Social interactions at school can affect academic achievement, career choice and ultimately labor market outcomes – see Lavy and Schlosser (American Economic Journal: Applied Economics, 2011) and Black, Devereux and Salvanes (Journal of Labor Economics, 2013). At the same time, interactions with siblings at home also affect educational choices and outcomes – see Butcher and Case (Quarterly Journal of Economics, 1994). While previous studies have considered the effects of social interactions at school and at home in isolation from one another, in this paper we bring together these two strands of research. We contribute to the literature by investigating whether interactions at home affect how interactions at school impact on education and long-term labor market outcomes.

Using administrative data on the Danish population we link schoolmates and siblings. We match family members through the civil registration system, and schoolmates through the schooling register which assigns school identifiers to each resident at any point of the educational curriculum. We define schoolmates as individuals born in the same year and attending the same school at age 15. Finally we link siblings and schoolmates to their educational outcomes and lifetime earnings derived from tax declarations. Our working sample consists of about 1 million individuals born between 1958 and 1975 and for whom we observe gross labor incomes between 1989 and 2015.

We use two measures of peer characteristics at school and in the family: gender composition and parental education. Boys’ exposure to females may reinforce stereotypes and the development of economic-relevant masculine traits such as competitiveness and risk taking. On the other hand, gender mixing may favor the acquisition of opposite-gender traits, mitigating competitiveness and risk taking of boys. We consider whether gender mixing in the family, by shaping individual traits, affects the way in which gender peer effects operates in schools.

Our research design is based on school fixed effects, and identification hinges upon the plausibly exogenous variation in gender composition and parental background of peers between cohorts within schools. When estimating interaction effects between family and school composition, we partial out family-specific traits common to all siblings including also family fixed effects.

We find that social interactions at home shape the effects of social interactions at school, and that gender peer effects at school significantly depend on siblings gender composition. For men without sisters, exposure to females at school positively affects employment in the long run, while the opposite occurs for men that have sisters. This suggests that gender mixing in the family determines whether gender stereotypes are reinforced or mitigated by gender mixing at school.

Also, conditional on gender, schoolmates parental background has a remedial effect on educational attainment and labor market outcomes. For men with low educated parents we find that the share of schoolmates with high educated parents has a significant effect on educational attainment, the choice of STEM fields at college and long-term earnings, while we find no effect for men with highly educated parents. These results suggest the existence of significant intergenerational social returns of education for boys but not for girls.

While precisely estimated, these effects tend to be small, in line with findings from previous studies looking at social interactions either in the family or at school. Our results suggest that the current debate concerning single-sex versus co-educational schools is a bit inflated, as the educational effects of interacting with female schoolmates is very small, if existent at all.

Keywords: Educational production function, gender peer effects, long-term outcomes
JEL codes: I21, J16, J24
SIBLINGS AND SCHOOLMATES

THE EFFECTS OF PEER CHARACTERISTICS ON EDUCATION AND LABOUR MARKET OUTCOMES

Marco Bertoni (Padova)
Giorgio Brunello (Padova)
Lorenzo Cappellari (Cattolica Milan)

VERY PRELIMINARY

Rome INPS 24 May 2017
Two strands of literature

• Social interactions at school can affect academic achievement, career choice and ultimately labour market outcomes – see Lavy and Schlosser, AEJ, 2011 (LS) and Black, Devereux and Salvanes, JOLE 2013 (BDS)

• Social interactions at home (siblings) also affect educational choices and outcomes – see Butcher and Case, QJE, 1994
Interactions at school

• The literature has focused on primary and secondary schools and used different measures of peer characteristics at school
  • the fraction of girls in the grade (both LS and BDS)
  • Average age in the classroom, average mother education and father’s earnings (BDS)

• Do peer characteristics have long-term effects?
  • For instance, do they influence employment and lifetime earnings?

• No much evidence so far on this
Interactions in the family

• Peer effects (siblings) occur also in families

• Do school and family peer effects interact in the production of individual outcomes at school and in the labour market?

