First generation elite: the role of school social networks

Sarah Cattan [†] Kjell G. Salvanes [‡] Emma Tominey [♦]

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[†] Institute for Fiscal Studies [‡] FAIR Norwegian School of Economics [♦] University of York

Introduction

Intergenerational persistence in education

Strong intergenerational persistence in education, even in high income mobility countries

- Bjorklund and Salvanes (2011); Heckman and Landerso (2017, 2021); Butikofer, Risa and Salvanes (2021)

Lack of educational mobility particularly high at top end of education distribution

- 3% (70%) of Harvard students come from the lowest (top) income quintile (Chetty et al., 2019)
- 18% (47%) of Norwegian elite graduates comes from the two lowest (top) quintile (Butikofer et al. 2021)

High returns to elite education

- Zimmerman (2019); Anelli (2020); Dahl, Rooth, Anders (2020); Britton et al. (2021); Butikofer et al. (2021)

Understanding the barriers for low SES students to complete elite education is important

This paper: school social networks and intergenerational persistence in education

Role of school social networks in elite degree enrolment

- **Elite peers**: fraction of parents with an elite education in the student's high school cohort

Norway: an interesting and convenient context

- Elite education: masters in Business&Engineering, Law or Medicine at a few elite institutions
- No tuition fees
- We measure prior ability; link individuals to parents, school peers and their parents

Expected effects of increased exposure to elite peers on elite degree enrolment

1. Exposure to elite educated families

- Elite peers (↑ or ↓)
  - Positive spillovers from high-achieving students on learning (Bifulco, Fletcher, Ross, 2011)
  - Loss of confidence/self-esteem (Cools, Fernandez, Patacchini, 2019); negative rank effect (Delaney and Devereux 2022; Murphy and Weinhardt, 2020; Dobbie and Fryer Jr, 2014)
- Elite adults (↑ or →)
  - Information or inspiration 'role model' (Lundberg 2020; Porter and Serra 2020; Many and Riley 2019)
  - Salience of effect will depend on aspiration window

2. Teacher behaviour (↑ or ↓)

- Teacher bias favouring low or high SES (Murphy and Wyness, 2020; Burgess and Greaves 2013)
- Pushy parents

⇒ **Overall effect ambiguous and likely different for low and high SES students**

Contributions & preview of findings

1. **Investigate whether school social networks can break down barriers for low SES students from entering elite education**

Sibling peer effects on college major exist (Altmejd et al, 2021); how important are elite school peers?

→ Positive peer effect for all, but much larger effects for high SES than low SES students

2. **Mechanisms for the SES gradient**

- We measure high school GPA and its components:
  - Elite peers: ↑ externally marked written exams but ↓ teacher assessment for low ranked students
- Aspirations: an increase in aspirations can raise the peer effect for low SES

3. **Importance of exposure to elite peers for intergenerational mobility**

- Elite peers during high school
  - drive long-run earnings of low and high SES students; SES gradient
  - increases intergenerational income mobility at low SES and increase persistence at high SES

Research design

Institutional details

After middle school (age 16) students decide whether to continue into high school

- **Academic** or vocational track
- Admission to high school - some areas by local catchment; other areas competitive based on middle school grades (our results are the same for these two admission systems)
- Exams across all 3 years: GPA a combination of teacher assessment; written exams; oral exams

Higher Education

- 3 year bachelor and 5 year combined bachelor-graduate degrees
- Elite degrees: 5 year degrees in STEM, Law or Medicine in a few elite institutions(Norwegian School of Economics; Engineering at the Norwegian University of Science and Technology; Engineering School in Trondheim or NTNU; and Economics, Law or Medicine from the U of Oslo, Bergen, Trondheim and Tromsø.) ▸ Earnings premium
- Centralized admission system based on high school GPA
- Apply to a course-institution combination

Research design: Data

Norwegian register and administrative data, linked by Statistics Norway

- Links students' educational records to parents' education and labour market outcomes for all youth in the same school

Sample: Norwegian students finishing middle school and entering high school b/w 2002 and 2012

- 178,000 students; 557 schools

Focus on differential effects of networks for low and high SES students

- Low SES: students w/ at least one parent compulsory level and no parent with an elite degree
- High SES: students w/ at least one parent with elite degree and no parent with compulsory level

Key variables: definition and summary statistics

- Outcome Y_{isc}: Indicator for whether youth *i* of high school *s* and cohort *c* enrolled in elite degree within 6 yrs of middle school completion

