education enrolment, we perform an Oaxaca Binder decomposition of the gap in elite education enrolment between low and high SES students using the estimates of equation (1). To perform this decomposition, we re-estimate the benchmark model estimated on the sample pooling the low and high SES subsamples and use the estimates of the model to compute the SES gap in elite degree enrolment that is attributable to the average SES gap in the explanatory variables and to the SES gap in the coefficients associated with these variables.

The estimates of this decomposition are reported in Table A4 and show elite peers in high school explain 2.5 ppts or 12% of the SES gap in elite degree enrolment overall. This is driven by the SES gap in the average share of elite peers in high school, which explains 1.5 ppts or 7.2% of the SES gap in elite degree enrolment, and the SES gap in the *effect* of students' exposure to elite educated families, which explains 1 ppt or 4.8% of the SES gap in the outcome.

To get a sense of the relative importance of elite peers in explaining the SES gap in elite degree enrolment, we present the results of the decomposition for a selected set of covariates included in the model in the same table. For example, the SES gap in middle school GPA explains 5 ppts or 24% of the SES gap in elite degree enrolment. The SES gap in the number of elite educated parents the student has (which is 0 in the low SES sample and 1 or 2 in the high SES sample, by construction) explains over half of the elite degree enrolment.

5.3 Validity of identification strategy

As described in section 4, we perform a number of checks to probe the validity of our identification strategy. Table A5 reports the results of our placebo checks. Specifically, each row reports the coefficient on the elite peer variables in Equation 1 where the dependent variable is a different birth outcome. As expected, the exposure to elite peers during high school is unrelated to outcomes measured before high school. We take this as encouraging indication that our treatment variable is unlikely to be correlated with unobserved student characteristics which could affect their educational outcomes.

Next, we re-estimate our main specification augmented with school-specific linear trends according to the specification in Equation 2. The results of this specification, which are reported in column (2) of Table 3, are very similar to those from our benchmark specification (included in the first column of the table for easy comparison). The third check that we perform is the 'drop if more than random' check, whereby we re-estimate the model on the sample of schools for which the cross-cohort variation in the proportion of elite families across cohorts is in-line with variation from a random or fictitious ordering of cohorts. The estimates of the model on this sample, reported in column (3) of Table 3, are also very similar to those obtained on the whole sample (reported in Table 2).

Finally, we estimate Equation 3 which restricts variation in treatment to within-family cross-cohort variation in the within-school proportion of elite educated peers by including additionally a family fixed effect. Column (4) of Table 3 reports the results which, although less precisely estimated for the low SES sample are reassuringly similar to the benchmark estimates. Overall, the results of all four of these robustness checks provide strong confidence in the validity of our empirical strategy.

5.4 Non-linearities in elite peer effects

Given that low SES students are, on average, less exposed to elite families in their high school than their high SES counterparts, the presence of increasing marginal returns to being exposed to elite families in high school could lead us to estimate a lower average treatment effect for the low SES group than for the high SES group. Several papers in the related literature have shown empirical evidence of non-linearities when considering the effects of high achieving peers, and it is important to test whether it is the case here too.[25] To do that, we re-estimate our main model, this time allowing the effect of elite peers to enter quadratically in the following specification:

$$Y_{isc} = \beta_{11} P_{-ics} + \beta_{12} P_{-ics} \times P_{-ics} + X'_{ics}\beta_2 + \alpha_s + \rho_c + \epsilon_{ics} \tag{4}$$

In Figure A1, we plot the marginal effect of the proportion of elite families as implied by the estimates of this specification (The estimates of the coefficients β_{11} and β_{12} used to compute these marginal effects are reported in column (5) of Table 3.). The graph overlays these marginal effects over the densities of the elite peer variable in each of the samples to show that there is common

[25] For example, Feld and Zoelitz (2017) find that while students benefit from better peers on average, low-achieving students are harmed by high-achieving peers. Lavy, Paserman and Schlosser (2011) find that the proportion of low achieving peers has a negative effect on the performance of regular students, especially those located at the lower end of the ability distribution. Tincani (2017) estimates peer effects as a flexible function of the variance in peer ability and finds evidence of substantial heterogeneity in the size and even in the sign of such effect across the ability distribution.

support for most of the distribution of the treatment variable. Overall, there is little evidence of non-linearity in the effect of the proportion of elite families on students' outcomes through most of the distribution of the treatment variable. The one exception is for the high SES group, for whom the coefficient on the square of the elite peer variable is negative and statistically significant and the non-linearity kicks in at particularly high levels of exposure to elite peers. Importantly, across the distribution of proportion of elite families, the peer effect is higher for high SES students, which confirms that the socio-economic gradient in the elite peer effect reported in Table 2 is not driven by non-linearity in the effect of elite peers.

5.5 Other robustness checks

Sensitivity of results to sample selection We next examine the extent to which our results are robust to changes in the sample composition including first born children and schools with different admission mechanisms. First, the effect of exposure to elite educated peers may be different for first born children compared to the total sample, if for example children of higher birth order are more influenced by their older sibling than their school peers and their parents (Black, Devereux and Salvanes, 2005*a*). Column (2) of Table A6 suggests this is not the case, as the benchmark estimates are very similar to estimates on the sample of first births.

Measurement error in the elite peer variable The incidence of marital breakup may be different across household socioeconomic status and it is possible that the rates of divorce or separation vary across the SES status of schools. This would cause a problem in our estimation as the treatment could have more measurement error in the low SES sample because it is based on all biological parents. Therefore the difference in coefficients between low and high SES may be driven by attenuation bias. We confirm that this is not a problem in Column (3) of Table A6 which restricts the sample to households who have not experienced divorce or separation by the year the student finishes middle school.

Credit constraints As argued earlier, the lack of tuition fees and wide availability of student grants and loans means that differential access to credit between low and high SES families is unlikely to be driving the SES gap in elite degree enrolment in the data. Nevertheless, it may be the case that for students attending high schools outside cities where elite degrees are offered, there are additional costs associated with moving to and finding accommodation in these cities. If low SES students do not have as many acquaintances or relatives in these cities as high SES students do, then this type of credit constraints may be one mechanism behind the SES gap in elite degree enrolment that the covariates included in the model do not control for.

To tease out the extent to which this is plausible, we re-estimate the model excluding students attending high school in Oslo. Oslo is the largest municipality in Norway, containing elite universities and a high exposure to elite educated families, and it is where this sort of mechanism is more likely to be at play. Column (4) of Table A6 show that the results are robust to this exclusion. These results also show that our benchmark results are not driven by students within Oslo naturally attending their local elite universities.

Small schools Our identification strategy may not be valid for areas with particularly small schools, where students may move together from a shared middle school to a shared high school. Column (5) of Table A6 suggests that our benchmark estimates are robust to dropping schools in the bottom decile of school size (where there are 31 or fewer students per cohort).