• Belongs to the broader question
  • Conditional on the family, do schools matter?
Why do we care?

• We wish to understand what factors affect school outcomes

• Are there long-run effects of school characteristics? See Chetty et al, QJE, 2011; Fredriksson et al, AER 2013

• Hanushek, 2006: the relationship between school resources and school outcomes is weak. School outcomes depend on the (unobserved) quality of teachers. Do the interactions in the class/school matter as well?

• Debate on the pros and cons of single-sex schools
Should boys and girls be taught separately?

• UK Department of Education and Skills study supports positive answer. Girls in single sex schools get better results than those in mixed schools, including those from poorer backgrounds

• European Association of single-sex education (www.easse.org) argues that the American standard of co-education needs to be challenged, particularly for girls

• Parents seem to want boys in co-educational schools but reckon girls do better in single-sex establishments (BBC news)

• Single-sex schooling may reduce the gender math gap (Fryer and Levitt 2010)
Previous literature

• Lavy and Schlosser (AEJ) use data from 264 schools in Israel to study whether a higher proportion of female peers in primary and secondary schools affect
  • Test scores
  • Matriculation status
  • Number of earned credits

• They find positive effects for both boys and girls moving to single sex schools would benefit girls but not boys

• Their estimated effects are however moderate: a 20 percentage points increase in the proportion of female peers increases average test scores by 1.3 points for girls and by 1.6 points for boys.

• Hoxby, 2000, finds similar results using data from Texas primary schools.
Previous literature

- Black, Devereux and Salvanes, 2013, use data on Norway to study junior high school peer effects on
  - Test scores
  - Teenage childbearing
  - Educational attainment
  - Average earnings over a three years window

- They find that a higher proportion of girls at school is generally good for girls and bad for boys. Moving to single sex schools would benefit both girls and boys. Estimated effects are small.

Why does the share of girls at school matter?

• A higher share of girls could improve the learning environment by reducing disruption (Lazear, 2000)
• …but it could also increase distraction (of teenage boys)

• A higher share of girls changes individual behaviour
  • disruptive or violent students are less so when there are many girls in the class (LS)
  • Risk attitudes may change (Booth and Nolan, 2012)
  • Attitudes toward competition may change (Gneezy, Nederlie and Rustichini, 2003)
  • Girls more competitive and risk taking in single sex schools
Interactions at home

- Women raised only with brothers have received on average significantly more education than women raised with any sister, controlling for household size. Men not affected (Butcher and Case (1994))
- Sex composition affects child’s attainment by acting on his/her personality, interests and skills
- Girls with brothers exhibit more masculine traits and boys with sisters exhibit more feminine traits (lower competition, higher risk aversion)
Our study

• We use two measures of peer characteristics at school and in the family:
  • Gender composition
  • Parental education (percent of parents with college education)

• At least as much as gender, parental education can shape the behaviour and characteristics of peers
Our study

- We investigate whether the share of girls and the share of schoolmates with at least one educated parent affect a broad set of outcomes, both at school and in the labour market.

- We ask whether having sisters or brothers at home may affect how the proportion of girls at schools impacts on educational attainment and labour market outcomes.

- We ask whether having at least one educated parent may affect how the proportion of schoolmates with at least one educated parent impacts on educational attainment and labour market outcomes.
Illustrative simple model (see Card 1999)

Let peer characteristics at school and in the family be SP and FP
Let

\[ \ln Y_i = \alpha + \beta S_i + \gamma SP_i + \delta FP_i + \phi(FP_i)SP_i \]

where \( Y \) is income and \( S \) is schooling

The costs of education are

\[ C_i = \frac{\sigma(SP_i, FP_i)}{2} S^2_i \]

convex in schooling
When individual utility is \( U_i = \ln Y_i - C_i \), the optimal schooling choice is

\[
S_i = \frac{\beta}{\sigma(S_{P_i}, F_{P_i})}
\]

