A Second Chance?

The Labor Market Outcomes of Reforming Access to Adult Education*

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Abstract

Roughly one third of a cohort drop out or do not complete high school across OECD countries, and developing effective tools to address prime-aged high school dropouts is a key policy question. We leverage high quality Norwegian register data to examine the labour market outcomes of expanding access to adult workers and exploit a large policy reform which greatly enabled access to high school education for adults. Our focus is on women who left school without completing high school. The results show a large and significant increase in education investments among these women, leading to higher earnings, increased employment, and decreased fertility. They also suggest that enhanced access to adult education, and the subsequent increase in years of education, can be an effective policy to reduce the gender earnings gap.

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1 Introduction

Across the OECD area, 20–30% of each birth cohort drop out of or do not complete high school before graduating (OECD, 2017).[1] High school dropouts face severe labor market conditions and lower labor market prospects are an important reason behind the widening earnings gaps between college and

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[1]Figure A.1 reveals returning to education is an important phenomenon across many OECD countries: on average, 7% of those aged 30–39 in 2017 are enrolled in any *formal* education across the OECD members. While there exist substantial differences across the OECD members states—for instance, Finland has the highest enrolment later in life, the United States is roughly in line with the OECD average, and France has the lowest enrolment in formal education—returning to education later in life is an important phenomenon in all countries.

non-college educated workers in recent years (Acemoglu and Autor, 2011; Blundell, Joyce, Keiller, and Ziliak, 2018). An important policy challenge is how to provide a second chance to low-educated workers and do so in a way that improves their labour market outcomes.

In this paper, we estimate the impact of a second chance of completing high school in Norway. Our focus is on women who left formal education without completing high school. More than 20% of a cohort drop out in Norway (see Figure A.2), and, similar to the US, high school dropout remains a considerable problem. The availability of second chance opportunities within the formal education system to finish high school, combined with high quality Norwegian register data and a large scale reform enabling access to high school for adults, makes the setting ideal for estimating the labor market benefits to second chance education. We examine how the timing of returning to high school affects life-cycle investments in education including the probability of progressing from high school to complete college education. We focus on enrolment in education for individuals in their late twenties and early thirties, ages at which a large majority of women who dropped out have already had their first child. Most men who return to education after dropping out have already done so by these ages but for women, the story is quite different: we find returning to education is significantly impacted by the reform. We show that female dropouts return to study in healthcare, primarily nursing and carework, and teaching of young and middle school aged children. This perspective adds to the literature on why measuring returns to education at a fixed age ignoring that the timing of completion may matter. It also suggests a route to reducing the considerable gender gap by increasing education investments of adult women, which we find increases employment and reduces future fertility.

While the labor market returns to education from on-time education are well established, causal evidence on the impacts of second chance education is scarce.[2] The education program we examine is distinct from programs in other countries which are not verified within the formal education system as in the UK (Blanden, Buscha, Sturgis, and Urwin, 2012) and distinct from the General Education Development (GED) program in the US, which is usually considered to be signalling without any human capital accumulation (Heckman, Humphries, and Mader, 2011; Tyler, Murnane, and Willett, 2000).[3] The existing GED literature finds little evidence of GED certification on labor market outcomes (Heckman and LaFontaine, 2006; Jepsen, Mueser, and Troske, 2016).[4] The program we examine

[2]See Schwerdt, Messer, Woessmann, and Wolter (2012) for the impacts of education vouchers in Switzerland.

[3]It has similarities to the extensive adult education program from 1997 to 2002 in Sweden which funded one year of high school for 25 to 55 year olds in Sweden. However, this program focused for the most part on unemployed, it was not within the education system but organized more as a job market program by the municipalities. Moreover, it was not necessarily aimed at a completed high school degree. There are several studies evaluating this either using structural models or matching techniques, and they find some positive employment effect for the lowest skilled Stenberg and Westerlund (2008); Albrecht, van den Berg, and Vroman (2009). The program is also different from an alternative route in Norway where you obtain a vocational degree through workplace training, and the degree externally verified by the education system. See Bratsberg, Nyen, and Raaum (2020) for details on this route.

[4]Clark and Martorell (2014) use a RD design to assess the signalling value of a high school diploma, finding little

is also distinct from the for-profit college system in the US which offers zero, or even negative, labor market returns with large increases in student debt (Deming, Goldin, and Katz, 2012; Deming, Yuchtman, Abulafi, Goldin, and Katz, 2016).

In addition to contributing to the literature on assessing the returns to a second chance within the formal education system, we also document how the completion of college education evolves over the life cycle following the late completion of a high school degree. In particular, we are interested in whether the timing of returning to academic high school, which includes an option for entering higher education, affects the probability of entering and completing college education. In general, we assess the interplay between the timing of fertility and returning to education. The timing of fertility affects the timing of completing high school for women, and the second chance option may enhance earnings and facilitate mothers back to work (Blundell, Dias, Goll, and Meghir, 2021). At the same time, returning to education may also impact future fertility decisions: Black, Devereux, and Salvanes (2008) find that additional on-time education causes declines in completed fertility. Indeed, we document strong gender differences in returning to education over the life cycle with academic high school completion continuing to increase for women after age 30.

Causally estimating the benefits of education when individuals return to complete levels of education they previously dropped out of presents an empirical challenge. First, high school completion and the timing of later life education are clearly endogenous decisions. Second, it is not straightforward to isolate a suitable counterfactual for late high school graduates. Third, the sequential nature of education implies that those who complete high school on-time may return to higher education later in life. Finally, prior research has demonstrated the importance of when earnings are measured when estimating the returns to education (Bhuller, Mogstad, and Salvanes, 2017).

We address each of these concerns and exploit a policy reform which overhauled the student support system, increasing the amount of unconditional student support for adults enrolled in high school. Within an event study framework, we measure earnings both prior to and after the completion of education over a long time horizon and examine both short- and long-run impacts of education on earnings. We exploit variation in the age at which different birth cohorts are treated by the reform to use older cohorts who were treated at a later age as a counterfactual for early treated cohorts.[5] As the event study framework exploits variation across different birth cohorts, changes in demographic characteristics over time may affect the similarity of early and later treated. As such, pre-treatment

evidence that graduating high school has signalling effects. Relying on the assumption that, conditional on controls, the year an individual decides to return to education is random, Albæk, Asplund, Barth, Lindahl, Strøm, and Vanhala (2019) suggest that adult education in the Nordic countries prevents labor force dropout.

[5]We show that on-time high school graduates are not a suitable counterfactual by exploiting a rich set of characteristics include cognitive test scores.

differences in the composition of the sample between early and later treated cohorts may affect the dynamics of the outcome variable post-reform, violating the parallel trends assumption. Abadie (2005) and Blundell and Dias (2009) show that weighting the regression by the propensity score estimated as a first step can account for such differences, and we follow a similar approaches taken Mastrobuoni and Pinotti (2015) and Goodman-Bacon and Cunningham (2019).

To estimate the causal impacts of later life education on labor market outcomes and subsequent fertility, we exploit a major policy reform which reduced the opportunity cost of returning to school through an unconditional stipend to return to high school. Comparing early to later treated cohorts, we find the reform significantly increases education among high school dropouts in their early 30s. A majority of women who return to complete high school at younger ages following the reform also continue in the education system to complete higher education, suggesting a relationship between returning to high school younger and the probability of continuing with higher education.

We find later life education improves labor market prospects for women with both increases in labor earnings and employment. The observed increase in earnings attributed to later life education is driven primarily by increases in employment rather than increases in wages. Female high school dropouts are weakly attached to the labor force prior to the reform, and such changes in employment vary across pre-reform levels of attachment: while those with low attachment see increases in labor force participation post-reform, those with stronger attachment remain in full-time employment at higher rates. In addition to improving labor market prospects, fertility is also impacted: returning to education reduces future fertility among women. Given the strong relationship between children and employment, a considerable portion of the increase in employment can operate through the joint decision of fertility and employment.

Similar to Blundell, Dias, Goll, and Meghir (2021), who document that job training can close the gender wage gap among females, we provide evidence that later in life human capital accumulation through formal education has the potential to impact the gender wage gap. An extensive literature documents considerable gaps in the labor market outcomes by gender and underlying reasons for such differences (Goldin, 2006; Blau and Kahn, 2017). Recent papers have emphasized the importance of the child wage penalty as an important underlying factor behind gender earnings differences (Angelov, Johansson, and Lindahl, 2016; Kleven, Landais, and Søgaard, 2019), which are considerable in the Scandinavian as well as many other countries (Kleven, Landais, Posch, Steinhauer, and Zweimüller, 2019). By inducing female high school dropouts to return to education, the pre-existing gender gaps in earnings were considerably reduced as labor market outcomes of women improve relative to men.

The paper proceeds as follows. Section 2 describes the Norwegian education system and register data and presents descriptive evidence on age-education profiles. Section 3 informs the choice of counterfactual by documenting the age-earnings profile of those who endogenously return to education, details the education reform, and describes the estimation sample. Section 4 identifies the impact of the exogenous policy reform on returning to high school, details how gender earnings gaps are impacted by later life education, and provides causal estimates of the labor market returns to later life education. Section 5 details the heterogeneity and robustness of the baseline results. Section 6 concludes.

2 Institutional Setting, Data and Descriptives

2.1 The Norwegian Education System

Following a 1959 reform (see Black, Devereux, and Salvanes (2005) for further details), compulsory schooling in Norway is composed of 6 years of primary school and 3 years of secondary school for our birth cohorts. After the completion of compulsory schooling, a student decides whether or not to continue into upper secondary education or drop out. All birth cohorts considered in this paper are under this compulsory schooling system, such that an individual may drop out at roughly age 16 to join the labor force.

After completing compulsory education, students may progress to high school. High school is comprised of both academic and vocational high school programs and lasts 3 to 4 years. Academic high school is geared towards future enrollment in university education and lasts 3 years. Vocational high school leads to professional employment in a given vocation after the completion of high school. The vocational route is based on a combination of school and apprenticeship. The main model is 2 years in school, followed by a 2-year apprenticeship. During the apprenticeship period, the apprentice is employed in an approved firm responsible for providing training of sufficient quality.

