The Making and Unmaking of Educational Opportunity:
Intergenerational Educational Mobility in 20th Century-Denmark

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Abstract

This paper studies trends in intergenerational educational mobility—the extent to which education is passed on from parents to children—over most of the 20th century in Denmark. While mobility levels were low in the first half of the century, they increased dramatically for cohorts born during the 1950s and 1960s when major schooling reforms significantly lifted the lower parts of the schooling distribution. Yet, for cohorts born during the 1970s and 1980s for whom the educational system began expanding at the college and university levels, educational mobility levels have been declining rapidly. Our findings suggest that levels of educational mobility depend on how the educational distribution changes over time. Whereas compression in the lower tail of the education distribution is associated with increasing mobility levels, expansion at the upper tail is associated with decreasing mobility levels. We also find that the link between education and skills changes in tandem with changes to the schooling distribution. While the compression at the lower tail reduced the correlation between education and cognitive skills by 25%, the gradual expansion at the upper tail is characterized by a strengthening of the links between education and non-cognitive skills. Furthermore, education has become increasingly predictive of outcomes such as crime, earnings, marriage rates, and mental health. Our study shows that differences in social mobility—whether regional or temporal—may reflect fundamental differences in underlying distributions and mechanisms.

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1 Introduction

Fostering human capital and promoting intergenerational social mobility are central concerns among researchers and policy-makers. Research on social mobility shows pronounced variation both between and within countries (e.g., Björklund and Salvanès 2011; Black and Devereux 2011; Chetty et al. 2018; Corak 2013), thereby pointing to which policies or institutional setups that potentially induce social mobility. For example, social mobility has been found to be relatively high in the Scandinavian countries, a finding which some explain in terms of the comprehensive welfare states in these countries (e.g., Corak 2013; Hertz et al. 2008). However, levels and trends in the attainment outcomes of interest often differ across countries or regions. Thus, insofar as countries or regions are in a transitional phase rather than in steady-state, mobility snapshots may provide a limited guide for understanding which policies that foster or hamper social mobility.

This paper examines long-run trends in intergenerational educational mobility for cohorts born over the course of the 20th century in Denmark. Education is often considered a strong determinant of inequality across the life course, and educational mobility is a widely used measure of equality of opportunity and is also regarded as a viable proxy for measuring the degree to which human capital is transmitted across generations.\footnote{The term \textit{human capital} has broader meaning than education alone (see Goldin and Katz 2020 for a description of how the term has evolved). However, education (schooling) is one of the most central inputs in human capital formation (Becker 1964). And human capital is also key determinant of the selection between different stages of education (e.g., Cameron and Heckman 1998).} The paper draws on full population register data, supplemented by historical survey data, to trace educational attainment and mobility across almost a century during which today’s comprehensive Danish welfare state was rolled out.

Fig. 1 summarizes the key finding of the paper by comparing intergenerational mobility estimates and education levels for Denmark and the U.S. across the 20th century. Fig. 1a shows the estimates
from linear regressions of children’s years of schooling on parents’ years of schooling—which we label
the Education IGE—for cohorts born 1911–1985 in Denmark and in the U.S.\textsuperscript{2} Educational mobility
changed dramatically over the century in Denmark compared to in the U.S. where mobility levels have been remarkably stable. Although Denmark is characterized by very low levels of educational mobility early in the century (a coefficient of roughly 0.55), in tandem with major schooling reforms, educational mobility increased dramatically over a 25 year period to a comparatively high level (a coefficient of roughly 0.30), substantially surpassing that reported for the U.S. Among Danes born in the 1970s and 1980s, however, mobility has decreased rapidly, and for the very youngest cohorts born in the mid-1980s, the estimates are similar to those reported for the U.S. at 0.45. Thus, mobility estimates for Denmark and the U.S. both markedly differ and are very similar within a relatively small time window as seen, for example, for cohorts born in the mid-1970s and the mid-1980s.

However, this finding does not imply that Denmark and the U.S. became more alike in terms of policies such as childcare, tuition costs, education grants, or overall levels of redistribution for cohorts born during the mid-1980s—if anything the contrary occurred. The only area in which the two countries converge is in education levels. Figs. 1b and 1c present trends in average years of schooling among children and their fathers, for children born 1955–1985 in Denmark and the U.S., respectively. Fig. 1b shows that in Denmark, average years of schooling increased from a level below 12 years for children and below 10 years for fathers to almost 14 years and 12 years, respectively. In contrast, in the U.S. the large educational expansion took place earlier in the 20th century (Goldin, 1998; Goldin and Katz, 1999). As Fig. 1c shows, the average years of schooling in the U.S. change much less and are far higher than those in Denmark until the most recent cohorts. Thus, estimates

\textsuperscript{2}The estimates we report for the U.S. are similar to those reported by Hilger (2017); Hout and Janus (2011), both of which also rely on the General Social Surveys (Hilger, 2017 also use PSID, NLSY79, and OCG surveys).
for Denmark and the U.S. are by no means comparing likes with likes until, possibly, cohorts born during the 1980s.

Our study further shows that not only are the overall changes in education levels between generations central to estimated educational mobility but so are the parts of the distributions that drive these changes in Denmark. On the one hand, the increase in educational mobility in Denmark among the cohorts born during the 1940s, 1950s, and 1960s is rooted in a substantial expansion at the bottom of the schooling distribution following major compulsory schooling reforms coupled with stagnating college completion rates. On the other hand, the decreasing mobility experienced by the youngest cohorts is associated with stagnating high school completion rates and increasing college and university completion rates—increases which are mainly driven by children born to well-educated parents.

We also document that education proxies different aspects of human capital and predicts life course inequality differently for different birth cohorts. Drawing on conscription records, we show that within only 15 years, the correlation coefficient between years of schooling and children’s (men’s) cognitive test scores decreased from around 0.60 for the cohort born in 1943 to 0.45 for the cohort born in 1958 (with the exact same cognitive test being administered for these cohorts). Cognitive skills became less decisive at the lowest levels of education following the compression of the education distribution at the bottom. Moreover, our findings suggest that non-cognitive skills have become a more important predictor of high school and college completion across time. This set of findings implies that regional or temporal differences in education inequality may not reflect differences in human capital inequality to the same degree. In addition, not only do the associations between skills and educational attainment change, so does the link between education and key life course outcomes in general. Differences in education are increasingly associated with differences in
Figure 1: Education IGE by child birth year and country

a) Education IGE

![Education IGE chart showing estimates by birth year for Denmark and the U.S.]

b) Average years of schooling, Denmark

c) Average years of schooling, U.S.

Note: Fig. a) shows estimates of the education IGE ($\beta^{IGE}$) by year of birth for Denmark and the U.S. regression of:

$$YOS_{Child} = \alpha + \beta^{IGE}YOS_{Parent} + u$$

Figs. b) and c) show average years of schooling for children and their fathers by year of birth. Danish estimates are based on survey and register data, and U.S. are based on the General Social Surveys. Section 2 describes the data.
outcomes such as youth crime, mental health, employment, wage earnings, and family formation—changes which are driven by the lower tail of the schooling distribution as high school dropouts are increasingly falling behind in all of the life course domains we consider.

Our paper contributions to several strands of literature. We add to the literature studying education expansions (e.g., Goldin 1998; Goldin and Katz 1999) and to studies of schooling reforms such as Black et al. (2005); Lundborg et al. (2014); Meghir and Palme (2005) by investigating how education expansions shape intergenerational mobility. Thus our study directly relates to the vast literature studying differences in social mobility among countries, regions within countries, or across birth cohorts (e.g., Breen and Jonsson 2005; Chetty et al. 2014; Corak 2013; Erikson and Goldthorpe 2002; Hertz et al. 2008).

Our paper also relates to the literature studying the importance of skills for educational attainment (e.g., Heckman and Rubinstein 2001) and the studies documenting how transitions between education levels are strongly related to skills (e.g., Cameron and Heckman 1998). We show that cognitive skills have become gradually less predictive of attained schooling in the lowest part of the schooling distribution, and that schooling instead increasingly reflects non-cognitive skills.

Our findings suggest that country, regional, or temporal differences in social mobility should be interpreted with caution. While policies targeting education and human capital have the potential to affect social mobility, our findings indicate that changes in the distribution of schooling is a

3 Contributions to the literature on education expansions also include Currie and Moretti (2003), Oreopoulos et al. (2003), Chevalier (2004), and Piopiunik (2014) studying college openings, changes minimum school leaving ages / compulsory schooling in the U.S., the U.K., and Germany on children’s outcomes. A separate line of research has studied the impact of schooling reforms on outcomes such as earnings of the generation affected: Bhuller et al. (2017) uses changes in compulsory schooling in Norway to estimate the effect of education on lifetime earnings. Oreopoulos (2006) compares the effects of U.K. and U.S. reforms, and Pischke and von Wachter (2008) study German reforms.

4 In line with Castex and Dechter (2014) findings for the U.S., we also find that wage earnings returns to cognitive skills are constant throughout the period. Similarly, Edin et al. (2018) finds that the returns to non-cognitive skills are increasing in Sweden.
key driver of variation in the estimated levels of educational mobility. The most recent Danish cohorts, who were exposed to universal high-quality childcare, increased access to (free) colleges and universities, and generous public education support, experience decreasing educational mobility.

The paper proceeds as follows: Section 2 describes the data and provides descriptive results on education levels in Denmark across the 20th century. Section 3 analyzes first the impact of schooling reforms from the late 1950s to the early 1970s and then mobility for more recent cohorts. Section 4 documents how the link between education, skills, and life-course trajectories has changed across time. Section 5 concludes the paper.

2 Background and data

2.1 The Danish education system at a glance

The Danish education system was originally shaped by the country’s strong dependence on the agricultural sector—a dependence that continued well into the 20th century. For example, 50% of males worked in farming in 1911, and 27% of the workforce were employed in the primary sector in 1948. Children also contributed to the agricultural workforce; 20% of family breadwinners in farm households in 1911 were children aged 10-15 [Statistics Denmark 1998, 2015] Therefore, until the large schooling reform of 1958, the educational system was divided into a rural and urban school system. In the rural school system, children had very few opportunities for continuing into lower and upper secondary education after completing primary school. Schools in rural areas only provided primary schooling from grades 1 through 7, with substantially fewer school days per year,

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5While twentieth century-Denmark is characterized by six major reforms of primary and lower secondary schooling in Denmark, we restrict our focus to the three that are important for the results we will present in the paper and the general features of the Danish educational system. Appendix B.1 provides a further description of all six reforms.
and fewer grade levels (such as a grade for "young children" and one for "old children").

The 1958 reform abolished the rural school system. As a consequence, rural municipalities (the local administrative units in Denmark) were required to offer schooling until grade 9 (at the minimum). All children in rural Denmark now had—for the first time—the opportunity to pursue schooling beyond the minimum required 7 years of schooling. Moreover, every school should supply all relevant grade-levels, and all children should attend school for the same number of days. The large changes following the reform were also seen in the substantial increases in investments in public schools, particularly in the rural areas.

The **schooling reform of 1972** increased the minimum required years of schooling in Denmark from 7 to 9, which is the combined duration of primary schooling (7 years) and lower secondary schooling (2 years). This reform corresponds to the Norwegian and Swedish schooling reforms studied in, for example, [Black et al. (2005); Meghir and Palme (2005)]. However, the Norwegian and Swedish counterparts were introduced during the 1960s and were gradually rolled out across regions, whereas the Danish reform was introduced later and implemented nationally at one point in time.

Fig. 2 provides a stylized illustration of the Danish education system. Before the 1972 reform, students had to decide whether to leave school after 7 years, complete 9 years of schooling (i.e., lower secondary schooling), or complete a vocational apprenticeship-based degree. After the 1972 reform, the dashed lines in the figure disappear from the opportunity set, and the first decision is whether to leave school after 9 years of schooling or continue to upper secondary education which now consists of either an academic high school track (the *Gymnasium*) or a vocational apprenticeship-based track. Completing the academic high school track makes students eligible for enrolling in tertiary

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6See appendix B.1 and [Bingley and Martinello (2017)] who examine how the reform affects wealth accumulation.
education (college and university). Changes in educational mobility during the 20th century are driven by the horizontal path in Fig. 2 with the expansion from 7 to 9 years of compulsory schooling, and the further expansion of academic high school, college, and university.

**Figure 2:** The Danish education system at a glance

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7 College level education consists of two branches: i) semi-professional degrees such as teachers or nurses of 3-4 years' duration, and ii) bachelor level degrees that feed directly into master level programs of 5-6 years of duration. We do not distinguish between the two branches in the analysis as this margin is unimportant for the educational patterns and mobility trends in Denmark.