The marginal effect of raising SP is

\[
\frac{\partial S}{\partial SP} = -\frac{\beta \sigma_1}{\sigma^2} > 0
\]

if higher SP reduces the marginal cost of learning. Similarly

\[
\frac{\partial S}{\partial FP} = -\frac{\beta \sigma_2}{\sigma^2} > 0
\]

if a higher FP also reduces the marginal cost of learning.
\[ \ln Y_i = \alpha + \frac{\beta^2}{\sigma(SP_i, FP_i)} + \gamma SP_i + \delta FP_i + \phi SP_i(FP_i) \]

The effect of SP on \( \ln Y \) is

\[ \left( \frac{\partial \ln Y}{\partial SP} \right) = \gamma + \phi FP - \frac{\beta^2 \sigma_1}{\sigma^2} \]
Our study

- We investigate the importance of interactions at school in a context different from the one studied by LS and BDS (Denmark rather than Israel or Norway)

- We study the effects of these interactions on
  - Years of completed education – as BDS
  - College degree
  - Type of high school or college degree (STEM or else) – as Schone et al
  - Lifetime ("permanent") earnings, approximated by average earnings from 31 to 40 (if at least 5 data points)
  - Earnings 36-40 (if at least 3 data points)
  - Employment (employed at least three or five years in the past ten)
Lifetime earnings and the lifecycle bias

• The appropriate concept to evaluate long-term labour market benefits is lifetime earnings

• Life cycle bias: difference between the marginal effect of X on earnings at age a and the marginal effect on lifetime earnings (Haider and Solon, 2006)

• The literature suggests that this bias is minimized when using average earnings between age 31 to age 40
  • Examples: Bjorklund and Jantti, 2012; Bhuller, Mogstad and Salvanes, 2011; Brunello, Weber, Weiss, 2017
Schools in Denmark

- Compulsory education until age 16 in a comprehensive school
- Gymnasium and higher preparatory: humanities, natural and social sciences
- Commercial: social sciences, foreign languages
- Technical (HTX): technological and scientific programs
- These programs last three years
- College
- We define as STEM technological and scientific programs at HTX and college
Empirical strategy: baseline

• We estimate

\[ Y_{ics} = \alpha_c + \beta_s + X_{ics} \lambda_1 + \pi_1 SG_{cs} + \pi_2 SH_{cs} + \varepsilon_{cs} \]

• where \( c \) is the birth cohort, \( s \) the school, \( i \) the individual
• \( X \): gender, age of mother at birth, whether first born, number of siblings, education of parents, urbanicity; enrolment, average urbanicity, school specific linear cohort trends
• All variables are interacted with the gender dummy
• \( SG \): share of female schoolmates in grade 9\(^{th}\) (age 15)
• \( SH \): share of schoolmates in grade 9\(^{th}\) (age 15) with at least one highly educated parent
• As in BDS: teenagers particularly susceptible to peer influence
Empirical strategy

• We also estimate

\[ Y_{ics} = \alpha_c + \beta_s + X_{ics}\lambda_1 + \pi_1SG_{cs} + \pi_2SH_{cs} + \pi_3SG_{cs} \times FG_{ics} + \pi_4SH_{cs} \times FH_{ics} + \beta_F + \varepsilon_{ics} \]

• **FG**: dummy for at least one sister in the family
• **FH**: dummy for at least one highly educated parent in the family
• **\( \beta_F \)**: family fixed effects F
Measures of peers

• We use the peer characteristics of one’s birth cohort (in the school)

• This is different from BDS, who use the peer characteristics of pupils in the same grade (one can interpret our estimates as ITT, with first stage effects very close to 1)

• Our measure is not exposed to the endogeneity threats faced by BDS
  • Parents can strategically choose starting age to place their offspring in the desired group
Measures of peers

• Our measures are very close to the proportion of peers in the grade because:

