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Overeducation and economic mobility☆

Simen Markussen, Maria Nareklishvili, Knut Røed *

The Ragnar Frisch Centre for Economic Research

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ABSTRACT

We assess the hypothesis that declining intergenerational economic mobility in Norway is attributable to a rising signaling value of education accompanied by more overeducation particularly among upper-class offspring. We identify five empirical facts that together point in this direction:

- The educational earnings premium has risen, but only through the extensive (employment) margin.
- The rising earnings premium is associated with completed degrees only. When educational attainment is measured as time actually invested, the premium has declined.
- Both educational attainment and the labor market's skill-requirements (as predicted by the occupational distribution) have increased, but attainment has risen faster than requirements such that the incidence of overeducation has increased.
- There is a steep positive social gradient in overeducation: Overeducation is more frequent and has risen faster among offspring in upper-class families.
- There is a steep negative social gradient in non-employment: Non-employment is more frequent and has risen faster among offspring in lower-class families.

1. Introduction

Over the past decades, educational achievement has become a more important ingredient of economic success. In the US and some other developed countries, this trend has materialized in the form of a rise in the college wage premium (Goldin & Katz, 2008; Fortin et al., 2011; Autor, 2014). In Norway, as we show in the present paper, it has primarily materialized in a rising value of high-school education. Regardless of the way it plays out, a potentially important, but often disregarded consequence of higher returns to education is that it also implies higher "returns" to family background.[1] Empirical evidence has shown that family support and encouragement are vital inputs in the production of educational outcomes and that lower-class families provide less such encouragement and support (Guryan et al., 2008; Kalil et al., 2012; Doepke & Zilibotti, 2019; Mayer et al., 2019; Flood et al., 2022). In particular, it has been documented that economically advantaged parents on average produce more cognitively stimulating home learning environments, and spend more time supporting their children's education. Ceteris paribus, this implies that as educational attainment becomes a more critical ingredient of economic success, the handicap of being born into a less resourceful family increases, and the economic mobility out of the lower classes declines.

In Norway, recent empirical evidence suggests that intergenerational economic mobility has indeed declined, particularly at the bottom of the parental earnings rank distribution (Markussen & Røed, 2020; Hoen et al., 2022). A considerable part of this decline has materialized in the form of larger employment gaps. For example, Markussen and Røed (2020) show that while men born into the lowest parental earnings rank vigintile in 1952 were 9 percentage points less likely to be employed at prime age (34–40) than those born into the highest class, this differential had increased to 19 percentage points for men born in 1975.

The present paper explores the hypothesis that declining bottom

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* Corresponding author.
E-mail addresses: simen.markussen@frisch.uio.no (S. Markussen), maria.nareklishvili@frisch.uio.no (M. Nareklishvili), knut.roed@frisch.uio.no (K. Røed).

[1] There is a related literature studying the intergenerational mobility of education, indicating that the expansion of higher education have disproportionately favored offspring from richer families; see, e.g., Blanden and Machin (2003) and Blanden et al. (2004) for evidence from the UK and Karlson and Landersø (2024) for more recent evidence from Denmark.

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class mobility and rising returns to education are two sides of the same coin and that one of the driving forces is a rising signaling value of education in the competition for low-skill jobs. The suggested mechanism is that rising attainment levels have intensified the competition for jobs with low skill-requirements, such that some people end up in occupations for which they are overqualified whereas others end up in involuntary non-employment. Somewhat simplified, the story could go as follows:

- Educational attainment is regarded by employers as a signal of productivity and reliability. By investing in education, a person not only signals and/or raises own qualifications, but also improves his/her *rank* in the job queue by pushing other potential workers down to a lower rank. This is an externality that may lead to more education than what is optimal from a social viewpoint (Moen, 1999).
- When overall attainment levels rise, each given attainment implies a lower rank than before, and more education may be needed to land a given job. If educational requirements in vacant jobs do not keep pace, this creates a bumping-down effect, whereby more people queue for jobs for which they are overeducated. At the bottom of the job ladder, this implies that persons without any educational credentials at all lose out in the competition for the limited number of low-skill jobs for which they are qualified.
- In this signaling game, offspring from lower class families have a disadvantage because it is more costly for them to obtain the required educational signal. Hence, lower class offspring will to an increasing extent be pushed out of the labor market.

To empirically assess the hypothesis that intergenerational mobility has been held back by overeducation and socially inefficient rank competition, we examine the distribution of educational attainment and the associated earnings premiums within and across narrowly defined occupations for all people born in Norway from 1973 through 1992.

The analysis is based on labor market status observed at age 30, with all educational activities and degrees measured up to that age. To identify the minimum educational requirements in each occupation, we use as our preferred definition the lowest attainment level needed to account for at least 30 % of newly hired workers. Overeducation then takes the form of higher (or more) education than what is required in the occupation. Interpreted this way, overeducation is not necessarily wasted education, and it may (or may not) contribute to raise within-occupation productivity.

In the descriptive part of our paper, we show that both actual attainment, required education, and overeducation have increased over the two decades covered by our data. The fraction of employees that are overeducated by age 30 (as defined by their highest completed degree) has risen from 34 to 40 percent. Notably, the level as well as the rise in overeducation are strongly and positively associated with parental earnings rank, confirming that the effort cost of education is higher for offspring with a disadvantaged family background. We also show that the offspring from the lower parental earnings ranks have fallen more and more behind in terms of own adult earnings rank and employment, but that the relative decline of the lower classes is much less pronounced when we condition on own educational attainment. The trends in the class-structure of education, overeducation and early labor market outcomes are thus consistent with a bumping-down story whereby overeducated offspring from the middle and upper classes outrank less educated people from the lower classes in the competition for a declining number of low-skill jobs.

To assess the role of signaling in this process, we examine the empirical association between educational attainment and annual earnings separately for each birth cohort. In our baseline specification, we use family fixed effects to account for selectivity, but in the appendix we present a number of robustness analyses where we add controls for GPA from junior high-school and (for boys) IQ test scores.[2] In the pure signaling story (Spence, 1973) education is important to get a job, but not so much to do a job. Moreover, there is an extra return to graduation over and above the time and effort actually invested in education. This is sometimes referred to as the sheepskin effect, and interpreted as the signaling value of education. If the returns to education are primarily driven by its productivity-enhancing effects (Becker, 1964), we expect them to be reflected in earnings also conditioned on employment and occupation, and to arise from educational attainment whether or not it leads to a higher degree.

Our analysis of the returns to education decomposes the premium into three factors; i) the probability of becoming employed, ii) the choice of occupation, and iii) individual earnings within occupation. Overall, we estimate that the earnings premium associated with one extra year of successfully completed education (confirmed by graduation) has increased from around 7 % of average earnings for the 1973 cohort to 8 % for those born in 1992.[3] Notably, this increase is fully accounted for by the extensive margin, i.e.; a rising influence of educational attainment on the probability of becoming employed at all. Education has neither become more important for obtaining a better paid occupation nor for individual pay within occupation. For the most recent cohort in our data, roughly 60 % of the premium is driven by the extensive employment margin, whereas approximately 30 % is driven by occupational choice, and the remaining 10 % is caused by a within-occupation earnings premium.

To examine the role of a sheepskin effect, we also estimate education premiums as functions of the number of years actually spent in education, without conditioning on successful completion. The overall estimated earnings premium then drops by approximately 60–70 % and the within-occupation premium becomes negative. The rise in the premium over time almost disappears. Hence, the sheepskin effect appears to be considerable and also to be a main force behind the recent rise in the premium. It is notable that the returns to time spent in education is largest at the bottom of the parental earnings rank distribution. This suggests that sorting into education based on expected returns is more prominent in the lower than in the upper classes, most likely because educational decisions to a lesser extent are dictated by parental expectations.

To further examine trends in the wage premiums conditional on employment, we estimate both Mincer-type log-earnings equations, where the explanatory variables of interest are alternative definitions of educational attainment, and Duncan-Hoffman-style regressions where the explanatory education variables are expressed in terms of required education, overeducation, and undereducation. Our results confirm that the returns to completed degrees have been stable, both across and within occupations, and that the returns to time actually spent studying have declined.

Although our data does not enable us to decompose the rising return to education into contributions from signaling and productivity, respectively, there are at least two observation that point toward signaling as an important contributor. The first is that whereas the returns to completed degrees have increased, the returns to time spent in education have remained flat or declined. The second is that the

[2] These data are not available for all cohorts and are therefore not used in the main part of the analysis.

[3] We relate the estimated earnings premium to average earnings in the economy, rather than to individual earnings, as the inclusion of the extensive employment margin implies that many people have zero (or very low) earnings such that an effect measured relative to own earnings has no meaning. In the subsequent analysis of wage premiums for the employed, we return to a more standard analysis of effects relative to own wage built on a log(earnings) specification.

observed increase in returns is exclusively captured by the extensive employment margin. Conditional on being employed, we see no sign of increasing returns, except in the small segment of high-skill jobs (and even there, there is no increase in the returns to time spent in education).

Our paper contributes to several literatures. First, there is a large existing literature about overeducation addressing both its prevalence and its earnings consequences, primarily from a descriptive viewpoint; see, e.g., Groot and Van den Brink (2000), McGuinness (2006) and Leuven and Oosterbeek (2011) for surveys.[4] We contribute to this literature by introducing the class (family background) perspective and by suggesting a novel strategy for identifying the required education for each occupation based on the lowest attainment level needed to account for a specific fraction newly hired workers. Common ways of defining overeducation build on taking the modal or average attainment level within occupations as indicators of required education. For typical low-skill occupations, these strategies become awkward as the overall rise in educational attainment in the population almost by construction imply a rise in estimated requirements. In particular, in today's mass-education environment, no (or very few) occupations will have "no post-compulsory education" as the modal attainment level.

Second, our paper contributes more broadly to the returns-to-education literature. Whereas most of the existing literature is preoccupied with identifying the returns to education conditional on employment, we show that the premium operating through the extensive employment margin is of paramount importance. Moreover, in addition to measuring education in terms of normed years associated with the highest completed degree, as is common in the literature, we use information about additional credits obtained (without raising the "highest obtained") and about total time actually spent in education. From an individual investment perspective, it is arguably the returns to time spent in own education (without conditioning on a successful outcome) that is the relevant metric to consider. Our results indicate that the difference between economic rewards to educational degrees and to the time actually invested is large.

Third, our findings may call for a reinterpretation of parts of the empirical literature on the signaling role of education. Attempts to disentangle signaling from human capital formation often builds on an analysis of how wages evolve with tenure (or work experience), as the relative influence of a signal should decline as the employer discovers the employees' true productivity; see, e.g., Farber and Gibbons (1996), Altonji and Pierret (2001), Lange (2007), and Aryal et al. (2022). However, when disentangling private and social returns to education based on this idea, it is a tacit presumption that education does not noticeably affect the probability of becoming employed in the first place. In the present paper, we show that enhancing employability is an important part of the returns to education for many individuals, and that the educational system to an increasing extent has become the de facto "gatekeeper" of the labor market. Ignoring this role of educational credentials may lead to an incomplete understanding of the private and social returns to education. Another implicit assumption behind the wage-by-tenure regression approach is that wages are ultimately determined by fully informed employers, such that they gravitate toward marginal productivity over time. However, at least in a Norwegian context, wages are in practice determined through a (partly centralized) bargaining process whereby educational credentials as well as tenure play important roles far beyond their influence on individual productivity.

This paper proceeds as follows: In the next section, we describe our data and the way we define required education, overeducation, and class background. Section 3 provides a descriptive overview of trends in education, overeducation and labor market outcomes by class background. Section 4 offers a decomposition of the educational earnings premium and its trend into the different margins of employment, occupation, and within-occupation earnings. It proceeds by examining earnings differentials conditional on employment within the framework of Mincer and Duncan-Hoffman style regressions. Finally, Section 5 concludes.

2. Data and definitions

We use encrypted administrative population data from Norway, which from 2003 provide occupational status for all employees in Norway based on the International Standard Classification of Occupations (ISCO). We identify 339 different occupations in Norway. The occupation data are merged at the worker-level with educational registers that provide information about educational attainment in a sufficiently consistent fashion for all cohorts born from 1970 and onwards. To ensure comparability over time, we focus on labor market outcomes measured at a particular age. Given that occupations are identified from 2003 through 2022, we have reliable and comparable data on both occupation and education for all persons born between 1973 and 1992 when measured at age 30.

Below, we describe how we use the different data sources and how we define the concepts of required education and overeducation.

2.1. Institutional setting and representation of educational attainment

We divide the level of individual educational attainment into four main categories based on the highest completed degree (CD):

i) Only compulsory education (first digit in the International Standard Classification of Education (ISCED 2011) equal to 0, 1, or 2), normed to 0 non-compulsory education years (NCEY) in our analysis,
ii) High-school level (ISCED 2011 equal to 3), normed to 3 non-compulsory years,
iii) College/University at Bachelor's level (ISCED 2011 equal to 4, 5, or 6), normed to 6 non-compulsory years, and
iv) College/University at Master's level or higher (ISCED 2011 equal to 7 or 8), normed to 8 non-compulsory years.

Since 1994, high-school education has been a legal entitlement in Norway (fully affecting cohorts born after 1977), and it is divided into an academic and a vocational track. Over the period covered by our analysis, the high-school completion rate has increased gradually, from approximately 76 % for the 1973-cohort to 82 % for the 1992-cohort.

In Norway, education is offered free of charge at all levels. Admission to college and university education is competitive and mainly (but not exclusively) based on grades from high-school.

In addition to the highest completed degree, many individuals have taken courses that have not lead to a higher attainment level. For example, a person with only compulsory education may have taken courses at the high-school level, but without completing a valid high-school degree. A person with a Bachelor's degree may have taken courses at the master level, but without completing a Master's degree. Some students also take more than one degree at the same level. We will characterize each person's highest completed education in terms of the four categories listed above, sometimes recoded into the number of normed non-compulsory education years (NCEY). Educational attainment that has not lead to a higher completed education level, yet still added educational credit points, will similarly be measured in terms of normed years. Finally, we will characterize each person in terms of the total number of semesters registered in non-compulsory education (measured in years). Hence, we have three measures for each person's number of non-compulsory education years:

[4] There is also a literature focusing on the influence of overeducation on job satisfaction, health problems, and premature labor market exit, which we do not discuss here; see, e.g., Vieira (2005), Garcy (2015), and Bender and Heywood (2017).

i) Highest completed degree (CD): Normed number of years associated with the highest completed degree
ii) Total credits (TC): Normed number of years associated with all registered credit points
iii) Time spent (TS): Actual number of years registered in non-compulsory education

We then have (by construction) that $TC \geq CD$ and typically (but not always) that $TS \geq TC$. Approximately 35 % of the persons covered by our analysis have at some stage been enrolled in courses at higher levels than what was registered as their highest completed degree at age 30. In particular, this is the case for the vast majority of those who ended up without any non-compulsory degree at all (NCEY=0). After the introduction of high-school as a legal entitlement (covering cohorts born after 1977), as much as 95 % of those without any non-compulsory degree had at least made some attempt at obtaining a high-school degree before dropping out.

2.2. Identification of required education in each occupation

To establish the level of required education in each occupation, we use data for all Norwegian employees aged 30–33 in 2003 (the first year of sufficiently complete occupational data). We focus on younger workers in this context as they have been exposed to the same educational system as subsequent cohorts, and also have been hired relatively recently and thus presumably offer an updated picture of the hiring requirements in each occupation. We then define the required education in an occupation as the lowest degree needed to account for at least 30 % of these newly hired workers. A low-skill occupation is thus an occupation where at least 30 % of the young workers do not have any completed degree beyond compulsory education, whereas a medium-low-skill occupation is an occupation where at least 30 % of the workers have maximum high-school education. We prefer this definition over the more commonly used definitions based on the mode or the mean education, as it more directly focuses on the level of attainment that seems to be sufficient.[5]

Based on the highest completed degree (CD), we characterize occupations as follows:

i) Low-skill occupations: No non-compulsory education required (104 occupations, comprising 31 % of the age 30–33 workers in 2003)
ii) Medium-low-skill occupations: High-school level required (137 different occupations, comprising 36 % of the age 30–33 workers in 2003)
iii) Medium-high-skill occupations: Bachelor's level required (72 different occupations, comprising 29 % of the age 30–33 workers in 2003)
iv) High-skill occupations: Master's level required (23 occupations, comprising 4 % of the age 30–33 workers in 2003)

The choice of the 30 % threshold is a bit arbitrary; hence, it has been guided by a discretionary assessment of plausibility to ensure that the resultant division accords with common sense. In the Appendix Table A1, we show the 10 most common occupations within each category. In the low-skill category, for example, we find occupations such as salespersons (retail), stock clerks, cleaners, waiters, childcare workers (assistants), and truck drivers. In the high-skill category, we find occupations such as medical doctors, college/university teachers, lawyers, architects and engineers.

We have chosen to make the skill-requirement definitions time-invariant. We realize that this may not be valid for all occupations, as technological progress may have changed the requirements. However, based on a closer inspection of the occupations placed in each skill-category, it arguably seems to be appropriate for low-skill and medium-low-skill occupations, and these are the occupations that will play the leading roles in the analysis of overeducation. Had we instead used the 30 % cutoff (or the mode) as a time-varying threshold, we would have introduced some rather spurious fluctuations in the measured degree of overeducation as some occupations close to the threshold shift from being just above or just below from year to year.