As mentioned previously counties across Norway differed in their admissions procedure for high school between a local catchment area and, more commonly competition based upon middle school GPA. Our benchmark analysis was repeated separately by the procedure for admissions to high schools but the results are almost identical in the two samples. For the full sample, the coefficient on treatment of the proportion of parents with an elite degree is 0.027 (standard error 0.004) and 0.026 (standard error 0.005) for areas with local catchment and school choice admissions, respectively.

5.6 Interpretation of the elite peer effect

Elite peers are, on average, of higher ability and from families with high levels of income or with parents working in high status occupations. In order to start exploring the mechanisms underlying the elite peer effect, in this section we shed light (descriptively) on the extent to which the peer effect we identify is driven by the fact that these peers have parents with an elite education - as opposed to other, correlated characteristics.

First, we re-estimate the benchmark model (1) this time also controlling for the proportion of peers whose family income is in the top decile of the national distribution and for the proportion of peers whose parents work in elite occupations (i.e working in a STEM occupation or as a doctor or lawyer). The results of this specification are reported in column (6) of Table A6 and show that the elite peer effect we have focused on so far is very robust to the inclusion of these other peers' characteristics, suggesting that the elite education of the peers' parents is likely to be driving the results we find.

Second, the elite peer effect might also pick up the effect of exposure to peers with a higher level of academic achievement. However this is not the case, as when the treatment variable is replaced with a measure of peer ability - the leave one out peer mean of the middle school GPA - there is a negative effect of an exogenous increase in mean peer ability on enrolment to elite education.[26] This suggests firstly that our peer effect is not just picking up exposure to high quality peers, but also that adding an elite peer to the cohort can work against enrolment to elite education, possibly through a reduced confidence or self-esteem as suggested by Cools, Fernández and Patacchini (2019).

6 Elite peer effects on students' academic performance

Having established the presence of a significant elite peer effect on elite degree enrolment and a socioeconomic gradient in this effect, we turn to exploring the mechanisms underlying this effect. As explained in section 2, student's enrolment in an elite degree is determined by whether they apply to such a degree and by their high school GPA. In this section, we ask whether and why elite peers affect high school GPA.

6.1 Elite peer effects on overall GPA and its sub-components

We start by estimating the elite peer effects on overall GPA by estimating equation Equation 1, this time with high school GPA as dependent variable. The estimates of these models are reported in Panel A of Table 4 and show that an increase in the proportion of elite peers in a student's school cohort has a negative and statistically significant effect on overall GPA across the whole sample. Coefficients in the second and third column of the table reveal a strong socio-economic gradient in

[26] The coefficients (standard errors) for the low and high SES students are -0.014 (0.003) and -0.050 (0.018) respectively.

we now focus on reporting the results for low SES students.

Panel B of Table 5 reports the IV estimates of Equation 5. As expected, high school GPA has a strong positive and statistically significant effect on the probability of enroling in an elite degree. The coefficient on the elite peers in the IV specification is 0.038 and statistically significant in the low SES sample, which means that an increase in exposure to elite peers by one standard deviation encourages low SES students to raise their enrolment in elite degree by 3.8 percentage points (conditional on GPA). This direct effect is consistent with elite peers (and/or their families) raising students' motivation or aspiration to pursue an elite education over and beyond any effect they have on academic performance, for example by acting as role models and/or providing information on elite degrees and their returns.

The final rows of Table 5 decompose the total peer effect on student enrolment to an elite degree from Table 2 into the direct effect γ_1 from Equation 5 and the indirect effect $(\delta_1 * \gamma_2)$. Interestingly the effect of exposure to elite peers coming from grades is almost the same magnitude as the effect coming from the other mechanisms of information and role models. The indirect effect of exposure to elite peers on elite enrolment through high school grades reduces enrolment by 2.7 percentage points. This suggests that a policy reform to increase the proportion of written maths examinations assessed blindly for low SES students would reduce the teacher bias from exposure to elite peers and raise enrolment of low SES students in elite degree programmes.[32]

8 Does exposure to elite peers reduce intergenerational income mobility?

We conclude our analysis by considering the implications of our results for earnings and intergenerational earning mobility. If the return to enrolling in an elite degree is positive for both low and high SES, a direct implication of our results is that exposure to elite families reduces intergenerational income mobility. If the return to studying for an elite degree is very low for low SES students (as it has been shown by Zimmerman (2019) for Chile, for example),[33] then any policies to increase enrolment on elite degree programmes for these students - through increased exposure

[32]The direct effect for high SES students also increases once we condition on high school GPA, however with such a low F-statistic we do not consider these results as reliable.

[33]Zimmerman (2019) shows that the returns to elite degrees in Chile are close to zero for males and females not from private high schools, which are the types of high schools that charge high tuition and serve upper-income households.

to elite educated peers or more blind assessments at school - will not reduce earnings inequalities by SES background.

To shed light on these hypotheses, we use data on the earnings of the three oldest cohorts in our data (born between 1986-1988). For these cohorts it is possible to measure income for some ages between 30 and 32 years old, which has been shown to be the age at which earnings rank becomes relatively stable and predictive of earnings rank at older ages (Bhuller, Mogstad and Salvanes, 2017). Using these data, we ask the following questions: First, is the earnings premium from an elite degree similar across student SES background? Second, does exposure to elite peers raise the longer-run outcome of earnings age 30-32? Third, does exposure to elite degrees exacerbate or mitigate the link between child and parents' earnings?

We first investigate the association between an elite degree and earnings for the two subsamples of low and high SES students. To do so, we estimate a Mincer style regression of earnings on an indicator for whether the student enrolled in a degree and an indicator for enrolling in an elite degree (with the category of no degree is omitted) on the set of individual level controls we included in equation (1), school and cohort fixed effects. The results of this specification are reported in Table 6 in columns (1) and (2) where the dependent variable is the (within cohort) percentile rank of earnings age 30-32 in Panel A and an indicator for earning in the richest decile in panel B. In line with Bütikofer, Risa and Salvanes (2021), we find evidence of very high average returns to enrolling in an elite degree.[34] And, in contrast with the findings of Zimmerman (2019) for Chile, the return for low SES students are only slightly smaller than they are for high SES students. Specifically, enrolling in an elite degree increases the percentile rank at 30-32 by 26.7-30.5 percentiles for low and high SES students respectively. From panel B, enrolling in an elite degree is associated with an increase in the probability to earn in the richest decile by 25.0 and 28.4 ppts relative to someone with no degree. The similarity of these coefficients across SES is an interesting finding - which we do not believe had been uncovered before - especially as it appears in great contrast with evidence available for other countries.