8 One of the most striking features of the Danish education system is the absence of pecuniary costs. While education has been 'free' throughout the period studied, the strong selectivity into who had the opportunity to go beyond 7 or 9 years of schooling was a binding barrier until cohorts born during the mid-1960s. As we show below, it is only for later cohorts that tertiary education becomes prevalent. Also, public education support was introduced in 1970 but have been expanded substantially later, in particular in 1988 (studied in Nielsen et al., 2010).
2.2 Data

We base our analyses of educational mobility in Denmark on two data sources. The first source is full population register data for cohorts born 1921–1988 in Denmark. Our starting point is the demographic register in which we obtain date and parish of birth, allowing us to analyze differences in education across regions of birth for the full population born throughout most of the 20th century. For cohorts born from 1956 onwards, we use the link to their parents in the register data (information on parents is not included in the register data for cohorts born before 1956). We subsequently link these data to the education register, which is available from 1981–2017 and which provides us with information on the highest completed educational degree and the years of completed schooling.

To study the earnings-schooling associations across time, we also include wage earnings from the income registers 1980–2018. We measure wage earnings as the average from ages 32–36. We use this age range as income measured in the mid to late 30s proxy lifetime earnings closely. Also, expanding the age range in either direction would reduce the number of cohorts for which we are able to measure wage earnings, thereby limiting the purpose of using the earnings data. We also link the data to the demographic registers, which contain information on marital status, and to the crime registers to measure youth crime (defined as a criminal charge between ages 15–17).

We merge the register data with conscription records including cognitive test scores for all males for those born 1940–1988, except for those born 1959–1969 for whom records are unavailable. A particular feature of these cognitive test data is that all cohorts have been administered the exact

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9 We consequently omit immigrants not born in Denmark from our analyses.
10 As the register data is first available in 1980, data for earlier cohorts are conditioning on survival 1980. Therefore, we do not explore variation in education before 1921 as mortality rates increase rapidly after age 60.
same test. The conscription records come from three different sources: the historical conscription register for cohorts born 1940–1958 (Christensen et al., 2015), the register for cohorts born 1970–1986, and the register for cohorts born after 1987. The first and third conscription registers contain the full test score (i.e., the total number of correct answers on the test). However, as a result of administrative processing errors in the past, the full-range test scores have been lost for cohorts born 1970–1986. Thus, for these cohorts, we only have available a dichomitized version of the original test dividing individuals into a normal and a low intelligence group.\footnote{Table B.3 maps the cognitive test scores to the IQ scale. A test score below 36 corresponds to an IQ below 90. As the 1988-cohort is the first cohort after the 1958-cohort for which the data include the full-range test score, we use this cohort to test the robustness of the trends identified using the dummy category from 1970–1986, even though we have to measure education for the 1988-cohort at age 29, as the last year of education information is 2017.}

The conscription data from 1970 onwards also contain information from the health assessment across four domains (physical performance, upper extremities, lower extremities, and mental health) which we i) define as 0/4 counting the number of domains in which health is assessed as normal and ii) use for assessing whether health in each of the four categories is assessed as very problematic (taking 1 if it is very problematic and 0 otherwise).

Fig. A.4 presents data coverage by year of birth and Table A.1 presents summary statistics for the outcomes considered in the paper other than education. Fig. A.5a presents the register data sample size by birth cohort. The solid line presents the full sample size and the dashed line presents the sample size for the conscription data. Cohort sizes vary from 42–82,000. Fig. A.5b shows for selected cohorts the sample size by birth cohort and whether birth was registered in an urban or rural area. All sample sizes in the register-based analyses we present below—even when we condition on region of birth and conscription data—exceed 10,000 individuals.

The second data source is based on seven nationally representative surveys conducted between 1970 and 2010. Pooling the surveys allows us to trace intergenerational educational mobility further.
back than the cohort of 1956, which is the earliest cohort for which we can link parental information to children in the registers. In all of the seven surveys, respondents provide information about their own and their father’s schooling, and their region of birth. The pooled data comprise 8,650 respondents born 1911–1976. Appendix B describes the coding and data sources of the Danish data in detail, and Appendix C describes the U.S. data we use to construct Fig. 1.

Measuring education   Most of our analysis is based on the highest degree completed measured in years of schooling. This measure facilitates a comparison of educational levels and mobility throughout a century during which educational systems were reformed, degrees disappeared and new emerged, and what characterized a prestigious degree changed. However, as the increase in educational attainment for cohorts born from the mid-1960s onwards relates to transitions into academic high school, college, and university, we also examine how the transitions and sorting between those levels have changed across time. Moreover, we present results using alternative estimation strategies (e.g., polychoric correlations, proportional reductions in entropies, log-multiplicative layer effect models). The results are very similar to those based on years of schooling, stressing the robustness of our findings.

We measure years of schooling in terms of the highest degree completed at age 30. We convert this highest degree into years of completed schooling using the minimum number of years it takes to complete the degree (e.g., today a 3-year college degree takes $9 + 3 + 3 = 15$ years to complete as compulsory schooling lasts 9 years, academic high school 3 years, and college 3 years).

For the historical survey data, schooling is reported in levels and degrees, and not always in years of schooling. We consequently assign each educational category the associated years of schooling that...
prevailed for the specific cohorts studied.  

### 2.3 Trends in schooling levels

Fig. 3 shows average years of completed schooling by year of birth for persons born 1921–1987, based on the administrative registers. Fig. 3a shows highest completed levels of education and the average years of schooling, Fig. 3b shows the fraction who has completed a specific degree or higher, and Fig. 3c shows the year-by-year change in the different educational levels (i.e. the slope in Fig. 3b).

As Fig. 3 illustrates, although average years of schooling increases almost linearly during this period, the trend is driven by educational expansions at different discrete schooling levels. For those born 1921–1957, the downward trend in the share with no more than 7 years of schooling (i.e., the minimum level of compulsory schooling years until 1972) dominates. While 60% of the 1921 birth cohort completed no more than 7 years of schooling, 40% of the 1941 cohort and only 4-5% of the 1956 cohort did so (the 1956 cohort is the last cohort not affected by the 1972 reform that increased the minimum required years of schooling from 7 to 9). The share completing high school increased modestly for those born during the first half of the 20th century (10 percentage points for the cohorts 1921–1940), and more rapidly for those born 1950–1965 (30 percentage points). Cohorts born 1965–1987 have experienced a significant expansion at the college and university levels. While roughly 10% of the 1965 cohort obtain a college degree as their highest completed education, slightly more than 20% of the 1987 cohort obtain such degree. Similarly, whereas only 5% of the 1965 cohort completed a university degree, this fraction increased to almost 20% for the 1987 cohort.

In other words, the education expansion has occurred in different parts of the distribution over

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13To conduct this recoding, we have been assisted by Jakob Linnet Schmidt, Ning de Coninck-Smith, and Signe Holm-Larsen, Danish educational historians and experts on the development of the educational system in Denmark.
the century. Figs. 3b and 3c show that the lower tail—completing at least 9 years of schooling—changed drastically from the cohorts born during the 1920s and until the 1972 schooling reform for which the 1957 cohort is the first affected cohort. The figure further shows that the fraction completing high school has increased throughout the century, but the increase became more rapid in among those born after WWII, only to slow down in the two most recent decades. The fraction with a college or university degree is almost constant throughout the first two-thirds of century, and only increases for cohorts born from 1965 onwards. While the uptake in all broad fields at the university level has increased, the expansion has been most pronounced for degrees within humanities (which increased from 7% of university degrees in the 1965 cohort to around 25% two decades later). Fig. A.7 illustrates the development in mean cognitive test scores from the 1940–1988 cohorts, showing that mean cognitive test scores increased until the cohorts born in the late 1960s when the progress gradually stopped. Mean test scores have remained stable from the 1975 cohort onwards.

3 Educational mobility

We divide the analysis of trends in educational mobility into two subsections. The first subsection analyzes the dramatic increase in educational mobility among those born in the late 1940s through the mid-1960s. The second subsection studies the decrease in educational mobility for those born

14 As a comparison, we plot the corresponding marginal schooling distribution for the U.S. in Fig. A.6. The figure shows that average years of schooling increased rapidly and linearly from 1913 through 1950. From 1950 through 1984, however, the annual growth rate in years of schooling has declined significantly. The rapid growth from 1913 through 1950 was driven by, on the one hand, a decline among those with less than a high school degree (i.e., less than 12 years of schooling) and, on the other hand, an increase among those with at least some college. The stagnating trend for those born 1950-1984 appears to be driven by stagnation among all educational margins, although the fraction of college students begins increasing between those born 1960 and those born 1984. This evolution corresponds to education trends presented in e.g., Goldin and Katz (2007).
during the 1970s and 1980s.  

### 3.1 Towards higher educational mobility

At the turn of the 20th century, Denmark had two separate school systems: a rural and an urban one. As described in Section 2, the rural school system offered primary schooling from grades 1 through 7, often with only a few grade levels (e.g., younger and older children), and required school attendance for a limited days per week. In contrast, the urban school system provided full-day school for every grade level the entire week, offered 9 years of schooling and access to higher education. Thus, children living in rural areas had much poorer access to education than children living in urban areas.

Fig. 4 illustrates how significantly the 1958 reform impacted schooling levels in Denmark. Fig. 4a shows the fraction with no more than 7 years of schooling by rural-urban origin for cohorts born 1921–1965. Among cohorts born 1921–1941, children from both urban and rural areas gradually became less likely to obtain only 7 years of schooling. However, starting from the birth cohort of 1942—the first cohort affected by the 1958 reform—the rural-urban gap at this schooling margin was virtually closed in approximately 15 years. Figs. 4c and 4d show similar trends in average years of schooling. For those born before 1942, the gap was stable at around 1 year of schooling, but 15 years later the gap was less than one-fifth of a year. The remaining gap of roughly one-fifth of a year results from differences in the prevalence of college and university degrees (not shown here).

To further examine the impact of the 1958 reform, we illustrate the impact on the rural-urban

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15 Fig. A.1 shows the regression intercepts and intergenerational correlations corresponding to the education IGE estimates from Fig. 1. To show that the estimated trend in Education IGEs is not an artifact of changing data source for cohorts born before and after 1957, in Fig. A.2 we present Education IGE estimates for Denmark based on survey data only extending the cohorts to all available cohorts born 1911–1976. The trend for those born 1957–1976 is virtually identical, suggesting that differences in underlying data sources do not drive our results. Fig. A.3 shows that the trends do not arise from changing nonlinearities.
Figure 3: Education levels by child year of birth

a) Education levels, Denmark

b) Aggregate education levels
c) Year-by-year change in aggregate education levels

Note: Fig. a) is based on full population register data, and shows discrete education levels and years of schooling by child birth cohort. Fig. b) shows aggregate education levels by birth cohort. Fig. c) shows year-by-year changes (i.e., the slopes in a). Education is measured in 1981 for cohorts born before 1951 (and thus conditional on survival to 1981). Education is measured at age 30 for cohorts born after 1950. Education is measured in 1981 for cohorts born before 1951 (and is therefore conditional on survival to 1981). Education is measured at age 30 for cohorts born after 1950. Lower secondary: 8-11.9; High school: 12-14.9; College: 15-16.9; University: 17-21.5.
gap in cognitive skills using the conscription records. Figs. 4e and 4f show the average cognitive test score levels and differences by rural-urban origin and year of birth. For the 1940 cohort, we find a substantial rural-urban gap in the skill distribution. However, for the 1958 cohort, the rural-urban gap has been reduced by around 75%, suggesting that the impact of the 1958 reform not only equalized formal schooling but also cognitive skill levels between regions in Denmark.\footnote{Fig. A.8 show full cognitive test score distribution by region of birth for the birth cohorts 1940 and 1958. The distribution in 1940 for children from rural areas is right-skewed and significantly shifted to the left compared to the distribution for children from urban areas, whereas the 1958 distributions only differ to a small extent.}

While the 1958 reform unified the educational system and significantly expanded access to lower secondary schools, the 1972 reform changed the years of compulsory schooling from 7 to 9. While the reform corresponds to the reforms in Norway and Sweden studied in Black et al. (2005); Lundborg et al. (2014); Meghir and Palme (2005), the Swedish and Norwegian reforms were rolled out somewhat earlier during the late-1950s and 1960s. As a result of the strong downward trend in the fraction completing only 7 years of schooling in Denmark, around 95% percent of a cohort already completed more than 7 years of schooling at the eve of the 1972 reform (which affected the second half of the 1957 cohort onward)\footnote{Similarly, Oreopoulos (2006) shows that two consecutive compulsory school laws in the U.K. had different impact; the first resulted in a strong increase in schooling while the second only had minor impact as it coincided with an existing trend.} Still, the reform induced the remaining small fraction to complete 9 years of schooling.\footnote{We define reform as individuals born in 1957 or later. While the reform’s main impact was for the 1957 cohort, the reform was not completely binding until the 1959 cohort as some had dropped out at the time of the enactment – these children were not forced back to school. Appendix B.1 describes the reform in detail.}

Fig. 5 illustrates how the 1972 reform affected education outcomes. As previously described, the 1972 reform followed from a long upward trend in completed education driven by an increasing prevalence of completing lower secondary schooling. As the figure shows, before the enactment of the reform around 95% completed at least 8 years of schooling and almost 90% completed 9 years
Figure 4: Impact of the 1958 reform on education and urban-rural gap

Fraction with no more than 7 years of schooling

a) Level, urban and rural areas  b) Urban-rural gap

Average years of schooling

c) Level, urban and rural areas  d) Urban-rural gap

Average cognitive test scores

e) Level, urban and rural areas  f) Urban-rural gap

Note: Figs. a), c), and e) show the fraction with 7 years of schooling, total years of schooling, and average cognitive test scores by whether individuals were born in urban or rural areas by birth cohort from 1921 to 1962 (1940-1958 for test scores). Figs. b), d), and f) show the corresponding urban-rural gap. Figures A.8 show full cognitive test score distribution by region of birth for the birth cohorts 1940 and 1958.
of schooling. The reform led to a discrete jump in education levels with the result that virtually all completed more than 7 years of schooling and around 95% completed at least 9 years. Moreover, the reform also led to a discrete reduction in the standard deviation of years of schooling (cf. Fig. 5d).