	Total	Low SES	High SES
Proportion enrolled in elite degree	0.102	0.053	0.260
	(0.303)	(0.224)	(0.439)
N	177,219	58,610	20,018

Key variables: definition and summary statistics

- Outcome Y_{isc}: Indicator for whether youth *i* of high school *s* and cohort *c* enrolled in elite degree within 6 yrs of middle school completion
- Treatment P_{-isc}: Proportion of elite educated parents in the youth's school cohort *sc* excluding the focal student *i*'s own parents

	Total	Low SES	High SES
Proportion enrolled in elite degree	0.102	0.053	0.260
	(0.303)	(0.224)	(0.439)
% Parents w/ elite degree	0.061	0.047	0.100
	(0.056)	(0.047)	(0.068)
N	177,219	58,610	20,018

▸ Additional Stats

Research design: Identification of elite peer effect

Identification strategy exploits within school, between cohort variation in peer characteristics (Hoxby, 2000; Burke and Sass, 2008; Lavy and Schlosser, 2011; etc.)

Benchmark model: Let *i* index the individual student, *s* the school and *c* the cohort

$$Y_{isc} = \beta_1 P_{-isc} + X'_{isc}\beta_2 + \alpha_s + \rho_c + \epsilon_{isc}$$

- Y_{isc}: student *i* enrols in elite degree (Masters in STEM, Law or Medicine)
- P_{-isc}: % of cohort-school peers' parents with an elite degree (mean(0) sd(1))
- X'_{isc}: student *i*'s gender, middle school GPA, mother and father's years of schooling and elite education, income, Norwegian born
- α_s: school fixed effect
- ρ_c: cohort fixed effect
- ϵ_{isc}: error term

$\rightarrow$ β_1 = effect of one SD increase in % of elite parents in the youth's cohort on the likelihood to enroll in an elite degree

Validity of empirical strategy

1. Variation in P_{ics} is large enough

- Raw data: Mean = 0.061 / SD = 0.056
- Conditional on school and cohort effects: SD = 0.027

2. Identifying assumption: Any variation in the characteristics of peers' parents from one cohort to another, within the same school is random (conditional on the X's we control for)

- Checks:
  - Placebo test: within-school variation in P_{-ics} is not related to variation in student birth outcomes
  - Robustness checks including school-specific linear cohort trends
  - 'Drop if more than random'
    - For schools exhibiting time trends in the proportion of elite educated parents, drop if this variation is higher than the variation from mis-assigning the years randomly.

Benchmark results

Exposure to elite school peers exacerbates intergenerational education persistence

Dependent variable: Indicator for enrolling in an elite degree

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

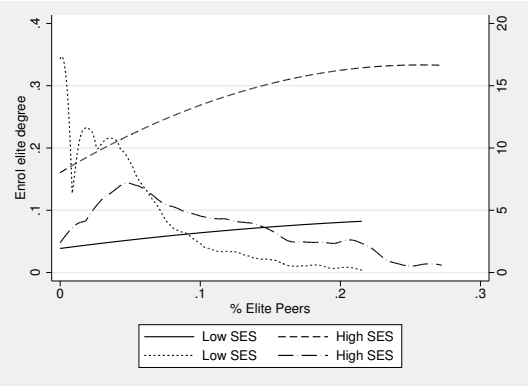
▸ Oaxaca decomposition

Non-linearity does not explain the SES gradient in elite network effect

We re-estimate the benchmark model with quadratic in elite peers:

$$Y_{isc} = \beta_{11} P_{-isc} + \beta_{12} P^2_{-isc} + X'_{isc}\beta_2 + \beta_3 \overline{M_{-ics}} + \alpha_s + \rho_c + \epsilon_{isc}$$

Figure 1: Implied effect of exposure to elite social networks



Sensitivity

- Our results are robust to including % of parents in top income decile; or % of parents working in elite occupations ▸ Resuts
  - Suggests information or role model effect of education
- Robust to including family fixed effect; school linear trends; drop if more than random ▸ Validity
- Robust to excluding OSLO; first born only; drop small schools; ▸ Sensitivity
- Placebo analysis with birth outcomes ▸ Placebo

Mechanisms

Exposure to elite peers decreases overall GPA of low and high SES students

- We-estimate the model, this time with high school GPA as dependent variable

$$GPA_{isc} = \beta_1 P_{-isc} + X'_{isc}\beta_2 + \alpha_s + \rho_c + \epsilon_{isc}$$