Given similarly high earnings returns to an elite degree for low and high SES students and our benchmark results on elite peer effects from Table 2, we move on to estimate the causal elite peer effect on earnings. To do so, we re-estimate our benchmark equation (1), this time with the

[34] These are descriptive rather than causal returns, estimated through OLS.

indicator for the percentile rank (panel A) and earnings in the top decile (panel B) as outcomes. We present the estimates of this specification in columns (3) through (4) of Table 6. Being exposed to elite peers in high school increases the percentile rank but this effect is lower for low SES students than it is for high SES students (0.86 percentiles compared to 2.5). It also increases the probability of being in the richest decile at age 30-32 but only for high SES students (2.2 ppts). These results are in line with our earlier evidence that elite peers have a less positive effect for low SES students than for high SES students but suggests additionally that the effect of elite peers persists into later life.[35]

Together, these findings show that elite peers increase the educational attainment and earnings of low SES students, but because they have a stronger effect on the outcomes of high SES students, exposure to elite peers may exacerbate the intergenerational persistence in education. To get a sense of how large the effect of such social interactions are on intergenerational income mobility, we estimate intergenerational mobility rank-rank regressions and allow the persistence in earnings across generations to vary across exposure to elite educated peers.[36] An indicator for high exposure to elite peers is defined to take the value of 1 in school cohorts with above mean exposure ot elite peers (with a proportion above 6%) and 0 otherwise. We estimate a regression where the dependent variable is the child's percentile rank between age 30-32, regressed on an indicator for high exposure to elite peers, a quadratic in the parents' percentile rank for the child ages 15-19 and a quadratic interaction between high exposure and the parents' percentile rank.[37]

Figure 2 demonstrates a strong link between the percentile rank of the parent and their child which is strengthened by high exposure to elite peers in the high school cohort. For any value of the parent percentile rank, the child's percentile rank is higher in the high exposure group with above average proportion of elite peers than in the low exposure treatment. Importantly, the additional

[35] The results do not imply that the only way through which elite peers affect earnings is by boosting students' probability of enrolling in an elite degree. Indeed, elite peers may have other effects on earnings over and beyond their effect on educational attainment (for example through connections that could help secure a good job). When re-estimating the model this time also controlling for whether the student has enrolled in an elite education (available upon request), we still find a positive effect and an SES gradient of elite degrees on earnings. Understanding these mechanisms is beyond the scope of the paper but we note that these findings as an interesting avenue for future research.

[36] This follows a similar strategy of Pekkarinen, Uusitalo and Kerr 2009, used for example in Bütikofer and Salvanes 2020 and Kaila et al. 2021.

[37] Specifically, the equation we estimate is as follows: $PCT^{student}_{ics} = \phi_1 P_{-ics} + \phi_2 PCT^{parent}_{ics} + \phi_3 PCT^{parent^2}_{ics} + \phi_4 P_{-ics} * PCT^{parent}_{ics} + \phi_5 P_{-ics} * PCT^{parent^2}_{ics} + \phi_6 X_{ics} + \alpha_s + \rho_c + \epsilon_{ics}$; where $PCT^{student}$ and PCT^{parent} denote the percentile rank of the student (30-32) and the parent (child aged 15-19) respectively.

uplift in the relationship is highest at the bottom and the top of the parent income distribution. This means that whilst exposure to elite peers may increase mobility for low SES students, it also increases persistence at the top of the income distribution and may therefore contribute towards the particularly high intergenerational persistence in education at the upper tail.

9 Conclusion

Socioeconomic inequalities in elite education are high, even in Scandinavian countries, where income inequality is notoriously low. This paper examines the role of social interactions in driving such inequalities both within and across generations in Norway. We show that exposure to elite peers in high school increases the enrolment in elite degrees of students in a way that exacerbates socioeconomic inequalities in elite education. This is due to the fact that elite peers have a much stronger positive effect on the probability of enrolling in an elite degree of high SES students than it does on that of low SES students. Nevertheless, elite peers also increase mobility for low SES students and may therefore help these students become first generation elite.

We further show that this difference in the effect of elite peers between low and high SES students is due to two main factors. First, exposure to elite peers penalises the GPA of low SES students much more than for high SES students. We exploit a unique feature of the Norwegian examination system to rule out competing explanations and argue that this pattern is most likely driven by teacher grading behaviour adjusting to the presence of elite peers to the detriment of low SES students.

Second, conditional on GPA, a causal mediation analysis suggests that students' exposure to elite peers increases their likelihood to apply to an elite degree, but this effect is higher for high SES students than it is for low SES students.

As we show in this paper, the very high monetary returns to an elite degree for both low and high SES students means that the strong intergenerational persistence in elite education is an important driver of the intergenerational transmission of income at the top end of the income distribution. Overall, our findings suggest that considering peer interactions is very important for policy-makers interested in improving the life chances of low SES students as well as intergenerational mobility. Specifically, we show that policies that increase social mixing in high school may well increase the fraction of first generation elites, but could also have the perverse effect of exacerbating the intergenerational persistence in elite education. Crucially, to increase social network effects for low SES students, our results highlight the need for blind, externally marked assessments of student achievement in the place of teacher assessments.

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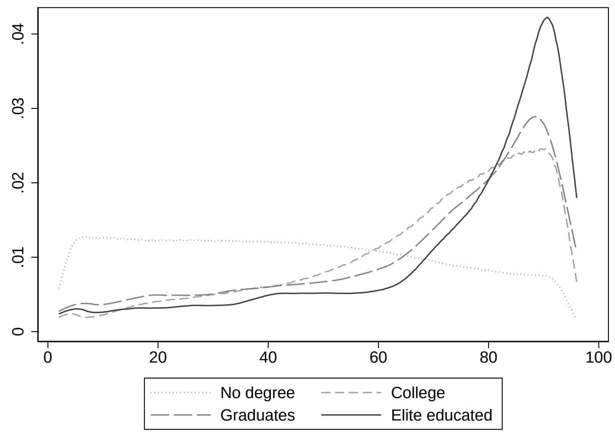
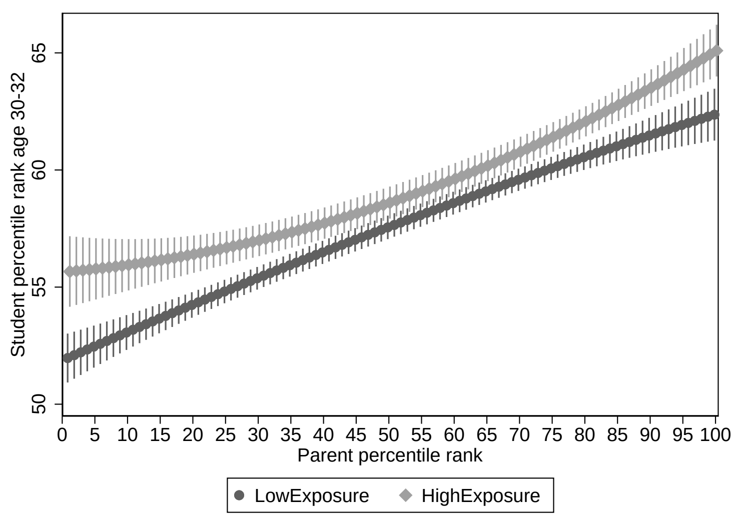
Figure 1: Density of earnings percentiles by education level



Notes: This graph plots the density of earnings percentiles across educational groups. Sample is the population of Norway aged 28-40 between 1993-2001. The percentile rank of earnings is calculated within each birth cohort.