Fig. 1 shows the distribution of completed degrees within each occupation category for the 1970–73 birth-cohorts. For comparison, we also show the distribution of attainment for the non-employed and the self-employed. In low-skill occupations, we note that approximately 44 % of the workers are without any completed non-compulsory degree. Approximately 41 % have completed high-school, 13 % have a Bachelor's degree, and 2 % have a Master's degree. We thus infer that 56 % of the young employees in low-skill occupations have higher educational attainment than what is required. In that sense, they are "overeducated". Based on the same logic, we note that 33 % of the employees in medium-low-skill occupations and 15 % of the employees in medium-high-skill occupations are overeducated. We emphasize that overeducation as defined here is not necessarily wasted education, in the sense that it does not improve productivity and/or individual wages. That will vary across occupations and workers, and we return to the earnings-effects of overeducation later in this paper. Overeducation is in many cases also a temporary state. Approximately 19 % of the overeducated age 30-workers in 2003 found a better job within two years.

2.3. Class background

To establish class background in terms of parental earnings rank, we use data for mother's and father's labor market earnings from their age 47 to age 53, inflated to a common year value based on a national wage index tied to the Basic Amount (BA).[6] This gives us up to 14 annual earnings observations – seven for the father and seven for the mother. We then choose the highest three of the available earnings observations for each parent pair, and use them to rank the parental background of offspring belonging to each birth cohort into 10 equally sized bins (deciles). Markussen and Røed (2020) show that earnings obtained in the mid 50′s are most highly correlated with lifetime earnings. When we measure parents a few year younger than that it is to make the sample as balanced as possible over time, as very young parents are not yet observed in their late fifties at the end of our data window. By using the three best earnings years to rank the parents we arguably obtain an earnings rank measure that comes close to characterizing human capital resources and permanent income potential, without being dominated by differences in the timing of labor market entry or breaks due to, e.g., parental leave; see Markussen and Røed (2023) for a more thorough discussion. For parents born after 1969 we do not have earnings data for the whole age 47–53 interval (as our earnings data ends in 2022), and in these cases we include the required number of earnings observations at lower ages instead.

We use the parental earnings rank to divide offspring into five social/economic classes:

i) The bottom class (first decile in the parental earnings rank distribution),
ii) The lower class (decile 2–3)
iii) The middle class (decile 4–7)

[5] As we return to below, we present in the appendix some results based on two alternative definitions of required education; one where we use the modal education among newly hired workers, and one where we build on requirements specified in the US database O*NET.

[6] The Basic Amount is a part of the Norwegian Pension system, and it is adjusted each year approximately in line with the average wage growth. In 2023, the BA was equal to NOK 118 620.

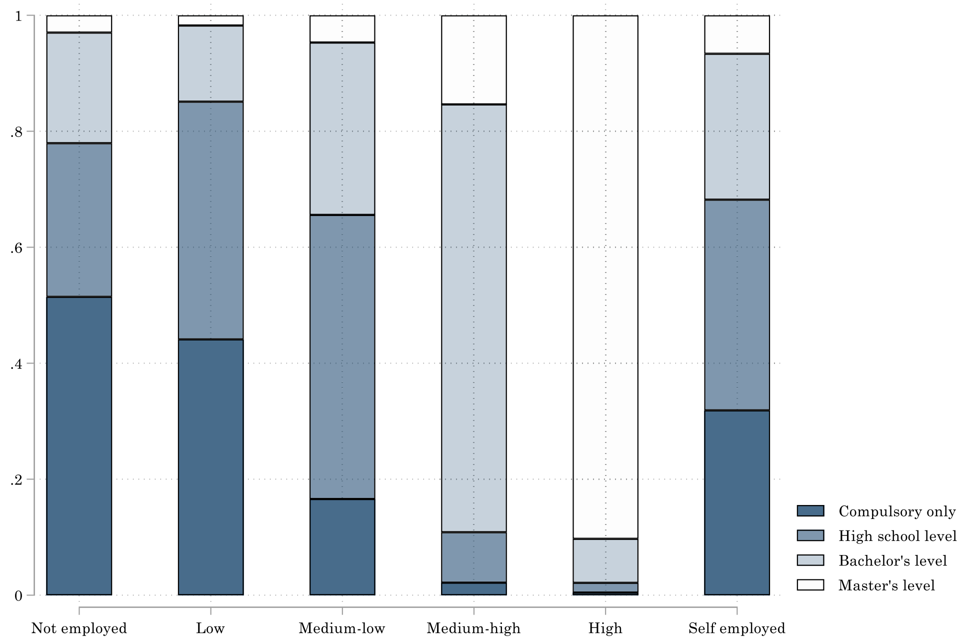

Fig. 1. The distribution of completed educational attainment in occupations with different skill requirements
Note: Data based on all residents in Norway born 1970–73. Employment status refers to 2003. Persons with annual earnings below 1 "Basic Amount" (BA) (NOK 118 620 in 2023) are considered non-employed. Persons with earnings above 1 BA, but no registered employer/occupation are considered self-employed. The number of observation is 250,162. 77.3 % of the sample are in regular employment, 14.3 % are non-employed and 8.4 % are self-employed.

iv) The upper class (decile 8–9)
v) The top class (decile 10)

Although the resultant classes are based on parental earnings, they will obviously reflect everything that is correlated with these earnings, such as the parents' human capital, their social status, peer characteristics, and networks.

2.4. Human capital

For men, we add data on cognitive ability test score obtained at enrolment to military service (around age 18/19). For both men and women, we also add data on grade-point averages (GPA) from lower secondary school (obtained at age 15/16). These data are not available for people born before 1986, however; hence we can only use these data for more recent cohorts. GPA is a composite of grades obtained in all subjects at the final year of compulsory school, some graded by the teacher and some by external examiners.

In the paper's regression analyses, we use family fixed effects as a proxies for socially and genetically inherited human capital characteristics.

3. Trends in education and overeducation and in the social gradient of labor market outcomes

In this section, we describe trends in educational attainment, overeducation, and labor market outcomes with a focus on the role of social/economic class background. The description is based on the complete population born from 1973 through 1992, provided that at least one parent can be identified in administrative registers and that the persons in question are still alive and residents in Norway at age 30. Employment, occupation, and educational attainment are recorded at age 30.

3.1. Educational attainment and educational requirements

Fig. 2 shows how the distribution of highest completed educational degree has changed over the 1973–92 birth cohorts, together with the distribution of skill-requirements for the jobs held by employees in the same cohorts. Focusing first on the distribution of attainment, we note that the fractions with only compulsory or high-school education have declined, whereas the fractions with Bachelor's or Master' degrees have increased. The fraction of jobs with no or low educational requirements have also declined, although it exceeds the fraction of workers with no or low education throughout the period. The fraction of jobs requiring at least a Bachelor's degree have become much more widespread, whereas the attainment of higher education has shifted from Bachelor's to Master's levels.

It seems clear that the rise in educational attainment is larger than the rise in educational requirements that can be attributed to changes in the composition of occupations. This point is further illustrated in Fig. 3, where we show how the mean (normed) number of completed-degree-years have changed among employees together with the changes that can be explained entirely by shifts in the occupational structure (i.e., with the composition of education within each occupation exactly as for the 1973-cohort). The rise in attainment levels has been much larger than predicted from changes in the occupational composition only. Hence, as illustrated by the shaded area, educational attainment has increased considerably also within narrowly defined occupations.

Fig. 4, panel A, shows trends in educational attainment for the complete birth cohorts, measured in terms of highest completed degree (CD), total credits obtained (TC) and time spent (TS) up to age 30. All the metrics display an upwards trend. On average (over the whole period) persons have reached a degree normally requiring 4.1 non-compulsory years of education, and in addition completed approximately 0.8 years of education that do not contribute to a higher degree. To achieve this education, the average person has spent 6.4 years. In Online Appendix Fig. A1, we show trends in educational attainment (panel A in Fig. 4) separately for men and women. Women take more education than men, and the rise has also been steeper for them, in terms of degrees as well as in terms of total credits and time spent.

The remaining panels of Fig. 4 show trends in educational attainment

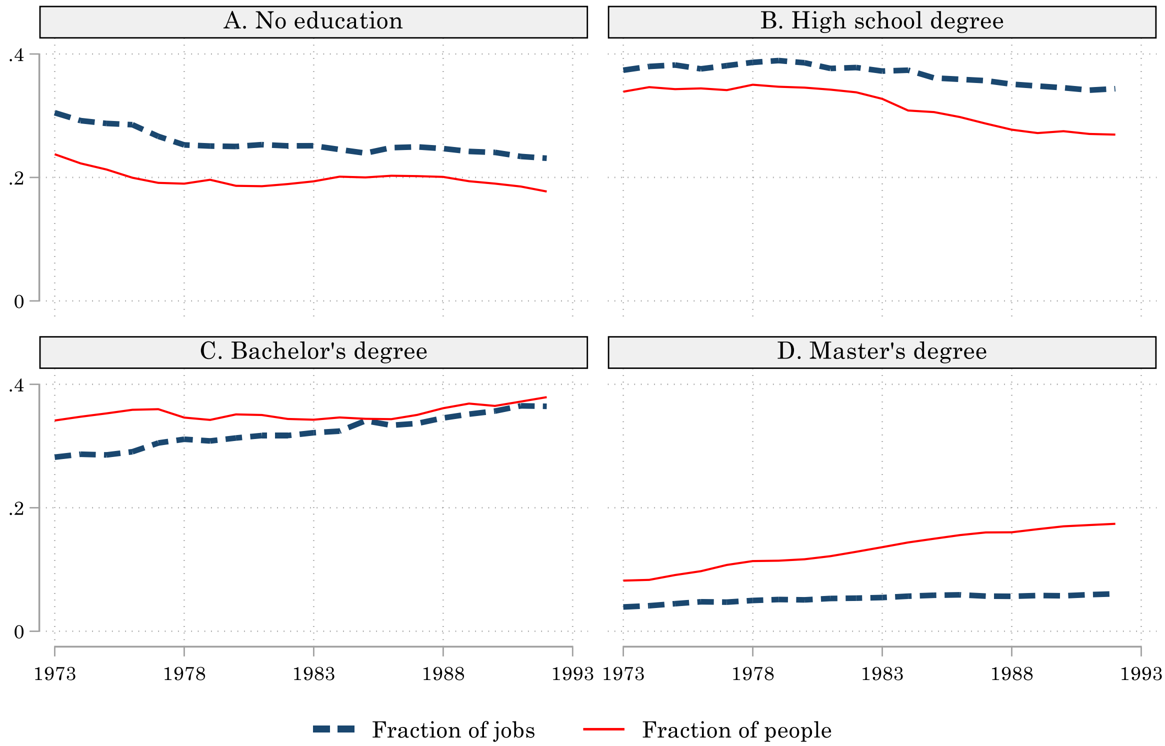

Fig. 2. Highest completed degree and the distribution of educational job requirements by age 30. By birth year.
Note: Job requirements are measured for all employees in our data at age 30, and the "'fraction of jobs" lines show the fraction of jobs requiring no particular education (panel A), at least a high-school degree (panel B), at least a Bachelor's degree (panel C), and at least a Master's degree (panel D). The "Fraction of people" lines show the fractions of the complete birth cohorts (including non-employed and self-employed) holding the corresponding attainment levels (highest completed degree).

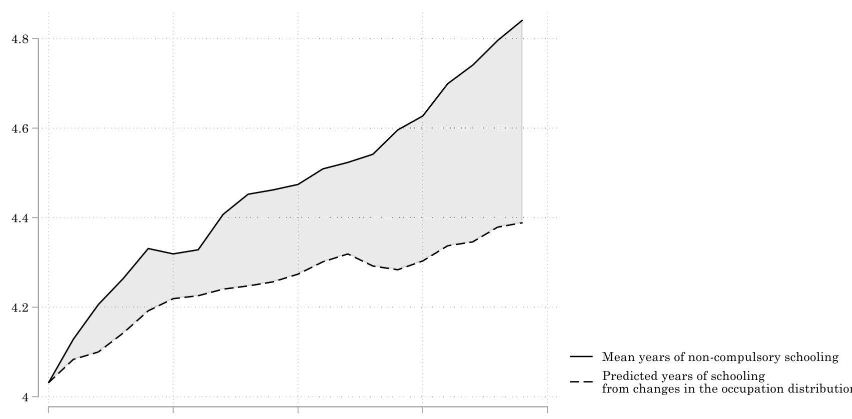

Fig. 3. Mean years of highest completed degree among persons employed at age 30 and predictions based on changes in occupational distribution only. By birth year.
ote: The solid lines describe the average number of normed non-compulsory education years (completed degrees) for all employees aged 30, by birth year. The dashed lines show what these numbers would have looked like if the distribution of educations within each occupation had been the same as it was for the 1973-cohort.

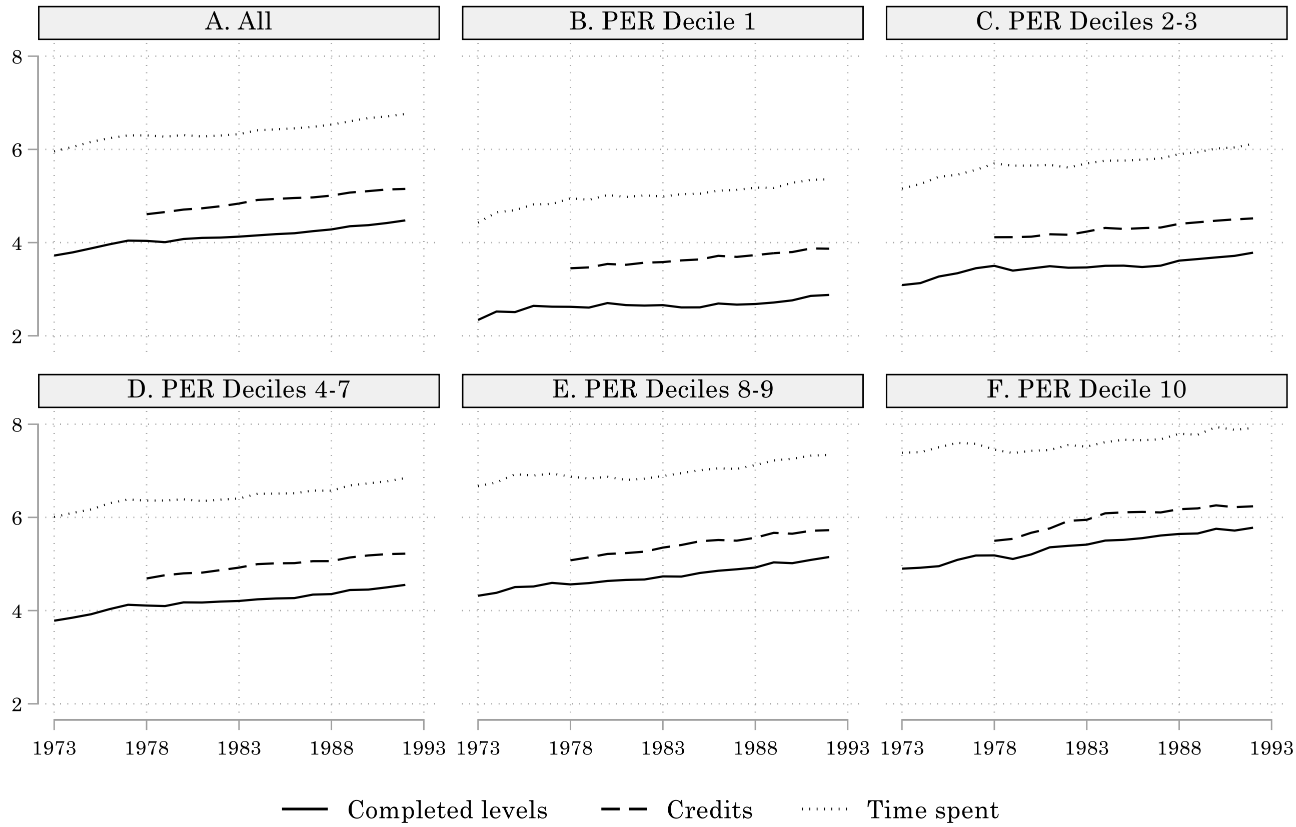

Fig. 4. Years of education by age 30 by birth year and parental earnings rank.
Note: Educational attainment and activities are measured up to age 30. See Section 2.1 for the definitions of education and Section 2.3 for the identification of parental earnings rank.

by class background. There is a remarkable social gradient in educational achievements as well as in time spent in education. And with rising attainment, the social gradient has become steeper.[7]

3.2. Overeducation

Fig. 5 displays the incidence by age 30 of two measures of overeducation, based on highest completed degree (CD) and total credits (TC), respectively. Using CD, the fraction of overeducated employees has increased by approximately 6 percentage points, from 35 to 41 %.[8] Taking additional credits into account, the levels of overeducation are much higher, and have also risen considerably more. There is a remarkable social gradient in the incidence of overeducation, and it has become steeper over time. Whereas the incidence of CD-measured overeducation has remained relatively stable at 30–32 % in the bottom parental earnings class, it has increased from 40 to 50 % in the top class.

Similar pictures emerge when we look at the *degree* of overeducation, measured as the average difference between attained and required education years; see Fig. 6. A possible interpretation of the class gradient in overeducation is that educational ability and family encouragement/support are positively correlated with class background, such that it is less costly for offspring from upper classes to obtain higher education. In response to the rising private returns to educational attainment, this comparative advantage has become more important. However, as educational attainment has risen faster than educational requirements, jobs that do not require higher education have to an increasing extent been filled by overeducated persons from the middle and upper classes who has out-conquered qualified, but less educated, persons from the lower classes.

Appendix Figs. A2 and A3 show versions of Figs. 5 and 6 where we have used the modal education in each occupation to define occupational requirements. The fractions as well as the level of overeducation then become considerably smaller, whereas the trends and class structure remain more or less the same. Appendix Figs. A4 and A5 show versions where we have used an occupational crosswalk from the US database of occupation requirements and worker attributes O*NET to define minimum requirements. In this case, we are unable to match 82 out of the 339 occupations, but for the occupations that we are able to match and characterize, we obtain a very similar pattern of overeducation as we obtained for our preferred definition, both for levels, time trends, and class structure.