• The vast majority start school at the prescribed age
  • In the 1980s, 95% of pupils aged 15 were in grade 9th (Bingley, Cappellari and Tatsiramos, 2016)

• There are very few grade retentions

• In Denmark, the vast majority of students complete primary and secondary education in the same school
  • Mobility between schools less common
Identification

- Self-selection and sorting of students into schools an issue
- To address this
  - We use school fixed effects and the within school variations in SG and SH across adjacent cohorts (Hoxby, 2000)
  - We estimate by OLS. To dissipate concerns that SG or SH are correlated with unobserved parental characteristics, we also use family fixed effects
Data

• Administrative registers of Danish population
• Since 1968 the civil registration system attributes a unique personal identifier to all residents
• This can be used to reconstruct family linkages and to track individuals through various registers
• Beside family reconstructions, the main ingredients for our analysis are:
  1. Tax declarations from which we obtain labour incomes (starts in 1980)
  2. School register, which assigns school identifiers to each resident at any point of their educational curriculum. Introduced in 1973 to monitor compliance with compulsory school reform
• We also have information on parish of residence
Data

- We have individual information on completed education at age 31
- Link each individual with schoolmates on 31 October of the calendar year the individual turns 15 (typically 9th grade) to compute SG and SH
- Link individual with household information to obtain info FG and FH
- Link to tax records to obtain pre-tax annual labour earnings at 2005 prices
- Annual earnings take into account that individuals may spend part of the year without a job
Data

- 18 cohorts of individuals born between 1958 to 1975 and observed between 1989 and 2015
- 1,009,924 individuals (860,879 for real earnings)
- 1,459 schools
# Summary statistics

<table>
<thead>
<tr>
<th>Variables</th>
<th>Males - means</th>
<th>Males - standard deviations</th>
<th>Females - means</th>
<th>Females - standard deviations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Years of education</td>
<td>12.944</td>
<td>(2.28)</td>
<td>13.113</td>
<td>(2.20)</td>
</tr>
<tr>
<td>Tertiary education</td>
<td>0.303</td>
<td>(0.45)</td>
<td>0.383</td>
<td>(0.48)</td>
</tr>
<tr>
<td>STEM as highest degree</td>
<td>0.319</td>
<td>(0.46)</td>
<td>0.067</td>
<td>(0.25)</td>
</tr>
<tr>
<td>STEM as tertiary degree</td>
<td>0.088</td>
<td>(0.28)</td>
<td>0.030</td>
<td>(0.17)</td>
</tr>
<tr>
<td>Humanities and Arts as tertiary degree</td>
<td>0.049</td>
<td>(0.21)</td>
<td>0.054</td>
<td>(0.22)</td>
</tr>
<tr>
<td>Health and Related Fields as tertiary degree</td>
<td>0.051</td>
<td>(0.22)</td>
<td>0.221</td>
<td>(0.42)</td>
</tr>
<tr>
<td>Law and Social Sciences as tertiary degree</td>
<td>0.088</td>
<td>(0.28)</td>
<td>0.072</td>
<td>(0.26)</td>
</tr>
<tr>
<td>log earnings age 31 to 40</td>
<td>12.781</td>
<td>(0.46)</td>
<td>12.462</td>
<td>(0.38)</td>
</tr>
<tr>
<td>log earnings age 36 to 40</td>
<td>12.848</td>
<td>(0.44)</td>
<td>12.541</td>
<td>(0.40)</td>
</tr>
<tr>
<td>employed three of past ten years</td>
<td>0.885</td>
<td>(0.32)</td>
<td>0.848</td>
<td>(0.36)</td>
</tr>
<tr>
<td>employed five of past ten years</td>
<td>0.848</td>
<td>(0.36)</td>
<td>0.856</td>
<td>(0.35)</td>
</tr>
<tr>
<td>At least one sister in the family</td>
<td>0.546</td>
<td>(0.49)</td>
<td>0.580</td>
<td>(0.49)</td>
</tr>
<tr>
<td>At least one parent with higher education</td>
<td>0.239</td>
<td>(0.42)</td>
<td>0.231</td>
<td>(0.42)</td>
</tr>
<tr>
<td>share of girl in school and cohort (Sg)</td>
<td>0.489</td>
<td>(0.09)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% with high parental education in cohort and school (Sh)</td>
<td>0.238</td>
<td>(0.15)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>enrollment in school and cohort</td>
<td>47.044</td>
<td>(21.28)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Share of girls in the school and cohort
Share of schoolmates with at least one educated parent
### BALANCING