Tertiary education in Norway includes both university colleges—which specialize in shorter higher education programs such as engineering, nursing, and teaching—and universities. For instance, in order to become a nurse or a teacher, an academic high school degree is required. In addition, technical colleges offer post-secondary education in the vocational track. Such programs are short, spanning a minimum of 6 months to 2 years, and convey the status of a skilled vocational technician. The direct costs of attending are close to zero, as there are no tuition charges and most students qualify for grants and loans from the government.

2.2 Norwegian Register Data

In order to analyze the phenomenon of later life education, the paper makes use of administrative-based Norwegian Register Data. The data is linked by Statistics Norway across different sources by an anonymized personal identification number. The paper merges information across several different registers to create an individual-level panel following people from birth to age 45. The focus of the empirical analysis are cohorts born between 1964 to 1970 since these cohorts are covered by the educational reform we use for identification. We have earnings data up to 2015, and this is the reason we measure educational attainment and earnings up to the age of 45. In the descriptive analysis below, we extend the cohorts up to 1980.

We extract population information from the central population register which contains information such as an individual's birth year, gender, age, citizenship, municipality of residence in a given year, and municipality of birth. Information is available for any person who is legally resident in Norway. The central population register also links families across generations, which links parents to children. Such linkage permits the construction of measures for parental education as well as information on any children born to both mothers and fathers.

The Education Register provides information, in each year, on ongoing student status as well as years of education and the exact qualification achieved.[6] Qualifications are measured at the detailed field of study level, and correspond to the International Standard Classification of Education (ISCED) system. Schools have a legal requirement to report any information on enrollment and graduation to Statistics Norway, which minimizes the potential for measurement error. Throughout the paper, educational qualifications at the high school level are grouped into academic or vocational.

Data on earnings is extracted from the tax and earnings register, where annual labor earnings are recorded. We use two alternative measures of earnings. Gross earnings includes pre-tax total labor earnings, including any earnings from self-employment, and includes some transfers such as taxable benefits received in a given year such as parental leave, unemployment, or sickness benefits. Gross market income excludes any transfers. Employment data is provided from the Register of Employers and Employees. This provides information on employment status, hours worked, and industry of employment.

We also draw on measures of cognitive ability for all males at age 18 from compulsory military testing data. Although not available for women, this does provide some indicative information about the initial relative cognitive distributions between different high school completion groups. Cognitive ability is comprised of three examinations: an arithmetic test similar to the arithmetic test in the

[6] Years of education are measured as the number of years it should take a student to achieve a given qualification.

Wechsler Adult Intelligence Scale (WAIS), a word similarities test similar to the same test in the WAIS, and a figures test similar to the Raven Progressive Matrix test. The cognitive ability measure is measured on a 9 point scale, with a mean of 5 and a standard deviation of 2.

2.3 Differences in returning to education between men and women

Figures Ia and Ib plot the high school completion rate from ages 20–45 for females and males respectively. Figure I reveals returning to education is an important phenomenon over the course of the life cycle: across 20 years of birth cohorts in Norway from 1961-80, the high school completion rate increases by 6–17 percentage points between the ages of 20–25, by an additional 7–10 p.p. between the ages of 25–35, and by an additional 2–7 p.p. from 35–45. While the high school completion rate begins to flatten over the course of the life cycle, individuals continue to complete high school through age 45, well after an "on-time" student would.[7] Among those born 1961–1970 who drop out of high school and do not graduate on-time, 39% of women and 47% of men go onto complete high school by age 45.

Across different birth cohorts, on-time high school completion increases from older to younger cohorts. Most of the differences in eventual high school completion across birth cohorts are due to the level shift in on-time completion. However, age-education profiles are not parallel across cohorts: as on-time completion has increased, returning to high school over the life cycle has declined. This appears to be more true for men than for women, though high school completion continues into older ages even for men. As the cohorts 1961–1970 closely correspond to the cohorts who are impacted by the reform described in Section 3, we focus mainly on these birth cohorts.

There exist considerable gender differences in high school completion from on-time completion up until age 45. Across all birth cohorts, females complete high school on-time at a higher rate than males. Irrespective of gender, high school education continues to increase over the life cycle, but at a slightly decreasing rate.

However, the age at which women and men return to education differs greatly. From 20–25, the high school completion rate of men increases rapidly relative to women such that the large gap in high school completion at age 20 between men and women is reversed by age 25. Women, on the other hand, return to high school at higher rates than men at later stages in the life cycle. For instance, from ages 30 onwards, women return to high school substantially more than men. This is especially true from 35–45, where the high school completion rate of women is nearly double that of men.

Not only does the timing of completion differ across men and women, but also the type of high

[7] The figures throughout follow individuals until age 45, where the 1971–1975 cohorts are missing data for age 45 and the 1976–1980 cohorts are missing data for age 40 and 45.

school they return to and subsequently the extent of attending higher education. Corresponding to the two different types of high school in the Norwegian education system, Appendix Figure B.1 shows the evolution of academic and vocational high school completion rates for both women and men born 1961–1970. Females return to complete academic high school, which is geared towards higher education, primarily from the ages of 20–30. After age 30, the academic high school completion continues to increase for women until age 45, albeit at a slightly lower rate with age. Men, who have much lower levels of academic high school completion relative to females, see small increases in their academic high school completion rate from 20–25. However, academic high school completion rates are relatively similar at the ages of 25 and 45 for men.

Completing academic high schools also provides the option of attending higher education, Figures IIa and IIb plot the fraction of each birth cohort from 1961–1980 who complete any higher education at different ages for women and men respectively. Indeed, females complete higher education at a much higher rate than males. In addition, females also return to higher education later in life at much higher rates than men, as the age-education profile is much steeper later into the life cycle for women. In order to present a complete picture, Appendix Figures B.2a and B.2b replicate Figure I for years of education rather than high school completion. For females, increases in years of education later in life do not flatten off compared to high school completion while increases in years of education begin to flatten for men. Between 30–45, after the typical student has had the opportunity to complete university education, years of education increases by roughly 0.5 years for women and 0.25 years for men. Women complete more years of education than men at age 20, and this gender gap is expanding over the life cycle as years of education increases more for women than men.

Important differences in when in the life cycle women and men return to education suggest different considerations in the decision of women and men at the margin of returning to high school. Relative to men, returning to high school is more common for women in their 30s and early 40s. Section 4.2.2 examines differences in the importance of childbearing for women relative to men as a potential reason behind this. Relative to women, on-time high school dropout is more problematic for men. This suggests that the returns to high school education may not be large enough to justify investments in human capital for young boys or that the labor market opportunities available in youth may be more appealing to men than women. However, by age 25, a large fraction of male dropouts have returned to complete high school, suggesting that some of these dropouts quickly see the need for additional human capital.

3 Empirical Specification, Access Reform and Sample

In this section, we describe the reform which introduced a new financial incentive combined with the removal of a barrier to access that took place over a three year period from 2000. As we show below, the reform successfully lowered the opportunity cost of returning to education for those who dropped out of high school. We present the counterfactuals and sample used, and lay out the empirical specification we adopt as well as some econometric issues. In order to motivate our choices of specification, counterfactual, sample selection and empirical approach, we first provide some key features in the age-earnings profiles of those who return to education at different ages.

3.1 The Age-Earnings Profiles of Those Who Return to Education

Traditionally, the completion of high school is thought to occur at (roughly) a similar age for all individuals. All else equal, earlier investments in education will have larger benefits over the life cycle as younger individuals who complete education on-time have more prime-age employment years to reap the labor market returns of the additional education. In addition, the opportunity cost of completing high school, foregone wages while studying, will depend on the age of the worker. This cost of forgone earnings is likely lower at younger ages, as earnings potential increases with labor market experience.

When all students complete high school at the same age, the impact on earnings can be estimated comparing those who graduate high school to those who drop out (abstracting from endogeneity concerns). Departing from the notion of on-time completion to later life completion complicates the estimation of the effect of education on lifetime earnings. However, understanding to what extent late completers close the gap in earnings to on-time graduates, and to what extent younger late completers fare better than older late completers, is crucial to understand the labor market returns to later life education. To do so requires a comparison of the evolution of earnings prior to study, during study, and after the completion of education. The subsequent figures focus on the evolution of earnings over the life cycle, from the ages of 18–45, for all individuals born 1964–1970 who complete high school at different ages: completed high school at 20 or younger (on-time), 24–26, 30–32, 36–38, and not completed by 45.[8] While all individuals here return to high school, it remains informative to compare the evolution of earnings between on-time graduates and late completers of different ages over time.[9]

[8] Results using other birth cohorts display similar patterns. Appendix C presents results for the completion of higher education across different ages, and show similar patterns of age-earnings profiles.

[9] If one is willing to assume that age of completion is as good as random, then this is causal impact of returning to high school on earnings. However, the extent to which this assumption holds is questionable. Those who complete high school at age 30 had the opportunity to also complete high school at each age from 21–29, but chose not to do so. There are good reasons to believe why one returns to education later in life rather than earlier in life is due to a host of explanations (e.g. changing personal or family situations, changes in employment status, etc).

Figures IIIa and IIIb plot the age-earnings profiles among the five groups including those who go onto complete higher education after high school. Prior to completing high school at 24–26 and 30–32, and 36–38, as indicated by the shaded regions of Figure III, those who complete high school experience a decline in log earnings.

However, the short-run earnings penalties while returning to high school are more than compensated by higher earnings in each subsequent year after completion. Indeed, the slower earnings growth prior to graduating high school is quickly compensated by rapid earnings growth in the years immediately after completing high school. As time goes on, the earnings growth of late completers converges to the slope of the earnings profile of on-time graduates. Despite this strong growth after completion, later completers never fully catch up to earnings levels of on-time graduates: while the earnings growth of late completers reaches the slope of on-time graduates, there remains a persistent levels difference. Additionally, the age an individual returns to complete high school matters for their earnings by age 45, as those who return earlier have earnings which more closely resemble the earnings of on-time graduates while those who never graduate high school have the lowest earnings.