To further examine the differential impact of the two reforms (in 1958 and 1972), Fig. A.9 presents the cumulative distributions of cognitive test scores for birth cohorts 1940, 1941 (the two last cohorts not affected by the 1958 reform), 1942 (the first cohort affected by the 1958 reform), 1956 (the last cohort not affected by the 1972 reform), and 1957, 1958 (the first two cohorts affected by the 1972 reform). While we see no differences between the distributions of the 1940 and 1941 cohorts, the 1942 cohort’s distribution is clearly shifted upwards, corroborating the finding reported earlier. As the difference between the 1942 and 1956 cohorts shows, the following decade saw a further increase in cognitive skills. However, as the pronounced overlap in test score distributions of the 1956, 1957, and 1958 cohorts indicate, the compulsory schooling reform of 1972 did not significantly increase the equality in cognitive skills. In contrast, the equalizing trend in skills was already in place before the reform.

To formally test how educational expansion at the bottom of the schooling distribution affected overall mobility levels, we report by year of birth the education IGE and the intergenerational correlation in years of schooling defined as:

\[ E_{i,t}^C = \alpha_t + \beta_t^{IGE} E_{i,t}^P + u_{i,t} \quad \text{and} \quad \text{corr}(E_{i,t}^C, E_{i,t}^P) \]  

(1)

where \( E_{i,t}^C \) are children’s years of schooling and \( E_{i,t}^P \) are parents’ years of schooling. Panel A of Table 1 shows educational mobility estimates for the cohorts not affected by the 1958 reform (those born 1932–1941) and the first ten cohorts after the reform (cohorts born 1942-1951). Panel B of Table 1
Figure 5: Education levels around the increase in compulsory schooling, by year of birth

(a) Years of schooling
(b) Fraction with more than 7 years of schooling
(c) Fraction at least 9 years of schooling
(d) Standard deviation of years of schooling

Note: The figure plots education outcomes by year of birth. The estimated effects of the reform on these education outcomes and are reported in Table A.2 for the full country and separately for rural and urban areas.
similarly shows estimates for the last cohort not affected by the 1972 reform (the cohort of 1956) and the first cohort affected by the reform (the cohort of 1958). The table presents estimates for the entire country and by rural-urban origin. Panel A shows that mobility increased significantly across the 1958 reform. This result holds irrespective of whether we examine the education IGE or the education correlation. Panel A also shows that cohorts born before 1942 in rural areas experienced less mobility with an education IGE estimate of 0.58 compared to those born in urban areas with an estimate of 0.48. However, among those born after 1942, the rural-urban gap completely disappears. Thus, while educational mobility for those who grew up in urban areas remain roughly constant across the entire period, mobility increases significantly for those born in rural areas. Panel B shows equivalent estimates for the 1972 reform. However, the compulsory schooling reform of 1972 affected only a small fraction of children, with its largest impact being on the variance in years of schooling (cf. Fig. 5d). As a consequence, Panel B shows that the 1972 reform is associated with only a minor decline in the education IGE and no changes to the education correlation.

3.2 Towards lower educational mobility

To visualize the extent of the reversal from high levels of mobility towards lower levels of mobility, Fig. 6 plots by birth year the education IGE and education correlation for those born 1956–1987. The figure shows that cohorts born 1956–1958 experienced the lowest education correlation in our entire data period of cohorts born throughout the 20th century. Beginning with the cohort of 1958, the education correlation increases gradually. The figure also shows that the education IGEs continue to decline beyond the correlation low-point into the mid-1960s (the discrepancy in trends in the 1960s is driven by decreasing variance in years of schooling, see Appendix 5d). The result was unprecedented levels of educational mobility as measured by the education IGE. Over roughly
Table 1: Education IGE by rural-urban origin and child year of birth

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<th>A) 1958 reform (Survey data)</th>
<th>B) 1972 reform (register data)</th>
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<td>Pre-reform</td>
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<td>1932-41</td>
<td>1942-51</td>
</tr>
<tr>
<td><strong>Full country</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\beta_{IGE}$</td>
<td>0.579</td>
<td>0.424</td>
</tr>
<tr>
<td></td>
<td>(0.027)</td>
<td>(0.025)</td>
</tr>
<tr>
<td>Correlation</td>
<td>0.512</td>
<td>0.409</td>
</tr>
</tbody>
</table>

| **Urban areas**      |            |             |          |          |          |          |
| $\beta_{IGE}$       | 0.476      | 0.438       | -0.039   | 0.350    | 0.326    | -0.023*** |
|                      | (0.038)    | (0.039)     | (0.054)  | (0.005)  | (0.004)  | (0.007)   |
| Correlation          | 0.450      | 0.389       | -0.073*  | 0.326    | 0.326    | 0.000     |

| **Rural areas**      |            |             |          |          |          |          |
| $\beta_{IGE}$       | 0.584      | 0.382       | -0.203*** | 0.317    | 0.292    | -0.024    |
|                      | (0.040)    | (0.034)     | (0.052)  | (0.013)  | (0.011)  | (0.017)   |
| Correlation          | 0.544      | 0.422       | -0.122*** | 0.225    | 0.232    | 0.007     |

Note: The table shows coefficients from regressions of child years of schooling on fathers’ years of schooling by child year of birth and rural and urban regions of upbringing (see Section B). The table also shows the corresponding correlation coefficients. Child cohorts binned as 1932-1941 and 1942-1951 in Panel A.

*: p < 0.05; **: p < 0.01; ***: p < 0.001
one quarter of a century, educational mobility increased from an education IGE of about 0.55 to about 0.30.

Nonetheless, Fig. 6 also documents stark increases in the education IGE and education correlation for cohorts born the mid-1960s through the mid-1980s. This trend is remarkable in light of the welfare policies that were rolled out during this period. These are the cohorts who were the first to have access to public childcare early in life (rolled out during the late 1960s through the early 1970s), who benefited from the generous redistribution via progressive taxation and social transfers, and who faced no direct pecuniary costs of education at all levels; all factors that are often emphasized as being central parts of the Scandinavian welfare regime, and which have been shown to increase educational attainment (e.g., Havnes and Mogstad 2011; Nielsen et al. 2010). Our finding does not imply that policies such as universal childcare did not have positive effects for those from the weakest backgrounds as found in earlier studies. By way of contrast, it shows the potent impact of the overall changes to the educational distribution at this point in time.

To test the robustness of the trend in the education IGE to the way in which we measure education, Fig. A.11 presents trends using categorical measures of education. In Fig. A.11a, we show trends over the century using Kruskal-Goodman’s gamma coefficient, a nonparametric correlation coefficient for ordinal variables, the polychoric correlation coefficient (which takes schooling as an ordinal measure of an underlying normally distributed latent variable), and taking education distributions as an ordinal measure of underlying skills (as in Fletcher and Han 2019). These

The trends with decreasing mobility are perfectly mirrored in trends in the dispersion of schooling. Fig. A.10a shows the standard deviation in years of schooling for cohorts born 1921–1985. Those born 1942 (i.e., those affected by the 1958-reform) through 1957 (i.e., those affected by the 1972 compulsory schooling reform) experienced a very large decline in educational inequality, and the decline continued at a lower rate through those born in the mid 1960s. However, for cohorts born cohorts born 1965–1984, inequality has begun increasing. Fig. A.10b provides another way of illustrating this finding by plotting by birth cohort the average years of schooling for the bottom and top 30% of the schooling distribution. The figure shows a similar rapid decline in inequality caused by the 1958 reform, reaching an all-time low in the mid-1960s, from where it begins increasing again through the mid-1980s.
Figure 6: Education IGE by child year of birth, birth cohorts 1955–1987

Note: The figure shows coefficients from regressions of child years of schooling on parents’ average years of schooling, and the correlation coefficients between parents’ average years of schooling and child years of schooling, by child year of birth.
supplementary analyses show trends that are much similar to those reported in Figs. 1 and 6a.

In Fig. A.11b, we report by year of birth for cohorts born 1957–1988 estimates of the Information Theory Multigroup Index, Theil’s H, \cite{ReardonFirebaugh2002}. The index compares the average conditional entropy of children’s schooling given parents’ schooling to the unconditional entropy of children’s schooling, and can thus be considered a measure much similar to the R-squared in linear regression \cite{Theil1973, p. 173}. We estimate this index using the a highly granular measure of education for both parents and children. Fig. A.11b shows by year of birth the estimated index both for dissaggregate education degrees (around 1,000 categories in total) and for the aggregate degrees (20 categories in total). We find a clear upward trend in coefficients, showing that we reach the same conclusion about educational mobility declining across these cohorts when we measure mobility using different measures of education and approaches to measuring mobility.

Fig. A.11c also replicates the overall finding using the log-multiplicative layer-effect or unidiff model \cite{EriksonGoldthorpe1992}, which summarizes how the overall origin-destination (parent-child) association in a cross-tabulation of education levels changes across time relative to an index period (in our case 1957).

We also reach the same conclusions when we plot the trends over the entire century in the correlation between parents’ years of schooling and whether children are upwardly or downwardly mobile (in an absolute sense), respectively (see Fig. A.12). While upward (downward) educational mobility was increasingly (decreasingly) experienced by children with low-educated parents for cohorts born during the 1940s, 1950s, and 1960s, the younger cohorts have seen a reversed pattern in which upward (downward) educational mobility is becoming more prevalent among children whose parents have higher (lower) degrees.

In sum, our key finding reported in Fig. 6 is robust to alternative ways of measuring education
and educational mobility, meaning that all evidence point to that mobility has decreased substantially for cohort born after the mid-1960s. In the following section we will describe this trend in two steps. We first show how transitions from high school into higher education changes drastically for cohorts born in the mid-1960s when the upper tail expansion of the education distribution starts. We then turn to the long-run expansion of college and university degrees and how these changes are related to parental schooling.

**Changes to transitions into higher education**

As a first step in further analyzing the reversal in the mobility trend for cohorts born after the mid-1960s, Fig. 7 plots by year of birth the fractions transitioning to academic high school, to college given academic high school completion, and to university given college completion, for cohorts born 1921–1987. The transition probabilities are calculated conditional on being eligible for enrolling as illustrated in the stylized model of the Danish educational system in Fig. 2: completion of 9th grade is required for enrolling in academic high school, completion of academic high school is required for enrolling in college, and college completion is required for university enrollment. The figure shows that only around 20% of those completing the 9th grade went on to complete academic high school until the 1940 cohort. For those born 1940–1965, the conditional academic high school completion probability doubled. As the fraction of eligible completing at least 9 years of schooling increased from around 60% to 100%, this implied that overall (unconditional) academic high school completion was required for enrolling in academic high school, completion of academic high school is required for enrolling in college, and college completion is required for university enrollment.

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20 As completing academic high school is a prerequisite for college enrollment, this next section specifically examines the completion of this academic track and not the completion of all types of high school (which would include also analyzing the vocational track). Several studies have examined the importance of transition probabilities in shaping overall education trends in the U.S., for example documenting an increasing share (of males) graduate with a GED instead of a formal high school degree (Heckman and LaFontaine, 2010), a substantial drop in college graduation rates for males, which is matched by an increase for females (Card and Lemieux, 2001) and decreasing college graduation rates conditional on college enrollment (Bound et al., 2010).
high school completion increased from approximately 15 to 40%. Yet, as the figure also shows, college completion conditional on academic high school completion dropped dramatically as only around 15% of the additional high school graduates went on to higher education. For the 1950 cohort, 80% of those completing academic high school completed college afterwards. Thus, for cohorts born in the early 1960s, this fraction had dropped to around 40%.