<table>
<thead>
<tr>
<th>Variable</th>
<th>Sg</th>
<th>Sh</th>
<th>Observations</th>
<th>R-squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>-0.100*** (0.011)</td>
<td>0.009 (0.010)</td>
<td>1,009,924</td>
<td>0.005</td>
</tr>
<tr>
<td>Mother's education</td>
<td>0.080* (0.042)</td>
<td>-0.202*** (0.065)</td>
<td>1,009,924</td>
<td>0.154</td>
</tr>
<tr>
<td>Father's education</td>
<td>0.049 (0.044)</td>
<td>-0.231*** (0.069)</td>
<td>1,009,924</td>
<td>0.125</td>
</tr>
<tr>
<td>Firstborn</td>
<td>0.009 (0.007)</td>
<td>0.006 (0.009)</td>
<td>1,009,924</td>
<td>0.018</td>
</tr>
<tr>
<td>Number of siblings</td>
<td>0.014 (0.013)</td>
<td>-0.028* (0.016)</td>
<td>1,009,924</td>
<td>0.075</td>
</tr>
<tr>
<td>Degree of urbanization</td>
<td>0.001 (0.004)</td>
<td>0.005 (0.006)</td>
<td>1,009,924</td>
<td>0.703</td>
</tr>
<tr>
<td>Mother's age</td>
<td>-0.032 (0.072)</td>
<td>0.013 (0.088)</td>
<td>1,009,924</td>
<td>0.028</td>
</tr>
<tr>
<td>Share of girls in the family</td>
<td>-0.003 (0.006)</td>
<td>-0.006 (0.007)</td>
<td>1,009,924</td>
<td>0.007</td>
</tr>
<tr>
<td>Single child</td>
<td>-0.008* (0.005)</td>
<td>0.007 (0.006)</td>
<td>1,009,924</td>
<td>0.027</td>
</tr>
</tbody>
</table>

We always control for gender and parental education.

We replicate our estimates using family fixed effects.
The effects of SG and SH on outcomes – Females

OLS estimates

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Sg</th>
<th>Sh</th>
<th>Observations</th>
<th>R-squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Years of education</td>
<td>0.075*</td>
<td>(0.041)</td>
<td>0.041</td>
<td>(0.043)</td>
</tr>
<tr>
<td>At least some college</td>
<td>0.018**</td>
<td>(0.009)</td>
<td>0.008</td>
<td>(0.009)</td>
</tr>
<tr>
<td>tertiary education</td>
<td>0.011</td>
<td>(0.009)</td>
<td>0.008</td>
<td>(0.009)</td>
</tr>
<tr>
<td>STEM in secondary or tertiary</td>
<td>0.006</td>
<td>(0.005)</td>
<td>0.045***</td>
<td>(0.009)</td>
</tr>
<tr>
<td>STEM in tertiary</td>
<td>0.004</td>
<td>(0.003)</td>
<td>-0.006</td>
<td>(0.005)</td>
</tr>
<tr>
<td>log average income 31-40</td>
<td>0.002</td>
<td>(0.008)</td>
<td>0.008</td>
<td>(0.009)</td>
</tr>
<tr>
<td>log average income 36-40</td>
<td>0.000</td>
<td>(0.008)</td>
<td>-0.003</td>
<td>(0.009)</td>
</tr>
<tr>
<td>employed in three of past ten years</td>
<td>0.009</td>
<td>(0.006)</td>
<td>0.017**</td>
<td>(0.007)</td>
</tr>
<tr>
<td>employed in five of past ten years</td>
<td>0.005</td>
<td>(0.006)</td>
<td>-0.002</td>
<td>(0.007)</td>
</tr>
</tbody>
</table>
The effect of SG and SH on several outcomes – Males