	(1) Full sample	(2) Low SES	(3) High SES
Dependent variable:			
Overall GPA	-0.118***	-0.170***	-0.046***
	(0.013)	(0.016)	(0.012)
Number of observations	177,219	58,328	20,018
Mean GPA	4.175	4.005	4.484

Exposure to elite peers decreases overall GPA: Why?

$$\text{GPA} = \underbrace{\text{External written exams}}_{\text{Blind assessments}} + \underbrace{\text{Teacher assessment} + \text{Semi-external oral exams}}_{\text{Non-blind assessments}}$$

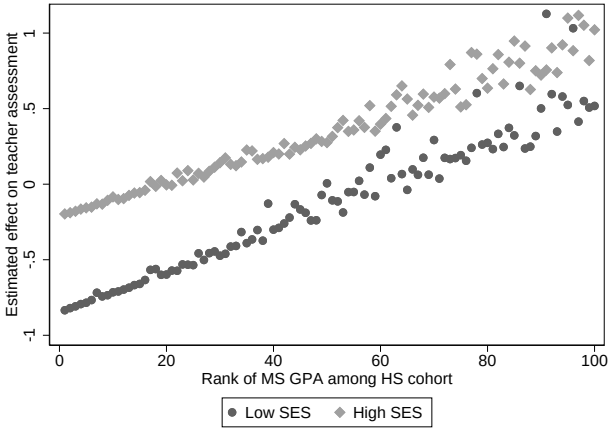
	(1) Full sample	(2) Low SES	(3) High SES
Dependent variable:			
External written exams	0.025***	0.030**	0.030*
	(0.009)	(0.012)	(0.016)
Teacher assessments	-0.110***	-0.162***	-0.040***
	(0.013)	(0.016)	(0.012)
Semi-external oral exams	-0.036***	-0.064***	-0.013
	(0.008)	(0.011)	(0.014)
Number of observations	177,219	58,328	20,018

- Elite peers exposure ↑ written scores: positive learning / effort channel
- But ↓ teacher assessment: teacher bias against other students
- (Officially) teachers do not mark to a curve; instead suggests a bias against other students

Teacher bias is against lower ranked students

We-estimate the model, this time with interacting the peer variable with the student's middle school GPA rank

$$GPA_{isc} = \beta_{11} P_{-isc} + \beta_{12} P_{-isc} * Rank_i + X'_{isc}\beta_2 + \alpha_s + \rho_c + \epsilon_{isc}$$



Mediation analysis

We want to decompose the total effect of elite peers into

- Direct effect from encouragement to apply to elite degrees (conditional on GPA)
- Indirect effect through high school grades & teacher bias

We aim to quantify the elite peer effect conditional on high school GPA:

$$Y_{isc} = \rho_1 P_{-ics} + \rho_2 GPA_{ics} + X'_{ics}\rho_3 + \alpha_s + \rho_c + \epsilon_{ics}$$

GPA_{ics} is endogenous so we instrument it by exploiting unique institutional feature in Norway generating random variation in GPA

- Subject of written exams in 2nd and 3rd years are randomly allocated across students, within schools

IV for High School GPA

Background on Norwegian high school assessments:

- All high school subjects are assessed by a teacher
- In 2nd and 3rd year randomization of the subject of written exams
- Maths is a subject very important for entrance to elite university degrees; if randomly allocated to take a written maths exam low SES students can potentially mitigate the teacher bias from elite parent peers
- Evidence from Denmark that a similar randomization of (semi-external) maths test reduced gender gap in graduation from STEM degrees (Burgess et al 2022)

Proposed IV:

- Random allocation to externally assessed *math* exam in year 2 or 3 of high school
- It strongly drives the GPA of low SES students (relevant)
- It is plausible it only affects the probability to enrol in elite education through its effect on GPA (rank)

▸ Balance

Estimates of the elite peer effect on elite degree enrollment, conditional on GPA

	(1) Low SES OLS	(2) Low SES IV	(3) High SES OLS	(4) High SES IV
A - First stage: high school GPA				
Student took written math exam (IV)		0.031***		0.029**
		(0.008)		(0.013)
F stat		16.23		5.00
Number of pupils	*58,586*	*58,586*	*19,968*	*19,968*

Estimates of the elite peer effect on elite degree enrollment, conditional on GPA

	(1) Low SES OLS	(2) Low SES IV	(3) High SES OLS	(4) High SES IV
B - Second stage outcome: enrollment to elite degree				
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*