Figure 2: Intergenerational mobility: estimating the percentile rank-rank correlation across exposure to elite peers



Notes: This graph plots the fitted values from an intergenerational mobility rank-rank regression allowing for the interaction between exposure to elite peers and the parent percentile rank to be quadratic. High exposure is defined as above mean proportion of elite peers in the high school cohort.

Table 1: Summary statistics of the sample

	Full sample	Low SES sample	High SES sample
	Mean (sd)	Mean (sd)	Mean (sd)
Enrolls in higher education	0.904	0.861	0.956
Enrolls in elite degree	0.102	0.053	0.260
% of parent with elite degree	0.061	0.047	0.100
	(0.056)	(0.047)	(0.068)
Covariates			
Female	0.601	0.651	0.527
Born in Norway	0.873	0.836	0.852
Middle school GPA (std)	0.676	0.496	0.921
	(0.634)	(0.639)	(0.591)
Mother's highest education level			
Compulsory education	0.516	0.932	0.161
High school degree	0.126	0.068	0.144
University degree	0.358	0.000	0.695
Father's highest education level			
Compulsory education	0.578	0.916	0.073
High school degree	0.139	0.084	0.042
University degree	0.282	0.000	0.885
% of own parents with an elite degree	0.066	0.003	0.580
	(0.194)	(0.038)	(0.183)
Family income in the top decile	0.214	0.123	0.485
	(0.309)	(0.244)	(0.352)
% of peer parents in top income decile	0.247	0.230	0.308
	(0.110)	(0.103)	(0.120)
% of peer parents in elite occupation	0.017	0.014	0.023
Mechanisms			
High school GPA (std)	0.013	-0.252	0.494
	(0.999)	(0.951)	(1.000)
Long-run			
Student in top decile of earnings 30-32*	0.141	0.104	0.230
Student percentile rank 30-32	58.494	55.181	64.667
	(26.728)	(25.926)	(28.068)
N	177,219	58,328	20,018

Notes: Sample of students ending middle school and entering high school between 2002-2012. The table presents means and standard deviations (in parentheses) of the main variables used in the analysis. Elite degree status defined as enrolment into Business/Engineering, Law of Medicine at a top institution (see section 3). High school GPA is standardized within cohort to have mean 0 and standard deviation 1. Middle school GPA is standardized to have mean 0 and standard deviation 1 within the cohort. % of local elite workers measure the % of workers in STEM, law or medicine occupations whose father was not in a professional occupation. *Measured for oldest 5 cohorts where sample size is 59,043; 20,454; 6,765 for the total sample; low SES and high SES respectively.

Table 2: Effect of elite peers on the probability of enrolling in an elite degree

	(1) Full sample	(2) Low SES	(3) High SES
Proportion of parents with elite degree (std)	0.026***	0.013***	0.040***
	(0.003)	(0.003)	(0.008)
Number of students	*177,219*	*58,328*	*20,018*
Number of schools	*556*	*524*	*459*

Notes: OLS estimates of a regression of an indicator for whether the student is enrolled in an elite degree within 6 years of starting high school on: the proportion of parents with elite degree in the student's school's cohort, student's gender, middle school GPA, an indicator for whether the student was born in Norway, mother and father's highest education level, a variable measuring the number of student's own parents who have an elite education, and an indicator for whether the student's family income is in the top decile of the overall income distribution. Regressions include cohort and school fixed effects. Column (1) reports the coefficient on the proportion of parents with an elite degree estimated in the full sample, column (2) and column (3) report the same coefficient estimated in the low SES and high SES samples, respectively. The low SES sample is defined as the group of students who have at least one parent with no more than the compulsory level of education, but no parent with an elite education. The high SES sample is defined as the group of students who have at least one parent with a post-secondary education, but no parent with a compulsory level of education. Regressions are weighted by school size to take account of the parent peer variables group averages, taken from groups of different sizes. Standard errors clustered at the school level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 3: Validity of the empirical strategy

	(1) Benchmark	(2) School-specific linear trends	(3) 'Drop if more than random'	(4) Including family fixed effect	(5) Quadratic specification
A - Low SES students sample					
Proportion of parents with elite degree (std)	0.013***	0.013***	0.010**	0.010	0.014***
	(0.003)	(0.003)	(0.004)	(0.006)	(0.003)
Proportion of parents with elite degree squared					-0.001
					(0.001)
Number of pupils	*58,610*	*58,610*	*28,181 58,610*		*58,610*
Number of schools	*524*	*524*	*284*	*524*	*524*
B - High SES students sample					
Proportion of parents with elite degree (std)	0.040***	0.047***	0.038***	0.032***	0.058***
	(0.008)	(0.008)	(0.013)	(0.012)	(0.010)
Proportion of parents with elite degree squared					-0.008**
					(0.004)
Number of pupils	*20,018*	*20,018*	*8,420*	*20,018*	*20,018*
Number of schools	*459*	*459*	*240*	*459*	*459*

Notes: OLS estimates of the coefficient on the variable measuring the fraction of elite educated parents in the student's youth cohort in different specifications in the low SES sample (Panel A) and in the high SES sample (Panel B). Column (1) refers to the benchmark specification (equation 1) and reported in Table 2. Column (2) refers to the benchmark specification augmented with a quadratic term in the elite peer variable. Column (3) refers to the benchmark specification this time estimated on the subsample of schools where variation in the elite peer variable evolves over time in a random way. Specifically, we drop the schools where the R^2 from a school-level regression of the proportion of elite educated peers on a quadratic in year is 1.05 times the R^2 from five regressions where cohorts are randomly re-ordered for each. See section 4 for full details. Column (4) refers to the benchmark specification where we also control for a family fixed effect. Column (3) refers to the benchmark specification where we also control for school-specific linear trend. Column (5) refers to the benchmark specification but allowing for a quadratic in the treatment variable. Regressions are weighted by school size to take account of the parent peer variables group averages, taken from groups of different sizes. Standard errors clustered at the school level. Standard errors clustered at the school level. *** p<0.01, ** p<0.05, * p<0.1