Figures IIIc and IIId plot the earnings of those who complete high school at different ages, excluding those who continue onto any further education after high school. While excluding higher education clearly ignores the fact that the completion of high school leads to additional higher education, such a sample permits the comparison of the value of a high school degree completed at different ages.[10] Compared to Figures IIIa and IIIb which include higher education, the differences in age-earnings profiles across different ages of high school completion are much smaller.

Abstracting from endogeneity concerns, the difference between any two curves in Figures IIIc and IIId represents the labor market premium to completing high school (and no further education) at a given age relative to another age. For instance, those who complete high school after 20 have higher earnings at younger ages than those who complete high school on-time. However, already by the early 20s, this difference has reversed, and on-time graduates begin to earn higher levels. Relative to each age of completion, there exists a discount rate which equalizes the present value of the two age-earnings profiles.[11] Relative to the female sample, the earnings penalties incurred by male on-time graduates are much larger. While there are clearly selection issues in comparing late completers of different ages and on-time graduates, it is interesting that the discount rates are considerably lower for men compared to women. Among late completers 24–26—an age range when considerably more men return to complete high school relative to women—discount rates of 5–7% equalize the present value of

[10] The sample restricts to those who by age 45 still have high school as their highest level of education. Only 36% of those who finish high school on-time still have high school as their highest education level by age 45.

[11] Table D.1 reports more details, and present the discount rates required to equalize the present value of earnings of on-time graduates to later life completers.

earnings to on-time graduates compared to 27–45% for women. Such low discount rates suggest that more present-biased men may actually find it worthwhile to drop out of high school and return later in life, while the calculated discount rate for women indicates strong incentives to return to education.

3.2 The Access Reform and Choice of Counterfactual

In the 2003/2004 academic year, the Norwegian government introduced significant overhaul of the student support system for students enrolled in high school. This reform resulted in substantial changes in the level of financing available for adult education: it directly lowered the earnings penalty incurred from a reduction in hours spent in employment by providing a generous unconditional monthly stipend to return to education. Following the reform, any student who lived away from their parents became entitled to an unconditional monthly stipend of 3,450 NOK.[12] Prior to this, those living away from home were only entitled to means-tested support and the majority of these students were eligible to very little support. This reform was part of an new agenda to enhance access to adult education in Norway which began in the 2000/2001 academic year when a new law was introduced extending the legal right to enroll in high school education as an adult.[13]

The reform took place over a three year period and covered the whole economy, consequently we have to take care in isolating a suitable counterfactual in order to estimate the causal impact. We require a similar group who is, at the same time, not impacted by the reform at the comparison age. Figure III suggests three potential groups: those who have completed high school on-time, those who never return to high school, and those who return to high school at even later ages.

On-time high school graduates are unlikely to be a suitable counterfactual. Appendix Figure E.1 highlights the substantial differences in cognitive ability between on-time high school graduates and dropouts. Likewise, Appendix F shows that a strong socio-economic gradient exists for on-time graduates and late completers. As such, while on-time graduates are not treated as they have already completed high school, they also will have different trends in income compared to on-time high school dropouts in the absence of the educational reform. This can be seen in Figures IIIa and IIIb. Moreover, those who never complete high school are also unsuitable as they choose not to take up the reform. Using such a group, never returning to high school, would select on post-reform outcomes.

Given the incomparability of on-time graduates and never completers, we exploit variation in the

[12] 3,450NOK represents a considerable stipend as it corresponds to 12% and 14% of median monthly earnings of similar aged workers. Median income at the time of the change in 2003 of those aged 30–34 is 28,185NOK for men and 25,052NOK for women (Statistics Norway, Table 05218: Average monthly earnings for employees, full-time equivalents, by working hours, age-group and sex). In addition to this unconditional monthly stipend, students remain eligible to means-tested grants up to a maximum of 1,730NOK depending on their own income.

[13] The introduction of the right to upper secondary education required counties to accept any student who was willing to return to high school where their prior inflexibility represented a barrier to enrollment.

age at which different birth cohorts are first treated by the policy reform to use later treated cohorts as a counterfactual for early exposed cohorts. We focus on the timing of when in the life cycle different birth cohorts return to high school and ask how those who return at younger ages fare compare to those returning at slightly older ages. Such an approach, when combined with the reform, provides a source of exogenous variation in the age at which different cohorts are treated by the reform. Thus, while all cohorts are eventually treated, the age at which they are treated differs. The variation exploited is similar to recent papers exploiting the timing of the event in an event study framework (see e.g. Angelov, Johansson, and Lindahl, 2016; Kleven, Landais, and Søgaard, 2019), however, with the difference that we use educational reform for identification.

3.3 Empirical Approach

To exploit variation in the age at which high school dropouts are treated by the education reform, we define two groups: early and later treated cohorts. As noted above, although the treatment begins in 2000, the full implementation does not take place until 2003. Early treated cohorts are those aged a^0 in 2000 while later treated cohorts are treated from age $a^0 + \delta$, that is δ years later. In our baseline specification, $\delta = 3$, and later treated cohorts are exposed to the same reform three years after early treated cohorts. Early treated is defined as:

$$earlytreated_i = \begin{cases} 1, & \text{if } a^0 = a \text{ in year 2000} \\ 0, & \text{otherwise.} \end{cases}$$

As later treated are assigned 0 throughout the time period, our estimated treatment effects compare differences in exposure to the reform, where later treated cohorts always serve as the counterfactual for early treated cohorts.[14] Variation comes from the fact that while all cohorts are exposed at the same calendar year, the reform affects different cohorts at different ages. By defining treatment from the year 2000, we incorporate the full effect of the reform which began in the 2000/2001 academic year. Thus, we compare early and later treated cohorts at the same ages, and the panel dimension of the data is age, rather than calendar year.

Event time is calculated relative to a^0, a "base age" which indicates the age at which the early treated cohort is treated.[15] Event time is defined as $time = a - a^0$. As such, by $time = 6$, the treated cohort continues to be treated by the reform while the later treated cohort is first treated.

By defining time with respect to a^0, the event study approach compares the age-education and

[14] Similar approaches are taken in Nekoei and Seim (2018); Malkova (2018); Fadlon and Nielsen (2019), where the counterfactual group is treated in the future.

[15] Section 5.5 details the robustness of the results to the choice of base age a^0.

age-earnings profiles among high school drop outs of different birth cohorts who are exposed to the educational reform at different ages. The paper estimates the following event study regression separately for women and men:

$$y_{ijlt} = \sum_{k=-4}^{14} \delta_k D_{it}^{k\ years\ after\ reform} + \tau_t + \psi_j + \gamma_l + u_{ijlt} \tag{1}$$

where the estimated δ_k coefficients corresponds to the treatment effect comparing early to late treated in time t (k years after the reform) for individual i. $D_{it}^{k\ years\ after\ reform}$ is defined as:

$$\begin{cases} = 1, \text{ if } earlytreated_i = 1 \text{ and } time = k \\ = 0, \text{ otherwise.} \end{cases}$$

In results that follow, y_{it} corresponds to one of five different outcomes of individual i in time t: three education measures—years of completed education, a binary variable indicating the completion of high school, and a binary variable indicating the completion of higher education—and two labor market outcomes—log of annual labor earnings and a binary variable indicating employment.

The coefficients δ_k for $k = 0, \ldots, 14$ represent the impact of the educational reform k years after the reform on one of each of these outcomes. The pre-reform coefficients $\delta_{-4}, \ldots, \delta_{-1}$ reveal whether early and later treated individuals had any existing differential pre-reform trends in the relevant outcome variable. The coefficient δ_{-1} is conventionally set to zero, such that the estimated difference is interpreted relative to the difference between early treated and later treated individuals in $k = -1$. That is, we fix the difference in outcomes at age $a^0 - 1$ to be constant and ask whether the differences over time are significantly different between the early and later treated groups (relative to the difference between the two groups). τ_t corresponds to age fixed effects within a given base age a^0. ψ_j corresponds to pre-reform sector fixed effects, where sector is defined as manufacturing, public, employed in any other sector, or non-employed (no sector). γ_l corresponds to fixed effects for the age which a student first left the education system and dropped out of high school, where $l = 16, \ldots, 20$. Standard errors are clustered at the municipality level.[16]

Exploiting the variation in the ages at which different birth cohorts are exposed to the same reform requires the identifying assumption that, in the absence of the reform, the education/labor market outcomes of early and later treated groups would have evolved the same over the life cycle. This implies that had early treated cohorts (and eventually later treated groups) not been exposed to the reform, they would have continued to experience the same changes in education/labor market outcomes over the same ages. Given the speed at which the law in 2000 was passed and implemented—the eventual

[16] Results using non-clustered standard errors produce similar results.

change was proposed 28 April 2000, passed 30 June, and came into force as of 1 August—the age at which high school dropouts of different birth cohorts are treated by the educational reform is likely to be as good as random. The rapid implementation of the law and the inflexibility of the education system prior to the change (*St.meld. nr. 32 (1998-99)*) also limits the scope for anticipation.

3.3.1 Defining the sample

The paper isolates a sample of on-time high school dropouts by imposing four sample restrictions:

I. As there exists a strong relationship between fertility and education (see Figure VI), and the presence of children in the household clearly matters for returning to education, we focus the main treatment group on birth cohorts who are treated from 30–33. Two specific observations support this selection. First, the distribution of age of first birth peaks in the late 20s and the average age of first birth among high school dropouts is 27.5. Focusing on those who return to education from age 30 allows the average dropout's first child to begin kindergarten at the time the Norwegian government reforms the adult education system.[17] These ages represent a key point in the life cycle, and previous literature reveals the importance of child birth for the labor market outcomes of women (Angelov, Johansson, and Lindahl, 2016; Kleven, Landais, and Søgaard, 2019). Second, in contrast with a younger sample, we can measure completed fertility post-reform among those treated from 30–33. As the majority of the sample has children by the time of the reform, such a choice of ages allows us to assess whether later life education impacts the timing of fertility as well as completed fertility.

II. The sample is restricted to those who have completed either one or two years of high school, but left education at age 20 or younger having not finished high school.

III. The sample is restricted to those who, at time -6, have still not completed high school prior to the reform. To the extent that high school dropouts return to education at different levels prior to the 2000 reform, this will be reflected in the estimated pre-reform coefficients δ_{-4}, δ_{-3}, and δ_{-2}.