Based on our preferred definition of educational requirements, Appendix Figs. A6 and A7 show trends in overeducation for men and women separately. Using completed degrees as the point of reference, overeducation is a bit more frequent among men than women, whereas women are more overeducated according to total credits. The trends are similar for men and women, however.

[7] Although not shown here, there is also a strong social gradient in the orientation of the chosen high-school education. Whereas the vocational and academic tracks are equally popular among bottom class offspring, the academic track outnumbers the vocational track by a factor of five in the top class. There has also been a rise over time in the fraction of high-school graduates who has chosen the academic track, and this rise has been larger the more advantaged is the family background.

[8] These numbers are a bit higher than self-reported instances of overqualification. According to a survey made by FINN (2019), 31% of Norwegian age 18-29 workers and 24% of age 30-39 workers consider themselves as overqualified for their current job.

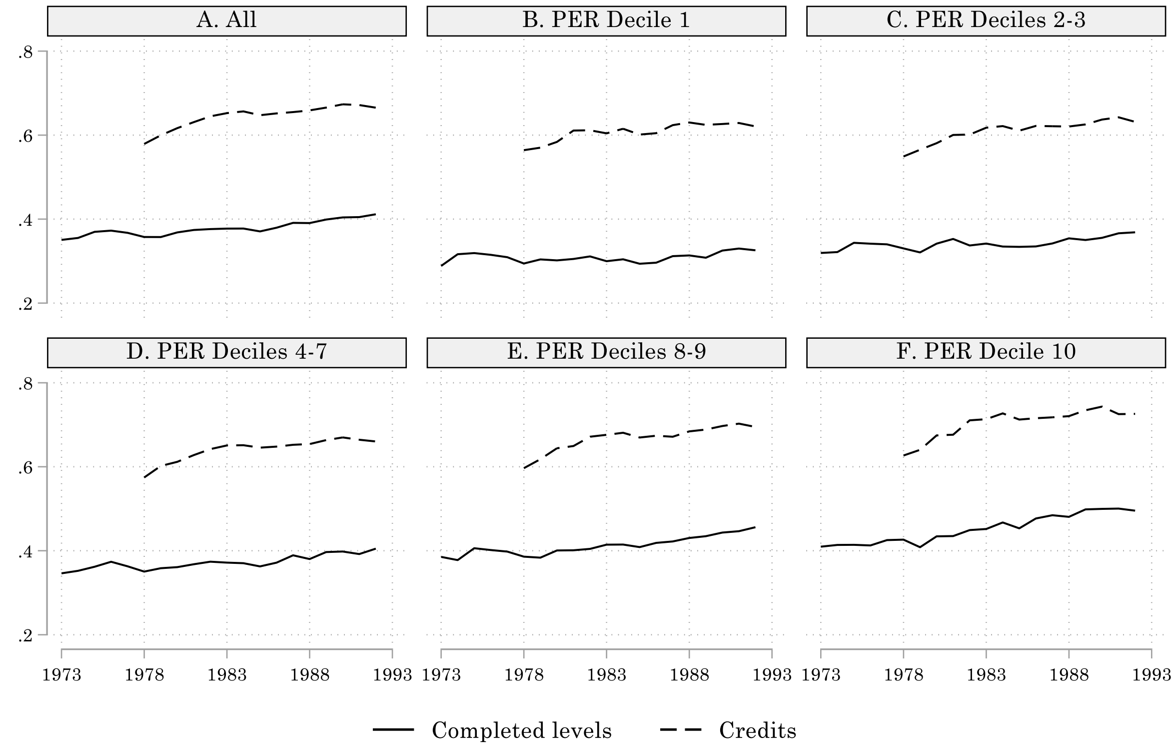

Fig. 5. Fraction overeducated at age 30 by birth year and parental earnings rank.
Note: The data cover people employed at age 30. See Section 2.1 for the definitions of education, Section 2.2 for the definition of required education, and Section 2.3 for the identification of parental earnings rank.

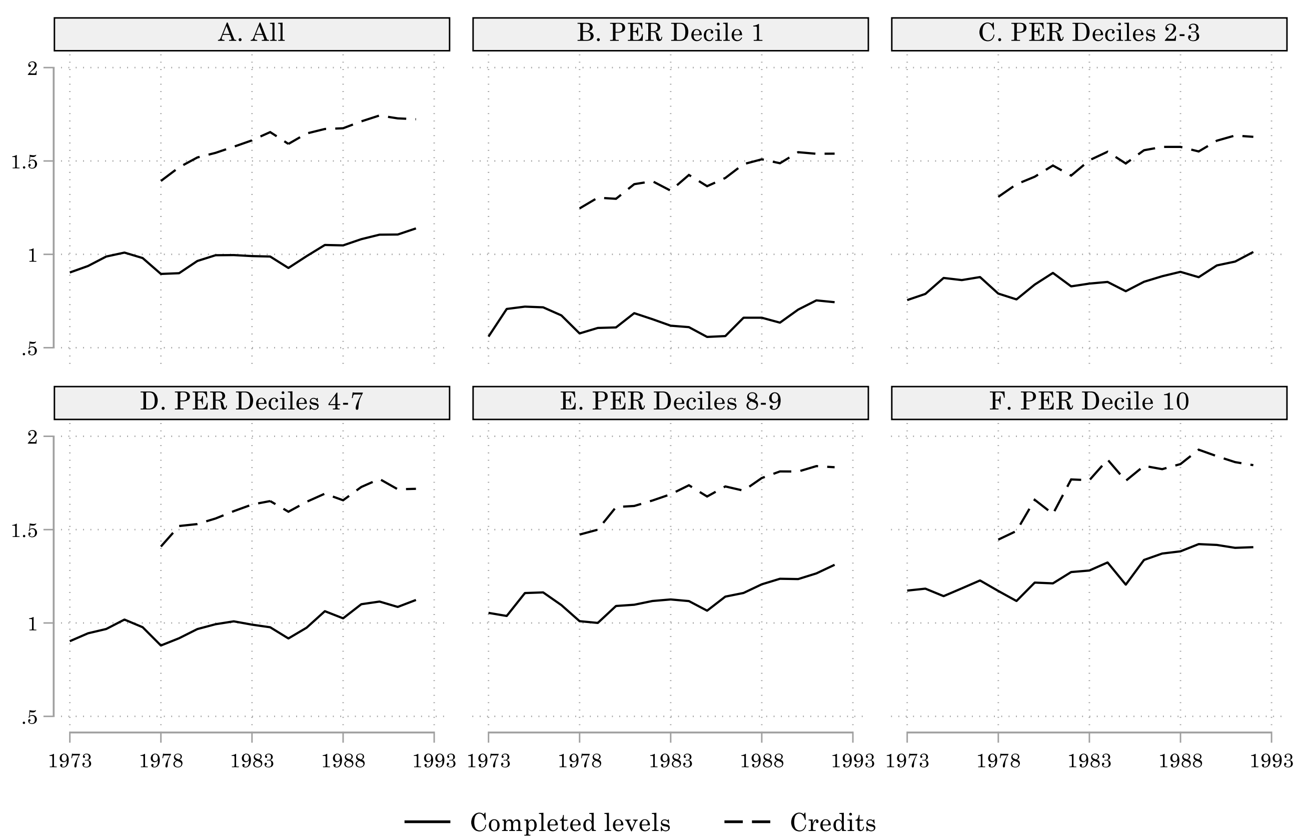

Fig. 6. Average years of overeducation (degree/credits obtained minus required in occupation) among employees at age 30 by birth year and parental earnings rank.
Note: The data cover people employed at age 30. See Section 2.1 for the definitions of education, Section 2.2 for the definition of required education, and Section 2.3 for the identification of parental earnings rank.

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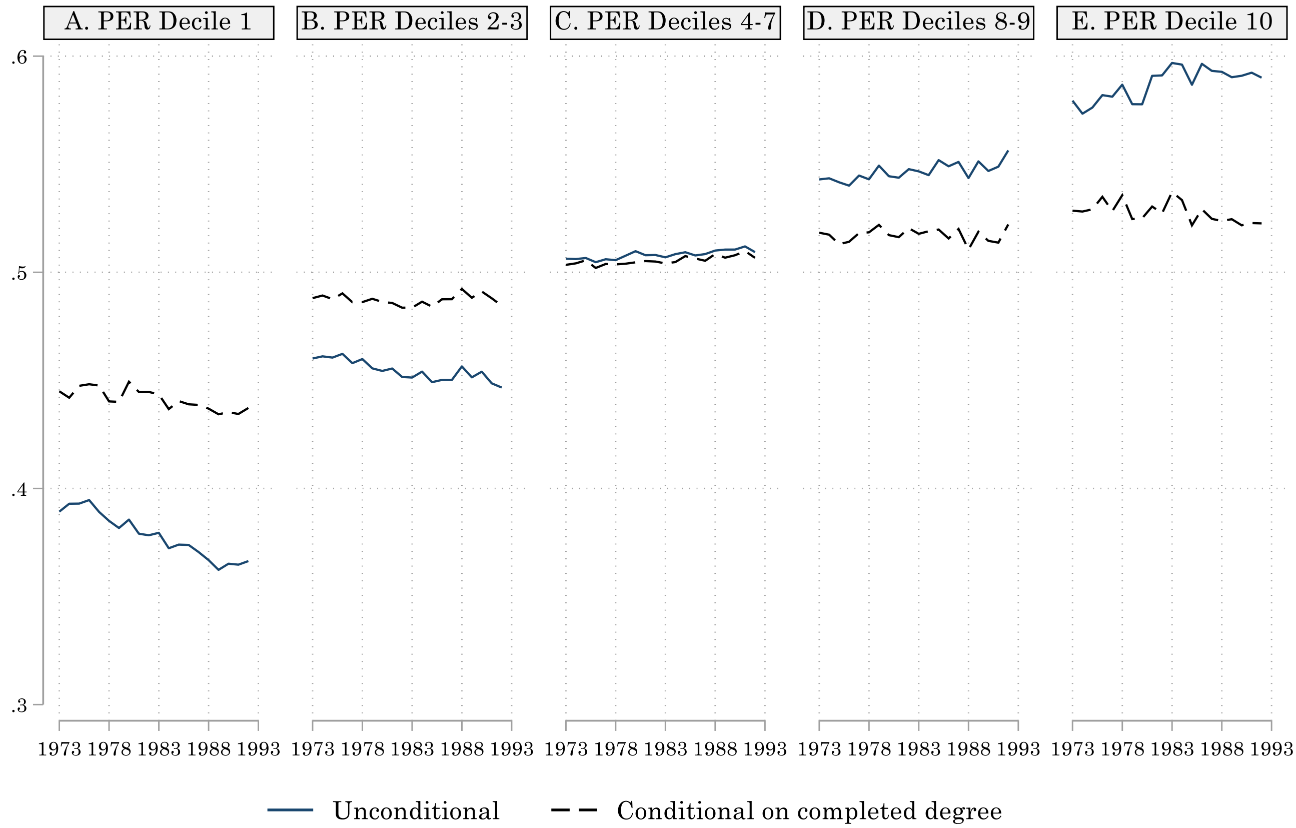

Fig. 7. Offspring's' earnings rank at age 30 by parental earnings rank (PER). By birth year.
Note: Rank outcomes are measured on a uniform [0,1] scale. The conditional series are constructed by first regressing, separately for each birth cohort, own age-30-earnings on the four categories of completed degrees, and then using the residuals to form ranks on a uniform [0,1] scale.

3.3. The social gradient of earnings and employment

The steepening of the social gradients in education and over-education has been accompanied by a steepening of the social gradients in labor market outcomes. Fig. 7 shows how the offspring's own adult earnings ranks have developed by their parents' rank, with and without conditioning on own educational attainment (completed degree). Looking first at the unconditional earnings rank outcomes, it is clear that the bottom and lower classes have fallen consistently behind over time, whereas the upper and top classes have improved their ranks. Hence, intergenerational earnings rank-rank mobility has dropped considerably over the 20 birth cohorts studied here. For example, the difference in expected earnings rank between the top and the bottom classes have increased by approximately 5 percentiles, from 18 (57−39) for the 1973 cohort to 23 (59−36) for the 1992 cohort. Conditioning on own attainment clearly reduces the gap between the different classes, suggesting that own attainment is an important mediator of intergenerational earnings persistence. More importantly in the present context: Conditioning on own attainment eliminates much of the decline in rank-rank mobility. Education has thus become a *more important* mediator of intergenerational rank-rank persistence.

Fig. 8 displays the corresponding patterns of class-specific employment rates. The employment rates of people born into the bottom and lower classes have declined, whereas the employment rates of the upper and top classes have increased. For the bottom class, the employment propensity has dropped by as much as 5 percentage points relative to the cohort average. Considering Fig. 7 and Fig. 8 together, it appears that the rising differences in class-specific earnings ranks is an artefact of rising differences in employment propensities.

4. Trends in the individual educational earnings premium

In this section, we evaluate the earnings premium associated with alternative definitions of educational attainment. In order to include as recent cohorts as possible in our analysis, we measure earnings and wage outcomes as early as age 30, which most likely is a bit too early in order to properly assess the effects on lifetime (permanent) income or on the internal rate of return to educational investments; see, e.g., Bhuller et al. (2017). A primary purpose of our analysis is to disentangle the educational earnings premium into its three separate channels of employment propensity, choice of occupation, and earnings within occupation. In addition, we aim at assessing the influence of the alternative measures of education, such as the highest completed versus the time spent, and, conditional on occupation, required education versus over- or undereducation.

4.1. The educational earnings premium and its sources

We first evaluate the earnings premium in terms of overall annual earnings obtained at age 30. To identify the three separate channels of employment propensity, choice of occupation, and earnings level within occupation, we estimate three linear regressions, with educational attainment (or time spent in education) as the key explanatory variables.

As before, we define employment as having annual earnings above 1 "Basic Amount" (BA). Let $\overline{y}_t^e$ be the average annual earnings level among all employees (and self-employed) belonging to birth-cohort t, let $\overline{y}_t^n$ be the average earnings of the non-employed (close to zero), and let $\overline{y}_{it}$ be a dichotomous variable equal to $\overline{y}_t^e$ for all employees and $\overline{y}_t^n$ for the non-employed. Furthermore, let $\overline{y}_{iot}$ be the average earnings level in individual *i's* occupation *o* ($\overline{y}_t^n$ for the non-employed), and let y_{it} be individual *i's* own earnings level (zero or close to zero for the non-

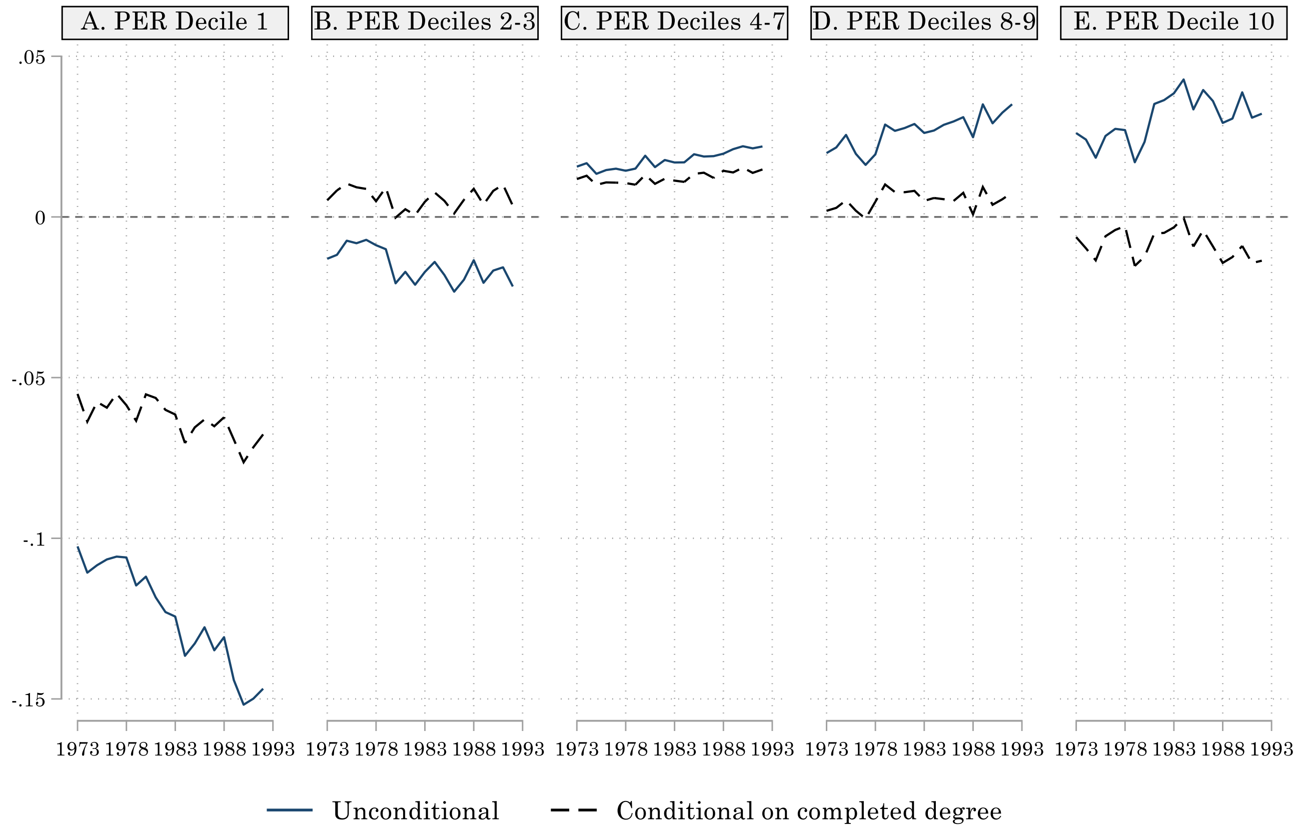

Fig. 8. Offspring's employment status at age 30 by parental earnings rank (PER). Deviation from cohort mean. By birth year.
Note: The conditional series are constructed by first regressing, separately for each birth cohort, a dichotomous employment-at-g-30 indicator on the four categories of completed degrees, and then computing the average residual for each class background.

employed). The three regressions can then be expressed as follows:

$$\overline{y}_{it} = \alpha_1 + \beta_{1HSt}HS_i + \beta_{1BACt}BAC_i + \beta_{1MASt}MAS_i + Controls + \varepsilon_{1it}, \quad (1)$$

$$\overline{y}_{iot} - \overline{y}_{it} = \alpha_2 + \beta_{2HSt}HS_i + \beta_{2BACt}BAC_i + \beta_{2MASt}MAS_i + Controls + \varepsilon_{2it}, \quad (2)$$

$$y_{it} - \overline{y}_{iot} = \alpha_3 + \beta_{3HSt}HS_i + \beta_{3BACt}BAC_i + \beta_{3MASt}MAS_i + Controls + \varepsilon_{3it}, \quad (3)$$

with HS_i=1 if attainment is at least at the high school level, BAC_i=1 if attainment is at least at the Bachlor's level, and MAS_i=1 if attainment is at least at the Master's level. The reference category is less than completed high school. *Controls* include family-fixed effects and birth-year-by-sex fixed effects. The only thing that distinguishes these estimations from completely separate estimations for each birth cohort is the inclusion of family-fixed effects. Eq. (1) is the employment regression (with a scaled dichotomous variable as the outcome), Eq. (2) identifies the earnings premium derived from the chosen occupation, and Eq. (3) identifies the within-occupation contribution.