OLS estimates

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Sg</th>
<th>Sh</th>
<th>Observations</th>
<th>R-squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Years of education</td>
<td>0.038</td>
<td>0.147***</td>
<td>1,009,924</td>
<td>0.152</td>
</tr>
<tr>
<td>At least some college</td>
<td>0.000</td>
<td>0.033***</td>
<td>1,009,924</td>
<td>0.121</td>
</tr>
<tr>
<td>tertiary education</td>
<td>0.001</td>
<td>0.036***</td>
<td>1,009,924</td>
<td>0.119</td>
</tr>
<tr>
<td>STEM in secondary or tertiary</td>
<td>0.022**</td>
<td>-0.069***</td>
<td>1,009,924</td>
<td>0.110</td>
</tr>
<tr>
<td>STEM in tertiary</td>
<td>0.005</td>
<td>-0.003</td>
<td>1,009,924</td>
<td>0.033</td>
</tr>
<tr>
<td>log average income 31-40</td>
<td>0.002</td>
<td>0.022**</td>
<td>860,879</td>
<td>0.199</td>
</tr>
<tr>
<td>log average income 36-40</td>
<td>0.005</td>
<td>0.041***</td>
<td>832,630</td>
<td>0.175</td>
</tr>
<tr>
<td>employed in 3 of past ten years</td>
<td>-0.008</td>
<td>0.003</td>
<td>1,009,924</td>
<td>0.017</td>
</tr>
<tr>
<td>employed in 5 of past ten years</td>
<td>-0.004</td>
<td>0.003</td>
<td>1,009,924</td>
<td>0.011</td>
</tr>
</tbody>
</table>
Results from baseline specification: SG

• SG has no statistically significant effect on earnings or employment
• For females, a 10 p.p. increase in Sg (approximately one standard deviation) raises the probability of at least some college by 0.2 p.p. and years of education by 0.0075
• For males, the percentage with STEM education increases by 0.22 p.p.
• Very small effects
Results from baseline specification: SH

- The parental education of schoolmates has broader effects on outcomes, especially for males
- For males, a one standard deviation increase in SH (0.15)
  - Increases tertiary education by 0.54 p.p.
  - Increases lifetime earnings by 0.33 percent
  - Increases years of education by 0.022
  - Reduces attainment of a STEM degree by 1 percentage point
- For females, a one standard deviation increase in SH
  - Increases attainment of a STEM degree by 0.67 percentage points
  - Increases employment (for three out of ten years) by 0.25 percentage points
Extrapolating

• We do not have single sex schools in the sample
• A shift from a co-educational school with median share of girls = 0.49 to a single-sex school would
  • For girls, increases years of schooling and the share with some college by 0.88 and by 0.8 percentage points respectively
  • increases the share of boys with a STEM degree by 0.9 percentage points

• Effects are very small
Interacting school and family indicators

- We interact school peer effects with parental variables FG and FH
- Since parental variables could correlate with omitted unobserved parental characteristics, we use family fixed effects (on top of school fixed effects)
Baseline estimates with family fixed effects - Males

