	Yes	No	Yes	No
School-by-family and cohort fixed effects	No	Yes	No	Yes
Individual-level controls	Yes	Yes	Yes	Yes
School-by-cohort controls	Yes	Yes	Yes	Yes
School specific cohort trends	Yes	Yes	Yes	Yes
Max (spacing)	17	17	17	17
Only family where all siblings attend the same school	No	No	No	No

Notes: Panel (A): each cell reports the coefficient of the mean years of education of peers' parents - E(PE) - in an OLS regression of the outcome reported in the heading of each column on E(PE), and the controls, fixed effects and trends listed at the bottom of each column Peers are defined as pupils belonging to the same cohort of the individual, who attended the same school on the 31st of October of the year when they turned 15.Individual-level controls are: gender, birth order dummies, a dummy for whether the individual lives in a parish in the top tertile of urbanicity at age 15. Additional controls included in Columns (1a) and (2a) are individual mean years of parental education – PE – immigrant background, age of mother and father at birth, number of siblings. School-by-cohort controls are: % girls, enrolment, average number of siblings, average age of mother and father at birth, % living in parish in top tertile of urbanicity at 15, % first-born, % second-born, % third-born, % immigrant. Columns (1a) and (2a) include singletons in terms of school-by-family groups, while Columns (1b) and (2b) do not. The number of observations is 1,007,939 in Columns (1a) and (2a), and 569,468 in Columns (1b) and (2b). There are 1,442 schools in the full sample used in Columns (1a) and (2a). After including school-by-family fixed effects and dropping families where there are siblings born in the same year and school-by-family groups where there is no within-group variation in E(PE), we retain 1,435 schools in Columns (1a) and (2a). There are 252,121 families and 253,398 school-by-family groups in the sample used in Columns (1b) and (2b) E(PE) and PE are standardized (zero mean and unit standard deviation in the full sample). Standard errors are clustered by school in Columns (1a) and (2a), and by school and family (two-way) in Columns (1b) and (2b). ***: $p<0.01$; **: $p<0.05$; *: $p<0.10$

Table A8. Average and heterogeneous effects of mean years of education of peers' parents - E(PE) – on untrimmed average log real earnings, age 31-40.

Dependent variable: average log real earnings, age 31-40, not trimmed	(1)	(2)	(3)	(4)	(5)
Panel A: average effect of peers' parental education					
Mean years of education of peers' parents – E(PE)	0.026	0.030*	0.010	0.014	0.018
	(0.018)	(0.018)	(0.019)	(0.023)	(0.023)
Panel B: heterogeneous effects of peers' parental education interacted with own parental education					
Mean years of education of peers' parents – E(PE)	0.018	0.024	0.007	0.015	0.018
	(0.018)	(0.018)	(0.019)	(0.023)	(0.023)
Mean years of education of peers' parents – E(PE) x	-0.051***	-0.046***	-0.035***	-0.043***	-0.043***
own parental education – PE	(0.012)	(0.012)	(0.013)	(0.018)	(0.015)
School-by-family and cohort fixed effects	Yes	Yes	Yes	Yes	Yes
Individual-level controls	No	Yes	Yes	Yes	Yes
School-by-cohort controls	No	Yes	Yes	Yes	Yes
School specific cohort trends	No	No	Yes	Yes	Yes
Max (spacing)	17	17	17	5	17
Only family where all siblings attend the same school	No	No	No	No	Yes

Notes: the table reports average (Panel A) and heterogeneous (Panel B) effects of peers' parental education on log real earnings in the age range 31-40, retaining all earnings and setting them to zero in the event of non-employment. Peers are defined as pupils belonging to the same cohort of the individual, who attended the same school on the 31st of October of the year when they turned 15. The specifications adopted to estimate average peer effects are as in Table 4. The ones used for heterogeneous peer effects are as in Table 5. ***: p<0.01; **: p<0.05; *: p<0.10

Table A9. Average and heterogeneous effects of mean years of education of peers' parents - E(PE) – on labor market outcomes, controlling for neighborhood composition

	(1)	(2)
Dependent variable:	Average log real earnings, age 31-40	Years employed, age 31-40
Panel A. Average effect of peers' parental education		
Mean years of education of peers' parents - E(PE)	0.003	0.024
	(0.003)	(0.019)
Panel B. Heterogeneous effects of peers' parental education interacted with own parental education		
Mean years of education of peers' parents - E(PE)	0.003	*0.024*
	(0.003)	*(0.019)*
Mean years of education of peers' parents – E(PE)	-0.009***	-0.003
x own parental education – PE	(0.002)	(0.012)
School-by-family and cohort fixed effects	Yes	Yes
Individual-level controls	Yes	Yes
School-by-cohort controls	Yes	Yes
School specific cohort trends	Yes	Yes
Max (spacing)	17	17
Only family where all siblings attend the same school	No	No
Mean years of education of neighborhood peers' parents	Yes	Yes