Appendix Table A2 describe the data used for regression purposes. The use of family-fixed effects implies a loss of observations from 1076,351 to 806,387, but as can be seen from the appendix table, the conditioning of at least two siblings does little to change the composition of the data in terms of either human capital, parental background, or outcomes.

It is clear that a regression of $y_i$directly on educational attainment will give coefficients that adds up the coefficients from regressions (1), (2) and (3); for example,$\beta_{1HSt} + \beta_{2HSt} + \beta_{3HSt}$ is the estimated total effect on age-30 earnings of having a high-school degree as the highest attainment for a person belonging to birth-cohort t. As we aim for a linear decomposition in this analysis, which also includes a large number of zero-earnings, we measure earnings in levels (1000 NOK inflated to 2022-value with the BA wage growth index) rather than in logs.[9] We return to the more standard log-specification in the next subsections, where we examine hourly wages conditional on employment.

Based on point estimates from the three regressions described above, Fig. 9 presents a decomposition of the earnings premium for the three categories of non-compulsory completed degrees.[10] Whereas the two shaded areas indicate the employment premium and the occupation premium, the solid lines mark the estimated total premium. The differences between the solid lines and the top of the shaded areas thus indicate the within-occupation return. For expository reason, we do not show standard errors or confidence intervals in these graphs, but we present point estimates with standard errors in selected robustness analyses in Appendix Tables A3 and A4. Standard errors are in general small, relative to the sizes of the point estimates (typically in the range of NOK 2–4000 for the three separate effects shown in Fig. 9 and NOK 4–6000 for the total effect), and our focus is in any case more on the overall trends in the various premiums, and not on the statistical significance of individual estimates.

Our estimates suggest that high-school education primarily affects earnings through its influence on employment propensity. This part of the premium has increased from NOK 85,000 to NOK 130,000 (i.e., by approximately 50 %) over the past 15 years. By comparison, average

[9] To avoid excess outlier-influence, we have winsorized the outcomes at zero and at 20 BAs, the latter number corresponding to NOK 2.37 million in 2023.

[10] For expository reasons, we disregard (the small) statistical parameter uncertainty here. We present estimates with standard errors for selected cohorts below.

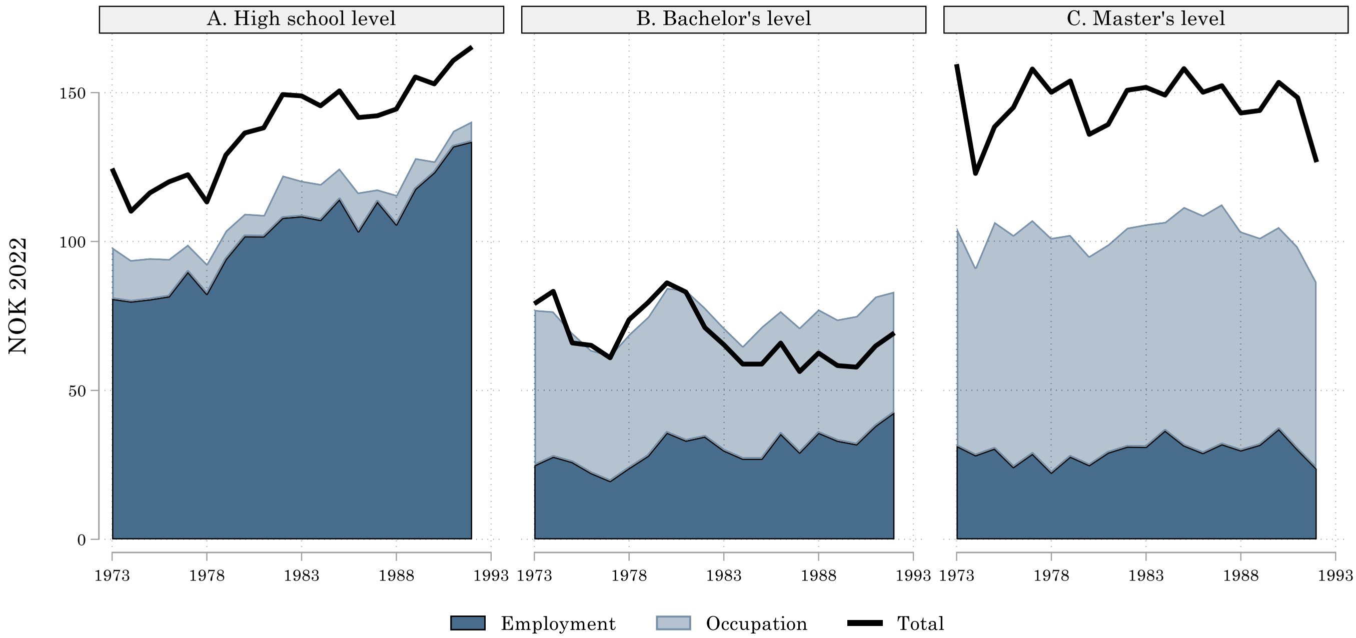

Fig. 9. The earnings premium at age 30 associated with completed degrees of education. Point estimates by birth year.
Note: Each panel reports the estimated added premium in excess of the premium derived from lower degrees. For example, the overall estimated premium for a Master's degree (compared to no non-compulsory education) is the sum of the premiums in panels A, B, and C. Average earnings (measured in 2022-value) in our siblings data are NOK 509,150 (unconditional on employment). All regressions include family-fixed effects and birth-year-by-sex fixed effects. For expository reasons, standard errors are not reported. For all three outcomes (employment, occupation, and within-occupation premiums) and for all three educations (High-school, Bachelor's and Master's) standard errors (conventionally calculated) are typically between NOK 2000 an NOK 4000. Standard errors for total effects (employment + occupation + within-occupation) are typically between NOK 4000 and NOK 6000. Total number of observations is 806,387.

earnings among employees in our data is around NOK 500,000. High-school education only marginally affects the earnings-level of the occupation, whereas it increases the earnings level within occupation by NOK 20–25,000. Adding a Bachelor's degree raises the premium further by NOK 70–80,000, with most of the extra earnings coming from a better paid occupation. The Bachelor's premium has declined somewhat over time, however, and the within-occupation returns have become negative. Adding a Master's degree on top of the Bachelor's raises earnings at age 30 by NOK 130–150,000, with contributions from both a better paid occupation and higher within-occupation pay. This premium has remained stable. The most notable feature of Fig. 9 is that the increased returns to education are fully accounted for by the rising influence of high-school education on the probability of being employed at all.

In Fig. 10, panel A, we show estimates from a model where we have converted the highest completed degree into normed non-compulsory years of education (NCEY), such that the estimates can be interpreted as extra earnings gained per year normally required to reach the highest completed degree. In Eqs. (1)-(3) we have thus substituted a scalar (normed years of highest completed degree) for the three categorical variables, assuming a linear relationship between years of education and

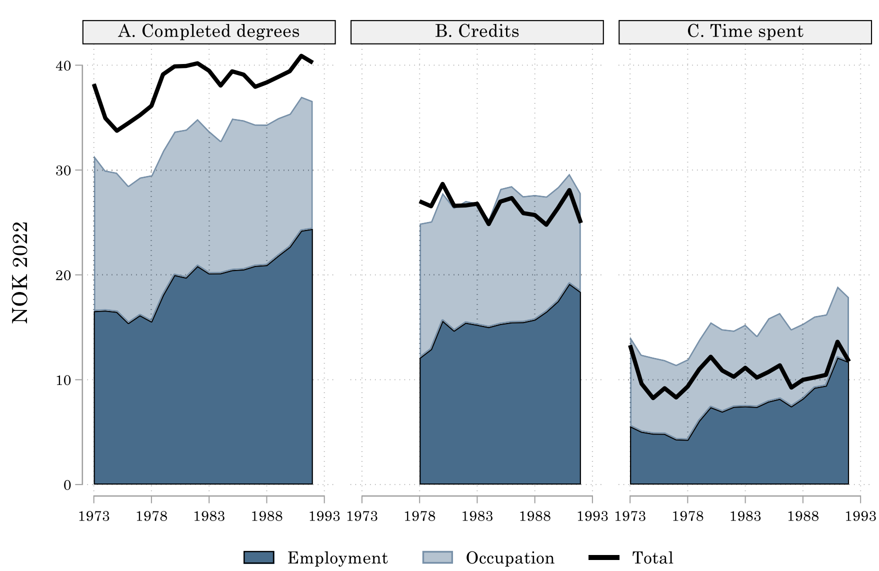

Fig. 10. The earnings premium at age 30 associated with years of non-compulsory education. By definition of years of education. Point estimates by birth year
Note: All regressions include family-fixed effects and birth-year-by-sex fixed effects. Total number of observations is 806,387.

outcomes. Overall, our estimates indicate that the premium associated with each extra (successfully completed) education year has increased from around NOK 35,000 for cohorts born in the mid-seventies to 40,000 for the most recent cohorts (corresponding to 7–8 % of average earnings in our data) (standard errors in these regressions are typically around 300–600 NOK). Somewhat lower premiums are estimated when we instead use the years normally required to obtain all educational credit points, including those that did not lead to a higher grade (panel B). In this case, the estimated within-occupation effect is negative, and the negative effect has increased somewhat over time. Although additional credits may document skills that are valued by employers, it appears plausible that they in some settings also send a negative signal of not having completed an intended higher degree.

To properly assess the returns to education from an individual perspective, the economic rewards need to be evaluated relative to the time actually invested, and without conditioning on a favorable outcome in terms of a completed degree or added credit points. Using time spent in education as the key explanatory variable instead of normed years for the highest completed degree (panel C) cuts the overall premium estimates by as much as 60–70 %. The negative within-occupation premium then becomes large and it has also become larger over time.

The interpretation of the within-occupation effect of time spent in education is complicated by the fact that our regressions do not include any controls for tenure or work experience. Hence, the time spent-variable probably captures both the productivity effect of having invested more time in education (which should be positive) and the effect of having less work experience in the current occupation (which should be negative). Whereas the former of these effects are likely to be persistent, the latter may be washed out over time, but since we measure earnings as early as at age 30, it is probable that the-lack-of-work-experience-effect is attributed much more weight in our regression than it would have done in, say, a regression with lifetime earnings as the dependent variable.

Employment and occupation effects are likely to be more lasting however. And even if we focus exclusively on them, the estimated returns to an extra education year is cut by half when we move from the completed degrees-definition to the time spent-definition. The difference between the returns to completed degree years and years actually spent in education is sometimes interpreted as the so-called sheepskin effect; i.e., the part of the education premium that stems from graduation and, hence, can be attributed to signaling; see, e.g., Jaeger and Page (1996) and Caplan (2018). The existence of a sheepskin effect in relation to diplomas in Norway has also been confirmed by Andresen and Løkken (2024), who study the outcomes of high-stakes exams in the Norwegian High School and show that failing due to randomly being drawn to a written high-fail-probability exam rather than an oral low-fail-probability exam has considerable consequences for the future career of academically marginal students. Failing the exam translates into lower wage earnings as adults and a higher probability of becoming self-employed.

It is notable that irrespective of the way we measure educational attainment, the estimated *rise* in its premium is again fully accounted for by its stronger association with employment propensity. Using the words of Caplan (2018, p. 108), it appears that "the amount of education you need to *get* a job really has risen more than the amount of education you need to *do* a job."

In appendix Tables A3 and A4, we report estimates (with standard errors) for the earnings premiums shown in Figs. 9 and 10 estimated jointly for the 1986–92 birth cohorts. For these cohorts, we have information on the grade point average (GPA) from primary school, which has been shown in previous work to be strongly correlated with adult earnings (Markussen & Røed, 2023), and, for most of the boys, we also have information on cognitive ability from IQ tests at military conscription. By adding these variables into the regression analysis, we can control for within-family sorting into education, and thus facilitate a critical assessment of the causal interpretation of the estimated educational premiums. The results in Table A3 indicate that all the premium estimates become a bit smaller when we control for GPA. For example, the total effect of high school graduation is reduced from NOK 156,354 in the "baseline" model to 145,697 when GPA is controlled for. The sorting component seems to be particularly important for the within-occupation premiums and for the effects of time spent. Hence, it seems clear that parts of the premiums shown in Figs. 9 and 10 arise from sorting rather than causality. Also adding IQ score for boys has little influence on the estimated effects, however.[11]

In Appendix figures A8-A11, we show versions of Figs. 9 and 10 with separate estimates for men and women. These figures indicate that whereas high-school education is more valuable for men, a Bacholor's degree add more to the women's earnings. And while the returns to completed degrees are roughly the same for men and women, the returns to additional credits and time spent in education are larger for women than for men.

In Fig. 11 and Fig. 12, we report returns-estimates for completed degrees and time spent, by class background. The total earnings premiums for completed degrees (Fig. 11) are similar across the class distribution, with a slight U-shape indicating largest returns at the bottom and top of the class distribution. But, whereas the employment margin accounts for most of the returns for bottom class offspring, the occupation and within-occupation margins are more important at the top. The overall premiums derived from time spent in education (Fig. 12) are largest for offspring with a disadvantaged family background. This may reflect that selection into education based on expected returns is stronger for the lower than for the upper classes, as upper class offspring more often are expected by their parents to take education regardless of their talents, and thus spend more time in education without obtaining a corresponding degree. This is confirmed by the fact that the correlation between completed degree and time spent is particularly low for the top class (correlation coefficient equal to 0.70, compared to 0.76 for the middle class and 0.75 for the bottom class). The within-occupation returns to time spent also seem to be more negative the higher is the class background. To the extent that the time spent in education is an indicator for short tenure, this is exactly what we would expect, as offspring from the higher classes more often end up in high-skill occupations with relatively high age at entry and steep earnings profiles during the first years in employment.

4.2. The returns to education conditional on employment

We now take a closer look at educational wage premiums conditional on employment, based on log-earnings equations. In these conditional models, we could in principle have controlled for work experience or tenure as in the standard Mincer models (in contrast to the unconditional models in the previous subsections, where such a variable would have no meaning in the employment and occupation regressions). We have chosen to drop these controls, however, and the motivation for this is both to ensure comparability with previous results and that by age 30 – when we measure the earnings level – it is natural to think of experience as largely determined by time spent in education. The alternative to obtaining a longer education will typically be to start working earlier. If conditioning on experience, one arguably estimates the returns to education *as if* it did not cost anything in terms of a lower wage due to forgone work experience.

$$\log(y_{it}) = \delta + \gamma_t NCEY_i + Controls + \xi_{it} \tag{4}$$

[11] Note that since we use family-fixed effects in all regressions, the sample becomes much smaller when fewer birth cohorts are included (since we can then only use siblings that are born just a few years apart). It becomes particularly small when we only look at boys (since we can then only include brothers).