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Sg</th>
<th>Sh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Years of education</td>
<td>-0.077</td>
<td>0.123**</td>
</tr>
<tr>
<td>At least some college</td>
<td>-0.018</td>
<td>0.042***</td>
</tr>
<tr>
<td>tertiary education</td>
<td>-0.022*</td>
<td>0.047***</td>
</tr>
<tr>
<td>STEM in secondary or tertiary</td>
<td>0.016</td>
<td>-0.074***</td>
</tr>
<tr>
<td>STEM in tertiary</td>
<td>0.002</td>
<td>0.002</td>
</tr>
<tr>
<td>log average income 31-40</td>
<td>-0.006</td>
<td>0.011</td>
</tr>
<tr>
<td>log average income 36-40</td>
<td>-0.008</td>
<td>0.028*</td>
</tr>
<tr>
<td>employed in three of past ten years</td>
<td>-0.009</td>
<td>-0.006</td>
</tr>
<tr>
<td>employed in five of past ten years</td>
<td>-0.017</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Nobs: 725,722
Interactions of school and family effects - Males

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Sg * (1-Gf)</th>
<th>Sg*Gf</th>
<th>Sh*(1-Fh)</th>
<th>Sh*Fh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Years of education</td>
<td>-0.046</td>
<td>-0.093</td>
<td>0.185***</td>
<td>0.016</td>
</tr>
<tr>
<td>At least some college</td>
<td>-0.016</td>
<td>-0.018</td>
<td>0.043***</td>
<td>0.042**</td>
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<tr>
<td>tertiary education</td>
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<td>-0.020</td>
<td>0.052***</td>
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<tr>
<td>highest STEM degree completed</td>
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<td>0.016</td>
<td>-0.044***</td>
<td>-0.132***</td>
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<tr>
<td>highest STEM tertiary degree</td>
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<td>0.006</td>
<td>-0.001</td>
<td>-0.013</td>
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<tr>
<td>log average income 31-40</td>
<td>0.004</td>
<td>-0.011</td>
<td>0.026*</td>
<td>-0.022</td>
</tr>
<tr>
<td>log average income 36-40</td>
<td>0.005</td>
<td>-0.014</td>
<td>0.032**</td>
<td>0.013</td>
</tr>
<tr>
<td>employed in 3 of past ten years</td>
<td>0.027*</td>
<td>-0.027**</td>
<td>-0.011</td>
<td>0.000</td>
</tr>
<tr>
<td>employed in 5 of past ten years</td>
<td>-0.001</td>
<td>-0.025*</td>
<td>0.002</td>
<td>-0.000</td>
</tr>
</tbody>
</table>

Nobs: 725,722
Males

- A higher share of girls at school (age 15)
  - *increases* the employment (3 years out of 10) of males who have no sister
  - *reduces* the employment (3 years out of 10) of males who have at least one sister

- A higher share of schoolmates with at least one highly educated parent
  - increases completed years of schooling and earnings later in life for men whose parents are not highly educated
  - reduces the probability of completing a STEM degree. The effect is quantitatively larger for men with at least one highly educated parent.
Baseline estimates with family fixed effects - Females

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Sg</th>
<th>Sh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Years of education</td>
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<tr>
<td>STEM in secondary or tertiary</td>
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<tr>
<td>STEM in tertiary</td>
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<tr>
<td>log average income 31-40</td>
<td>0.009</td>
<td>0.008</td>
</tr>
<tr>
<td>log average income 36-40</td>
<td>0.005</td>
<td>0</td>
</tr>
<tr>
<td>employed in 3 of past ten years</td>
<td>0.016</td>
<td>0.013</td>
</tr>
<tr>
<td>employed in 5 of past ten years</td>
<td>0.009</td>
<td>0.007</td>
</tr>
</tbody>
</table>