Nevertheless, similar to the trend in overall mobility estimates, the cohorts born during the mid-1960s mark a turning point. Academic high school completion increases from less than 40% for cohorts born in the mid-1960s to almost 60% for cohorts born in the mid-1980s. Furthermore, the probability of completing college conditional on graduating from academic high school increases from around 40% to 70% over just 20–25 cohorts. And while the probability of completing university conditional on college completion stagnates until cohorts born in the mid-1970s, the transition probability increases from around 33% to almost 50% over the 10 youngest cohorts. Thus, within a relatively short period, transitions into higher education increase dramatically.
Figure 7: Fractions of a birth cohort making given educational transitions, by birth cohort

Note: Figure shows average education levels by year of birth for cohorts born 1921–1987. The solid line shows average academic high school completion conditional on completion of 9th grade (which is the eligibility criterion). The short-dashed line shows the probability of college completion conditional on academic high school completion, and the long-dashed line shows that probability of university completion conditional on completing college (i.e., completing either a university bachelor’s degree or a university college bachelor’s degree).

College and university completion by family background

As a second step in analyzing the reversal of the mobility trend—which began among those born in the mid-1960s—we link the changes to higher education completion rates in Fig. 7 to parents’
education. Fig. 8a shows the correlation between educational transitions (to high school overall, to the academic high school track, to college, and to university) and parents’ years of schooling among those born 1956–1987. Fig. 8b shows the same trends in the correlation coefficients as in Fig. 8a with the coefficients being indexed relative to those reported for the 1960 cohort. The figures show pronounced differences in the correlations between children’s education and parents’ years of schooling during the period in question. Although the correlation between high school completion and parental schooling is roughly constant throughout the cohort window, parents’ education correlates increasingly with children’s higher education attainment. Parents’ education becomes increasingly predictive of children completing college and university degrees for cohorts born during the 1960s. Indeed, over the course of 30 years, the correlation between completing a university degree and parents’ years of schooling increases by around 50%. This pattern suggests that children of highly educated parents have benefited more than children of low-educated parents from the college and university expansion.

Fig. 8c zooms in on the transitions from high school to college and university. The figure presents the correlation between parents’ years of schooling and the conditional probabilities of college completion and university completion. Fig. 8d shows the same figures with the correlations indexed relative to the 1965 cohort. The figures show that the transition probabilities increase by 30-40% over the roughly 20 cohorts in question. Thus, a substantial part of the education expansion appears to be driven by an increased propensity to transition from lower to higher levels of education, a change that has been most pronounced for children born to highly educated parents.21

21 As shown in [Cameron and Heckman, 1998], a unadjusted analysis of transition probabilities is subject to sample selection bias between different levels. However, 8a shows that the correlation between academic high school completion and parents’ education is almost constant across the period in question. Therefore, sample selection bias in this dimension is not likely to affect our results. In Section 4, we analyze changes to skill-based selection across the educational margins.
Fig. A.13 graphs college and university completion rates across parents’ education by year of birth and field of study. The figure shows that the increasing college completion rates for cohorts born in the mid-1960s onwards are driven by increases in teacher and pedagogue degrees, and college degrees within humanities and social sciences. However, only the latter type of education sees increasing gaps across parental education. For university completion, degrees in humanities and social sciences increased by around 400% from the cohorts born in the mid-1960s to those born mid-1980s—an increase almost exclusively driven by children born to well-educated parents.\footnote{For cohorts born in the mid-1980s, children whose parents are in the lowest tertile of years of schooling make up 8%, 13%, and 13% of degrees within the medical sciences, technical degrees and natural sciences, and humanities and social sciences, respectively. For comparison, children whose parents belong the top tertile of years of schooling comprise 75%, 62%, and 63% of the three categories.}

To examine how much of the decrease in educational mobility for cohorts born between the mid-1960s and the mid-1980s that can be attributed to the differential changes to transition probabilities between education levels, we exploit that educational attainment is a series of sequential decisions \cite{Boudon1974, CameronHeckman1998, Mare1980, Mare1981}, which, by the Law of Iterated Expectations, makes the probability of completing education level $j$ equal to $p(E_j = 1) = \prod_{k=1}^{j} p(E_k = 1|E_{k-1} = 1)$. We can thus express children’s average years of schooling $E(Y)$ as a simple product of (conditional) education transition probabilities multiplied by the average years of schooling associated with each education level from the lowest $j = 0$ to the highest $j = J$:

\[
E(Y) = \sum_{j=0}^{J} \left( \prod_{k=1}^{j} p(E_k = 1|E_{k-1} = 1) \right) \left[ E(Y|E_j = 1) - E(Y|E_{j-1} = 1) \right]
\]

(2)
Figure 8: Correlation between education level and parents’ education, birth cohorts 1955–1987

Correlation parents’ years of schooling and child education levels
a) Unadjusted
b) Relative to 1960 cohort

Correlation parents’ years of schooling and child education levels, conditional on completion of previous level

c) Unadjusted
d) Relative to 1965 cohort

Note: Fig. a) shows correlation coefficients between parents’ years of schooling and child completion of specific degrees. Fig. b) shows the correlations indexed relative to those estimated for the 1960 cohort. Figs. c) and d) show the correlation between parents’ years of schooling and i) college completion conditional on academic high school completion, ii) university completion conditional on college completion. Fig. d) shows the correlation indexed to those estimated for the 1969 cohort.
Fig. 9 presents the results of four simulations using the decomposition of years of schooling by different transition probabilities across parental education levels. The solid line presents the observed education IGE as a benchmark. The four other lines present the education IGEs i) if the transition into academic high school had been fixed to the pattern in the 1969 cohort, ii) if the transition from academic high school to college had been fixed to that in the 1969 cohort, iii) if the transition from college to university had been fixed to that in the 1969 cohort, and iv) if all the aforementioned transition probabilities were fixed to the pattern in the 1969 cohort.

The figure shows that the transition into academic high school and the transition from college to university only account for a minor part of the increased education IGE. The result for the former is a consequence of the correlation between academic high school completion and parents’ education being almost unchanged across the period in question (see Fig. 8), whereas the result of the latter is a consequence of the relative small proportion of a cohort completing a university degree (i.e., the transition into university has become more selective but this only affects a small fraction). The figure shows that the lion’s share of the decreases in educational mobility is caused by college becoming more selective on family background over time. Had the selection into college across parental background been as it was for the 1969 cohort, the education IGE for the 1987 cohort had been 0.41 instead of 0.48. If all transition probabilities collectively had remained as in the 1969 cohort, then the education IGE would only have reached a level just above 0.35.
Figure 9: Simulated Education IGE by child year of birth, birth cohorts 1969–1987

Note: The figure shows coefficients from regressions of child years of schooling on parents’ average years of schooling, and the correlation coefficients between parents’ average years of schooling and child years of schooling, by child year of birth.
4 Education, skills, and life course inequality

Our analyses show that changes to the levels of educational mobility in Denmark are strongly related to educational expansion. However, given the dramatic changes to the schooling distribution, we turn to examining changes in the underlying components of education over time. We address this question in two steps. First, in Section 4.1 we examine if the selection into different education levels proxies the same type of skills today as it did half a century ago. Second, in Section 4.2 we describe the changes to how predictive education is of a broader set of life course outcomes such as earnings, employment, marriage, health, and crime.

4.1 The association between education and skills

Fig. 10 plots by year of birth the correlation between children’s cognitive test scores and their years of schooling. As Fig. 10a shows, the correlation declines dramatically for cohorts born 1940–1958. This result holds irrespective of whether we consider the full-range test score or the normal-test score dummy (the latter covering a larger range of birth cohorts). However, as Fig. 10b shows, the correlation coefficients among the younger cohorts—who have been affected by the expansion of college and university education—have not reversed back towards the levels of the older cohorts. In contrast, the correlation appears stable for later cohorts.

While Fig. 10 clearly establishes a disconnect between overall years of schooling and cognitive skills, our earlier findings—regarding changing transition probabilities from lower secondary school to high school and from high school to college—raise the question of whether the lower association between cognitive skills and years of schooling is observed for all educational transitions. Fig. 11 presents the correlation between cognitive test scores and highest level of education by birth cohort.
Figure 10: Correlation between cognitive skills and years of schooling, by birth cohort

Fig. 11a presents the associations for years of schooling (as in Fig. 10) for reference, and for high school, college, and university completion separately. The figure shows that correlations decline until those born in the late 1950s, after which the correlation coefficient is more or less constant. However, as Figs. 11b-d show, the decline is mainly driven by a drop in the association between cognitive skills and completion of lower secondary schooling (9th grade). While Fig. 11b shows a decrease in the correlation, Fig. 11c, which shows high school completion conditional on completing 9 years of schooling, presents a very different picture: Cohorts born 1940–1958 start out at a much lower level when considering the correlation between academic high school completion conditional on 9th grade completion and cognitive skills (11b). After a small increase, the correlation subsequently declines a little. Furthermore, the association between college completion conditional on academic high school completion and cognitive test scores (11d) is low at around 0-0.1 and almost constant across the period (perhaps mildly increasing for the most recent cohorts). These findings suggest that the selection on cognitive skills into different education levels changes substantially over time as the educational system expands at different levels. Thus, differences in education levels for the most recent cohorts do not reflect the same cognitive skill gaps as for the cohorts born, say, during the 1940s.

Yet, skill dimensions other than cognitive skills are also important for educational attainment (Almlund et al., 2011). While the conscription data allow us to study the cognitive skills of cohorts born almost 50 years apart, we do not have available comparable measures of non-cognitive skills in the register data. However, two Danish surveys allow us to attempt a crude comparison: the Danish Youth Longitudinal Study for children born around 1954 and the Danish Longitudinal

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23 Fig. A.14 examines how education expansions across different margins are related to the selection on cognitive skills at different parts of the skill distribution. The figure shows that educational expansion was driven by the children with low cognitive skills until the late 1950s. Yet, from the 1970s onwards the education expansion instead involves increasing levels of positive selection where education have expanded mostly for individuals with high cognitive skills.
Figure 11: Correlation between cognitive skills and education levels, by birth cohort

a) All education levels, unconditional

b) 9th grade completion

c) Academic high school completion | 9th grade completion

d) College completion | academic high school completion

Study of Children (DALSC) for children born in 1995. Both are nationally representative surveys that include identical measures; the same cognitive test score measured at ages 14–15 (a verbal intelligence test) and the Rosenberg self-esteem scale (Rosenberg, 1965) measured at around age 20.24 Table 2 shows the estimated coefficient from regressions of the schooling outcomes on cognitive and non-cognitive test scores separately for the two surveys. Panel A presents results for the 1954 cohort, and Panel B presents results for the 1995 cohort. Panel C shows the coefficient changes (Panel B minus A), and in Panel D we present regression results using the Big-5 inventory from the 1995 survey (measured at age 15).

Column 1 in the table shows that the coefficient of cognitive skills on academic high school completion decreases between the two surveys, suggesting that the selection by cognitive skills at this margin has become weaker over time. Comparing the estimates for cognitive skills between columns 1, 2, and 3, we find that (i) cognitive skills in both cohorts are strongly associated with academic high school completion, (ii) much of the association between college education and cognitive skills can be explained by the sorting into academic high schools, and (iii) while the importance of cognitive skills has decreased at the high school margin, it has increased at the college margin, both when we consider the unconditional and conditional college margins in columns 2 and 3, respectively. These overall patterns corroborate the findings based on the conscription registers reported in Fig. 11. Nonetheless, the table also shows that our non-cognitive measure, self-esteem, is more predictive of educational attainment in the 1995 cohort than in the 1954 cohort.25 While there is no association in the 1954 cohort, self-esteem is significantly associated with both high

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24 Section B.3 describes the data construction. As the 1995 cohort have not yet reached an age when we can measure their college and university completion rates, we instead define college completion as having completed a college degree (or higher) or being enrolled in college or university.

25 Similarly, Blanden et al. (2007) find that non-cognitive skills play a greater role in mediating intergenerational income mobility for more recent cohorts in the U.K., and Edin et al. (2018) find an increasing return to non-cognitive skills in Sweden during recent decades.
school and college completion in the 1995 cohort (although associations are smaller than those involving the verbal intelligence measure). This finding suggests that the declining relationship between cognitive skills and academic high school completion appears to have been replaced by a growing selection based on non-cognitive skills, thus mirroring the U.S. findings with respect to high school drop outs, GED recipients, and high school graduation for which non-cognitive skills also play an important role in the selection (e.g. Heckman et al. 2011).

However, non-cognitive skills and behavioral traits are not fully captured by a single measure such as Rosenberg’s self-esteem. Panel D exemplifies this point by replacing the Rosenberg scale with the the Big-5 traits in the 1995 cohort survey. We find that the selection on different aspects of skills and traits is highly non-monotonic across different education transitions. For example, conscientiousness becomes stronger associated with education as education levels increase. After conditioning on high school completion in Column 3, the regression coefficient of conscientiousness has roughly the same magnitude as the coefficient for cognitive skills. However, conscientiousness is only mildly associated with academic high school completion. In contrast, extraversion is positively associated with academic high school completion, but negatively associated with college level education.