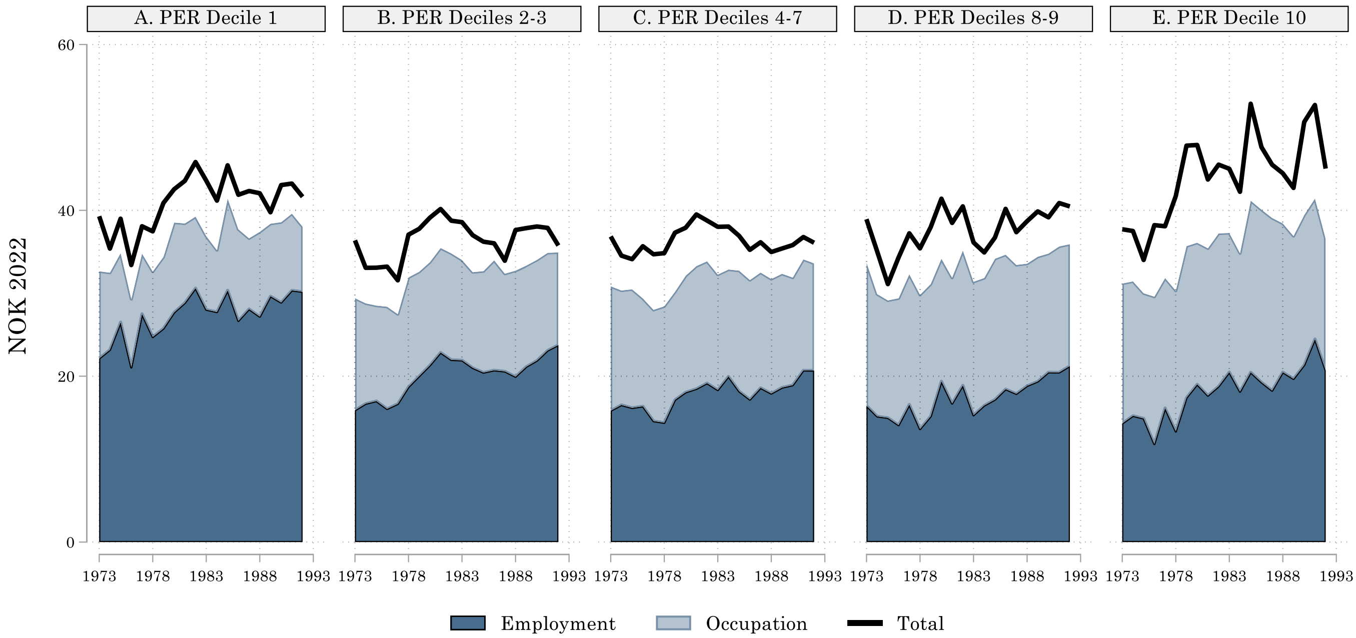

Fig. 11. The earnings premium at age 30 associated with normed years of completed educational degrees (CD). Point estimates by class background and birth year
Note: All regressions include family-fixed effects and birth-year-by-sex fixed effects. Total number of observations is 806,387.

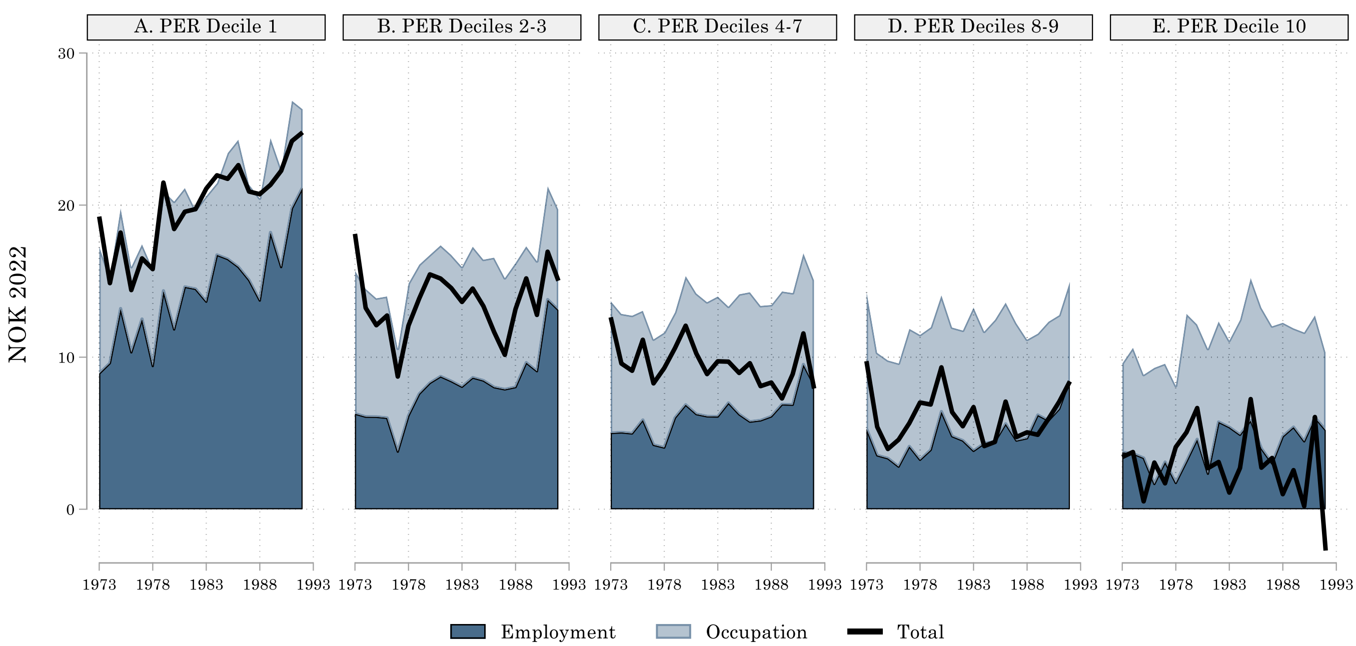

Fig. 12. The earnings premium at age 30 associated with years spent in non-compulsory education (TS). By definition of years of education. Point estimates by class background and birth year
Note: All regressions include family-fixed effects and birth-year-by-sex fixed effects. Total number of observations is 806,387.

where $NCEY_i$ is non-compulsory education years, either measured in terms of highest completed degree (*CD*) or in terms of years actually spent (*TS*), and *controls* include family-fixed effects and separate birth-year fixed effects for men and women. Also here, the only thing that distinguishes Eq. (4) from completely separate estimations for each birth cohort is the inclusion of family-fixed effects. To identify the within-occupation part of the returns, we estimate Eq. (4) both with and without occupation-by-birth-year fixed effects.

The results are shown in Fig. 13 (this time including 95 % confidence intervals). With the standard specification using normed years of highest degree (CD) as the explanatory variable, our estimates indicate that an extra year of successfully completed education raises annual earnings at age 30 by approximately 4.5–5.0 % (panel A), out of which approximately 2.0–2.5 percentage points are identified as a within-occupation component (panel B). The returns estimates are stable over time, both with and without conditioning on occupation, with a possible exception for the very first cohort.

The estimated returns drop considerably when we measure years of education as time actually spent in education (TS). Unconditional on occupation, the earnings premium drops to around 2 %, and it exhibits a

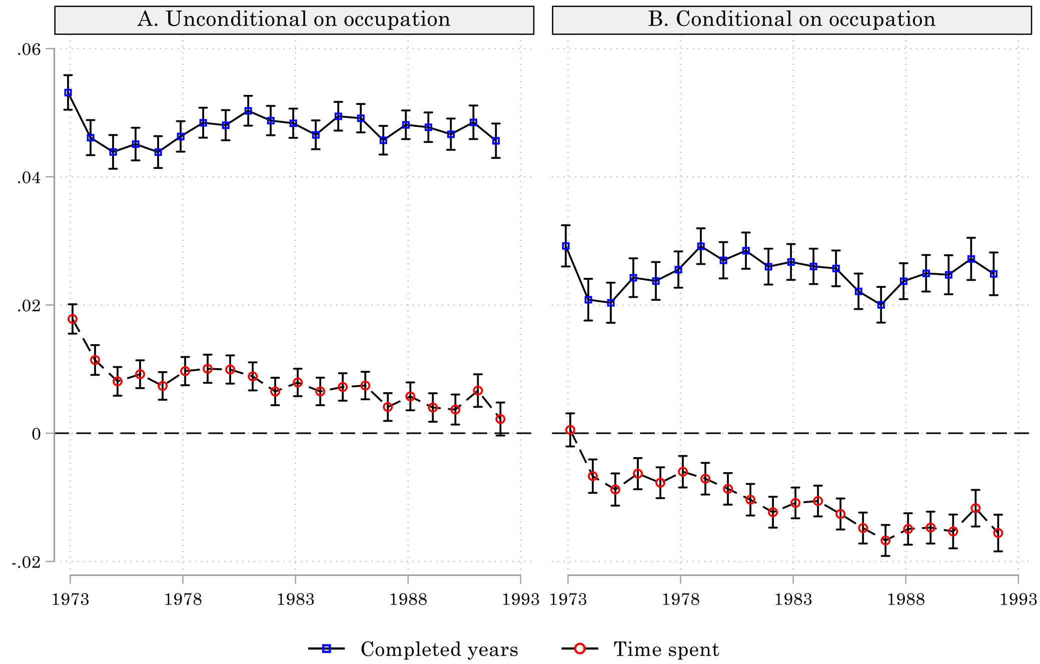

Fig. 13. The estimated returns to education at age 30, conditional on employment. By birth year.
Note: The figures report the cohort-specific estimated effects of non-compulsory education years (NCEY) on log annual earnings, based on Eq. (4). With 95 % confidence intervals. Controls include sex-by-cohort-fixed effects and family-fixed effects and, and in panel B also occupation-by-cohort-fixed effects. The number of observations is 645,027.

declining pattern over time. If the difference in returns to diploma-confirmed years and years actually spent is interpreted as a sheepskin effect, this result suggests that signaling may account for more than half of the educational wage premium even conditional on employment, and that its share of the premium has risen in line with the rise in overall attainment. For the within-occupation component, we estimate a significant negative premium, again with a declining pattern over time.

Separate results for men and women are shown in appendix Figs. A12 and A13. It is clear that women have higher returns to education than men, both unconditional and conditional on the chosen occupation.

In appendix Tables A5 and A6, we present a robustness exercise based on the 1986–92 birth cohorts, with the grade point average (GPA)

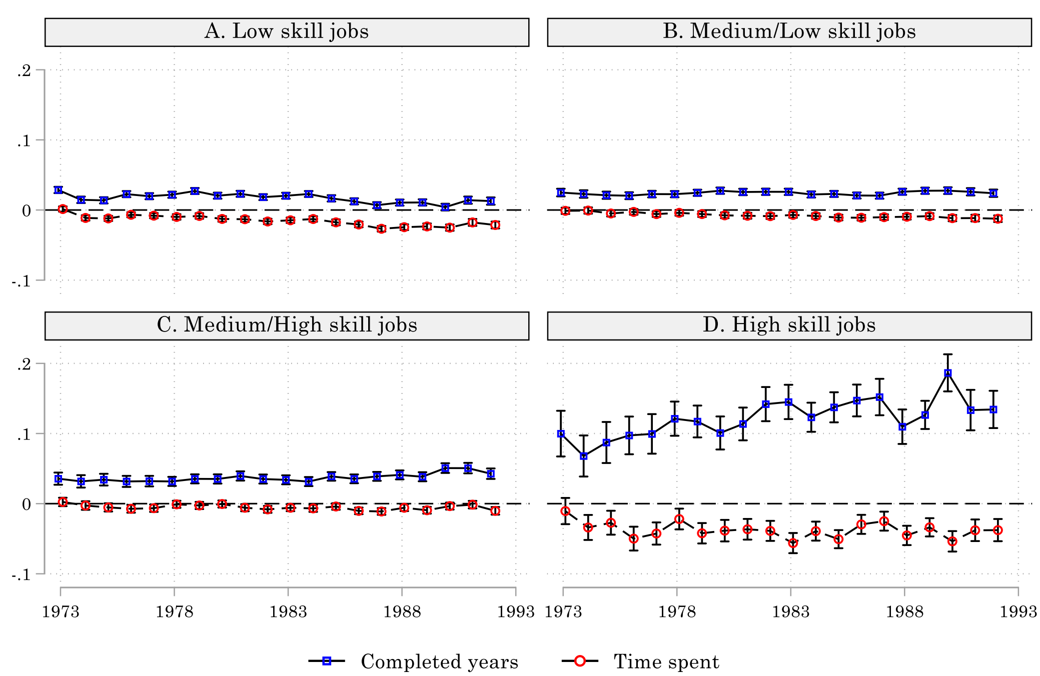

Fig. 14. The estimated returns to education at age 30, conditional on employment. By skill requirement in occupation. By birth year.
Note: The figures report the cohort-specific estimated effects of non-compulsory education years (NCEY) on log annual earnings, based on Eq. (4) estimated separately for the four categories of required skills. With 95 % confidence intervals. Controls include sex-by-cohort-fixed effects, occupation-by-cohort-fixed effects and family-fixed effects. The number of observations is 701,557.

from primary school and IQ test score (for boys) added as covariates. For these cohorts we are also able to compute hourly wage rates, admittedly with some error, such that we can examine the educational premiums in terms of the hourly wage instead of annual earnings. Again, the results indicate that the estimated premium of completed degrees is not particularly sensitive with respect to the inclusion of additional human capital controls, whereas the estimated effect of time spent is pushed downwards. Substituting the hourly wage for annual earnings as the dependent variable reduces the estimated returns considerably, suggesting that higher education not only entails higher employment propensity, but also larger labor supply along the intensive margin. These results must be interpreted with some care, however, as the hourly wage is likely to be measured with considerable error.

The within-occupation educational earnings premiums can also be examined separately by type of occupation. Fig. 14 shows results for such an analysis, with Eq. (4) estimated separately for each skill requirement. The estimated returns to completed years have declined in low-skill jobs, remained stable in medium-low-skill jobs, increased slightly in medium-high-skill jobs, and increased considerably in high-skill jobs. The latter result may indicate that the productivity-enhancing effect of education actually has increased in high-skill jobs. However, the returns to time spent in education have remained stable or declined within all skill categories, even in high-skill jobs.

4.3. The returns to overeducation and undereducation

We now turn to a more direct analysis of the returns to required education in the chosen occupation as opposed to overeducation and undereducation. The analysis is built on what is sometimes referred to as "Duncan-Hoffman regressions" (Duncan & Hoffman, 1981). Let RE_i be a measure of required education in individual i's occupation, here specified as normed years of education. Let OE_i be a measure of overeducation (max(0, obtained minus required degree)) and let UE_i be a measure of undereducation (max(0, required minus obtained degree)). Furthermore, let EC_i be any extra credits beyond the highest obtained degree (also measured in years). Our regression is then specified as follows:

$$\log(y_i) = \phi + \lambda_{RE}RE_i + \lambda_{OE}OE_i + \lambda_{UE}UE_i + \lambda_{EC}EC_i + Controls + \zeta_i \tag{5}$$

The results are shown in Fig. 15. The returns to required education-years have declined slightly over time, from around 7 % to 6 % per year. The reward of overeducation increased for cohorts born during the late 1970s, and have thereafter stabilized at approximately 5 %. The loss associated with undereducation has increased from around 3 % to 5 %. Hence, educational attainment does seem to pay off in terms of individual wage, even when it deviates from the required education in the chosen occupation. This does not seem to be the case for extra credits, however, which actually affect the wage negatively in our regression. We suspect that the latter result either reflects unobserved sorting or that the extra credits have come at the cost of less work experience.

Separate results for men and women are reported in appendix figures A14 and A15. Again, it is noticeable that women have higher returns to education than men. This difference is primarily associated with required education.

5. Concluding remarks

Based on administrative data from Norway, we have examined the patterns of education, overeducation, and earnings for cohorts born between 1973 and 1992. We have defined overeducation as attainment in excess of the lowest degree needed to account for at least 30 % of newly hired employees in the occupation. Our main findings can be summarized as follows:

- Both attainment levels (supply) and educational requirements (demand) have increased over time, but attainment has increased faster than requirements, such that the incidence and the degree of overeducation has also risen. At the end of our data period (2022), approximately 40 % of age-30-workers in Norway are overeducated, in the sense that they have a higher degree than what seems to be required in their occupation.
- There is a strong positive social gradient in the pattern of overeducation: It is more frequent and has risen much faster among offspring born into upper class families. At the same time, non-employment is more frequent and has risen much faster among offspring born into lower class families. The data are thus consistent with a bumping-down story, whereby overeducated offspring with advantaged family backgrounds outrank offspring with disadvantaged backgrounds in the competition for lower-skill jobs.

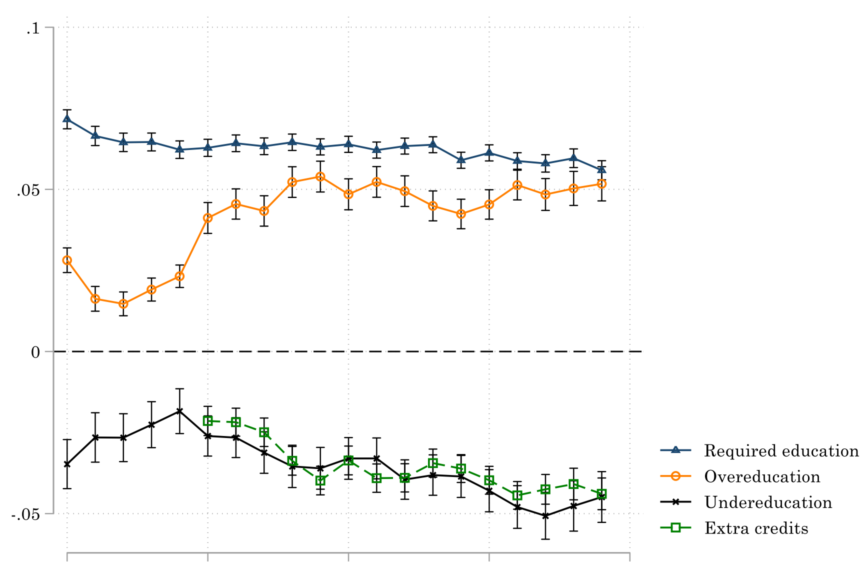

Fig. 15. The estimated returns to education at age 30, conditional on employment. By birth year.
Note: The figures report the cohort-specific estimated effects of non-compulsory education based on Eq. (5), measured in terms of required degree in the occupation, years of overeducation, years of undereducation, and years of extra credits. With 95 % confidence intervals. Controls include sex-by-cohort-fixed effects and family-fixed effects. The number of observations is 645,027.