Nobs: 725,722
Interactions of school and family effects - Females

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Sg * (1-Gf)</th>
<th>Sg*Gf</th>
<th>Sh*(1-Fh)</th>
<th>Sh*Fh</th>
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</thead>
<tbody>
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<td>Years of education</td>
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<td>(0.064)</td>
<td>(0.062)</td>
<td>(0.089)</td>
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<tr>
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<td>0.019</td>
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<tr>
<td></td>
<td>(0.021)</td>
<td>(0.014)</td>
<td>(0.013)</td>
<td>(0.020)</td>
</tr>
<tr>
<td>tertiary education</td>
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<td>0.009</td>
<td>0.003</td>
<td>-0.019</td>
</tr>
<tr>
<td></td>
<td>(0.022)</td>
<td>(0.014)</td>
<td>(0.013)</td>
<td>(0.020)</td>
</tr>
<tr>
<td>highest STEM degree completed</td>
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<td>0.049***</td>
<td>0.037***</td>
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<td>(0.013)</td>
<td>(0.019)</td>
<td>(0.012)</td>
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<tr>
<td>highest STEM tertiary degree</td>
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<td>0.006</td>
<td>0.026***</td>
<td>-0.064***</td>
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<td>(0.009)</td>
<td>(0.009)</td>
<td>(0.007)</td>
<td>(0.012)</td>
</tr>
<tr>
<td>log average income 31-40</td>
<td>-0.001</td>
<td>0.014</td>
<td>0.013</td>
<td>0.011</td>
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<tr>
<td></td>
<td>(0.019)</td>
<td>(0.014)</td>
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<tr>
<td>log average income 36-40</td>
<td>-0.022</td>
<td>0.018</td>
<td>0.007</td>
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<td></td>
<td>(0.021)</td>
<td>(0.016)</td>
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<td>(0.022)</td>
</tr>
<tr>
<td>employed in 3 of past ten years</td>
<td>0.000</td>
<td>0.023*</td>
<td>0.021*</td>
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<td>(0.012)</td>
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<td>(0.016)</td>
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<tr>
<td>employed in 5 of past ten years</td>
<td>0.023</td>
<td>0.003</td>
<td>0.002</td>
<td>0.015</td>
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<tr>
<td></td>
<td>(0.017)</td>
<td>(0.013)</td>
<td>(0.016)</td>
<td>(0.016)</td>
</tr>
</tbody>
</table>

Nobs: 725,722
Females

• A higher share of girls at school (age 15) increases the employment (3 years out of 10) of females who have at least one sister
• A higher share of schoolmates with at least one highly educated parent
  • reduces completed years of schooling and increases employment and the share completing a STEM degree for females whose parents are not highly educated
  • reduces tertiary STEM for females whose parents are highly educated
Tentative implications

- SG has always a positive effect on the employment of girls, independently of whether they have sisters.
- For boys, the sign of the effect of SG on employment depends on the composition of siblings.
- Could it be that boys with sisters are less competitive, and that their competitiveness is further reduced by more schoolgirls?
- Boys with no sisters are more competitive and benefit from less disruption (higher SG).
Tentative implications

• Boys (and partly girls) who are from less privileged families benefit more from the interaction with schoolmates having good parental background
Tentative conclusions

• We find very small effects of peer characteristics in secondary schools on education and labour market outcomes of male and female Danes
• Small but fairly precise compared to existing literature (1 million obs help)

• In line with existing literature

• Our results imply that moving to single sex schools would slightly benefit girls without affecting boys (in contrast with what found by LS and in line with BDS) (extrapolation)
Tentative conclusions

• Measures of peer characteristics such as average parental education have broader effects on outcomes than the share of girls. Background matters more than gender.
• The effects of peer characteristics at school vary with family characteristics, including the presence of sisters and parental background.
• We find that boys from a disadvantaged background benefit more from interacting at school with schoolmates from a better background – against stratification.
• Our findings suggest that the effect of girls at school may interact with the effect of girls at home, especially for boys.
• We speculate that the gender of siblings at home may affect personality traits (masculinity, competitiveness).
• Boys with these traits may respond differently to the gender composition of schoolmates.
Tentative conclusions

• Some evidence that peer characteristics have long term labour market effects – on employment and earnings, especially for males. The size of these effects is small.

• The direction and size of these effects depend on family characteristics, including family peers
Tentative conclusions

- Our results suggest that the current debate concerning single-sex versus co-educational schools is a bit inflated, as the effects of interacting with female schoolmates is very small, if existent at all.
- Stratification by parental background seems more relevant.