IV. In order to focus on those who make real investments in human capital, we exclude dropouts who go on to complete a vocational degree under the Practical Candidate Scheme discussed in Section 2. The scheme offers an out of classroom opportunity for workers in a specific vocation to document their on the job knowledge and skills and attain a vocational high school diploma. Though certifying vocational skills in this out of classroom scheme may not necessarily reflect investment in human capital, the main results of the paper are similar including practical candidate degrees.

Table I describes the estimation sample of female high school dropouts in time -1, comparing early and later treated cohorts. Early and later treated cohorts are similar on observable characteristics,

[17] Section 5.5 details the robustness of the main results to the choice of a^0. Indeed, the take-up of education post-reform is slightly lower among a sample of younger base ages, the vast majority of whom have a young child at home at the time the reform is introduced.

while early treated cohorts come from slightly more educated families and are slightly less likely to be married. There exist strong gender differences in the sample of high school dropouts. On average, women have 1.6 children—compared to only 0.9 children for men of the same birth cohorts—and while 51% of women are employed, 70% of men in the same birth cohorts are employed. Unsurprisingly, the sample of high school dropouts in Table I are in the lower part of the national earnings distribution, where the average labor earnings of women correspond to the 28^{th} percentile (see Figure G.1).

3.3.2 Exploiting the Variation in Treatment Across Cohorts

As the event study framework exploits variation across different birth cohorts, changes in demographic characteristics over time may affect the similarity of early and later treated. For instance, early treated cohorts have slightly higher levels of parental education than later treated cohorts (see Table I). One potential reason for this is that parental education levels are slowly increasing over time as younger birth cohorts become increasingly educated.[18] As such, pre-treatment differences in the composition of the sample between early and later treated cohorts may affect the dynamics of the outcome variable post-reform, violating the parallel trends assumption. Abadie (2005); Blundell and Dias (2009) show that weighting the regression by an estimated propensity score accounts for such differences.[19]

Focusing on cohorts treated 3 years later limits the scope for major differences, as the cohorts are not born that far apart. However, in order to account for the possibility of minor differences in the composition of the sample of early and later cohorts, we weight the event study regression by an estimated inverse propensity score. We first estimate propensity scores predicting the probability of being in the early treated group compared to the later treated group. The inverse propensity score is then used to weight the event study regression by

$$treated\frac{p}{P\left(X_i\right)} + (1 - treated)\,\frac{1-p}{1-P\left(X_i\right)} \tag{2}$$

where p is the unconditional probability of early treatment and $P\left(X_i\right)$ is the conditional probability of treatment (the propensity score), see Mastrobuoni and Pinotti (2015). Intuitively, this method increases the weight of those in the later treated group with similar characteristics to the early treated group and weights down those in the later treated group with differences in the estimated propensity score.

In our application, the propensity score is time-invariant, using data one year prior to the reform in $time = -1$, and then used in all time periods from $time = -4, \ldots, +14$. It is estimated by matching

[18] Figure I suggests this is the case as the on-time completion rate increases from birth cohorts 1961–1965 to 1976–1980.

[19] Similar approaches are taken in Mastrobuoni and Pinotti (2015); Pohlan (2019); Goodman-Bacon and Cunningham (2019).

early and later treated individuals using a rich set of covariates: 3 binary variables indicating at least one highly educated parent, first birth at age 25 or younger, and married (measured at -1); binary variables for age of first drop outs (5 categories, 16–20); binary variables for broad field of study left high school with (10 broad categories); the number of children (measured at -1, including zeros); birth municipality; 2 digit industry dummies (measured at -1); and base age. Appendix Figure H.1 plots the estimated propensity scores, revealing substantial overlap between early and later treated. This suggests that, on the whole, the two groups are relatively similar in terms of the matching variables.[20] We report non-bootstrapped standard errors throughout.[21]

A limitation of exploiting variation across ages is that at the same time t, early and later treated cohorts are in different calendar years. For instance, at $t = 0$, the early treated cohort is in year 2000 while the later treated cohort is in year 1997. This implies that two people who live in the same local area face different economic conditions at the same point in event time. Likewise, two people who are in the same employment sector face different economic conditions. Note that time and year effects cannot be separated, as there is no group in the estimation sample which is never treated. To account for such differences, we make use of the population data and construct, separately for each gender, two fixed effects which we then merge into our base age sample.

Using data on all workers aged 25–54 who have not completed high school from 1993–2014, we construct two fixed effects: (a) *municipality* $\times$ *year* and (b) *initial field of study* $\times$ *year*. We define field of study at high school as the field of study an individual in the base age sample first dropped out of education with, as they all completed some high school yet did not finish. These two fixed effects account for differences in local economic conditions and time-varying shocks which affect early and later treated who dropped out of education in the same field of study and live in the same municipality differently. We make use of these fixed effects estimated on the entire population of dropouts in the estimation for income (Figure Va) and employment (Figure Vb).[22]

[20] Results are similar when using the unweighted event study regression.

[21] Busso, DiNardo, and McCrary (2014) show that with a large number of observations, non-bootstrapped standard errors are a reasonable approximation when weighting by the inverse propensity score. While typically bootstrapping does not produce valid standard errors in matching, this is not the case when weighting by the inverse propensity score (Abadie and Imbens, 2008). Mastrobuoni and Pinotti (2015) establish the similarity between bootstrapped and non-bootstrapped standard errors.

[22] Excluding these controls leads to slightly larger impacts of the reform on income and employment.

4 The Estimated Impact of the Educational Reform on Education, Labor Market Outcomes, and Fertility

4.1 Education and Labor Market Outcomes

Figure IV reports estimates of equation (1) for the three education variables for the sample of women: the completion of high school, years of education, and the completion of higher education.[23] Immediately after the reform, high school completion and years of education remain unchanged (Figures IVa and IVb respectively). Following the introduction of the student financing subsidy, education begins to increase among early treated and peaks at +6. Six years after the beginning of reform period, high school completion among early treated increases by 1.3 ppt (10.5% of the mean in −1) and years of education increases by 0.084 years (0.7%).[24] Both effects are significant at 5 and 1% respectively. Importantly, estimated pre-event coefficients are small in magnitude and not significantly different from zero, indicating that we cannot reject that the age-education profiles of early and later treated cohorts are parallel pre-reform.

As time goes on and the later treated cohorts are also exposed to the reform, increases in high school education among early treated cohorts relative to the later treated cohorts fade out. In the longer run, the differential impact on high school completion of early treated is not significantly different from zero. Years of education, however, *remains higher* among early treated compared to later treated individuals, an effect which is significant at the 5% level. The difference between the two sets of results can be explained by differences in the probability of continuing with higher education among the early treated cohorts, reported in Figure IVc. While some later treated individuals also continue into higher education, as evidenced by the decline in the estimated coefficient from its peak at +6, the probability of continuing past high school is higher among early treated women. That is there are are persistent increases in the probability of completing higher education among early treated women: 14 years after the reform, early treated women are 1 ppt more likely to have higher education (24% of the mean in −1).

Differences in the completion of higher education between early and later treated women reveal that the age of returning to high school may matter for the probability of continuing further in the education system. Such results suggest that in order to increase educational attainment later in life, policies encouraging individuals to return to finish high school at younger ages would have larger effects on higher education. As later treated are exposed 3 years later, they are also 3 years closer to

[23] Appendix I reports the corresponding age-education profiles comparing treated and counterfactual birth cohorts.

[24] Separating by academic and vocational high school reveals similar patterns, although vocational high school begins to increase earlier from +2.

retirement. It maybe that women in the later treated group may find it too costly to forego additional years of earnings to return to higher education while the early treated group may not. However, age of exposure seems to matter less for returning to high school, as both early and later treated women complete high school at roughly the same rates.

Corresponding with the observed increases in education, labor earnings (Figure Va) and full-time employment, defined as at least 30 hours per week, (Figure Vb) also increase among women. The timing of the changes in labor market outcomes coincide with changes in education: as early treated women complete education, labor market outcomes begin to increase and when later treated cohorts return to education, the increases in labor market outcomes stabilize or even decline. In the long run 14 years after the early treated cohorts are treated, earnings increase by roughly 5% and employment increases by 3 ppt (8.3%) relative to later treated cohorts. Increases in earnings are similar irrespective of whether or not benefits are included in the measure of labor earnings.

4.2 The Channels From Later Life Education to Labor Market Outcomes

We first present the reduced form estimates of the impact of the reform on years of education, earnings, hours and employment. We then use this analysis to estimate the impact of additional years of education on employment and earnings, as well as on the quality of jobs. To further understand the estimated impacts we also examine the employment impacts by pre-reform number of children and develop this analysis by estimating the impact of the education reform on fertility.

4.2.1 Impact of the Reform on Full-time Employment, Earnings and Years of Education

Table II presents the post-reform impacts across four outcomes: annual earnings, hourly labor earnings, a binary variable indicating full-time employment, and years of education. These regressions reflect the labor market responses seen in Figure V. The results in Table II correspond to a difference-in-differences regression, where the reported estimates represent the interaction between an indicator for early treated and the post-reform period. By looking at the impacts measured from +8 to +14, the difference-in-differences estimates provide the long-run impacts of the reform. As later treated cohorts always serve as a counterfactual for early treated cohorts and their treatment status never changes, the reduced form coefficients of Table II estimate the average of δ_k for $k \geq 8$ in equation (1).

Compared to the increase in annual labor earnings in Figure Va, the increase in *hourly* labor earnings is much smaller, and not significantly different from zero. This suggests that the bulk of the labor market impact of later life education comes through employment response rather than through an increase in wages. Early treated women see increases in full-time employment post-reform and, on average over the post-reform period, full-time employment is 6.5% higher relative to a low pre-reform level of 0.36. Indeed, the sample of high school dropouts is not that attached to the labor force. 31% of women are classified as outside of the labor force in −1 (column (1), Table III).