Table 4: Elite peer effect on overall GPA and its components

	(1) Full sample	(2) Low SES	(3) High SES
A - Overall GPA			
	-0.118***	-0.171***	-0.046***
	(0.013)	(0.016)	(0.012)
Number of observations	*177,219*	*58,610*	*20,018*
B - Components of GPA			
Externally assessed written exam grades	0.025***	0.030**	0.030*
	(0.009)	(0.012)	(0.016)
Number of observations	*177,219*	*58,610*	*20,018*
Teacher-assessed internal grades	-0.110***	-0.162***	-0.040***
	(0.013)	(0.016)	(0.012)
Number of observations	*177,219*	*58,610*	*20,018*
Semi-externally assessed oral exam grades	-0.036***	-0.064***	-0.012
	(0.008)	(0.011)	(0.014)
Number of pupils	*149,488*	*49,414*	*17,189*

Notes: OLS estimates of the effect of the proportion of parents with an elite degree in the student's school cohort in the benchmark model where the dependent variable is now a measure of academic performance. See notes to Table 2 for detailed list of controls. The measures of academic performance are: overall high school GPA (row 1), average performance on externally assessed written exams across all three years of high school (row 2), average performance on teacher assessed grades across all three years of high school (row 3), and average performance on oral exams marked by an external examiner and the student's teachers across all three years of high school (row 4). All measures of performance are standardized to have mean 0 and standard deviation 1 within cohort. Column (1) reports the coefficient on the proportion of parents with an elite degree estimated in the full sample, column (2) and column (3) report the same coefficient estimated in the low SES and high SES samples, respectively. Standard errors clustered at the school level. *** p<0.01, ** p<0.05, * p<0.1

Table 5: IV estimates and decomposition of the total effect of elite peers on elite degree enrolment

	Low SES		High SES	
	(1)	(2)	(3)	(4)
	OLS	IV	OLS	IV
A - Dependent variable: GPA				
Proportion of parents with elite degree (std)		-0.039***		-0.009
		(0.007)		(0.010)
Student took written math exam (IV)		0.031***		0.029**
		(0.008)		(0.013)
F stat		*16.23*		*5.00*
B - Dependent variable: elite degree enrolment				
Proportion of parents with elite degree (std)	0.010***	0.038***	0.032***	0.054***
	(0.004)	(0.008)	(0.006)	(0.024)
Overall high school GPA		0.690***		2.273**
		(0.172)		(0.970)
C - Decomposition				
Direct effect		0.038		0.054
Indirect effect		-0.027		-0.020
Total effect		0.011		0.034
Number of pupils	*58,586*	*58,586*	*19,968*	*19,968*
Number of schools	*500*	*500*	*409*	*409*

Notes: Data source, Norwegian administrative data. Sample of students ending middle school and entering high school between 2002-2012. Two-stage least squares estimation, IV for high school GPA is lottery to take written exam in maths in years 2 or 3 of high school. Dependent variable is indicator for studying for an elite (graduate) degree. Model controls the same as Table 2 including school, cohort and high school program fixed effects. Regressions are weighted by school size to take account of the parent peer variables group averages, taken from groups of different sizes. Standard errors clustered at the school level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 6: Long-term implications for earnings

	(1) Low SES	(2) High SES	(3) Low SES	(4) High SES
A - Dependent variable: Earnings percentile				
Student ever enrolled in degree	10.185***	14.369***		
	(0.455)	(1.574)		
Student ever enrolled in elite degree	26.701***	30.521***		
	(0.828)	(1.639)		
Proportion of parents with elite degree			0.816***	2.462***
			(0.344)	(0.615)
B - Dependent variable: Richest decile				
Student ever enrolled in degree	0.028***	0.082***		
	(0.005)	(0.024)		
Student ever enrolled in elite degree	0.250***	0.284***		
	(0.010)	(0.025)		
Proportion of parents with elite degree			0.004	0.022***
			(0.004)	(0.009)
Number of pupils	*20,454*	*6,765*	*20,454*	*6,765*
Number of schools			*457*	*372*

Notes: Columns (1) and (2) run a Mincer-style regression of earnings on an indicator for degree and an elite degree. The omitted category is no degree. The low SES sample in columns (1) and (3) is defined as the group of students who have at least one parent with no more than the compulsory level of education, but no parent with an elite education. The high SES sample in columns (2) and (4) is defined as the group of students who have at least one parent with a post-secondary education, but no parent with a compulsory level of education. Sample of birth cohorts 1986-1989. Income is deflated to 2020. For the cohorts 1986; 1987; 1988 and 1989 income is measured ages 28-32; 28-31; 28-30 and 28-29 respectively (see section 3). The regressions include controls from Table 2. The variable parent in richest decile is measured by taking average parent earnings when the child is agd 15-19 (deflated to 2020). Standard errors clustered at the school level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Online Appendix

A1 Gender heterogeneity

There are very well documented differences in college majors across genders which contribute towards the gender pay gap. We re-estimate the benchmark model from Equation 1 separately by gender to understand if the SES gap exists within gender. The results in Table A1 suggest that the effect of exposure to elite educated peers during high school on elite enrolment is larger for males than females (3.9ppt compared to 1.8ppt in the full sample). Within each gender, the SES gradient is still present and the peer effect is considerably larger for low SES males or females compared to high SES males or females.

Table A1: Gender differences in effect of elite parent peers

	(1) All	(2) Low SES	(3) High SES
A - Sample of females			
Proportion of parents with elite degree (std)	0.018***	0.008***	0.032***
	(0.003)	(0.002)	(0.008)
B - Sample of males			
Proportion of parents with elite degree (std)	0.039***	0.025***	0.051***
	(0.006)	(0.005)	(0.012)
Number of female pupils	106,421	37,945	10,559
Number of male pupils	70,798	20,383	9,459

Notes: Data source, Norwegian administrative data. Sample of students ending middle school and entering high school between 2002-2012. Two stage least squares estimation, IV for high school GPA is lottery to take written exam in maths. Dependent variable is indicator for studying for an elite (graduate) degree. Model controls for student Norwegian born, gender, middle school GPA, mother and father education and income in year before high school entry and fixed effects for school and year and peer mean middle school GPA. Standard errors clustered at school level. Low (elite) education household contains at least one parent with compulsory (elite) education. Upward mobility is gender specific, measuring the % of local elite occupations of the same gender of the student who come from a non-professional background.

A different way to consider at gender is the gender of the parents. Do the elite parent peer effects vary across the % of mothers or fathers with elite degrees? According to Table A2 the peer effects are stronger when the parent with an elite degree is a father, rather than a mother. For boys there is not a statistically significant difference in the peer effect across mothers and fathers whereas for girls there is where again it is the fathers who have the largest peer effect. The exception is the low SES boys.