Considered together, Fig. 11 and Table 2 show that the importance of skills for selection into education both changes across time and across education levels. This finding suggests that the intergenerational transmission of education likely proxies a different type of intergenerational skill transmission today than it did 30 or 40 years ago. Moreover, while we have shown how the associations between education and skills have changed for a few skill dimensions, the results based on the Big-5 traits suggest a less clear-cut pattern.
Table 2: Estimated association between cognitive and non-cognitive skills, and academic high school completion and college completion

<table>
<thead>
<tr>
<th></th>
<th>(1) Academic high school</th>
<th>(2) College</th>
<th>(3) College</th>
<th>aca. high school</th>
</tr>
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<tbody>
<tr>
<td><strong>A: 1954 cohort</strong></td>
<td></td>
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<tr>
<td>Cognitive test score</td>
<td>0.209***</td>
<td>0.134***</td>
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<td></td>
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<td>(0.007)</td>
<td>(0.023)</td>
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<tr>
<td>Non-cognitive (Rosenberg scale)</td>
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<td>-0.029</td>
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<tr>
<td></td>
<td>(0.008)</td>
<td>(0.007)</td>
<td>(0.023)</td>
<td></td>
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<tr>
<td><strong>B: 1995 cohort</strong></td>
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<td></td>
</tr>
<tr>
<td>Cognitive test score</td>
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<td>0.054***</td>
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<td></td>
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<td>(0.008)</td>
<td>(0.010)</td>
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<td><strong>C: 1995-1954 difference</strong></td>
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<tr>
<td>Cognitive test score</td>
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<tr>
<td>Non-cognitive (Rosenberg scale)</td>
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<td>0.059***</td>
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<tr>
<td><strong>D: 1995 cohort</strong></td>
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<tr>
<td>Cognitive test score</td>
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<td></td>
<td>(0.007)</td>
<td>(0.008)</td>
<td>(0.010)</td>
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<tr>
<td>Conscientiousness</td>
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<td>(0.009)</td>
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<td>(0.008)</td>
<td>(0.011)</td>
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<td>Agreeableness</td>
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<td></td>
<td>(0.007)</td>
<td>(0.008)</td>
<td>(0.010)</td>
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<td>Neurotism</td>
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<td>-0.018*</td>
<td>-0.010</td>
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<tr>
<td></td>
<td>(0.008)</td>
<td>(0.009)</td>
<td>(0.011)</td>
<td></td>
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</tbody>
</table>

Note: The table shows regression coefficients of academic high school completion (1), college completion/enrollment (2), and college completion/enrollment (3), on cognitive test scores, and the Rosenberg self-esteem scale in Panel A and Panel B. Panel C shows the differences between the 1995 and 1954 estimates. Panel D shows similar regression coefficients for the Big-5 inventories. All regressors have been standardized to mean 0 and std. dev. 1. All regressions are conditional on gender. Table B.3 presents correlations between the Rosenberg scale and cognitive test score used in this table and alternative measures of skills and traits. Number of observations: In the Youth cohort survey of 1954 2,551, 2,551, and 729, in columns 1,2, and 3, respectively; in the Danish Longitudinal Study of Children in the 1995 cohort 3,711, 3,711, and 2,642, in columns 1,2, and 3, respectively.

*: *p < 0.05*; **: *p < 0.01*; ***: *p < 0.001*
4.2 Education gaps and life course inequality across time

To further examine what education proxies, this section presents how the association between completed education and general life course outcomes changes over time in Denmark.

Fig. 12 plots correlation coefficients between cognitive skills and years of schooling, on the one hand, and within-cohort wage earnings percentiles (12a), employment rates (12b), an overall health score (12c), an indicator of health problems by type (12d), the probability of being married at age 35 (12e), and youth crime between age 15-17 (12f) on the other. The figure shows that the respective correlations with years of schooling and cognitive skills follow parallel trends until the late 1950s. For those born from the 1960s and onwards, however, the trends are characterized by a strong divergence for all six outcomes. Years of schooling have become increasingly predictive of wage earnings, employment rates, mental health, marriage rates, and crime rates, with correlations increasing by 50-100%, whereas the associations between cognitive test scores and the different outcomes remain constant.

Fig. A.16 shows that the trends presented in Fig. 12 are driven by those who do not complete a high school degree. Across education levels from less than high school to high school, college, and university completion, the slopes in all outcomes are similar in the 1960 and 1970 cohorts. However, when we compare cohorts born in the 1970s with cohorts born in the 1980s (which are the cohorts for whom high school completion rates are virtually constant), individuals without a high school degree increasingly fall behind. This pattern exists for income, employment, marriage probability, mental health, and crime.

Fig. A.15 links wage earnings and employment (measured at age 29) to full-range scores for the 1988 cohort illustrating that the divergence between how education and cognitive skills are associated with the outcomes also holds when considering the full test scores – i.e. the divergence is not a result of the focus on the lower part of the cognitive skills distribution when we use the cognitive test score dummy.
Figure 12: Correlation between years of schooling/cognitive skills and other outcomes

a) Wage earnings percentile, age 34-36

b) P(employment), age 34-36

c) Health score, age 18

d) Health, problems age 18

e) P(married), age 35

f) P(Youth crime), age 15-17

Note: The figure shows correlation coefficients between outcomes (wage earnings percentiles / employment / health / marriage / youth crime) and i) years of schooling ii) full cognitive test scores (for the years possible), and iii) the normal cognitive test score dummy.
Finally, returning to intergenerational social mobility, Table A.3 shows that the respective relationships between parental schooling and the six life outcomes also change across time and that these changes are mediated by children’s schooling. While the association between parents’ years of schooling and child cognitive skills remains unchanged over the period, the associations between parents’ years of schooling and the six outcomes increase in magnitude. However, upon adjusted for children’s years of schooling, we see substantially muted trends for all outcomes, with several estimates being borderline statistically significantly different from each other (with sample sizes of around 100,000 observations). Thus our results show that the increasing transmission from parents to children applies to many outcomes, a trend that is almost fully explained by children’s education.

In sum, the cohorts born during the 1950s and 1960s not only experienced a greater likelihood of educational mobility compared to cohorts born during the 1980s, the skill-based selection into education for these cohorts also changed. Moreover, education gaps today are associated with larger inequality in life course outcomes such as earnings, mental health, family formation, and crime. Thus, as the educational system and labor markets change, educational mobility is not only changing across time as a result of changes to the education distribution but is also likely proxying different types of underlying mechanisms related to skills.

5 Conclusion

This paper documents substantial changes to intergenerational educational mobility for cohorts born across most of the 20th century in Denmark using both full population register data and Table A.3 shows the estimates $\beta_{t}^{UA}$, $\beta_{t}^{1}$ from regressions of children’s outcomes $y_{i,t}^{C}$ on parents’ years of schooling $E_{i,t}^{P}$ unadjusted and conditional on child years of schooling $E_{i,t}^{C}$:

$y_{i,t}^{C} = \alpha_{t} + \beta_{t}^{UA} E_{i,t}^{P} + u_{i,t}$ and $y_{i,t}^{C} = \alpha_{t} + \beta_{t}^{1} E_{i,t}^{P} + \gamma E_{i,t}^{C} + \hat{u}_{i,t}$
historical survey data.

We link the large changes in educational mobility to how the educational system expanded at different margins across the century. While Denmark is widely regarded as having high levels of educational mobility by international comparison, our empirical estimates show that this is only true for a relatively small subset of birth cohorts born in the 1950s and 1960s. These cohorts benefited from the major schooling reforms in 1958 and 1972, which led to a substantial compression of the schooling distribution at its lower tail. For cohorts born before these reforms came into place, educational mobility levels were much lower. Furthermore, for the youngest cohorts born during the 1970s and 1980s, educational mobility has declined in tandem with the expansion of the educational system at its upper tail (i.e., at the college and university level). A strengthened link between parents’ education and the probability that children continue to college or university after high school completion is the main cause of decreasing mobility. Consequently, children born in the mid-1980s experience levels of mobility similar to those born in the mid-1940s or in the U.S. for similar cohorts. Thus our overall findings suggest that educational mobility is highly dependent on how schooling distributions change over time.

Our findings highlight some of the challenges that promoting equality of opportunity entails. Even with universal childcare, education without pecuniary costs, and generous public education support, educational mobility is rapidly declining in Denmark as the increasing college and university completion rates are predominantly driven by those born to well-educated parents.

Our study also draws on full population cognitive skill data from conscription records to examine how the relationship between education and skills changes. We find that the compression at the lower tail of the schooling distribution for cohorts born in the 1950s and 1960s strongly reduces the association between education and cognitive skills. Cognitive skills become less predictive of
educational attainment at lower levels in contrast to non-cognitive skills, which appear to become more predictive. Moreover, the links between education on the one hand and other life outcomes such as earnings, employment, health, marital status, or crime on the other become stronger for more recent cohorts as those who do not complete high school are increasingly falling behind on all of these dimensions.

In conclusion, our results show that the transmission of education between generations capture both different degrees and components of human capital transmission across the 20th century. Consequently, our study stresses the difficulties in comparing cross-sectional estimates of educational mobility among countries or among regions within countries. Snapshot estimates of mobility do not necessarily represent what is occurring in steady-state. When distributions change for children’s and/or parents’ generations, so do intergenerational mobility and the life course consequences of gaps in schooling.
References


### Table A.1: Summary of outcomes other than education

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<tbody>
<tr>
<td>Normal cognitive test scores (0/1)</td>
<td>0.62</td>
<td>0.78</td>
<td>0.81</td>
<td>0.82</td>
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<td>Wage earnings (1,000 2010$), age 32-34</td>
<td>34.70</td>
<td>39.51</td>
<td>40.92</td>
<td>40.56</td>
<td>39.09</td>
<td>39.59</td>
<td>39.48</td>
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<td>Employment (0/1), age 32-34</td>
<td>0.86</td>
<td>0.88</td>
<td>0.89</td>
<td>0.88</td>
<td>0.87</td>
<td>0.87</td>
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<tr>
<td>Youth crime (0/1), age 15-17</td>
<td>0.15</td>
<td>0.14</td>
<td>0.12</td>
<td>0.13</td>
<td>0.12</td>
<td>0.12</td>
<td>0.14</td>
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<tr>
<td>Married (0/1), age 35</td>
<td>0.69</td>
<td>0.68</td>
<td>0.68</td>
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<td>0.67</td>
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<td>Health (0/4), age 18</td>
<td>2.58</td>
<td>2.51</td>
<td>2.49</td>
<td>2.41</td>
<td>2.23</td>
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<td>Mental health problems (0/1), age 18</td>
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<td>0.10</td>
<td>0.14</td>
<td>0.16</td>
<td>0.18</td>
<td>0.18</td>
<td>0.19</td>
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Note: Table shows mean values for males by birth cohort (binned into categories of 2-3 years) for the outcomes other than education.
Table A.2: Effect of the compulsory schooling reform on education outcomes

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<tr>
<th></th>
<th>All</th>
<th>Urban</th>
<th>Rural</th>
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<tr>
<td>Years of schooling</td>
<td>0.240***</td>
<td>0.217***</td>
<td>0.305***</td>
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<tr>
<td></td>
<td>(0.019)</td>
<td>(0.019)</td>
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<tr>
<td>More than 7 years of schooling</td>
<td>0.029***</td>
<td>0.028***</td>
<td>0.031***</td>
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<tr>
<td></td>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.004)</td>
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<tr>
<td>At least 9 years of schooling</td>
<td>0.043***</td>
<td>0.044***</td>
<td>0.042***</td>
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<tr>
<td></td>
<td>(0.008)</td>
<td>(0.007)</td>
<td>(0.007)</td>
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<tr>
<td>Observations</td>
<td>2,198,120</td>
<td>1,697,210</td>
<td>500,910</td>
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</table>

Note: Table shows the estimated effects of the 1972 compulsory schooling reform on years of schooling, the probability of completing more than 7 years of schooling, and the probability of completing at least 9 years of schooling. Estimates are shown for all individuals and by region of birth. The estimates are based on a bandwidth of ±14 cohorts around the reform and allows for different slopes of each side of the reform approximated by fourth order polynomial. Estimates are clustered by year of birth.

*: p < 0.05; **: p < 0.01; ***: p < 0.001
Table A.3: Regression coefficients of child outcomes on parents’ years of schooling conditional on either child years of schooling or child cognitive test scores

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<tr>
<td>A) Cognitive test score dummy (0/1)</td>
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<tr>
<td>Unadjusted</td>
<td>0.043***</td>
<td>0.038***</td>
<td>0.037***</td>
<td>0.035***</td>
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<td>0.022***</td>
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<td>B) Ln(Wage earnings), age 32-34</td>
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<td>Unadjusted</td>
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<td>0.034***</td>
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<td>0.039***</td>
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<td>C) Employment (0/1), age 32-34</td>
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<td>D) Youth crime (0/1), age 15-17</td>
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<td>E) Married (0/1), age 35</td>
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<td>F) Health (0/4), age 18</td>
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<td>0.021***</td>
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<td>child years of schooling</td>
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<td>G) Mental health problems (0/1), age 18</td>
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<td>child years of schooling</td>
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Note: Table shows coefficients from regressing the outcomes in question on parents’ years of schooling (the rows unadjusted and conditional on child years of schooling (the rows | child years of schooling)).