Table III presents the estimated employment response across 4 variables corresponding to different measures of labor market status: outside of the labor force, employed less than 20 hours per week, 20–29 hours per week, and 30+ hours per week (full-time employment). The results of Table III reveal whether the observed increase in full-time employment in Table II originates from increasing labor market attachment (a decline in the probability of being outside the labor force) or increasing hours worked (a decline in employment less than full-time). Though the reduction in the probability of being outside the labor force is not significant, increases in full-time employment originate from women joining the labor force and declines in the probability of working less than 20 hours per week (columns (1) and (2) respectively).

Our results point to key responses in full-time employment among early treated women. We might also be interested in differences by occupation. Appendix Table J.1 displays the distribution of occupations between early and later treated women in +14 using occupation data available from the mid 2000s. While there is a sizable causal effect of later life education on labor force participation among women, the *distribution of occupations* between early and later treated women in +14 is broadly similar. As such, Table J.1 suggests that labor force participation is the primary reason behind the large labor market returns observed in Table II.

4.2.2 The Impact on the Education Reform on Fertility

The results of Table II point to large returns to later life education which originate, primarily, from increases in employment among early treated women. Indeed, only 36% of the sample is employed full-time prior to the reform, so there is scope for large increases in employment. The education literature estimates sizable reductions in fertility following additional education in addition to increased labor market prospects (Black, Devereux, and Salvanes, 2008). A natural question is whether early treated women, who complete higher education at higher rates than later treated women, also experience a decline in fertility. If so, the joint decision of employment and fertility among higher educated early treated women may be behind the large increase in employment. Consistent with this, Figure K.1 reveals a strong negative relationship between number of children and employment probability.

As a starting point to understand the relationship between later life education and fertility, Figure VI describes the relationship between child birth and education separately for women and men. The figure presents the distribution of age at first birth for four separate samples: on-time high school graduates (age 20 or less) and those who completed high school from 21–25, 26–30, and 31–35.

Figure VI reveals that childbirth is much more interruptive to on-time education for women compared to men: there exists a strong relationship between age of first birth and age of high school completion for women. In particular, fertility during the teenage years and the early 20s is much more common among women who return to education later in life.[25] For women who complete high school from 21–25, there is a clear mass who have their first child in their late teenage years and early 20s. The same is not true for men. The distributions of age at first birth differ even more among those who complete high school from 26–30 and 31–35: the vast majority of women who complete education at these ages had their first child in their teens and early 20s. Again, the same cannot be said of men. Interestingly, women who complete high school from 26–30 also exhibit a second peak in age of first birth in their late 20s, suggesting that later life education and childbirth may also be linked.

Given the strong relationship between childbearing and later life education among women, Figure VII plots the impacts of the education reform on fertility. Early treated women experience declines in the intensive margin, number of children, in the long-run relative to later treated women. However, there is no significant impact on the extensive margin, the probability of having any children, though the average woman in the sample has 1.5 children in time -1. Scaling the average reduced form impact in column (3) of Table IV by the estimated first-stage regression reveals a large implied LATE of later life education on fertility: one additional year of education reduces the number of children by 0.72.

As both early and later treated women are, at a minimum, aged 44 in time $+14$, the vast majority of births are completed by the end of the sample period. Such large declines in fertility suggest that a substantial portion of the increases in employment from later life education are due to declining fertility. While fertility and employment are clearly decisions made jointly, the impact of the education reform on full-time employment compares early treated women—who have less children as a result of additional education—with later treated women—who have more children. Given a correlation of -0.25 between employment and number of children prior to the reform, a simple calculation suggests that the difference in the number of children between early and later treated women can account for 37% of the reduced-form increase in full-time employment in column (2) of Table II. Indeed, a substantial portion of the observed increase in full-time employment in Table II among early treated women operates via the joint decision of fertility and employment.

4.2.3 The Impact of Adult Education on Women's Earnings and Employment

We can use the reduced form results on the impact of the reform on years of education as a first stage in the calculation of the local treatment effect of years of education on the outcomes of interest. Table V

[25] Figure L.1 presents adolescent fertility rates among the OECD founding member states and Finland in 1990. Norway ranks in the middle of the distribution of teenage fertility across the founding member states with 16.5 births per 1000 women aged 15–19.

presents the estimated reduced form labor market impacts scaled by the estimated impact of the reform on years of education. These estimate the labor market impact from additional education among the "treatment group switchers" and correspond to the Local Average Treatment Effect (LATE). This is the estimated impact on the compliers who return to high school education if and only if they are exposed to the education reform (using notation from de Chaisemartin and D'Haultfoeuille, 2018).[26]

The group of switchers represent a policy relevant group—those who are at the margin of returning to high school and only do so as result of the reduction in the opportunity cost attributed to the reform. However, they also represent a particular group—women in their early to mid 30s who have not returned to education at any younger age. Column (2) of Table II implies a large increase in annual earnings due to an additional year of education for this group. Column (3) shows an insignificant effect on hourly earnings. The large increases in income in column (2) are therefore attributed to increases in full-time employment, where an additional year of later life education increases full-time employment by 56%.

Although the estimated increase in employment due to later life education among the group switchers is large, the magnitude is perhaps unsurprising for two reasons. First, the potential for increased employment is high among the sample, as only 36% of women are employed full-time pre-reform and 31% are outside the labor force. Other factors may also change among early treated women as a result of the acquisition of later life education. We have shown that fertility declines as a result of increases in education and a substantial amount of the observed increase in employment can operate through decisions over fertility. Second, treatment group switchers represent the group of women at the margin of returning to high school in their early to mid 30s. Thus, the labor market returns to education among such a group may differ from the returns among other types of women. Under a framework of ordering on the unobserved cost of treatment as in Kowalski (2020), those who take up the reform find it more costly to return to education than always takers, those who return to education regardless of treatment status. When unobserved costs differ across individuals, part of the selection into treatment may depend on unobserved costs. In addition, there may be selection on gains. Those who take up the reform are those who find it most profitable to return to education. It seems likely that those who find it more costly to return to education require a larger return to do so.[27]

[26]de Chaisemartin and D'Haultfoeuille (2018) formalize the identifying assumptions of the Wald-DID estimator. In addition to the standard exclusion restriction in an IV framework—assuming that the education reform only has an impact on labor market outcomes through its impact on education—combining difference-in-differences with IV requires additional identifying assumptions in order for the Wald-DID estimator to estimate the LATE among the treatment group switchers. In particular, the Wald-DID requires a stable treatment effect over time.

[27]The marginal treatment effect literature emphasizes these two forces, for instance Bjorklund and Moffitt (1987); Heckman and Vytlacil (2001); Cornelissen, Dustmann, Raute, and Schönberg (2018).

4.2.4 Impact of the Reform on Employment by Pre-Reform Labor Market Attachment

Table VI examines the importance of pre-reform labor market status for the impacts on employment, separating the sample into low, some, and strong attachment to the labor force based on the number of hours worked in -1. Women with different levels of pre-reform attachment to the labor market see very different changes in employment outcomes post-reform.

Among women with low attachment—who are primarily outside of the labor force pre-reform—the probability of remaining outside of the labor force significantly declines post-reform. This translates into significant increases in part-time employment. Among women with some attachment—who are primarily employed part-time—the probability of working less than 20 hours per week decreases post-reform. This decrease translates into significant increases in the probability of working full-time. Among those with strong labor force attachment—who are predominantly employed full-time in -1—treated women are significantly more likely to continue to work full-time relative to later treated women, with significant declines observed in employment less than full-time. Relative to later treated women, the labor market responses of early treated women are markedly different across those with different pre-reform levels of labor market attachment: labor force participation increases among those with low labor market attachment while hours worked increase among those with some and strong of labor market attachment.

4.2.5 Impact of the Reform on Employment by Pre-Reform Number of Children

Table VII examines the importance of the number of children pre-reform in the impacts on employment. The four panels of Table VII correspond to women who had 0, 1, 2, and 3 or more children in time -1 respectively. As with pre-reform labor market status, women with different number of children also see markedly different changes in post-reform labor market outcomes.

Though the average woman in the sample has 1.5 children in -1, there are still some women who have no children pre-reform. Employment of women with no children, who also have the strongest attachment to the labor force, is largely unchanged, with slight declines in part-time employment. Increases in full-time employment are driven by women with children, in particular women with one child. Increases in employment are concentrated among women with children who, prior to the reform, are less attached to the labor force while women with no children see small changes in labor market outcomes.

4.3 Reducing the Gender Earnings Gap

Taking the estimates of equation (1) for labor earnings for women and for men, Figure VIII plots the comparison of predicted log earnings over the life cycle for early treated women and men. Comparing the two groups, while the earnings of men steadily increase post-reform, women see much larger growth in earnings after returning to education. As such, later life education closes the gap in labor earnings between early treated women and men: by +14, the gender gap has closed by 42% from its -1 value, from 0.53 log points to 0.31 log points.

5 Heterogeneity and Robustness of Results

The sections below detail the fields of study which female high school dropouts return to study (Section 5.1), the heterogeneity of the baseline results (Section 5.2), and further establishes the similarity of economic conditions between early and later treated cohorts (Section 5.3). Sections 5.4 and 5.5 detail the robustness of the results to the choice of δ, the time between early and later treated cohorts, and a^0, the base ages of the sample.

5.1 Differences by Field of Study

Table M.1 reports the highest attained degree 14 years after the reform among women who have graduated high school. Degrees are presented by the narrow field of study of the degree, for instance, nursing within the broad field of healthcare. Across both bachelors and high school degrees, female dropouts return to finish degrees in healthcare, primarily nursing and carework which represent over 7% degrees, and teaching of young and middle school aged children. Such increases are similar to what is seen in the community college literature in the US, which documents large returns to community college programs in healthcare (Stevens, Kurlaender, and Grosz, 2018; Grosz, 2020). In addition, some return to general high school, which leads to higher education, but do not go onto complete higher education by +14.

Table M.2 asks how the significant increases in higher education among women seen in Figure IVc vary by the most common fields of study. The increase in higher education is primarily driven by increases in the completion of higher education in healthcare. In contrast, the completion of higher education to become a teacher is unchanged post-reform. All other fields besides healthcare and teaching also increase, though the increase is not statistically significant.