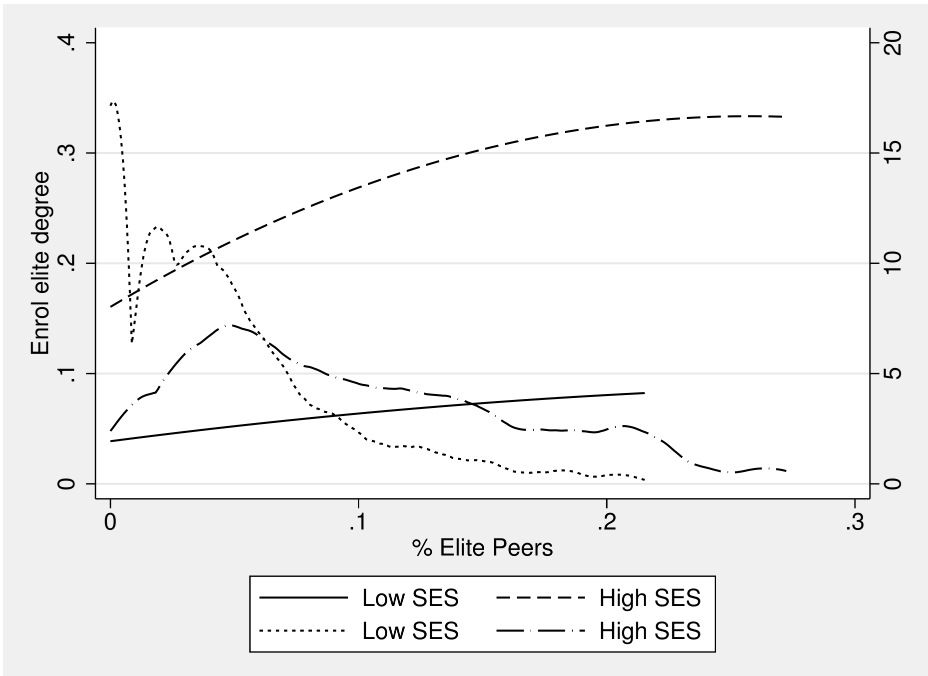
Table A2: Gender differences in effect of elite parent peers

	(1) All	(2) Low SES	(3) High SES
A - Sample of females			
Proportion of mothers with elite degree (std)	0.005*	0.000	0.006
	(0.003)	(0.003)	(0.007)
Proportion of fathers with elite degree (std)	0.014***	0.007***	0.028***
	(0.003)	(0.003)	(0.009)
B - Sample of males			
Proportion of mothers with elite degree (std)	0.014***	0.014***	0.018**
	(0.004)	(0.005)	(0.009)
	0.027***	0.013**	0.035***
Proportion of fathers with elite degree (std)	(0.005)	(0.005)	(0.013)
Number of female pupils	106,421	37,945	10,559
Number of male pupils	70,798	20,383	9,459

Notes: Data source, Norwegian administrative data. Sample of students ending middle school and entering high school between 2002-2012. Two stage least squares estimation, IV for high school GPA is lottery to take written exam in maths. Dependent variable is indicator for studying for an elite (graduate) degree. Model controls for student Norwegian born, gender, middle school GPA, mother and father education and income in year before high school entry and fixed effects for school and year and peer mean middle school GPA. Standard errors clustered at school level. Low (elite) education household contains at least one parent with compulsory (elite) education. Upward mobility is gender specific, measuring the % of local elite occupations of the same gender of the student who come from a non-professional background.

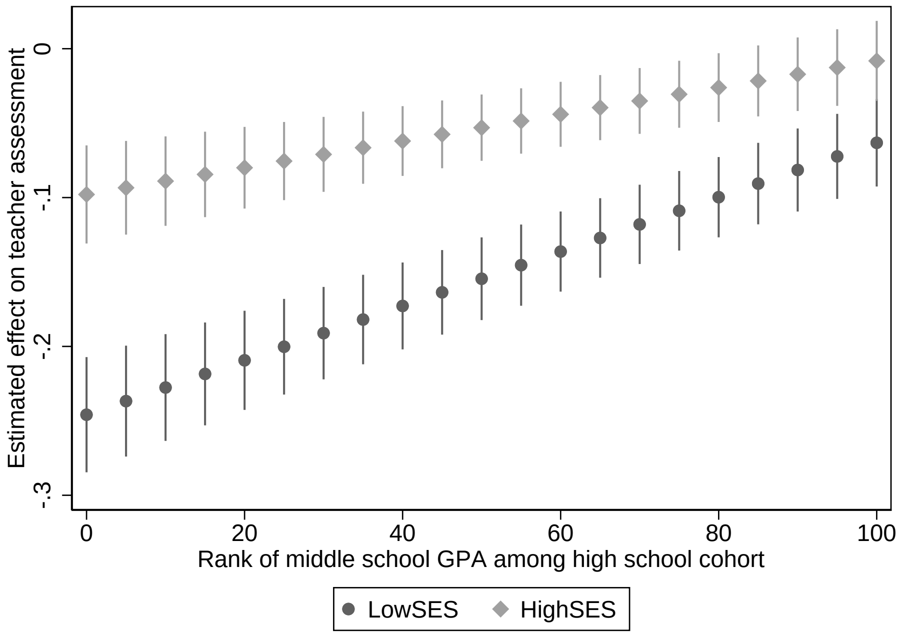
A2 Additional figures and tables

Figure A1: Marginal effect of exposure to elite social networks implied from quadratic specification