*: p < 0.05; **: p < 0.01; ***: p < 0.001
Figure A.1: Intergenerational education correlation by child year of birth

Intercepts from Education IGE estimates

c) Denmark
d) U.S.

Note: Figures A.1a and b show estimated intercepts (evaluated at fathers’ / parents’ with 7 years of schooling) of the education IGE estimates reported in Fig. 1 by year of birth for Denmark and the U.S. Figs. A.1c and d show the corresponding correlation coefficients between child years of schooling and fathers’ years of schooling in the survey data (1911-61) and parents’ average years of schooling in the register data (1956-84). Child cohorts binned into 1911-16, 1917-21, 1922-26, 1927-31, 1932-36, 1937-41, 1942-46, 1947-52, 1953-56, 1957-61, 1962-66, 1967-72, 1973-76, 1976-81, 1982-84.
Figure A.2: Intergenerational educational mobility estimates based on survey data only, by child birth cohort groups, for children born 1911-1976

a) Without sampling weights

b) With sampling weights

Note: The figure is based on survey data only and show education IGE estimates by birth cohort groups. Estimates are controlled for survey fixed effects. N = 8,650. Sampling (post-stratification) weights pertain to the European Social Survey (rounds 4 and 5). For each survey, we standardize the weights by dividing them with their mean.
Figure A.3: Nonlinear intergenerational educational mobility, by child year of birth

a) Survey data for cohorts born 1911-1957

b) Register data for cohorts born 1958-1986

Note: The figures show local polynomial smooths of children’s years of schooling across parents’ years of schooling by year of birth.
Figure A.4: Summary of register data, by birth cohort

Note: The figure summarizes the availability of register data across cohorts.
Figure A.5: Summary of sample size, by birth cohort

a) Full sample

b) By urban / rural area.

Note: The figure shows sample sizes for the total register data used and the conscription data (only males) in a) and the sample size by rural / urban birth for the cohorts where we study rural / urban differences in b).
Figure A.6: Education levels by child year of birth

Note: Fig. a) is based on full population register data, and shows discrete education levels and years of schooling by child birth cohort. Education is measured in 1981 for cohorts born before 1951 (and is therefore conditional on survival to 1981). Education is measured at age 30 for cohorts born after 1950, except in 1984 where education is measured a year earlier, explaining the small drop in average years of schooling from 1983-84. *Lower secondary*: 8-11.9; *High school*: 12-14.9; *College*: 15-16.9; *University*: 17-21.5. Figure b) shows highest completed education and total years of schooling by year of birth for the U.S. Fig. B) is based on cumulative data from the General Social Surveys 1972-2016 with information on years of schooling and completed degrees. *N = 31,582.*
**Figure A.7**: Cognitive test scores, by year of birth

a) Test score distributions, 1940, 1958, 1988

b) Average test scores and fraction with at least normal test scores

*Note:* The figure shows cognitive test scores distribution for cohorts 1940, 1958 and 1988 in Figure a), and in Figure b) the average test scores for cohorts born (which are available only for cohorts 1940-1958, and 1988) and the normal test score dummy (a test score of at least 36) for cohorts 1940-1958, 1970-1986, and 1988.
Figure A.8: Cognitive test score distributions by region of birth

a) Distribution: cohort of 1940  

b) Distribution: cohort of 1958

Note: The figure show full cognitive test score distribution by region of birth for the birth cohorts 1940 and 1958.
Figure A.9: Cumulative distributions of cognitive test scores, around the 1958 reform and the 1972 reform

Note: Figure shows the cumulative distribution of cognitive test scores for children born 1940, 1941, 1942, 1956, 1957, and 1958.
Figure A.10: Education inequality, by child year of birth

a) Standard deviation of years of schooling

b) Years of schooling, bottom and top 30%

Note: Fig. a) shows the standard deviation of years of schooling by birth cohort. Fig. b) shows the average years of schooling for the 30% with lowest (solid line) and highest years of schooling, and the dotted line shows the differences between the solid and dashed lines.
**Figure A.11:** Trends in educational mobility using categorical education variables

a) Kruskal-Goodman’s gamma coefficients and polychoric correlations

![Graph showing trends in educational mobility using categorical education variables.](image)

b) Information Theory Multigroup Index (Theil’s H)

c) Unidiff model

***Note***: Fig. a) shows by birth cohort estimates of Kruskal-Goodman’s gamma coefficient (a nonparametric correlation measure for ordinal variables) and estimates of the polychoric correlation (assuming underlying bivariate normality). Fig. b) shows estimates of the Information Theory Multigroup Index based on the rich education information in the administrative registers. According to Theil (1972), this index can be considered a nonparametric association measure of explained variance in qualitative variables (see also Reardon and Firebaugh [2002]). Figure c) shows estimates from unidiff model (Erikson and Goldthorpe [1992]), which is a log-multiplicative layer model comparing log-likelihoods of mobility transitions across time.
Figure A.12: Correlation, upward/downward mobility and parents’ years of schooling, by year of birth

Correlation, upward educational mobility and parents’ years of schooling
a) Survey data, cohorts 1920–1957

Correlation, downward educational mobility and parents’ years of schooling
c) Survey data, cohorts 1920–1957
d) Register data, cohorts 1956–1985

Note: Fig. shows, by birth cohort, the correlation between upward educational mobility (having more years of schooling than father / parents) and fathers years of schooling in a) and parents average years of schooling in b). Fig. a) is based in survey data. Fig. b) is based on full population register data. Figure a) presents five-year bins to increase stability, while figure b), with the larger sample size, presents coefficients on a yearly basis. While the level-difference from 1952-56 in Fig. a) to 1956 in Fig. b) seems large, the yearly coefficients in the survey data for the cohort 1956 is almost as low as the level seen in figure b). Similarly, Figures c) and d) show, by birth cohort, the correlation between downward educational mobility (having fewer years of schooling than father / parents) and fathers years of schooling in a) and parents education.
Figure A.13: College and university degrees by birth cohort, field of study, and parental education

**College level**

- a) Teachers and pedagogues
- b) Nurses
- c) Humanities
- d) Residual

**University level**

- e) Medical sciences
- f) Humanities
- g) Social science
- h) Technical / natural science

Note: The figure shows fraction of each cohort completing a college and university degree by field of study and parental education (defined as within-cohort tertiles of parents’ years of schooling). Residual college degrees consist mainly of shorter technical degrees, shorter financial degrees, social work degrees, and shorter language-business combinations. Technical and natural science degrees at university level also include agricultural science degrees.
Figure A.14: Correlation between education at expanding margin and cognitive test score dummy, by birth cohort

Note: The figure shows the correlation between offspring cognitive test scores and expansion at education margin. Expansion at education margin is defined as the percentage points difference between the fraction obtaining a given overall degree level in one cohort $E(C_{t-1} = e)$ and the fraction obtaining the same overall degree level in the next cohort $E(C_t = e)$ for an individual $i$ obtaining degree $e$. E.g., if 30% completed college in year $t-1$ and 32% in year $t$, whereas 10% completed university in year $t-1$ and 11% in year $t$, individuals with a college degree as their highest education are assigned 0.02, while individuals with a university degree in year $t$ are assigned 0.01.
Figure A.15: Correlation between years of schooling, cognitive skills, and other child outcomes, by birth cohort

a) Wage earnings percentile, age 29

b) P(employment), age 29

Note: The figure shows correlation coefficients between outcomes (wage earnings percentiles / employment) measuring wage earnings percentile and employment at age 29, as this allows the link to full test cognitive scores for the 1988 cohort.
Figure A.16: Average of life course outcomes, by education level and birth cohort

a) Wage earnings percentile, age 34-36

b) P(employment), age 34-36

c) Cognitive test score, age 18

d) Mental health, problems age 18

e) P(married), age 35

f) P(Youth crime), age 15-17

Note: The figure shows average levels of ln-wage earnings / employment / cognitive test scores / marriage / youth crime by educational level and birth cohorts.
B  Data appendix, Denmark

B.1  Major schooling reforms in the 20th century

Table B.1: Major educational reforms in Denmark in the 20th century

<table>
<thead>
<tr>
<th>Reform</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1903</td>
<td>Rural schools offer 7 years of schooling; urban schools track students in grade 5 into an advanced 4-year track and a basic 2-year track.</td>
</tr>
<tr>
<td>1937</td>
<td>Urban schools tracked in grade 5 into an advanced 4-year track and a basic 4-year track; rural schools continue to offer 7 years of schooling.</td>
</tr>
<tr>
<td>1958</td>
<td>The rural and urban school systems are unified; primary school tracking is abolished; lower secondary school is divided into an advanced and a basic track.</td>
</tr>
<tr>
<td>1972</td>
<td>Minimum required years of schooling increases from seven to 9.</td>
</tr>
<tr>
<td>1975</td>
<td>Primary and secondary schools detracked, but with tracking in certain courses.</td>
</tr>
<tr>
<td>1993</td>
<td>Primary and secondary schools completely detracked (the undivided school).</td>
</tr>
</tbody>
</table>

Note: The table provides an overview over major educational reforms in Denmark in the 20th century.

The 20th century is characterized by six major reforms of primary and lower secondary schooling in Denmark. Before we describe these reforms, we highlight three features of the Danish educational system. First, before the 1958 reform, the educational system was divided into a rural and urban school system. In the rural school system, children had very few opportunities for continuing into lower and upper secondary education after completing primary school. Schools in rural areas only provided primary schooling from grades one through seven. Second, before the 1972 reform, the minimum required years of schooling in Denmark was seven, which is the duration of primary schooling. The reform increased the minimum required years to nine, which is the combined duration of primary schooling (seven years) and lower secondary schooling (two years). Third, Denmark has
a German legacy in terms of apprenticeship-based vocational training. Upon completing primary or lower secondary school, children could become an apprentice of a skilled worker. Over the 20th century, formal schooling in vocational upper secondary schools constitutes an increasing portion of the apprenticeship-based vocational training. Thus upper secondary education in Denmark is bifurcated in terms of a vocational track and the traditional academic track (the Gymnasium). We base the following outline of the educational reforms on de Coninck-Smith and Rasmussen (2015); Gjerlof and Jacobsen (2014); Gjerlof et al. (2014). Table B.1 provides an overview of these reforms.

After the 1903 reform, the rural school system offered primary schooling from grades one through seven. While the urban school system similarly offered seven years of primary schooling, it tracked students from grade five into a basic or advanced track. The basic track was a two-year program, whereas the advanced track was a four-year program (known as Middle school). Thus those attending the advanced track would complete nine years of schooling, compared to seven years in the basic track. Upon completing the advanced track, students had two options. They could either enrol in academic upper secondary education (the Gymnasium), a three-year program, or complete a one-year academic program (Realklasse). Upon completing the one-year academic program, students were free to enroll in the three-year academic upper secondary program.

What were the reasons behind this segregated school system and the lack of focus on education in rural areas? There was both a practical reason as the children constituted a substantial share of the labor force, and few peasant families could afford to lose an able worker, and a more fundamental reason to the school’s purpose. Children had to attend school to enable them to read the bible, become good and virtuous citizens, and form the foundation for a common set of core Lutheran values for the population. Throughout the first half of the 20th century, the view of the school’s purpose changed. This was spearheaded by the Social Democrats who saw education as a potential
means to promote equality of opportunity. However, the interests in favor of a school with a purpose based on a common set of Lutheran values were strong and prevailed in the end. Thus, the 1937 reform school reform only ended as a fraction of what was originally discussed.

The urban school system was reorganized, whereas the rural school system continued to offer seven years of primary schooling, and often only with classes every second weekday and two grade levels (young and old children). In the urban school system, students were tracked from grade five on into two overall streams, one which offered an advanced four-year program (Eksamensmellemskole), and one which offered a basic four-year program (Fri mellemskole). Students in urban schools were not required to complete the four year programs, but could leave school after seven years of schooling, the minimum required years of schooling at the time. For students completing the four year advanced program, the upper secondary school options were the same as before the reform: They could enroll in academic upper secondary education, a three-year program, or completing a one-year academic program, and upon completing the one-year academic program, students could enroll in the three-year academic upper secondary program.

In the decade after WWII, the view of the school’s purpose changed, and both domestically and internationally the pressure for a modernization of the education system was building. Several OECD reports emphasized this, and phrases like “the mobilization of the intelligence reserve” were examples of this movement. This led to the 1958 reform, which is widely regarded as the major educational reform in Denmark in the 20th century. The reform had three overall components. First, the rural and urban school systems were unified into one educational system (or, more precisely, the rural school system was abolished). Hence, rural municipalities (the Danish local government level) now were required to offer lower secondary schooling. Children in rural Denmark consequently had the opportunity to pursue schooling beyond the minimum required 7 years of schooling. As we
document in a section below, the reform had a major impact on the school-related current and investment expenditures, and within 15 years after the reform, the fraction of a cohort completing no more than 7 years of schooling fell from about 20 percent to none. Second, the tracking in grades 5 through 7 in primary school (or, more precisely, in Middle school) was abolished. Thus primary schooling now consisted of seven years of untracked schooling in both rural and urban areas. Third, lower secondary school from grades 8 through 9 or 10 were tracked into an advanced track (Realskole, which comes from the German term Realschule), and a basic or general track. Both tracks lasted two years with an optional third year. Upon completing the lower secondary advanced track, students could enroll in the three-year academic upper secondary education program (Gymnasium).