5.2 Heterogeneity in Returning to Education Post-Reform

Figure N.1 examines the importance of two pre-determined factors in the estimated effects of the education reform on education: parental education and age of first birth. Descriptive results in Section F and Section 4.2.2 reveal that parental education matters in returning to education and that childbirth and education are strongly correlated for women. While such differences are not statistically significant, returning to education is stronger among those who have their first child at 25 or younger (Figure N.1b) while results are similar among high and low educated families (Figure N.1a).

Figures N.2 and N.3 examine the importance of two additional factors: cognitive ability (only available for men) and the importance of oil in the local labor market following the discovery of oil in Norway in 1969.[28] Both cognitive ability and oil seem to matter little for the estimates of returning to education. While the returns to education may differ between high/low oil areas (Cascio and Narayan, 2015), the presence of oil does not matter for returning to education for either women or men.

5.3 Similarity of labor market conditions between early/later treated cohorts

While women return to education following the reform, the reform has no discernible impact on the education of men and effects for men are imprecisely estimated (see Appendix O). Table P.1 replicates the results of Table II for men. While the fixed effects described in Section 3.3.2 capture differences in labor market conditions between early and later treated cohorts, it may be that other changes over time are not captured by the two included fixed effects. If this were the case, and education was not the driving force behind the increased labor market outcomes of early treated women, then similar increases in earnings and employment would be observed for men whose education is largely unchanged. Reassuringly, there are no significant changes in any measure of earnings or employment status for men, reinforcing that the increases in earnings and employment among women are due to increases in later life education.

5.4 Robustness of Results to Varying δ

Figure Q.1 examines how the results change by varying δ, the number of years which have passed until the later treated cohort is exposed to the same reform. The Figure examines how using a later treated group who is exposed even earlier ($\delta = 2$) and a later treated group who is exposed even later ($\delta = 5$) affects the results on high school completion and higher education compared to the baseline case ($\delta = 3$).[29] In the longer run, the estimated effects on high school completion are

[28] Following the discovery of oil, there was substantial geographic dispersion in how important oil was to different local labor markets (Løken, Mogstad, and Wiswall, 2012; Bütikofer, Dalla-Zuanna, and Salvanes, 2018).

[29] Including even more alternatives for δ resembles the patterns seen in Figure Q.1.

indistinguishable when using the three different levels of δ. However, the timing of when increases in high school completion fade out changes: using an even earlier later treated cohort corresponds to an earlier decline in the completion of high school while using an even later later treated cohort corresponds to a longer positive impact on high school completion. A similar picture emerges for the estimated effects on higher education.

Such variation in the timing of the estimated effects is consistent with the strength of the identification strategy: as δ increases, the peak of education moves later in time as the later treated cohorts are increasingly later exposed to the educational reform. As high school completion fades out at similar rates, this suggests that later treated cohorts return to high school at roughly similar rates despite the fact they are older at the time they are treated. Interestingly, the longer run impact on higher education is substantially lower for the sample of $\delta = 2$, reinforcing the idea that the returning to high school at younger ages increases the probability of completing additional higher education.

5.5 Robustness of Results to Varying Base Ages

Appendices Q.2– Q.4 examine the robustness of the baseline results to varying the base ages of the sample. Three different samples are used: (i) a slightly older sample, those aged 30–37 at the time of reform; (ii) an even older sample, those aged 38–41, who have mostly completed fertility at the time of reform; and (iii) a younger sample, those aged 26–33 at the time of the reform.

Figure Q.2 replicates the results on education extending the sample of workers to $a^0 = 30, ...37$. Including workers who are even older at the time of the reform produces similar results, with significant increases in high school which fade out over time and persistent increases in higher education. However, the post-reform increases in education are slightly smaller when compared to the baseline sample, suggesting that older workers are less responsive to the education reform.

To further examine the relationship between age and returning to education post-reform, Figure Q.3 compares results on education using base ages $a^0 = 38, ..., 41$ to results using $a^0 = 30, ..., 33$. The post-reform increases in high school are comparable between younger and older base age samples. However, results for higher education (Figure Q.3d) differ substantially: the increase in higher education among the younger sample is at least twice as large. Indeed, there is no significant increase in higher education for the older sample by +14. This is consistent with the fact that while take up of high school completion is similar irrespective of age, returning to high school younger increases the probability of completing higher education relative to returning to high school older.

Finally, Figure Q.4 examines the robustness of the results to including even younger workers, $a^0 = 26, ..., 33$. Including even younger workers produces similar results, with significant increases in higher education post-reform and an increase in high school completion which fades out as the later treated cohorts become treated.

6 Conclusion

In this paper we leverage high quality Norwegian register data to estimate the causal impact of providing a second chance of completing high school for adults within the formal high school system. A sizeable proportion (20–30%) of each birth cohort across OECD countries fail to complete high school on time and developing effective tools to tackle the declining labor market prospects of prime-aged high school dropouts is a key policy question which motivates our study.

Exploiting variation in the age at which different birth cohorts in Norway are exposed to a major reform in the 2000s enabling greater access to high school for adults, the paper establishes a causal link between returning to education later in life and labor market outcomes. Our focus is on women and we look at enrolment in education for individuals in their late twenties and early thirties. While most men who return to education have done so by this age, female high school dropouts are much more likely to return to education after having their first child and we estimate a significant impact of the reform on women returning to education at these ages. By reducing the opportunity cost of re-enrolling in high school, our results show that the reform significantly increased education among women. Our results also suggest that returning to high school at younger ages relative to older ages increases the probability of continuing with higher education later in life.

We find that the impact on female labor earnings operates primarily through increases in employment among high school dropouts who are, on average, weakly attached to the labor force to begin with. Fertility is shown to be an important mechanism: in addition to increasing employment, returning to education also leads to a reduction in fertility among women. Given the strong relationship between children and employment, a considerable portion of the increase in employment can be attributed to the joint decisions of fertility and employment. The results suggest that enhanced access to adult education, and subsequent increase in years of education, can be an effective policy to reduce the gender earnings gap.

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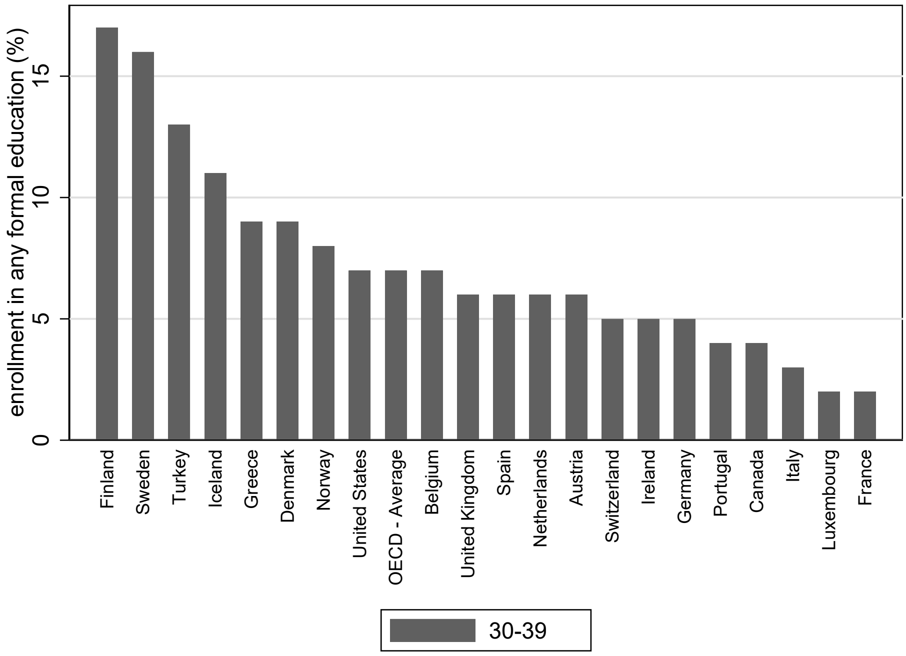
Appendix

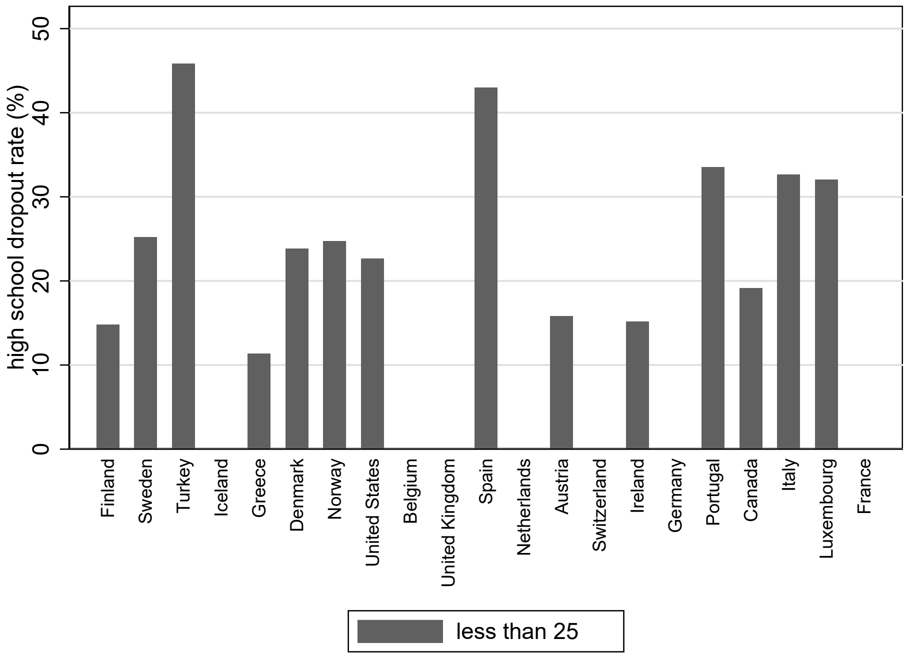
A Enrollment in Education and Dropout Rate Across the OECD

Figure A.1: Enrollment in Any Education Across OECD Countries, 30–39



Percent of age group enrolled in any formal education in 2017. Source - OECD.Stat, Adult education and learning (https://stats.oecd.org/index.aspx). Founding OECD member countries and Finland reported, OECD average calculated as average across all OECD members in 2017.