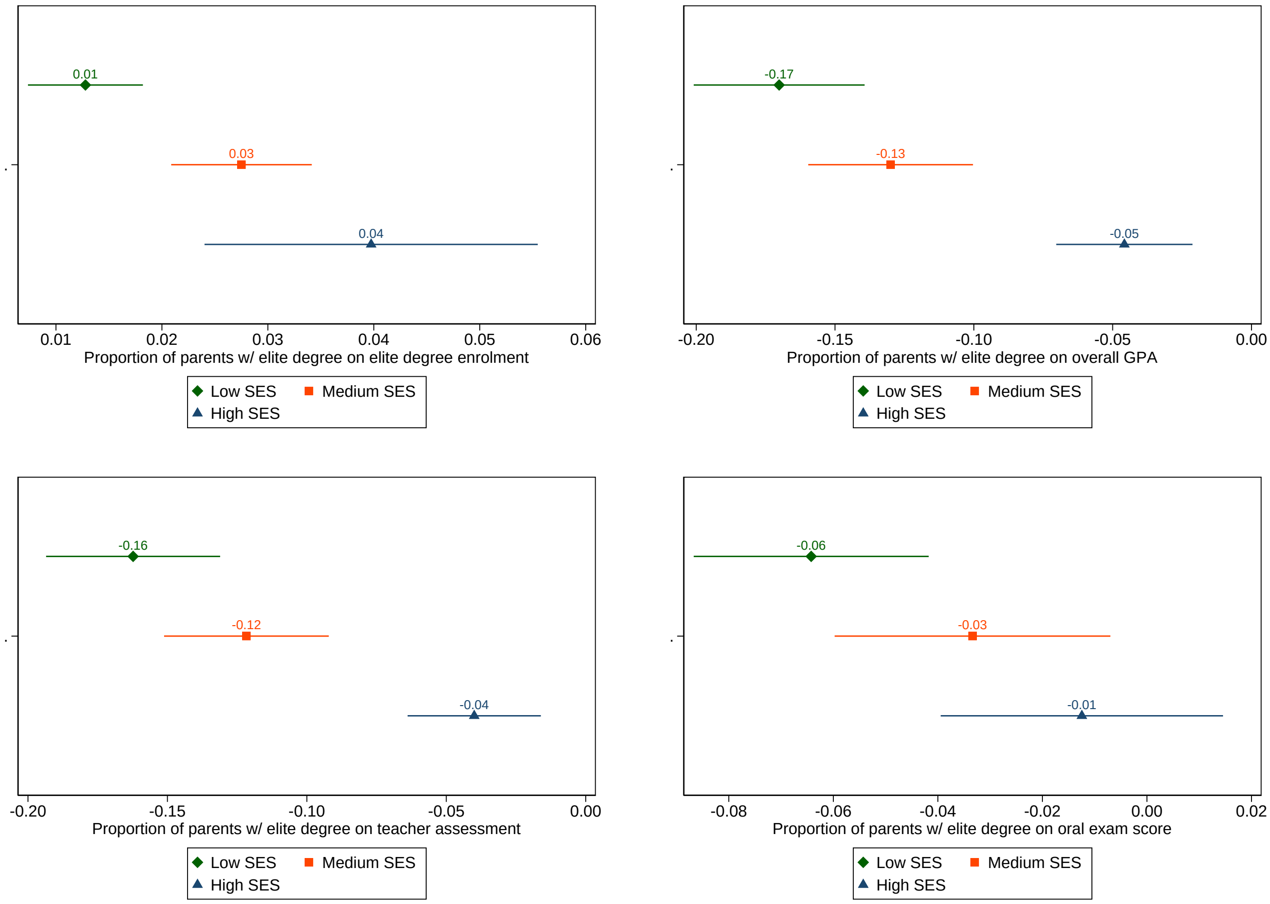
Notes: This graph plots the densities of P_{-ics} in the low SES (dotted line) and high SES samples (dot-dashed line). It also plots the marginal effect of an increase in P_{-ics} on the probability of enrolling in an elite degree as a function of P_{-ics} as implied by estimates of β_{11} and β_{12} in equation (4). The marginal effect in the low SES (high SES) sample is plotted as a solid (dashed) line. The estimates of these coefficients are reported in Column (5) of Table 3.

Figure A2: Marginal effect of exposure to elite social networks on high school teacher assessment across student middle school rank



Notes: This graph plots the marginal effect of an increase in P_{-ics} on the probability of enrolling in an elite degree as a function of the rank of the student's middle school GPA amongst the high school cohort. Estimated on the benchmark specification including the rank of middle school GPA and an interaction between the rank and the proportion of parents from an elite educated background. The marginal effect in the low SES (high SES) sample is plotted as a dark grey circles (light grey diamonds).

Figure A3: Effect of exposure to elite peers on student outcomes by socioeconomic background



Notes: This graph plots the marginal effect of an increase in P_{-ics} on student outcomes: the probability of enrolling in an elite degree; overall high school GPA; high school teacher assessment and high school written exams. The coefficients are estimated from regression Equation 1. See notes to Table 2 for details of the specification. The low SES sample is defined as the group of students who have at least one parent with no more than the compulsory level of education, but no parent with an elite education. The high SES sample is defined as the group of students who have at least one parent with a post-secondary education, but no parent with a compulsory level of education. The medium SES sample defines households with the education in between - where no parent left school at the compulsory age and no parent has an elite education.

Table A3: Effect of exposure to elite families in high school on the probability of enrolling in an elite degree : Coefficients on control variables

	(1) All	(2) Low SES	(3) High SES
Proportion of parents with elite degree (std)	0.026***	0.013***	0.040***
	(0.003)	(0.003)	(0.008)
Student is a female	-0.073***	-0.053***	-0.125***
	(0.003)	(0.003)	(0.007)
Student is born in Norway	-0.011***	-0.032***	0.013
	(0.003)	(0.004)	(0.009)
Student's middle school GPA (std)	0.132***	0.086***	0.255***
	(0.004)	(0.003)	(0.007)
Proportion of student's own parent with an elite degree	0.182***		0.162***
	(0.007)		(0.021)
Student's parents are in top income decile	0.027***	0.004	0.042***
	(0.003)	(0.005)	(0.009)
Mother's highest education level (ref = compulsory level)			
High school	0.015***	0.007	0.032***
	(0.003)	(0.005)	(0.011)
University	0.006**		0.006
	(0.002)		(0.010)
Father's highest education level (ref = compulsory level)			
High school	0.018***	0.018***	0.008
	(0.002)	(0.004)	(0.018)
University	0.020***		0.022**
	(0.002)		(0.011)
Number of students	177,219	58,328	20,018
Number of schools	556	524	459

Table A4: Oaxaca Binder decomposition of the SES gap in elite degree enrolment

	SES gap in characteristics		**SES gap in coefficients**	
	Gap	Contribution	Gap	Contribution
Fraction of elite peers	-0.015***	7.2%	-0.010***	4.8%
	(0.002)		(0.003)	
Student's middle school GPA	-0.050***	24.2%	-0.140***	67.6%
	(0.001)		(0.005)	
Fraction of own elite parent	-0.116***	56.0%	0.022***	-10.6%
	(0.011)		(0.003)	
Mother's highest education level (ref = compulsory level)				
High school	-0.001***	-0.5%	-0.003**	1.4%
	(0.000)		(0.001)	
University	-0.013***	6.3%	0.007**	-3.4%
	(0.005)		(0.003)	
Father's highest education level (ref = compulsory level)				
High school	0.000***	0.0%	0.001	-0.5%
	(0.000)		(0.001)	
University	-0.038***	18.4%	0.020***	-9.7%
	(0.008)		(0.006)	

Notes: This table reports a selected set of results from the Oaxaca decomposition of the gap in elite degree enrolment between the high SES and low SES groups of students. Specifically, we estimate the equation 1 in the sample pooling both low and high SES children, denoted by $g = L, H$ respectively. See notes to Table 2 for description of the regression and controls. For each covariate X_{ig} included in the model, we construct two objects, reported in the first and second columns of the table respectively. The first, $\Delta(X)$, measures the gap in elite education enrolment between High and Low SES students explained by the gap in average characteristic X between the two groups. That is: $\Delta(X) = \beta^p_X(E^H(X_i) - E^L(X_i)$ where β^p_X is the coefficient associated with variable X in equation 1 estimated in the pooled sample and $E^g(X_i), g = H, L$ is the expected value of X in each sample. The second, $\Omega(X)$, measures the gap in elite education enrolment between High and Low SES students explained by the gap in the effect of characteristic X between the two groups. That is: $\Omega(X) = (\beta^H_X - \beta^L_X)E^p(X_i)$ where β^g_X is the coefficient associated with variable X in equation 1 estimated in the sample of students $g = H, L$. and $E^p(X_i)$ is the expected value of X in the pooled sample.