Elite peer effects on university application behaviour: aspirations

'Aspiration window' hypothesis (Ray, 2006; Ray and Genicot, 2017)

- If elite degrees are too far from low SES students' current environment, they will not consider these routes as feasible and will not respond to external, supportive influences

We bring suggestive evidence for this hypothesis by exploiting variation in student's neighbourhood rates of social mobility

- Idea: Low SES students living in areas with higher rates of upward mobility may have higher aspirations and be more sensitive to the influence of elite school peers

We re-estimate the benchmark model with a new interaction:

$$Y_{isc} = \lambda_1 P_{-ics} + \lambda_2 P_{-ics} XAreaMobility + X'_{ics}\lambda_4 + \alpha_s + \rho_c + \epsilon_{ics}$$

Area mobility = % of adults working in STEM, Law or Medicine coming from non-professional backgrounds in the municipality

Do elite educated parents raise the aspirations of low SES students?

Dependent variable: Indicator for being enrolled in an elite degree

	(1) Total sample	(2) Low SES sample	(3) High SES sample
Proportion of parents with elite degree (std)	0.022	-0.016	0.026
	(0.019)	(0.016)	(0.059)
Proportion of parents with elite x Area upwards mobility	0.009	0.061**	0.036
	(0.036)	(0.031)	(0.124)
Area upwards mobility	0.029	0.067**	0.015
	(0.024)	(0.031)	(0.092)
Observations	157,090	51,512	17,559

Long run implications for earnings and intergenerational mobility

Long-term effect of elite peers

- Is there a peer effect on long-run earnings?
- Is there a "return" from elite education?
- For our oldest 5 cohorts we measure earnings aged 28-32

Table 1: Dependent variable: Indicator for earnings in the top decile at age 28-32

	(1) Low SES	(2) High SES	(3) Low SES	(4) High SES
Student ever enrolled in degree	0.023***	0.097***		
	(0.005)	(0.020)		
Student ever enrolled in elite degree	0.237***	0.309***		
	(0.008)	(0.021)		
Proportion of parents with elite degree			0.012***	0.039***
			(0.005)	(0.010)
Number of pupils	*27,630*	*9,067*	*27,630*	*9,067*
Number of schools	*471*	*387*	*471*	*387*

Long-term implications for intergenerational mobility

Dependent variable: student in richest decile at 28-32		
Parent in the richest decile (when child was 15-19)		0.064***
		(0.005)
Parent in richest decile x Proportion of parents elite		0.012***
		(0.004)
Proportion of parents with elite degree		0.011***
		(0.003)
Number of pupils	*55,423*	*55,423*
Number of schools	*484*	*484*

- Lower mobility: Intergenerational correlation at top of education distribution increases across presence of elite peers

Conclusion

Conclusion

This paper examines whether increasing low SES students' exposure to elite peers at school can help them become first generation elite and increase intergenerational mobility

We show that:

- Exposure to elite peers can help low SES students become first generation elite
- It does not increase mobility because elite peer effect is stronger for high SES students than for low SES students
- This SES gradient in the elite peer effect is due to learning; teachers response and the fact that low SES students have lower aspirations to begin with

Policy implications

- Higher reliance on blind assessments could mitigate detrimental effects of teacher bias
- Role model/mentoring programs could be beneficial

Additional Statistics

	(1) Low SES		(2) Elite SES		(3) Total	
	Mean	sd	Mean	sd	Mean	sd
University enrolment	0.861	0.346	0.956	0.206	0.904	0.295
Elite degree	0.053	0.224	0.260	0.439	0.102	0.303
Parent % w/elite degree	0.047	0.047	0.100	0.068	0.061	0.056
HS Year	2005.524	2.285	2005.568	2.303	2005.622	2.287
Norwegian born	0.832	0.373	0.852	0.355	0.873	0.333
Female	0.650	0.477	0.527	0.499	0.601	0.490
Mother compulsory ed	0.931	0.253	0.161	0.367	0.516	0.500
Mother HS ed	0.069	0.253	0.144	0.351	0.126	0.332
Mother degree+ ed	0.000	0.000	0.695	0.460	0.358	0.479
Father compulsory ed	0.916	0.277	0.073	0.261	0.578	0.494
Father HS ed	0.084	0.277	0.042	0.200	0.139	0.346
Father degree+ ed	0.000	0.000	0.885	0.319	0.282	0.450
Own MS GPA	0.497	0.639	0.921	0.591	0.676	0.634
Pear mean MS GPA	0.300	0.541	0.613	0.399	0.427	0.496
HS GPA total	4.005	0.611	4.484	0.643	4.175	0.642
HS Teacher assessment	4.099	0.628	4.574	0.647	4.268	0.653
HS Exam	3.293	0.729	3.848	0.804	3.487	0.778
HS Oral	4.227	1.065	4.803	1.004	4.441	1.066
Observations	58610		20018		177219	