· Educational earnings premiums have increased considerably, but in contrast to what we have seen in the US and some other advanced economies, the increase is primarily related to high-school graduation. Over the past two decades, the value of a high-school degree (compared to no non-compulsory education) has increased by an amount corresponding to >10 % of the average earnings level in Norway. Earnings differentials between college and high-school educated persons have not increased.
· Also in contrast to the US experience, the increasing returns to education in Norway seems to be fully accounted for by its rising influence on employment propensity. Conditional on employment, we find no evidence of increasing earnings premiums for either high-school or college/university education.
· The returns to education is much larger, and has increased more, when attainment is measured in terms of the highest obtained degree than when it is measured in terms of total credits obtained or in terms of years actually spent in education.
· The positive employment effect of education is largest for offspring with a disadvantaged family background. Considering the returns to the time actually spent in education, we also find that the total educational premium is largest for bottom class offspring.
· Conditional on employment, we estimate that the effect of an additional completed-degree-year (CD) on the wage at age 30 has been stable at approximately 4.5 %. However, when education is measured in terms of years actually spent (without conditioning on a successfully completed degree), the estimated returns to an extra year is typically below 1 % and it has declined over time.
· Overeducation is not wasted education, at least not from a private investment perspective. Conditional on employment, education having led to degrees beyond what is required in the occupation gives almost the same wage premium as the required years.

The findings that the rising returns to education is fully accounted for by the employment margin, and that it has increased more when education is measured in terms of highest degree than when it is measured in terms of time actually spent, suggest that it has not only been driven by its productivity-enhancing effects. Hence, it appears that the signaling channel of education has become more important, and, in particular, that a high-school degree to an increasing extent is used as a screening device also for jobs where the actual contents of a high-school degree seems irrelevant. A probable driver of this development is that attainment levels among young labor market entrants have increased more than educational requirements in available jobs, such that those without education are more often outranked by high-school graduates in the competition for low-skill jobs. The rising signaling-value of a high-school degree is in any case bad news for offspring born into lower-class families, as the cost of obtaining the high-school-signal is higher in these families.

Declaration of competing interest

The authors declare that there are no conflicts of interest in relation to this paper.

Data availability

The authors do not have permission to share data.

Appendix

Table A1
The 10 largest occupations within each skill-group.

	Number of workers of age30–33 in 2003	Percent of respective skill-group
Low-skill occupations (no non-compulsory education required)		
Shop salespersons and other salespersons (retail)	11,969	19.86
Child-care workers	6540	10.85
Stock clerks	4264	7.08
Personal care and related workers not elsewhere classified	3756	6.23
Helpers and cleaners in offices and other establishments	3508	5.82
Salespersons (wholesale)	2808	4.66
Heavy truck and lorry drivers	2604	4.32
Head waiters, waiters, waitresses and bartenders	1551	2.57
Metal-products machine operators	1194	1.98
Earth-moving and related plant operators	1191	1.98
Sum of 10 largest	39,385	65.37
Medium-low-skill occupations (at least high-school required)		
Nursing assistants and care assistants	7979	10.83
Technical and commercial sales representatives	4381	5.95
Clerical officers	3514	4.77
Secretaries	3131	4.25
Electricians, electrical and electronic equipment mechanics and fitters	2795	3.79
Carpenters and joiners	2648	3.59
Computer associate professionals	2519	3.42
Accounting and bookkeeping clercs	2287	3.10
Motor vehicle mechanics and fitters	1862	2.53
Directors and chief executives	1656	2.25
Sum of 10 largest	32,772	44.48
Medium-high-skill occupations (at least bachelor's level required)		
Secondary education teaching professionals	6417	11.82
Nurses	5372	9.89
Other public service administrative professionals	5007	9.22
Primary education teaching professionals	4297	7.91
Preprimary education teaching professionals	3510	6.47
Computer systems designers and computer programmers	3499	6.44
Accountant associate professionals and bookkeepers	1869	3.44

(continued on next page)

Table A1 (*continued*)

	Number of workers of age30–33 in 2003	Percent of respective skill-group
Production and operations managers in education, health and social security	1770	3.26
Civil engineering technicians	1654	3.05
Journalists and information associate professionals	1423	2.62
Sum of 10 largest	34,818	64.13
High-skill occupations (at least master's level required)		
College, university and higher education teaching professionals	1419	18.50
Medical doctors	1412	18.41
Lawyers	1017	13.26
Other engineers and related professionals not elsewhere classified	902	11.76
Mechanical engineers	535	6.98
Architects, town and traffic planners	496	6.47
Psychologists	459	5.99
Electronics and telecommunications engineers	453	5.91
Geologists and geophysicists	172	2.24
Pharmacists	142	1.85
Sum of 10 largest	7007	91.37

Note: The required education in an occupation is defined as the lowest degree needed to account for at least 30 % of age 30–33 workers in 2003.

Table A2
Data used in regression analysis.

	All observations	Sibling data (family-fixed effects)
# of observations	1076,351	806,387
Fraction female	0.49	0.49
Predicted IQ rank	0.50	0.50
GPA rank	0.50	0.50
Education age 29		
Years of education CD	4.13	4.17
Years of education TC	4.92	4.93
Years of education TS	6.38	6.41
Fraction employed at age 30	0.86	0.87
Earnings age 30 (1000 NOK, measured in 2022-value)	503.53	509.15
Parental earnings rank		
Bottom class	10.0 %	9.4 %
Lower class	20.0 %	19.5 %
Middle class	40.0 %	40.4 %
Upper class	20.0 %	20.3 %
Top class	10.0 %	10.4 %

Table A3
The educational earnings premium decomposed.

	Employment(Eq. (1))		Occupation(Eq. (2))		Within-occupation(Eq. (3))	
	Baseline	Baseline Plus GPA	Baseline	Baseline Plus GPA	Baseline	Baseline Plus GPA
A. Education categories						
High school (HS)	113.094	106.304	10.118	10.006	33.142	29.387
	(2.406)	(2.473)	(1.576)	(1.616)	(4.112)	(4.231)
+ Bachelor's degree	28.478	24.889	43.126	37.590	6.161	−0.183
	(2.022)	(2.131)	(1.325)	(1.392)	(3.457)	(3.646)
+ Master's degree	30.704	30.378	72.056	63.379	55.462	50.481
	(2.294)	(2.378)	(1.503)	(1.554)	(3.922)	(4.069)
R-squared	0.612	0.613	0.607	0.610	0.476	0.477
B. Normed years highest degree						
Years (CD)	20.207	19.087	14.040	12.250	9.294	7.439
	(0.363)	(0.408)	(0.240)	(0.268)	(0.618)	(0.696)
R-squared	0.608	0.609	0.597	0.604	0.475	0.476
C. Normed years total credits						
Years (TC)	14.240	11.976	11.238	8.052	5.710	2.730
	(0.379)	(0.423)	(0.251)	(0.278)	(0.639)	(0.716)
R-squared	0.594	0.598	0.587	0.594	0.473	0.474
D Time spent						
Years (TS)	7.964	4.812	6.835	4.053	2.010	−0.665
	(0.345)	(0.369)	(0.227)	(0.241)	(0.574)	(0.617)
R-squared	0.589	0.594	0.578	0.590	0.473	0.474
E. Model properties						
Gender by cohort fixed eff.	Yes	Yes	Yes	Yes	Yes	Yes
Family-fixed eff.	Yes	Yes	Yes	Yes	Yes	Yes
GPA rank fixed effects		Yes		Yes		Yes
N	101,650	101,650	101,650	101,650	101,650	101,650

Note: The dependent variable is annual earnings in the year persons become 30 years. All estimates are measured in 1000 NOK (inflated to 2022 value). Conventional standard errors are reported in parentheses. GPA rank fixed effects are represented by 10 dummy variables, one for each decile.

Table A4
The educational earnings premium decomposed. Boys only.

	Employment(Eq. (1))		Occupation(Eq. (2))		Within-occupation(Eq. (3))	
	BaselinePlus GPA	Baseline Plus IQ	BaselinePlus GPA	Baseline Plus IQ	BaselinePlus GPA	Baseline Plus IQ
A. Education categories						
High school (HS)	70.345	70.032	25.355	24.796	28.763	28.997
	(5.803)	(5.809)	(4.240)	(4.243)	(9.629)	(9.638)
+ Bachelor's degree	15.886	15.947	24.292	23.600	−2.460	−2.385
	(4.778)	(4.788)	(3.491)	(3.497)	(7.928)	(7.944)
+ Master's degree	29.852	30.567	68.358	67.766	53.254	53.601
	(5.658)	(5.681)	(4.133)	(4.150)	(9.387)	(9.426)
R-squared	0.569	0.569	0.603	0.603	0.555	0.555
B. Normed years highest degree						
Years (CD)	12.868	12.912	12.459	12.201	7.090	7.135
	(0.953)	(0.959)	(0.699)	(0.703)	(1.580)	(1.589)
R-squared	0.567	0.568	0.598	0.598	0.554	0.554
C. Normed years total credits						
Years (TC)	7.615	7.630	3.981	3.656	0.033	−0.045
	(0.989)	(0.994)	(0.734)	(0.737)	(1.636)	(1.645)
R-squared	0.562	0.562	0.586	0.587	0.553	0.553
D Time spent						
Years (TS)	0.514	0.476	1.950	1.656	−4.919	−5.006
	(0.859)	(0.863)	(0.634)	(0.637)	(1.411)	(1.418)
R-squared	0.559	0.560	0.585	0.586	0.553	0.554
E. Model properties						
Gender by cohort fixed eff.	Yes	Yes	Yes	Yes	Yes	Yes
Family-fixed eff.	Yes	Yes	Yes	Yes	Yes	Yes
GPA rank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
IQ-rank fixed effect		Yes		Yes		Yes
N	19,301	19,301	19,301	19,301	19,301	19,301

Note: Only boys with registered IQ are included. The dependent variable is annual earnings in the year persons become 30 years. All estimates are measured in 1000 NOK (inflated to 2022 value). Conventional standard errors are reported in parentheses. GPA rank fixed effects and IQ fixed effects are represented by 10 dummy variables, respectively, one for each decile.

Table A5
The educational earnings premium conditional on employment.

	Total returns			Within occupation		
	Log(earnings) Baseline	Log (earnings) Baseline Plus GPA	Log(wage)Baseline Plus GPA	Log(earnings) Baseline	Log (earnings) Baseline Plus GPA	Log(wage)Baseline Plus GPA
A. Normed years highest degree						
Years (CD)	0.049	0.044	0.025	0.026	0.024	0.015
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
R-squared	0.606	0.609	0.586	0.680	0.680	0.661
B. Normed years total credits						
Years (TC)	0.023	0.011	0.010	−0.000	−0.006	0.005
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
R-squared	0.588	0.594	0.579	0.675	0.677	0.658
C. Time spent						
Years (TS)	0.004	−0.006	0.003	−0.014	−0.018	−0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
R-squared	0.583	0.594	0.577	0.677	0.680	0.658
D. Model properties						
Gender by cohort fixed eff.	Yes	Yes	Yes	Yes	Yes	Yes
Family-fixed eff.	Yes	Yes	Yes	Yes	Yes	Yes
GPA rank fixed effects		Yes	Yes		Yes	Yes
Occupation fixed effects				Yes	Yes	Yes
N	80,637	80,637	76,831	80,634	80,634	76,827

Note: The dependent variable is log(annual earnings) in the year persons become 30 years or the log(hourly wage) observed in the job with highest earnings that year. Hourly wages are computed by dividing observed earnings with the registered number of regular work hours. Conventional standard errors are reported in parentheses. GPA rank fixed effects are represented by 10 dummy variables, one for each decile.

Table A6
The educational earnings premium conditional on employment. Boys only.

	Total returns			Within occupation		
	Log (earnings) Baseline Plus GPA	Log (earnings) Baseline Plus GPA and IQ	Log(wage)Baseline Plus GPA and IQ	Log(earnings) Baseline	Log (earnings) Baseline Plus GPA and IQ	Log(wage)Baseline Plus GPA and IQ
A. Normed years highest degree						
Years (CD)	0.035	0.035	0.022	0.020	0.020	0.015
	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)	(0.002)
R-squared	0.597	0.597	0.584	0.683	0.684	0.662
B. Normed years total credits						
Years (TC)	−0.005	−0.006	0.002	−0.013	−0.013	0.002
	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)	(0.002)
R-squared	0.587	0.587	0.577	0.682	0.682	0.660
C. Time spent						
Years (TS)	−0.019	−0.020	−0.005	−0.024	−0.024	−0.006
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
R-squared	0.591	0.592	0.577	0.686	0.686	0.660
D. Model properties						
Gender by cohort fixed eff.	Yes	Yes	Yes	Yes	Yes	Yes
Family-fixed eff.	Yes	Yes	Yes	Yes	Yes	Yes
GPA rank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
IQ rank fixed effects		Yes	Yes		Yes	Yes
Occupation fixed effects				Yes	Yes	Yes
N	16,221	16,221	15,394	16,171	16,171	15,338

Note: The dependent variable is log(annual earnings) in the year persons become 30 years or the log(hourly wage) observed in the job with highest earnings that year. Hourly wages are computed by dividing observed earnings with the registered number of regular work hours. Conventional standard errors are reported in parentheses. GPA rank fixed effects and IQ rank fixed effects are represented by 10 dummy variables, respectively, one for each decile.

Fig. A1. Years of education by age 30 by sex and birth year.
Note: Educational attainment and activities are measured up to age 30. See Section 2.1 for the definitions of education.

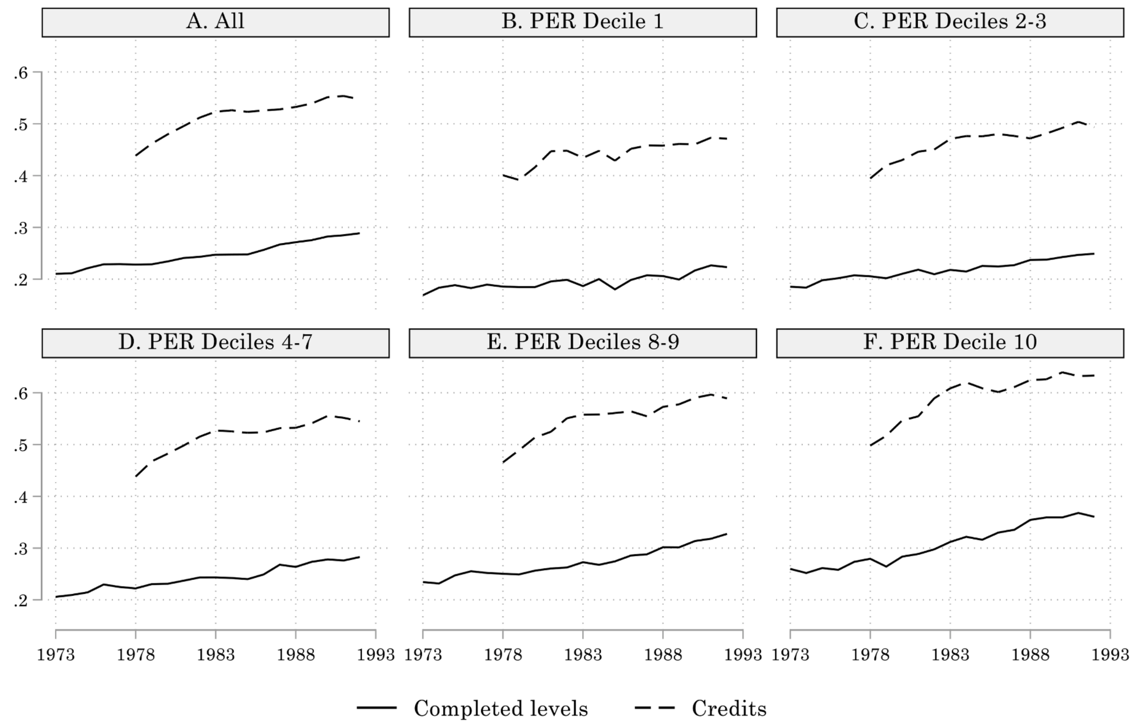

Fig. A2. Fraction overeducated at age 30 by birth year when the modal education in each occupation is used to define occupational requirements. By gender and parental earnings rank.
Note: The data cover people employed at age 30. See Section 2.1 for the definitions of education and Section 2.3 for the identification of parental earnings rank.

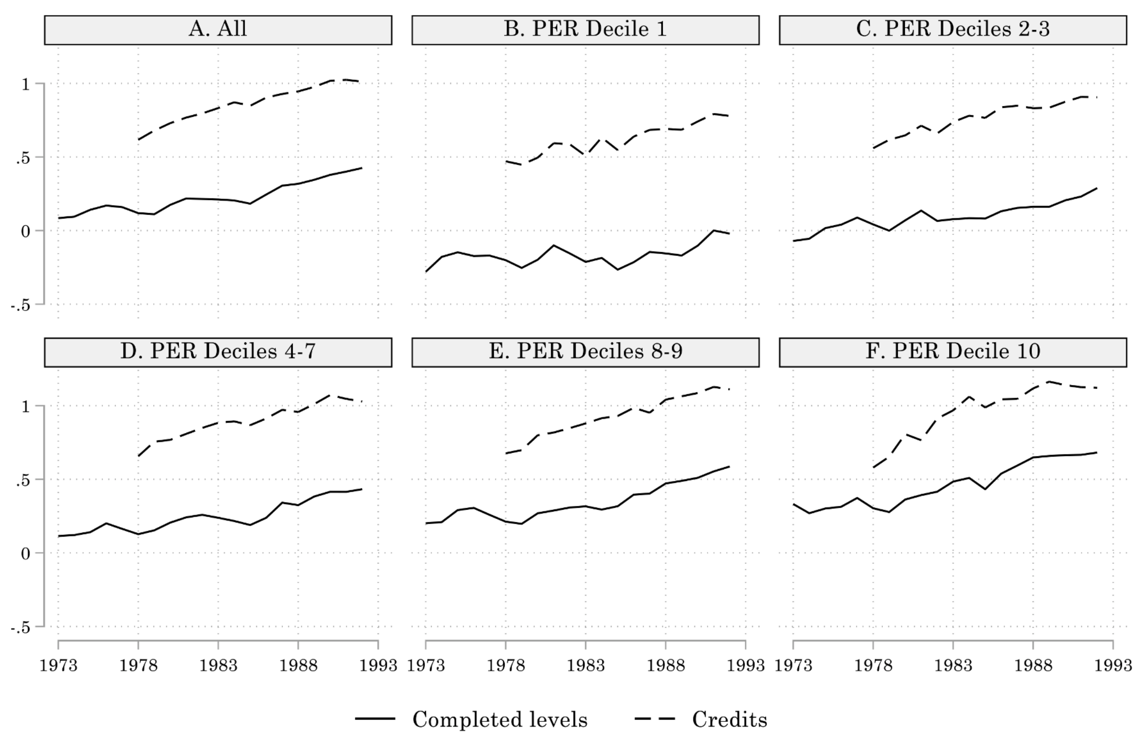

Fig. A3. Average years of overeducation (degree/credits minus required) among employees at age 30 by birth year when the modal education in each occupation is used to define occupational requirements. By gender and parental earnings rank.
Note: The data cover people employed at age 30. See Section 2.1 for the definitions of education and Section 2.3 for the identification of parental earnings rank.