Figure A.2: High School Dropout Rate Across OECD Countries, less than 25



Percent of age group who have dropped out of high school. Dropout defined as the percent of age group who have not graduated secondary education. Source - OECD.Stat, Graduation rates and entry rates (https://stats.oecd.org/index.aspx). Founding OECD member countries and Finland reported. Measured for age group less than 25 in 2010. Countries sorted by ranking as in Figure A.1, where some countries, along with OECD average, are reported as missing.

B Field of Study, Higher Education, and Years of Education Over the Life Cycle

B.1 Returning to High School Over the Life Cycle—Academic and Vocational High School

Figure B.1: Fraction of Birth Cohort Completed Relevant Margin of Education - Academic/Vocational

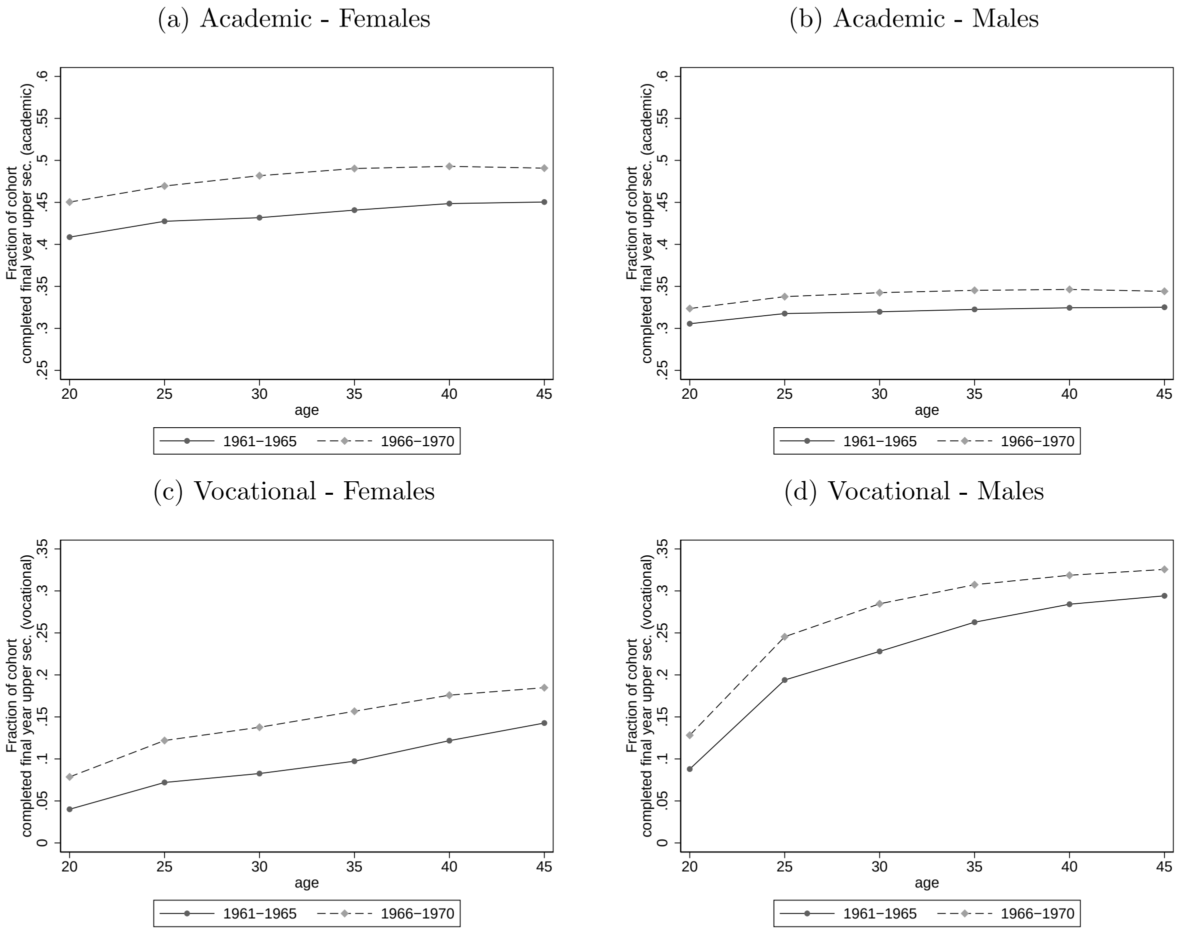
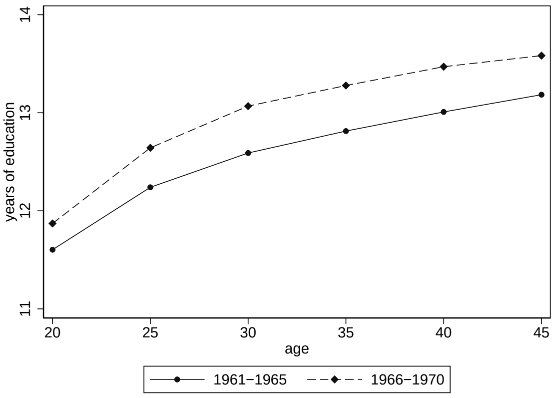


Figure plots the high school completion rate over the life cycle for birth cohorts 1961–1970 for academic and vocational high school, for women and men respectively. Academic high school prepares students for university education, while vocational high school is geared towards entry into the labor market directly after high school.

B.2 Returning to Education Over the Life Cycle—Years of Completed Schooling

Figure B.2: Evolution of Years of Education Over the Life Cycle

(a) Female



(b) Male

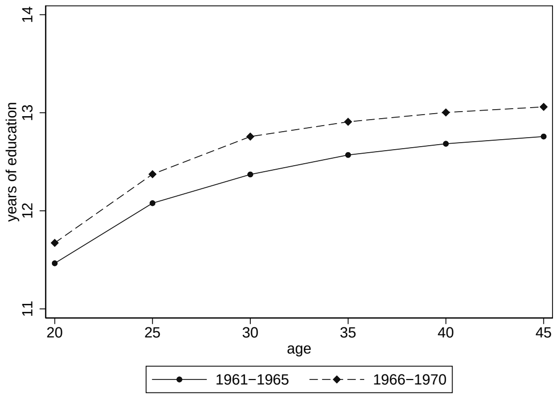


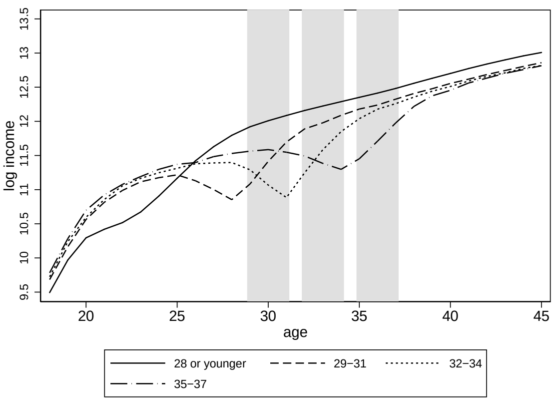
Figure plots average years of education over the life cycle for birth cohorts 1961–1970 for women and men respectively. Years of education measured as the typical number of years it takes a student to complete a specific qualification.

C Late Completion of Higher Education and Lifetime Earnings

Figures C.1a and C.1b present the evolution of earnings for those who complete any post-secondary education from age 28 or younger, 29–31, 32–34, and 35–37 for women and men respectively. The dip in earnings among later life completers relative to those who graduate post-secondary education at 28 or younger is quite large. As with the completion of high school, late completers catch up in terms of the slope of lifetime earnings, but not the level.

Figure C.1: Evolution of average earnings by different ages completed any post-secondary education

(a) Female



(b) Male

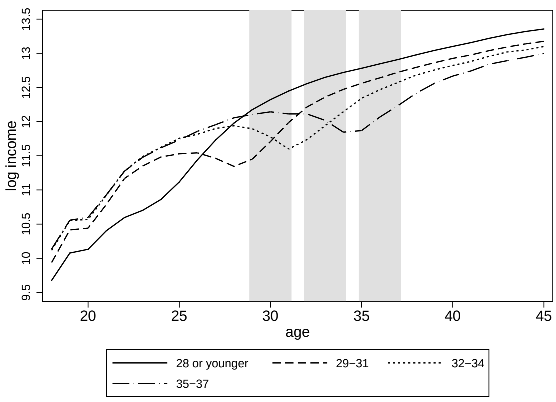


Figure plots, for women and men respectively, average of log earnings for on-time higher education graduates, late graduates aged 29–31, 32–34, and 35–37. Birth cohorts 1964–1970.

D Calculating the Discount Rates to Equalize Age-Earnings Profiles of On-Time and Later Life High School Graduates

The table calculates the discount rate over ages 18–64, assuming a stable difference in earnings from age 46 on. We calculate the discount rate as in Bhuller, Mogstad, and Salvanes (2017): $\sum_{a=18}^{45} \frac{\beta_a}{(1+\rho)^{a-17}} = 0$.

First, we calculate the discount rate which equalizes the present value of earnings of on-time graduates and late completers 24–26. For females, a large discount rate is required to equalize the earnings of the two groups: 27–45%. Compared to women, the earnings penalty incurred by male on-time graduates is much larger and the lifetime gains compared to late completers are much smaller. As such, a much lower discount rate is required to equalize the present value of earnings of the two groups for men: 5–7%.

Second, we calculate the discount rate which equalizes the age-earnings profiles of on-time graduates and late completers aged 30–32. For both women and men, the discount rates which equalize the earnings of the two groups are lower compared to those which equalize on-time graduates and late completers 24–26. For women, a discount rate 14–30% equalizes the age-earnings profiles. For men, a discount rate of 3–4% equalizes the age-earnings profiles.