Table A5: Placebo tests - Effect of elite peers on child birth outcomes

	Point estimate	p-value	Number of students	Number of schools
Outcome variables:				
Child birth weight	-3.303	(0.584)	169,864	554
Low birth weight	0.000	(0.891)	177,219	556
Gestation	-0.027	(0.584)	157,669	552
Height	-0.014	(0.743)	164,073	551
Head circumference	0.002	(0.812)	167,949	553
Congenital malformation	-0.001	(1.000)	170,133	554
Severe deformity	-0.002	(0.5446)	170,133	554

Notes: OLS estimates of the benchmark model (equation 1) on the full sample and where the dependent variables are predetermined characteristics of the student (indicated in the first column). Standard errors clustered at the school level and p-values adjusted using stepwise multiple hypothesis testing procedure that controls for family wise error rate. *** p<0.01, ** p<0.05, * p<0.1

Table A6: Sensitivity analysis and interpretation

	(1) Benchmark	(2) First born children	(3) Two-parent families	(4) Exclude Oslo	(5) Exclude small schools	(6) Control peer income & occupation
A - Low SES students sample						
Proportion of parents with elite degree (std)	0.013***	0.014***	0.013***	0.013***	0.013***	0.011***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Number of pupils	*58,610*	*51,270*	*49,025*	*52,938*	*50,882*	*58,610*
Number of schools	*524*	*524*	*518*	*482*	*280*	*524*
B - High SES students sample						
Proportion of parents with elite degree (std)	0.040***	0.041***	0.034***	0.040***	0.040***	0.042***
	(0.008)	(0.008)	(0.008)	(0.009)	(0.008)	(0.009)
Number of pupils	*20,018*	*15,439*	*17,435*	*16,444*	*19,153*	*20,018*
Number of schools	*459*	*449*	*450*	*418*	*279*	*459*

Notes: OLS estimates of the coefficient on the variable measuring the fraction of elite educated parents in the student's youth cohort in different specifications in the low SES sample (Panel A) and in the high SES sample (Panel B). Column (1) refers to the benchmark specification from (equation 1) and also reported in Table 2. Column (2) refers to the benchmark specification estimated just for first born children. Column (3) drops the sample of divorced or separated households. Column (4) refers to the benchmark specification this time estimated on the subsample of schools outside of Oslo. Column (5) refers to the benchmark specification excluding schools in the bottom decile of the size distribution. Column (6) refers to the benchmark specification where we also control for the fraction of peers whose parents are in the top decile of the income distribution and the fraction of peers whose parents work in high-paying/elite occupations. Standard errors clustered at the school level. *** p<0.01, ** p<0.05, * p<0.1

Table A7: Elite peer effect on GPA rank within the high school cohort

	(1) Full sample	(2) Low SES	(3) High SES
A - Overall GPA			
	-8.270***	-10.215***	-5.744***
	(0.433)	(0.543)	(0.463)
Number of observations	*177,219*	*58,610*	*20,018*
B - Components of GPA			
Externally assessed written exam grades	-6.140***	-7.152***	-4.670***
	(0.349)	(0.434)	(0.475)
Number of observations	*177,219*	*58,610*	*20,018*
Teacher-assessed internal grades	-8.272***	-10.141***	-5.757***
	(0.437)	(0.542)	(0.474)
Number of observations	*177,219*	*58,610*	*20,018*
Semi-externally assessed oral exam grades	-4.233***	-5.941***	-2.666***
	(0.347)	(0.460)	(0.530)
Number of observations	*149,488*	*49,414*	*17,189*

Notes: OLS estimates of the effect of the proportion of parents with an elite degree in the student's school's cohort in the benchmark model controlling for average peer ability where the dependent variable is now a measure of academic performance. See notes to Table 2 for detailed list of controls. The measures of academic performance are: overall high school GPA (row 1), average performance on externally assessed written exams across all three years of high school (row 2), average performance on teacher assessed grades across all three years of high school (row 3), and average performance on oral exams marked by an external examiner and the student's teachers across all three years of high school (row 4). All measures of performance are standardized to have mean 0 and standard deviation 1. Column (1) reports the coefficient on the proportion of parents with an elite degree estimated in the full sample, column (2) and column (3) report the same coefficient estimated in the low SES and high SES samples, respectively. Standard errors clustered at the school level. *** p<0.01, ** p<0.05, * p<0.1

Table A8: Balance

	(1)	(2)
	Low SES	High SES
Proportion of parents with elite degree (std)	-0.016*	-0.008
	(0.008)	(0.008)
Student is female	0.003	-0.003
	(0.005)	(0.007)
Student is born in Norway	0.001	0.014
	(0.007)	(0.010)
Mother years of schooling	-0.001	0.001
	(0.001)	(0.001)
Father years of schooling	-0.001	-0.001
	(0.001)	(0.001)
Middle school teacher assessment	0.068	0.036
	(0.076)	(0.125)
Middle school written exams	0.002	0.003
	(0.007)	(0.012)
Middle school oral exams	0.009	-0.000
	(0.006)	(0.010)
Middle school overall GPA	-0.132	-0.082
	(0.086)	(0.146)
Proportion of student's own parent with an elite degree	-0.032	0.007
	(0.047)	(0.016)
Student's parents are in top income decile	-0.002	-0.020**
	(0.008)	(0.008)
Number of pupils	58,586	19,968
Number of schools	500	409
Number of pupils	51,512	17,559

Notes: OLS estimates of a regression of an indicator for a lottery into taking a maths examination in years 2 or 3 of high school on the set of covariates reported and additionally school, cohort and programme fixed effects. The low SES sample in column (1) is defined as the group of students who have at least one parent with no more than the compulsory level of education, but no parent with an elite education. The high SES sample in column (2) is defined as the group of students who have at least one parent with a post-secondary education, but no parent with a compulsory level of education. Standard errors clustered at the school level. *** p<0.01, ** p<0.05, * p<0.1