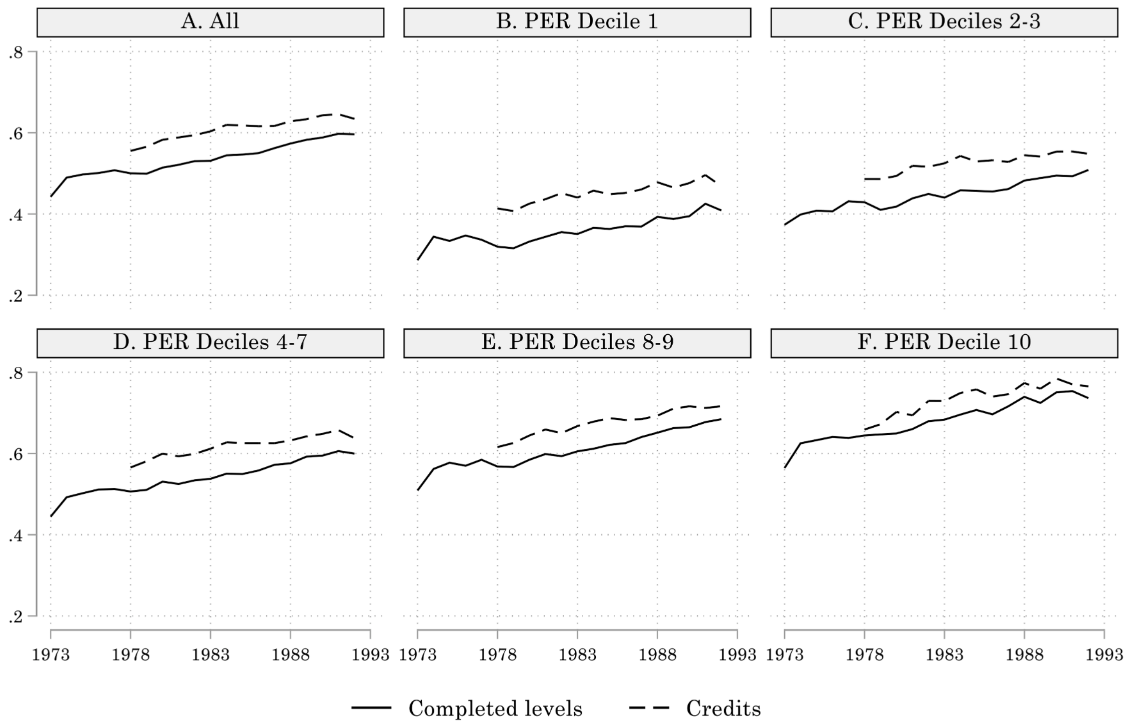

Fig. A4. Fraction overeducated at age 30 when the O*NET definition is used to define occupational requirements. By gender and parental earnings rank.
Note: Educational requirements are based on majority expert evaluations of US occupations in most recent version of O*NET, which are then matched to the Norwegian occupation codes (match obtained for 257 out of 339 occupations) and to the Norwegian educational system.

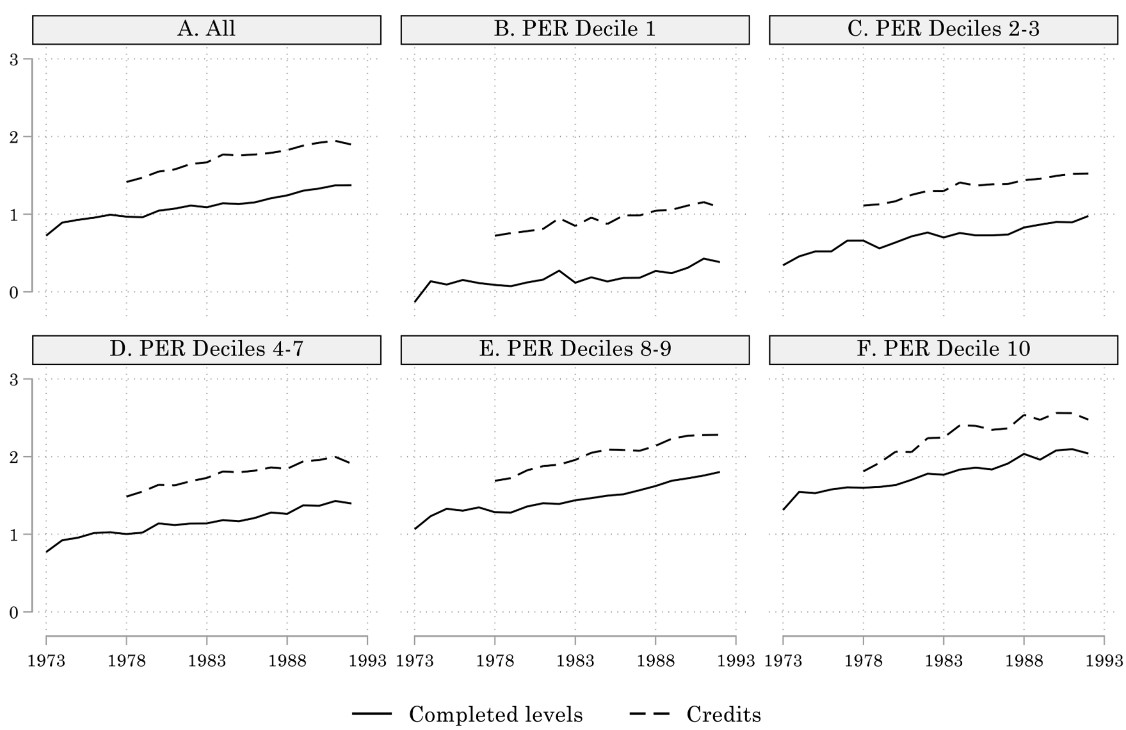

Fig. A5. Average years of overeducation (degree/credits minus required) among employees at age 30 by birth year when O*NET is used to define occupational requirements. By gender and parental earnings rank.
Note: Educational requirements are based on majority expert evaluations of US occupations in most recent version of O*NET, which are then matched to the Norwegian occupation codes (match obtained for 257 out of 339 occupations) and to the Norwegian educational system.

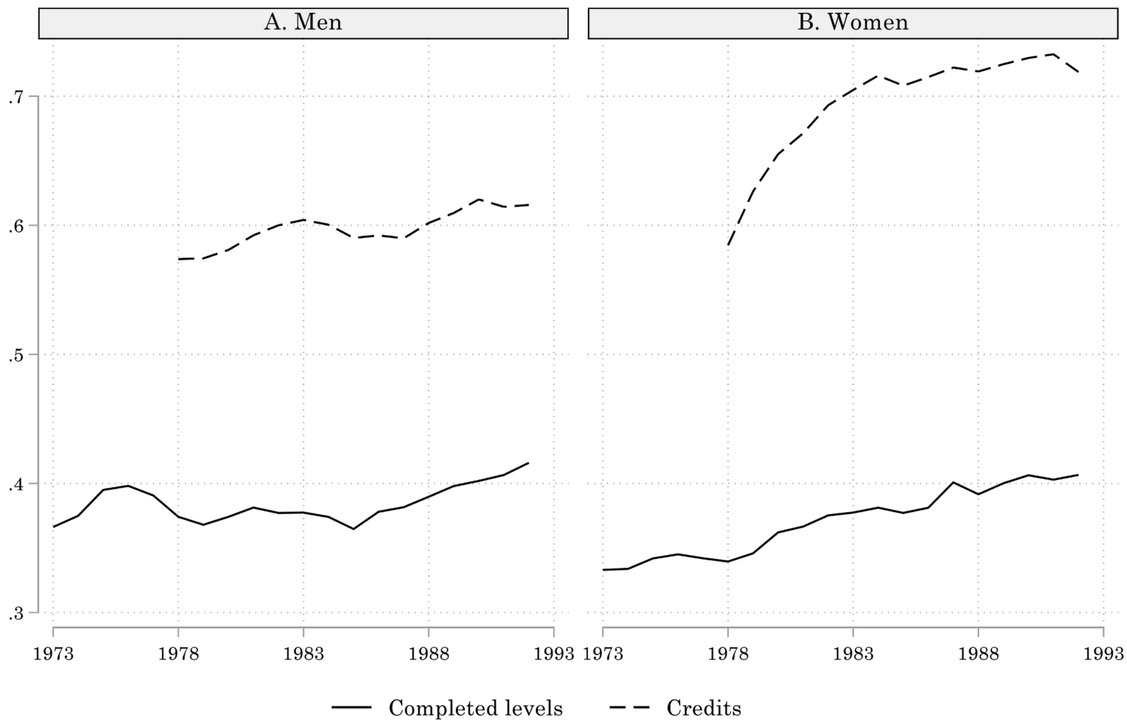

Fig. A6. Fraction overeducated at age 30 by sex and birth year.
Note: The data cover people employed at age 30. See Section 2.1 for the definitions of education and Section 2.2 for the definition of required education.

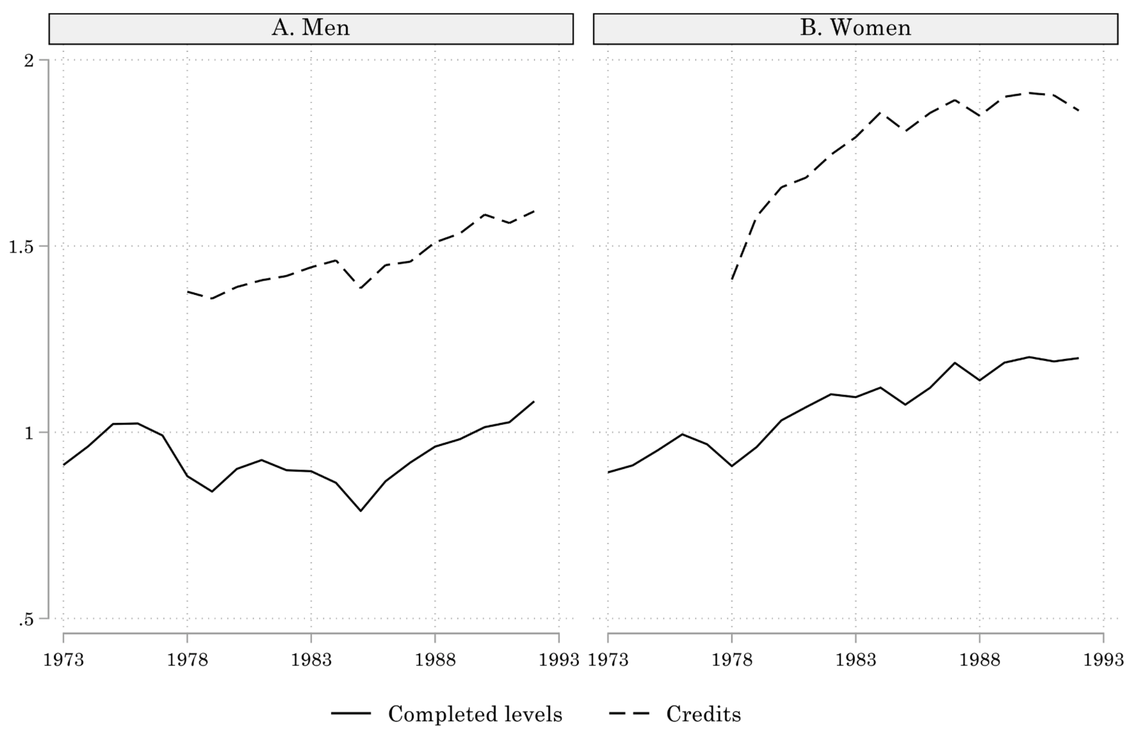

Fig. A7. Average years of overeducation (degree/credits obtained minus required in occupation) among employees at age 30 by sex and birth year.
Note: The data cover people employed at age 30. See Section 2.1 for the definitions of education and Section 2.2 for the definition of required education.

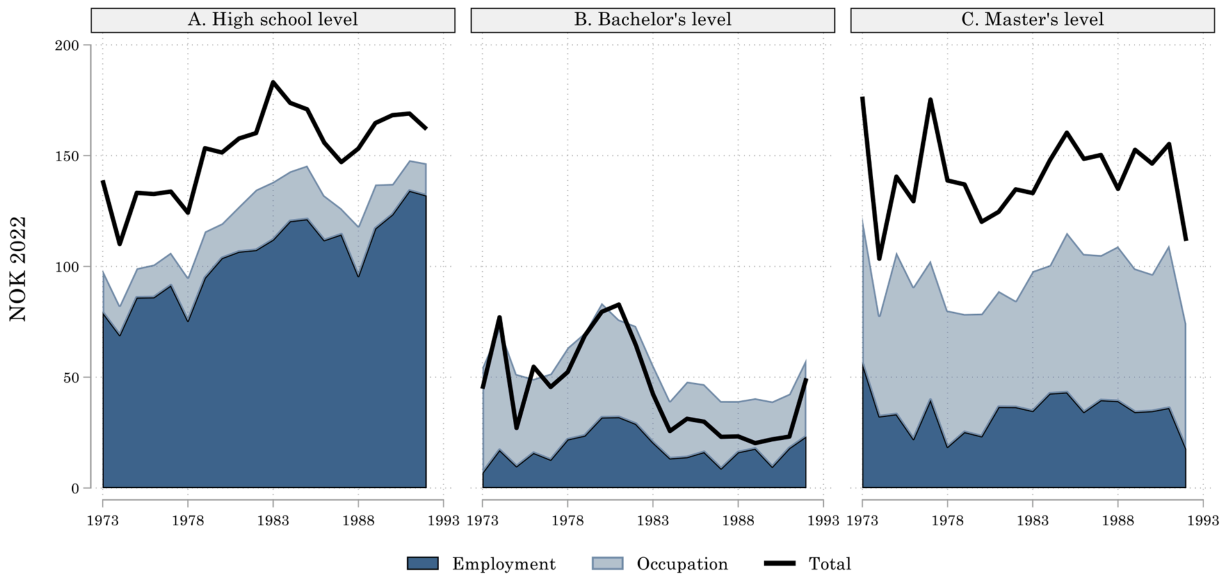

Fig. A8. The earnings premium at age 30 associated with completed degrees of education. Point estimates by birth year. Men
Note: Each panel reports the estimated added premium in excess of the premium derived from lower degrees measured in NOK (2020-value). See also note to Fig. 9 in the paper.

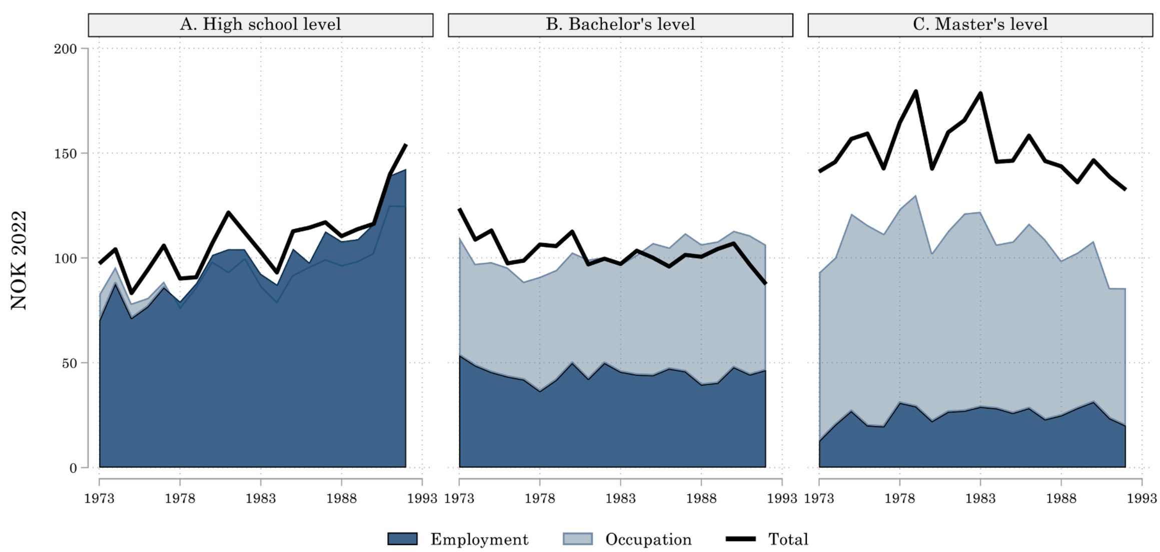

Fig. A9. The earnings premium at age 30 associated with completed degrees of education. Point estimates by birth year. Women
Note: Each panel reports the estimated added premium in excess of the premium derived from lower degrees measured in NOK (2020-value). See also note to Fig. 9 in the paper.