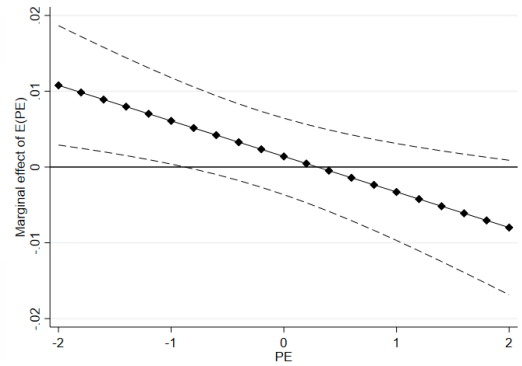
Notes: the table reports average (Panel A) and heterogeneous (Panel B) effects of peers' parental education on individual outcomes. Peers are defined as pupils belonging to the same cohort of the individual, who attended the same school on the 31st of October of the year when they turned 15. The specification adopted to estimate average peer effects is as in Table 5, Column 3. The one used for heterogeneous peer effects is as in Table 6, Column 3. In both columns we include as an additional control the mean years of education of the parents of pupils born in the same year and residing in the same parish on the 31st of October of the year when they turned 15. ***: p<0.01; **: p<0.05; *: p<0.10

Table A10. Average differences in labor market outcomes across demographic groups

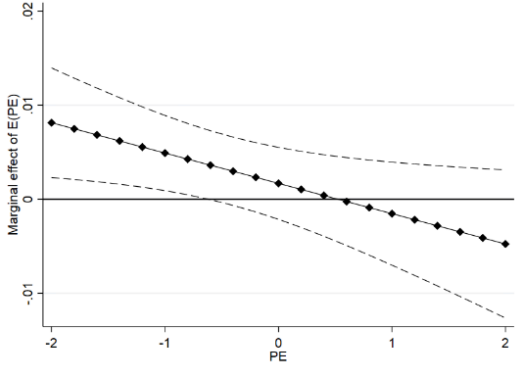
	Parental education		Immigrant background		Gender	
	Above average	Below – above average difference	Native	Immigrant – Native difference	Males	Female – Males difference
	(1a)	(1b)	(2a)	(2b)	(3a)	(3b)
Average log real earnings, age 31-40.	12.70	-0.14	12.62	-0.06	12.78	-0.32
Average years employed, age 31-40	8.21	-0.13	8.15	-1.70	8.18	-0.08

Figure A1. Heterogeneous effects of mean years of education of peers' parents - E(PE) –on education outcomes, at different levels of own parental education - PE.

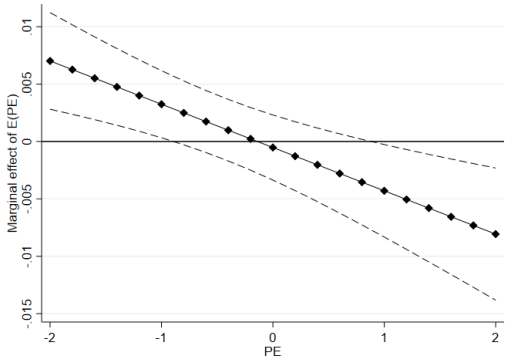
a. Has tertiary education degree



b. Has high-pay tertiary education degree



c. Has STEM degree



Notes: the heterogeneous effects of E(PE) by PE are obtained as linear combinations of the effects of E(PE) and E(PE)xPE in Column 3 of Table A5. Dashed lines for confidence intervals.

The Danish School System

Compulsory school in Denmark lasts 9 years (grades 1-9), covers primary and lower secondary education and normally involves pupils aged 7-15; compared to the cohorts of our paper (that is birth years 1958-1975) for younger cohorts one year of compulsory pre-school (grade 0) and one voluntary year of lower secondary school (grade 10) also apply. Compulsory education is predominantly publicly supplied and more than 90% of students in our cohorts attended a public school. Public schools are run by municipalities, while free school choice is warranted through private schools that are heavily subsidized by municipal governments (Bingley et al, 2006).

Assignment of pupils to schools generally occurs on the basis of catchment areas depending on residence. Families moving residence after first school assignment retain the right of being assigned to public school in the destination, but mobility is rather infrequent and most pupils attend the whole compulsory cycle within the same institution. In recent years, the year-to-year rate of retention at a given school has been above 90%. (Bingley et al, 2017). Primary and lower secondary public schools are comprehensive, whereby students are allocated to a class on entry, and class groups tend to be stable throughout all grades (Bingley et al, 2006).

Upon completion of compulsory school, the vast majority of students (about 90%) remain in the educational system either through upper secondary schools preparing for higher education (absorbing 55% of the continuing cohort) or through vocational training programmes (Bingley et al, 2006; OECD, 2016). Vocational education also features at the tertiary level in the form of university colleges and business academies, while general tertiary education is provided by universities. Education is publicly provided also at secondary and tertiary levels.

Additional references

Bingley, P., Myrup-Jensen, V., and Walker, I. (2006). Class Size and Educational Attainment in Denmark, paper presented at the 2006 EALE Conference in Prague

OECD (2016) Reviews of school resources: Denmark, Paris: OECD Press