Fig. B.1 examines the 1958’s impact on Danish schools’ teaching resources using administrative data on school expenditures from the Statistical Yearbooks (published each year by Statistics Denmark). We examine the total school expenditures (i.e., the sum of current and investment expenditures) for all municipalities in Denmark and deflate the expenditures according to the CPI. Fig. B.1a shows pre- and post-reform trends in the total expenditures, indexed to the year of 1957/58. Before the reform, the expenditures were at a relatively constant level. However, after 1958, expenditures increase substantially (cf. Fig. B.1b). Over a 10-year period, the expenditures per school-aged child increases by about a factor of three. This trend provides evidence of the major expansion of lower secondary education in rural areas following the 1958 reform.

Fig. B.1c provides further evidence of the large impact of the 1958 reform. It shows the number of school-aged children per teacher (in municipal schools) in Denmark from 1949 through 1963. The figure shows that the teacher to child ratio varied between 33 and 34 school-age children per teacher from the late 1940’s until 1957. However, from 1957 and onwards, the number of children per teacher decreased to 23, corresponding to a 30% drop (or 9,000 new teachers) in just six years.
Figure B.1: Impact of the 1958 reform on school expenditures and number of teachers

a) Expenditures per school-aged child (7-16)  

b) Year-by-year change in expenditures

Number of school-aged children (7-16) per teacher

Note: The figure is based on administrative data from the Statistical Yearbooks, 1954-1971. a) shows by year the total municipality expenditure per child aged 7-16. b) shows the year-by-year change in the total expenditure. We use the size of each birth cohort (reported by Statistics Denmark) to estimate the number of school-age children, because the specific cohort-sizes are reported in 5-year bins before 1970.
In the wake of the 1958 reform, a 1960/61 white-paper labelled *Den Blå Betænkning* had a very large impact on both didactics and the curriculum in primary and lower secondary schools, emphasizing collaboration and interdisciplinary work and depreciating testing and grading. However, despite its large impact on the content and style of instruction, the white-paper did not formally change the school system.

The **1972 reform** raised the minimum required years of schooling from seven to nine. This reform corresponds to the Norwegian and Swedish schooling reforms studied in Black et al. (e.g., 2005); Meghir and Palme (e.g., 2005). However, the Norwegian and Swedish counterparts were introduced during the 1960s and gradually rolled out across the respective countries, whereas the Danish reform was introduced later and implemented nationally at the same time. Yet, while such compulsory schooling reforms found to strongly affect the bottom of the schooling distribution for the cohorts in question in Norway and Sweden (among others), this was not the case for Denmark. As Section 2.3 will show, before the reform in 1972, around 95% of students completed more than 7 years of schooling. Thus the reform reflected a trend that already was in place before 1972. Moreover, the reform (and later reforms) did not affect (or instill the need for additional) resources as the 1958 reform did.

Moreover, due to three factors the 1972 reform was introduced in a staggered way such that schooling did not change discontinuously as seen in Sweden and Norway (albeit the reforms there were introduced gradually in different areas). First, while the 1959 birth cohort was the first cohort to be affected by the full implementation of the reform, it is evident in the data that the largest response happens immediately after the reform. Second, the stakeholders (politicians, teachers, parents) discussed those who would drop out after 7 or 8 years of schooling between the reform was passed (December 1972) and enacted (August 1st 1974). Here, the bill stipulated that "compulsory
schooling’ could for the last year be interpreted as 'skill related activities', such that parents could apply for exemptions from the new mandatory schooling level in cases where it was obvious that going back to school would be disruptive if the child instead entered youth employment for the equivalent amount of time. Finally, the reform also changes timing of school start such that it became defined by the calendar year. Before the reform, the law stipulated that i) children could start school the calendar year they turned seven, and ii) all children who had turned seven by August should attend school. Thus, there was a difference in school starting patterns between those born January-July and August-December which implied that many born in late 1957 were still at grade 7 when the law was passed. Hence, grade 7 disappears as from the data in three steps: 1) the last half of the 1957 cohort and 2) the 1958 cohort capture the main effect, and 3) the 1959 cohort captures the remaining when the reform was fully implemented.\footnote{See \textit{Lov om ændring af Folkeskolen m.fl. love} of 1972, \textit{Folketingstidende 1971/72 Tillæg A} page 1833-1834, and \textit{Folketingstidende 1971/72 Tillæg B} page 983.}

The \textbf{1975 reform} abolished tracking in lower secondary schools and introduced one overall program from grades 1 through 9 with an optional grade 10. However, while overall tracking was abolished, schools were allowed to track students in certain courses into an advanced and general level (in mathematics, physics, and foreign language).

The \textbf{1993 reform} abolished the course-based tracking of the 1975 reform, meaning that all students followed the same program from grades 1 through 9 or 10. The reform is regarded as the reform that fully instated the undivided comprehensive school in Denmark.

This analyses presented in the main text are based on two data sources. The first is full population register data that cover all Danes from 1980 onwards, and the second is nationally representative surveys comprising information on respondents’ and their parents’ (mainly father’s) education, along with characteristics such as region of birth or upbringing, and current residence.
B.2 Register data

Sampling: The register data comprise individuals born in Denmark by non-immigrant parents. As the full population register data (for the most parts) start in 1980, all cohorts born before 1980 is sampled conditional on surviving to 1980 (e.g., the cohort of 1930 is sampled conditional on surviving through age 50). As mortality before age 60 is largely uncorrelated with education or background, we assess the attrition from this sampling procedure to be of minor importance (had we sampled further back in time—e.g., conditional on survival to age 70—this would likely not be the case).

Measuring education: We measure completed education at age 30 for cohorts born in 1951 and later, and in 1981 for cohorts born earlier. Our main measure of education is years of completed schooling, which comprises compulsory schooling and further education and training such as vocational education, college degrees, and university degrees. We define years of schooling as the minimum number of years it takes to complete an education (e.g., a three-year college degree today takes $9 + 3 + 3 = 15$ years to complete in that compulsory schooling lasts nine years, high school three years, and college three years).

Our definition of education as years of completed schooling is chosen to simplify the definitions and facilitate comparisons across cohorts and other countries. However, the school reform of 1972—which increased the years of compulsory schooling from seven to nine years—results in a data break in that educational levels (and years) in the register data is coded relative to the post-1972 definitions. For example, an individual with seven years of compulsory schooling and three years of training (i.e., 10 years of schooling) will be assigned 12 years of schooling in the register data (9 years of compulsory schooling and 3 years of training). This data break results in education
being mis-measured around the 1972 reform, which Fig. B.2 also illustrates. The solid line in the figure shows the average unadjusted years of schooling. A decline in average education lengths is apparent for the cohorts born 1950-1955; this decline is mainly driven by educations with a few years of training after completing primary or lower secondary schooling. Furthermore, for the cohorts born 1955-1965, several categories either disappear from one year to the next or fade. The dashed line shows the adjusted years of schooling. Education is adjusted substantially downwards for the cohorts born before the school reform of 1972, which is a natural consequence of the adjustment. Moreover, the dashed line does not display the same downward kink for the 1950-1955 cohorts (though there is a minor discontinuity in the education category counting academic and vocational high school degrees, see Fig. 3).

It should be noted that around the 1960 cohort, a small drop in average years of schooling exists. This is a result of the 1975 school reform that abolished lower secondary school tracking (which may have had a positive effect on educational attainment for many) with the short run effect that many of those who previously ended up with the selective high track 10th grade as their highest education now ended up with the universal 9th grade instead.
Figure B.2: Average years of schooling by birth cohort, unadjusted and adjusted for change in education definitions

Note: Figure is based on full population register data.

Although this note mainly considers years of schooling, it also reports results by various discrete education categories defined by their overall schooling level. Table B.2 summarizes how we define these categories.

While most have completed their education by age 30 (the age at which we measure education), a minor fraction may still be studying at this age and their educational attainment will therefore be under-reported. Insofar as this underreporting is correlated with parents’ education, we may be
Table B.2: Education categories and years of schooling range

<table>
<thead>
<tr>
<th>Category</th>
<th>Years of schooling range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than high school:</td>
<td></td>
</tr>
<tr>
<td>7 years of schooling</td>
<td>6-7</td>
</tr>
<tr>
<td>Lower secondary</td>
<td>8-11.9</td>
</tr>
<tr>
<td>High school degree:</td>
<td></td>
</tr>
<tr>
<td>High school (academic and vocational)</td>
<td>12-14.9</td>
</tr>
<tr>
<td>Tertiary education:</td>
<td></td>
</tr>
<tr>
<td>College</td>
<td>15-16.9</td>
</tr>
<tr>
<td>University</td>
<td>17-21.5</td>
</tr>
</tbody>
</table>

either under- or overestimating educational mobility. Fig. B.3 presents results based on an analysis in which we have extended the age range up to and including age 32. Fig. B.3a illustrates the bias broken down by birth cohort and fathers’ education. On average, the bias increases over time, corresponding to the increasing share in university graduates. Moreover, the figure shows that the bias increases with fathers’ education. Fig. B.3b shows years of education beyond 15 by father’s education. We find that the underreporting increases over time and is largest for children with highly educated parents. Finally, Fig. B.3c presents education mobility estimates (i.e., regression coefficients from Fig. 1a) for education measured at age 30 and at age 32. The figures shows that the changes from year to year are almost identical irrespective of whether education is measured at age 30 or 32, suggesting that the overall trend is similar. However, the overall level is shifted upwards for by roughly 0.02 for the estimates based on education measured at age 32, suggesting slightly lower educational mobility across the entire birth cohort window. These results are compatible with Figures B.3a and b.
Figure B.3: How measuring education at age 32 change results

a) Difference in years of schooling

b) Years of schooling beyond 15

c) Education IGE

Note: The figure test the robustness of our results with respect to the age at which we measure children’s education. In the main text, we measure education at age 30 for the cohorts born after 1950 (i.e. all the cohorts we estimate educational mobility using register data) while we measure education at age 32 for the results displayed in this figure.
B.3 Conscriptio data

We use information from data from the Danish Conscription Database, which contains information from the compulsory conscription for all Danish males born 1940–1958. The test is known as the Børge Prien’s Prøve (BPP) and consists of 78 items. Uniquely, this test has been administered at conscription for more than half a century without any changes to the test, meaning that we can compare the scores across time. Table B.3 compares the test scores from IQ and the BPP test. The BPP test differs from the usual IQ test. Whereas the BPP test includes both language, math, and logic/reasoning, an IQ test includes only the latter.

Table B.3: Comparison of IQ and BPP distributions

<table>
<thead>
<tr>
<th>Percentile</th>
<th>5</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
<th>80</th>
<th>90</th>
<th>95</th>
<th>99</th>
</tr>
</thead>
<tbody>
<tr>
<td>IQ score</td>
<td>75</td>
<td>81</td>
<td>87</td>
<td>92</td>
<td>96</td>
<td>100</td>
<td>104</td>
<td>108</td>
<td>113</td>
<td>119</td>
<td>125</td>
<td>135</td>
</tr>
<tr>
<td>Constription test score</td>
<td>23</td>
<td>28</td>
<td>34</td>
<td>37</td>
<td>40</td>
<td>43</td>
<td>45</td>
<td>47</td>
<td>50</td>
<td>54</td>
<td>57</td>
<td>62</td>
</tr>
</tbody>
</table>

Note: The table shows estimated scores at different percentiles for IQ scores and the BPP test scores.
Source: Olesen, Mikkel Hollmen (2012). Sammenligning af Forsvarets intelligenstest og IQ-skalaen [A comparison of the Army’s intelligence test and the IQ scale].