Back

Controlling for income and occupation of peers' parents

	Total	Low SES	High SES	Total	Low SES	High SES
% parent w/elite degree	0.023***	0.010***	0.038***	0.028***	0.014***	0.044***
	(0.003)	(0.003)	(0.009)	(0.004)	(0.003)	(0.008)
% parents in top income decile	0.065***	0.074***	0.030			
	(0.022)	(0.018)	(0.080)			
% parents in elite occupations				-0.256	-0.073	-0.516
				(0.159)	(0.183)	(0.468)
Observations	177,219	58,328	20,018	177,219	58,328	20,018

Back

Sensitivity

	Total	Low SES	High SES
a) first born only			
% parent w/elite degree	0.026***	0.014***	0.042***
	(0.003)	(0.003)	(0.008)
b) drop OSLO			
% parent w/elite degree	0.025***	0.013***	0.040***
	(0.004)	(0.003)	(0.009)
c) drop small schools			
% parent w/elite degree	0.026***	0.013***	0.040***
	(0.003)	(0.003)	(0.008)

Back

Checks on the validity of the strategy

	(1) Birth weight	(2) Low birth weight	(3) Gestation	(4) Height	(5) Head cir.	(6) Congenital malf.	(7) Severe deformity
% parents w/elite degree (std)	-3.177	-0.000	-0.011	-0.010	0.004	-0.000	-0.001
	(3.483)	(0.001)	(0.012)	(0.015)	(0.009)	(0.001)	(0.001)
Observations	170,563	177,965	158,302	164,747	168,644	170,832	170,832
Number of high schools	555	557	553	552	554	555	555

Back

Checks on the validity of the strategy

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

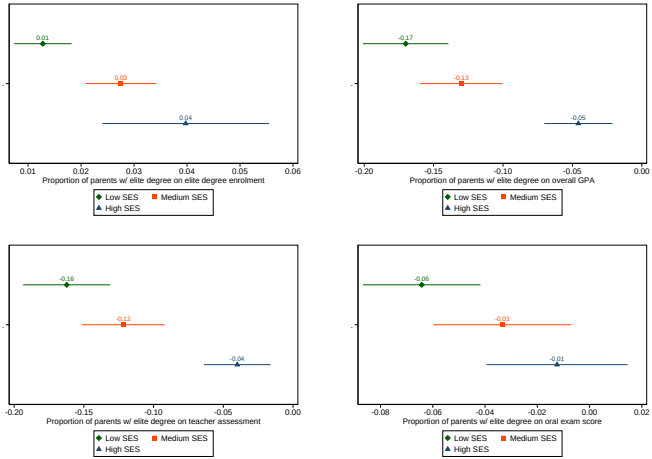
Back

Balance checks on the IV

	(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

Back

Figure 2: 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.

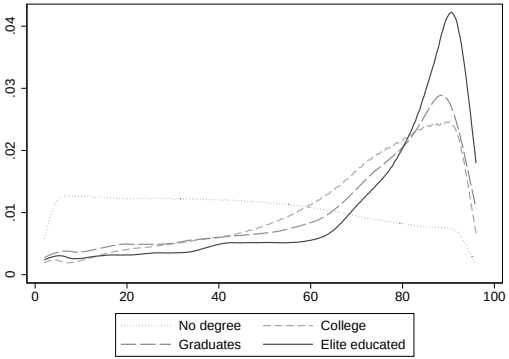
How much do elite peers contribute to the SES gap in elite degree enrollment?

Oaxaca-Binder decomposition of the SES gap in elite degree enrollment

SES gap in enrollment in elite degree		**-0.207*** (0.003)**		
	SES gap in characteristics		**SES gap in coefficients**	
	Gap in average characteristic	**Contribution to gap in enrollment**	**Gap in estimated coefficient**	**Contribution to gap in enrollment**
Proportion of parents with elite degree	-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 parent with an elite degree	-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)	

Back

Figure 3: 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.

Back