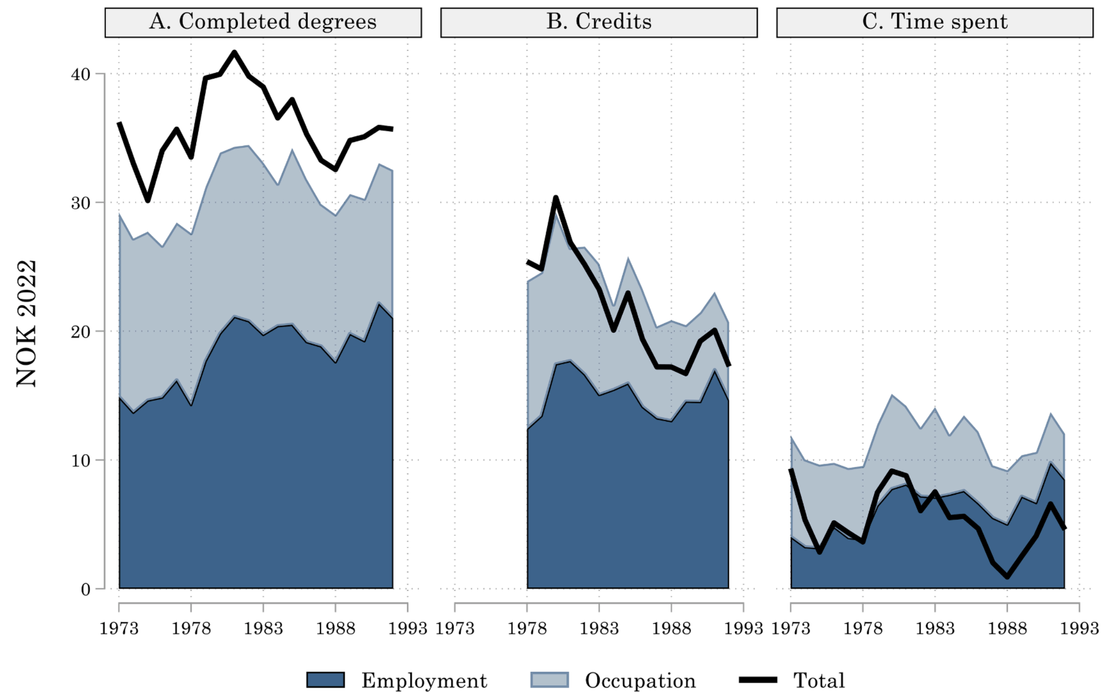

Fig. A10. The earnings premium at age 30 associated with years of non-compulsory education. By definition of years of education. Point estimates by birth year. Men
Note: All regressions include family-fixed effects and birth-year-by-sex fixed effects.

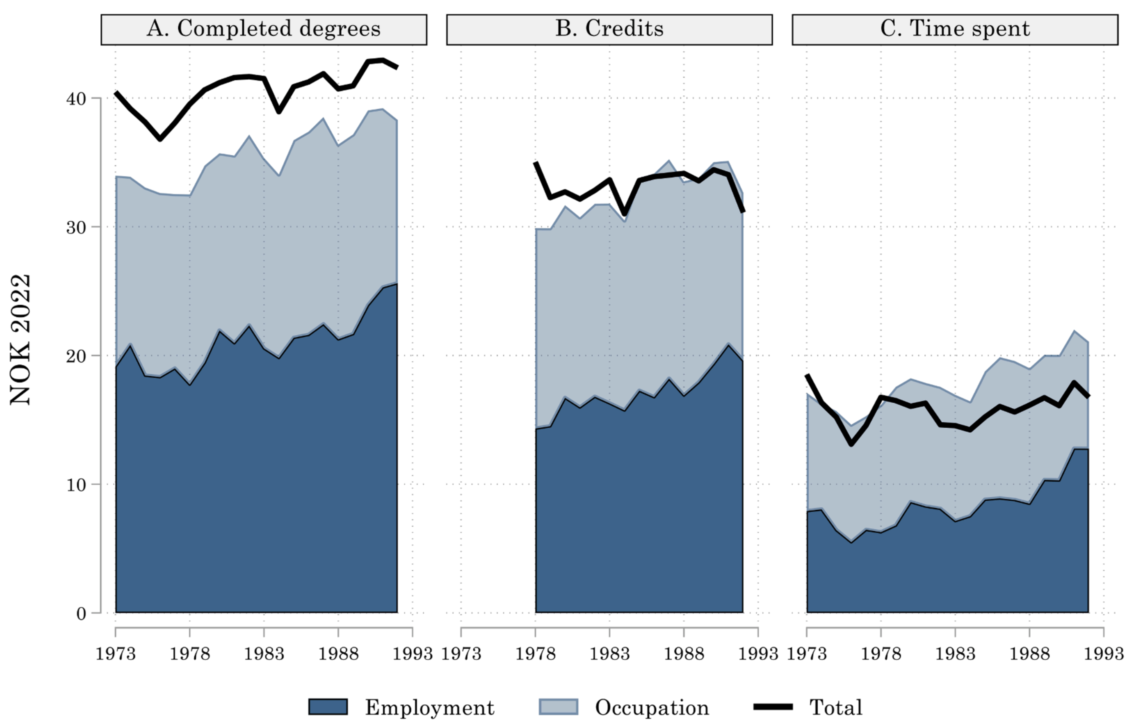

Fig. A11. The earnings premium at age 30 associated with years of non-compulsory education. By definition of years of education. Point estimates by birth year. Women
Note: All regressions include family-fixed effects and birth-year-by-sex fixed effects.

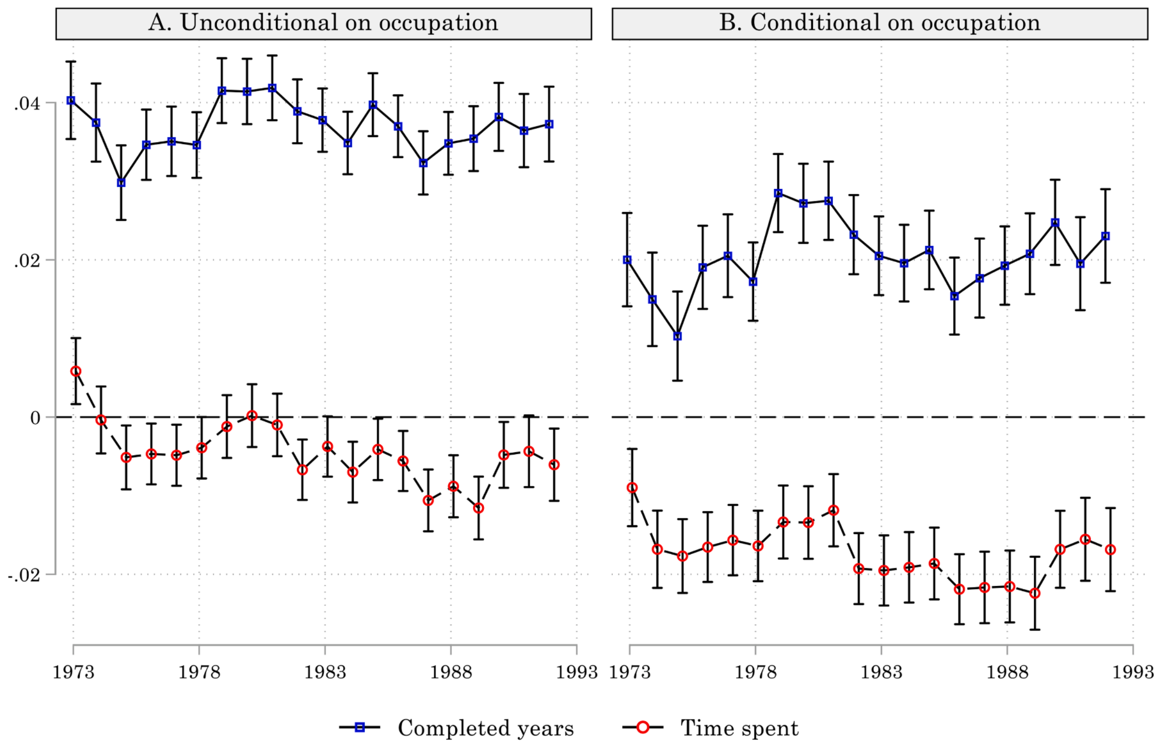

Fig. A. 12. The estimated returns to education at age 30, conditional on employment. By birth year. Men
Note: The figures report the cohort-specific estimated effects of non-compulsory education years (NCEY) on log annual earnings, based on Eq. (4). With 95 % confidence intervals, based on conventional standard errors. Controls include sex-by-cohort-fixed effects and family-fixed effects and, and in panel B also occupation-by-cohort-fixed effects.

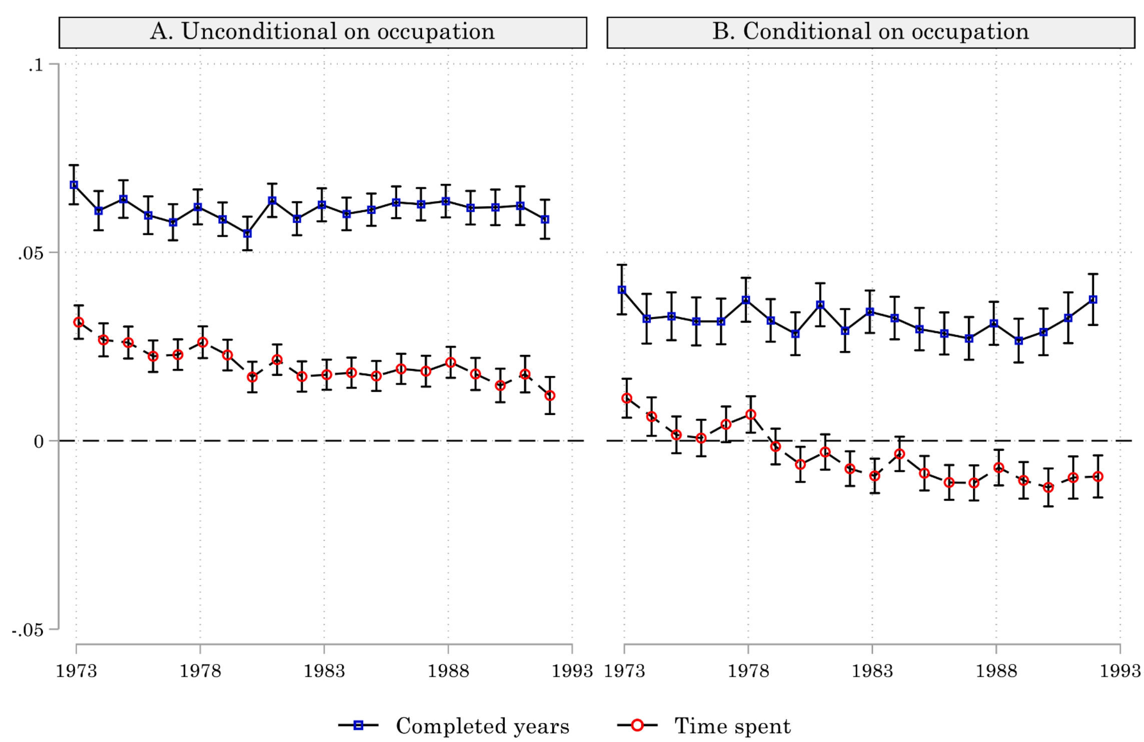

Fig. A13. The estimated returns to education at age 30, conditional on employment. By birth year. Women
Note: The figures report the cohort-specific estimated effects of non-compulsory education years (NCEY) on log annual earnings, based on Eq. (4). With 95 % confidence intervals, based on conventional standard errors. Controls include sex-by-cohort-fixed effects and family-fixed effects and, and in panel B also occupation-by-cohort-fixed effects.

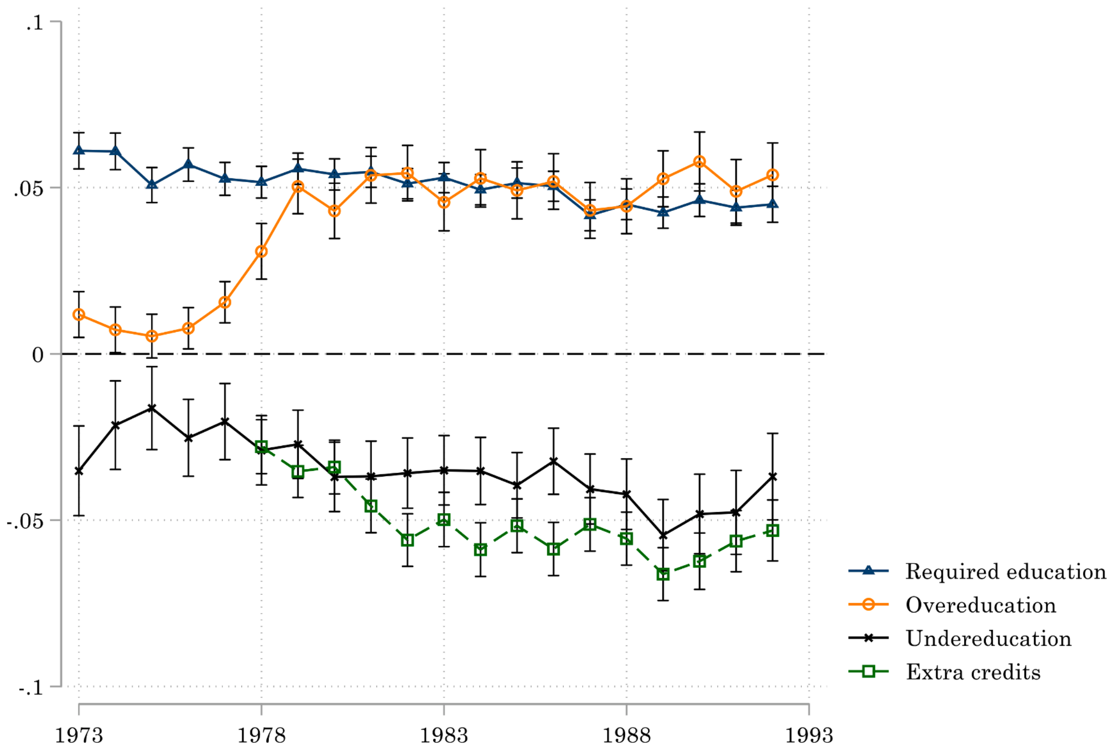

Fig. A14. The estimated returns to education at age 30, conditional on employment. By birth year. Me
Note: The figures report the cohort-specific estimated effects of non-compulsory education based on Eq. (5), measured in terms of required degree in the occupation, years of overeducation, years of undereducation, and years of extra credits. With 95 % confidence intervals, based on conventional standard errors. Controls include sex-by-cohort-fixed effects and family-fixed effects.

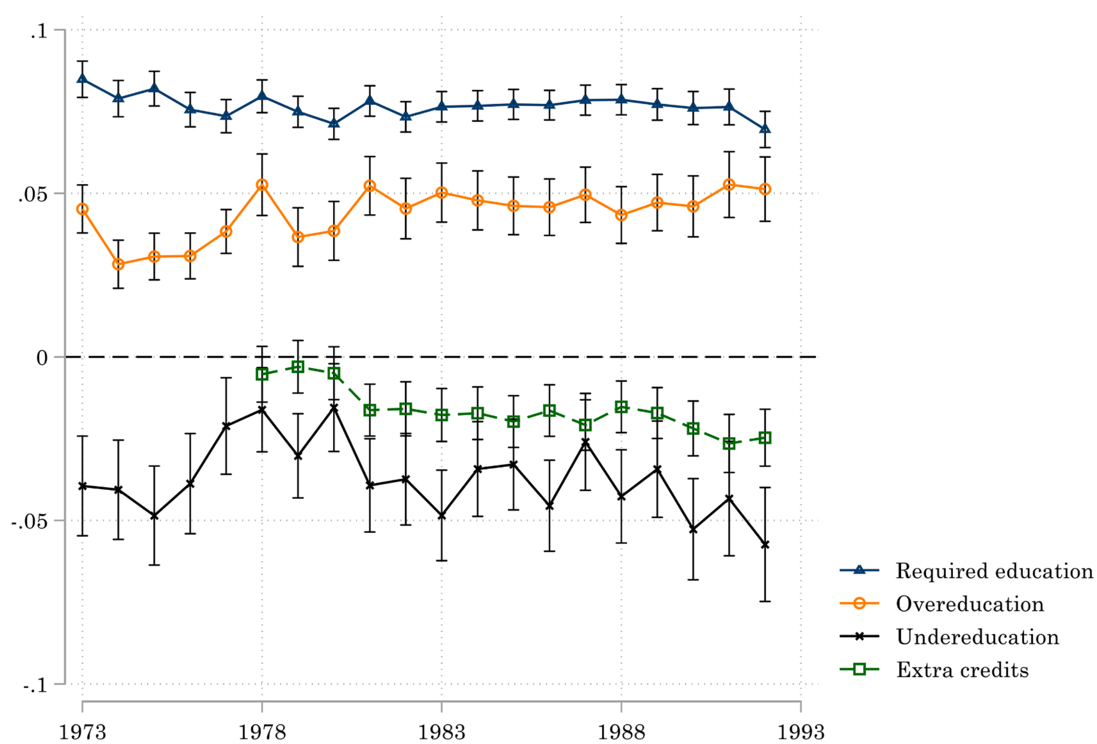

Fig. A15. The estimated returns to education at age 30, conditional on employment. By birth year. Me
Note: The figures report the cohort-specific estimated effects of non-compulsory education based on Eq. (5), measured in terms of required degree in the occupation, years of overeducation, years of undereducation, and years of extra credits. With 95 % confidence intervals, based on conventional standard errors. Controls include sex-by-cohort-fixed effects and family-fixed effects.

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