B.4 Survey data used for estimating educational mobility

The survey data come mainly from surveys stored by the Danish National Archives. These data are freely available for research purposes (upon formally registering with the Archive the purpose for which the data will be used). We have selected all representative surveys containing sufficiently detailed information on respondents’ and their parents’ (mainly fathers’) education. In addition, we have used Danish survey data from large international surveys such as the European Social Survey. Table B.4 summarizes the available surveys.
<table>
<thead>
<tr>
<th>#</th>
<th>Survey name</th>
<th>Survey year</th>
<th>First cohort</th>
<th>Last cohort</th>
<th>Number of obs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Valgundersøgelsen, 1971</td>
<td>1971</td>
<td>1911</td>
<td>1941</td>
<td>624</td>
</tr>
<tr>
<td>2</td>
<td>Undersøgelse af den voksne befolknings leveforhold</td>
<td>1976</td>
<td>1916</td>
<td>1946</td>
<td>2,931</td>
</tr>
<tr>
<td>3</td>
<td>Den skandinaviske velfærdsundersøgelse (Danmark)</td>
<td>1972</td>
<td>1912</td>
<td>1951</td>
<td>504</td>
</tr>
<tr>
<td>4</td>
<td>Den danske værdiundersøgelse</td>
<td>2008</td>
<td>1948</td>
<td>1978</td>
<td>721</td>
</tr>
<tr>
<td>5</td>
<td>International Adult Literacy Survey</td>
<td>1998</td>
<td>1938</td>
<td>1968</td>
<td>1,897</td>
</tr>
<tr>
<td>7</td>
<td>European Social Surveys 4-5</td>
<td>2008</td>
<td>1948</td>
<td>1980</td>
<td>1,505</td>
</tr>
</tbody>
</table>
While all surveys are representative of the population, a separate concern is the reliability of the education information (or whether the educational categories in the survey makes possible a sufficiently detailed analysis of trends in light of the drastic changes in education levels over the century). Fig. B.4a plots average years of schooling by birth cohort measured by the register data and by the different survey data. Surveys 1-3, 4-6, and 7 are graphed separately as some overstate education relative to the register data (over and above the adjustment to the register data discussed earlier), which we believe contain the most credible information (a similar overstatement is evident when examining fathers’ education). Importantly, the oldest surveys 1-3 (pre 1947) contain vary accurate information on years of completed schooling. Yet, the more recent surveys overstate the schooling duration, a problem arising from the lower tail of the educational distribution being underreported.

As the register data is available for cohorts born 1956-57, we only focus on survey data for the cohorts 1911-56. The estimates for the cohorts with overlapping survey and register data (which we do not report in the note) are very similar: Around around 0.28 for the survey data, and 0.30 for the register for the 1957-61 cohort. To ensure an overlap in cohorts from 1911 to those covered in the register data, we keep surveys 1, 2, and 3 (reliable) and 4, 5, 6, 7 (somewhat biased) in the analysis, resulting in a final sample of 5,772. Fig. B.4b plots the frequency by five year bins. We estimate all regressions using survey fixed effects to account for some of the variation, but the estimates for the cohorts around 1950 should, nonetheless, be interpreted with some caution. Finally, Fig. B.4c shows the sample sizes down by survey and cohort.
Figure B.4: Summary of survey sample characteristics, by child year of birth

a) Comparison of education lengths

b) Final sample size

c) Sample size by cohort and survey

Note: Fig. a) compares average years of schooling from the register data with the survey data information. The information from the older surveys is grouped as: i) Valgundersøgelsen, Undersøgelse af den voksne befolknings leveforhold, Den skandinaviske velfærdundersøgelse (Danmark), ii) Den danske værdiundersøgelse, International Adult Literacy Survey, International Social Survey Programme, and iii) European Social Surveys 4-5. Fig. b) plots the final sample size by year of birth (five year bins). Figure c) plots the sample sizes by birth cohort and survey.
**Further details**  Below we provide further details about the seven surveys.

#1 Valgundersøgelsen 1971 (The Danish Pre-Election and Post-Election Study 1971) is a two-wave, nationally representative study that interviewed 1,499 respondents in the first wave in August 1971, and 1,302 respondents in the second wave in October 1971. The sampling procedure is a two-stage sample of 2,100 Danish residents aged 21 or more (21 being the electoral age at the time). In the first stage, municipalities were selected on the basis of region and degree of urbanization, whereas in the second stage, respondents were randomly selected within municipalities. The survey is fully documented in English by the Danish National Archives at http://dda.dk/catalogue/7?lang=en.

#2 Undersøgelse af den voksne befolknings leveforhold 1976 (Danish Level of Living Survey 1976 or Danish Welfare Survey 1976) is a nationally representative survey of Danes aged 20-69. The purpose of the survey is to describe the living conditions of the Danish population (similar surveys have been conducted in the other Nordic countries). The sampling procedure is a two-stage sample of Danish residents between 20 and 69 as of 1 September 1976. The sample is first stratified by 72 geographically based strata and then individuals within these strata are randomly selected. The issued sample size is 5,960, and the achieved sample size is 5,166 (a response rate of 87 percent). The survey is fully documented in English by the Danish National Archives at http://dda.dk/catalogue/70?lang=en. Andersen, B.H. 2003. Udviklingen i befolkningens levekår over et kvart århundrede. København: SFI describes the sampling design.

#3 Den skandinaviske velfærdsundersøgelse (Danmark) (Scandinavian Welfare Survey 1972, Denmark) is a nationally representative survey of 1,000 individuals. The purpose of the survey is to compare living conditions and quality of life in the Scandinavian countries and was part of a comparative project led by Erik Allardt and Hannu Uusitalo. The survey population is all Danes born 1907-1956 who at the time of the interview in 1972 were healthy enough to complete the interviews. Only
people living in private households were interviewed. The issued sample size is not documented, nor is the sampling procedure, although the sampling likely is a two-stage design. The survey is fully documented in English by the Danish National Archives at http://dda.dk/catalogue/82?lang=en.


#4 Den danske værdiundersøgelse 2008 (The Danish Value Survey 2008) is the Danish part of the European Value Study round 2008 (see https://europeanvaluesstudy.eu/). It is a simple random sample of the Danish population older than 18 years in 2008. The issued sample size is not documented. The achieved sample size is 1,507. The survey is fully documented in English by the Danish National Archives at http://dda.dk/catalogue/21432?lang=en.

#5 International Adult Literacy Survey (IALS) 1998 is the Danish contribution to this international survey whose purpose is to assess adults’ skills in a number of countries across the globe. Although IALS was conducted in both 1994 and 1998, Denmark only participated in 1998. It is a nationally representative sample of the adult non-institutional civilian population aged 16 to 65 in 1998. The achieved sample size is 3,028, and the issued sample is about 4,600 (the response rate is 66 percent, cf. Jensen et al. 2002. “Danskernes læse-regne-færdigheder - udvalgte resultater”). The sampling design is not documented, but it appears to be a two-stage design according to the online documentation that we have been able to identify. IALS is documented in English at https://nces.ed.gov/surveys/ials/. Hertz (2007) bases the analyses for Denmark on this survey.

#6 International Social Survey Programme 1999/2000 is the Danish contribution to this international survey whose theme in the 1999 round was social inequality. The Danish contribution was collected in 2000. It is a simple random sample of the Danish population (age specifications not
detailed in the documentation). The issued sample size is 3,163, whereas the achieved sample size is 1,823 (a response rate of 59 percent).

European Social Survey 4-5 is the Danish contributions to this comparative survey, which examines attitudes and socio-demographics in a number of European countries. Rounds 4 and 5 were conducted in 2008 and 2010, respectively. They are both simple random samples of the Danish population aged 15 or older and who are living in a private household in Denmark. For round 4, the issued sample size is 3,008, and the achieved sample is 1,640. For round 5, the issued sample is 2,900 and the achieved sample is 1,576. The survey is documented in English at https://www.europeansocialsurvey.org/data/country.html?c=denmark

B.5 Survey data for the 1954 and 1995 cohorts

This section describes the supplementary data from the 1954 cohort study (The Danish Longitudinal Survey of Youth, DLSY) and the 1995 cohort study (The Danish Longitudinal Study of Children, DALSC) ²⁹

The 1954 cohort study is based on a random sample of 3,151 seven-graders in 1968. The initial survey of children, parents, and teachers was followed by a second round in 1969, and the sample has been followed since (with the latest interview was in 2004). The sample was born in 1954 (as the sample is initiated in grade 7, counting grade 1 from age 7). The data includes the unique individual identifier that facilitates a link with the register data including the educational registers.

²⁹ see www.dlsy.sfi.dk and www.aargang95.sfi.dk for further descriptions of the two surveys.
The 1995 cohort study is a sample of the approximately 6,000 children born in Denmark between September 1st and October 15th, 1995. Interviews of parents and later on children were conducted when the children were 6 months, and 3, 7, 11, 15, and 18 years old. The data includes the unique individual identifier that facilitates a link with the register data including the educational registers.

Both surveys were administered by the Danish Institute for Social Research (then called SFI, today ViVe), and there is therefore a substantial overlap in the questions and measured used. We use the verbal intelligence test, which was measured at age 15 for both surveys. Importantly, it is also the same test that was used in both surveys.

Both samples also responded to the questions of the Rosenberg self-esteem scale \cite{Rosenberg1965} around age 20. The Rosenberg scale is a 10-item Lickert scale, but as the DLSY only contains questions 1, 4, 5, 6, 7, and 8 we use these six questions to construct the scale in both samples (although results are almost identical when using the full scale in the 1995-cohort). The 1995 cohort surveys also contain a host of other measures of skills and traits. Table B.5 reports the correlation between the Rosenberg scale and intelligence test, and the Raven intelligence test, the traits from the Big-5 inventory, and the Strengths and Difficulties Questionnaire used to assess problem behavior of children (scale reversed in the table here).

We measure education at age 30 for the 1954 cohort survey. However, this is not possible for the 1995 cohort. We therefore use a combination of highest completed education and current enrollment, and we include all currently enrolled in college in the group with a college degree (few in Denmark have completed college by age 23, which is the last year we have education data for). While high school completion is measured consistently in the two surveys, college completion potentially includes measurement error relating to drop out and late enrollment in the 1995 cohort.
Table B.5: Correlation between the Rosenberg self-esteem scale and cognitive test and alternative measures

<table>
<thead>
<tr>
<th>Rosenberg (short)</th>
<th>Cognitive test score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rosenberg (short)</td>
<td>-0.01</td>
</tr>
<tr>
<td>Cognitive test</td>
<td>-0.01</td>
</tr>
<tr>
<td>Rosenberg full</td>
<td>0.97</td>
</tr>
<tr>
<td>Raven test</td>
<td>0.01</td>
</tr>
<tr>
<td>SDQ (reversed)</td>
<td>0.11</td>
</tr>
<tr>
<td>Openness</td>
<td>0.00</td>
</tr>
<tr>
<td>Conscientiousness</td>
<td>0.15</td>
</tr>
<tr>
<td>Extroversion</td>
<td>0.28</td>
</tr>
<tr>
<td>Agreeableness</td>
<td>0.18</td>
</tr>
<tr>
<td>Neuroticism</td>
<td>-0.45</td>
</tr>
<tr>
<td>Observations</td>
<td>3,385</td>
</tr>
<tr>
<td></td>
<td>3,385</td>
</tr>
</tbody>
</table>

C Data appendix, U.S.

This analyses presented in the main text are based on the cumulative data file of the General Social Surveys 1972-2016 (GSS), a national probability sample of the non-institutionalized U.S. population. The cumulative file combines all surveys conducted annually from 1972 through 1994 – except for 1979, 1981, and 1992 – and biennially thereafter. GSS contains information on both respondents’ and their parents’ educational attainment for respondents born over most of the 20th century. We restrict the sample to respondents with (i) valid information on their and their parents’ educational attainment and (ii) aged 30-59 at the time of the interview, resulting 31,582 parent-offspring pairs.

We measure schooling of both respondent and parents by years of schooling, ranging from 0 through 20 years. For parents, we use the highest number of schooling years reported by either of the two parents. To retain a larger fraction of the sample, we exploit additional information
on the highest educational degree completed by both respondent and parents. For respondents and parents with missing information on years of schooling, we impute their years of schooling in a three-step approach (for respondents and parents, respectively). First, we group the data with valid information on both years of schooling and educational degree into five-year cohorts. Second, for each five-year cohort group, we estimate the average years of schooling for each educational degree. Third, for respondents with missing information on years of schooling but valid information on educational degree, we impute their missing value with the average years of schooling from the second step.

We also use four additional variables: Residence at age 16, coded into a rural-urban indicator; gender; race; and family structure at age 16. Some of these variables have missing values, but these are few.

The GSS provides sampling weights. As Fig. C.1 applying these weights do not change any substantive conclusions regarding the overall trends in years of schooling over the 20th century. Moreover, as Fig. C.1 shows, the education IGE is also virtually unaffected by applying the sampling weights. For this reason, we do not apply these weights in the analyses.
Figure C.1: Child and parent average years of schooling by birth cohort, unweighted and weighted

Note: Figure is based on cumulative data from the General Social Surveys 1972-2016. N = 31,582. Sample weight provided by the GSS (wtssall).

Although this note mainly considers years of schooling, it also reports results by various discrete education categories defined by their overall schooling level.

Finally, Fig. C.3 compares the education levels from the survey data with Census statistics by birth cohorts. The figure shows that high school and college completion levels and trends in the two data sets follow each other closely.
Figure C.2: Education IGE, by child birth year, unweighted and weighted

Note: The figure is based on cumulative data from the General Social Surveys 1972-2016. N = 31,582. Sample weight provided by the GSS (wtssall).
Figure C.3: Education levels by child year of birth

a) Aggregate education levels

b) Year-by-year change in aggregate education levels

Note: Fig. a) is based on cumulative data from the General Social Surveys 1972-2016. N = 31,582. Fig. b) is based on U.S. Census statistics from 1940–2015.