Table D.1: Required Discount Rates to Equalize Earnings of Different Age of HS Completion Groups

	Discount Rate to Equal Age Group On-Time HS Graduates			
	(1)	(2)	(3)	(4)
	Females		Males	
	Excluding Post-Secondary (Figure IIIc)	Including Post-Secondary (Figure IIIa)	Excluding Post-Secondary (Figure IIId)	Including Post-Secondary (Figure IIIb)
	Earnings 18–64 (assuming stable difference 46–64)			
On-time graduate	ref.			
24-26	0.4507	0.2746	0.0674	0.0552
30-32	0.3044	0.1441	0.0348	0.0304
Observations On-Time	37195	120322	37734	108021
Observations 24–26	2506	6685	7393	12745
Observations 30–32	2722	5003	4797	6196

Table calculate the discount rate required to equalize the lifetime earnings of late high school graduates aged 24–26 and 30–32 to the lifetime earnings of on-time graduates (the reference group). Columns (1)–(2) present results for females while (3)–(4) present results for males, birth cohorts 1964–1970. Columns (1) and (3) exclude any individual who completed post-secondary education beyond high school, while columns (2) and (4) include post-secondary education. Assumes that the earnings difference at 45 persists in each future age from 46–64. Discount rate calculated as in Bhuller, Mogstad, and Salvanes (2017): $\sum_{a=18}^{45} \frac{\beta_a}{(1+\rho)^{a-17}} = 0$.

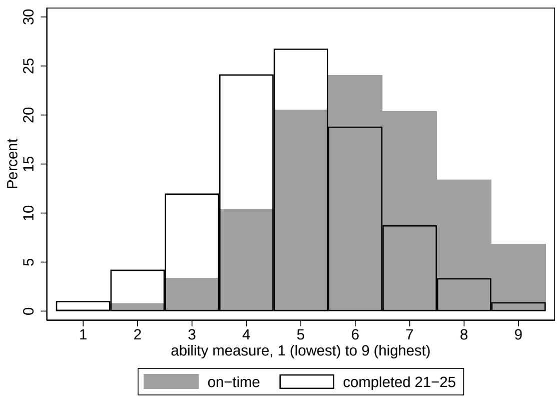
E The Relationship Between Cognitive Ability and Returning to Education

Using data available for men from compulsory military testing at age 18, Figure E.1 plots the distribution of cognitive ability measures across different ages of high school completion for the birth cohorts 1961–1970. The Figure compares the distribution of cognitive ability between on-time graduates and four groups: those who completed high school from 21–25, 26–30, 31–35, and those who never complete high school. Figure E.1 reveals clear differences in the underlying cognitive ability of on-time graduates, late completers, and never completers. On-time graduates are positively selected from the IQ distribution, with a median of cognitive ability of 6 and very few with cognitive ability score below the national mean of 5. As age of high school completion increases, the cognitive ability distribution shifts leftwards. While there are clear differences in the distributions of on-time and late completers aged 21–25 (Figure E.1a), where late completers have lower IQ scores, these differences are even more prevalent comparing on-time and late completers aged 26–30 and 31–35 (Figures E.1b and E.1c respectively).

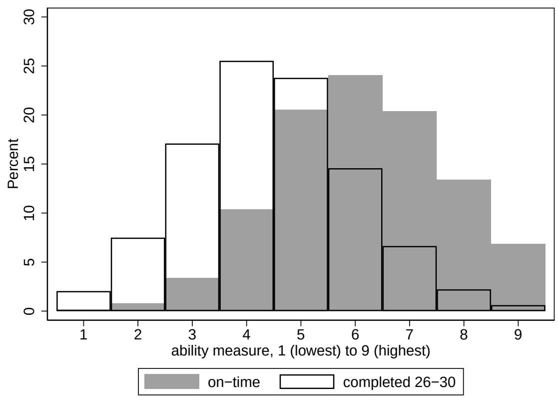
Figure E.1d compares the cognitive abilities of those who never complete high school to those who graduate on-time. While on-time graduates are positively selected, those who never complete high school by age 45 are negatively selected from the cognitive ability distribution. Such stark differences in cognitive ability complicate the comparison of late high school completers to on-time and never completers, and Section 3 discusses the choice of counterfactual for late high school completers in estimating the returns to later in life education.

Figure E.1: Distribution of IQ for Different Ages of High School Completion

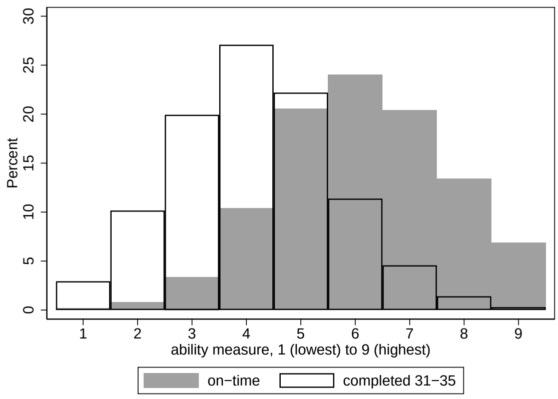
(a) Completed HS On-time and 21–25



(b) Completed HS On-time and 26–30



(c) Completed HS On-time and 31–35



(d) Completed HS On-time and Never Completed

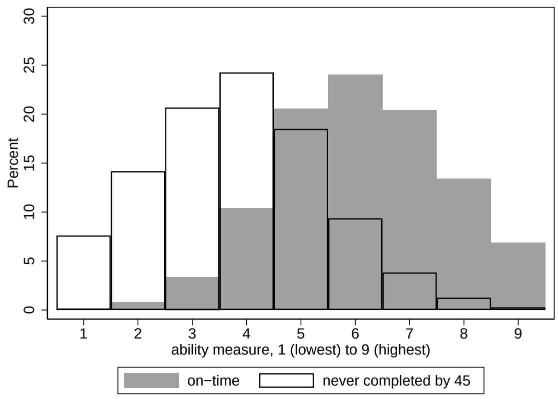


Figure compares the distribution of cognitive ability for men for on-time high school completers to four different groups: high school completers from 21–25, from 26–30, from 31–35, and those who never complete high school by age 45. Cognitive ability measured for all males at age 18 from compulsory military testing. Cognitive ability is measured on a 9 point scale, mean of 5 and standard deviation of 2. Measure is comprised of 3 examinations: an arithmetic test, a word similarities test, and a figures test as described in Section 2. Birth cohorts 1961–1970.

F The Relationship Between Socioeconomic Status and Returning to Education

Given the intergenerational link in education and earnings (see Black and Devereux, 2011, for an overview), socioeconomic status (SES) may be an important factor in returning to education over the life cycle. Do gaps in high school completion between high and low SES families persist over the life cycle, or do lower SES families catch up over time? Figures F.1 and F.2 plot the gaps in education by socioeconomic status (SES) over the life cycle for women and men respectively. SES is measured by parental education, where parental education is defined as the highest level of parental education ever attained, such that either the mother, the father, or both parents may have the indicated level of education. Figures F.1 and F.2 separate the sample into two groups of parental education: low-educated families, where the highest parental education is less than high school, and high-educated families, where the highest parental education is post-secondary education.[30]

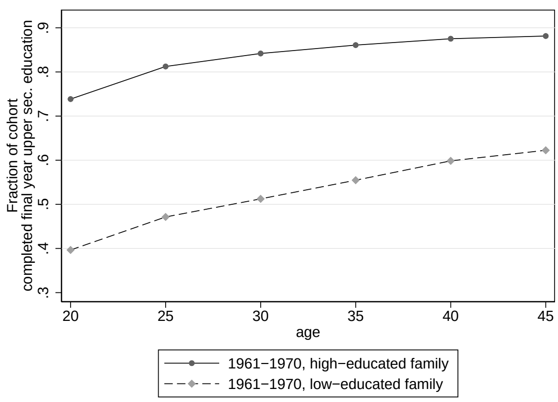
Unsurprisingly, there are sizable gaps in on-time high school completion by SES: those from low-educated families complete high school by age 20 at much lower rates. This is true for both men and women. SES gaps in high school completion decrease over time, as the completion gap is wider for the 1961–1970 cohorts compared to the 1971–1980 cohorts. Over the course of the life cycle, the SES gap in high school completion decreases, as those from low-educated families complete high school at higher rates than those from higher educated families later in life. For women born 1961–1970 (Figure F.1a), the SES gap in high school completion is 34 p.p. at age 20, 31 p.p at age 35, and 26 p.p by age 45. As seen before, men tend to return to education at younger ages relative to women.

While high school completion is key, it is informative to also understand how SES gaps evolve over the life cycle including all margins of education. As such, panels (c) and (d) in Figures F.1 and F.2 plot the SES gaps measured in terms of years of education. Unlike high school completion, SES gaps measured in years of education widen over the life cycle, as those from high-educated families continue to complete higher education beyond the high school level.

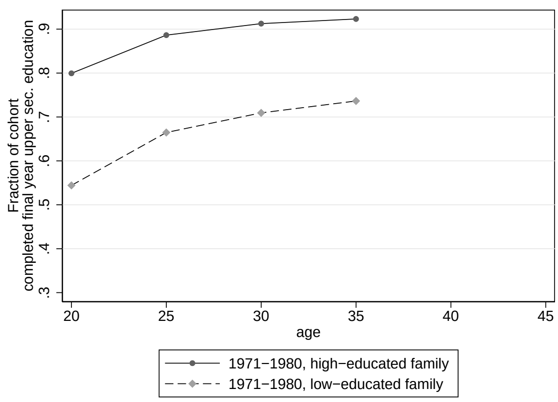
[30] Omitted are families where the highest level of parental education is the completion of high school. The high school completion of children in such families lies in between the high- and low-SES families.

Figure F.1: Completion of High School/Years of Education Females, by Highest Parental Education

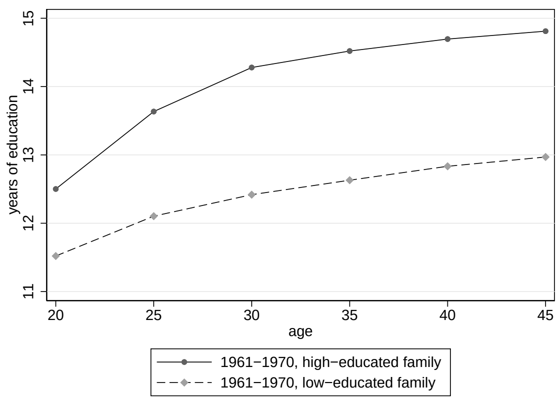
(a) 1961–1970



(b) 1971–1980



(c) 1961–1970



(d) 1971–1980

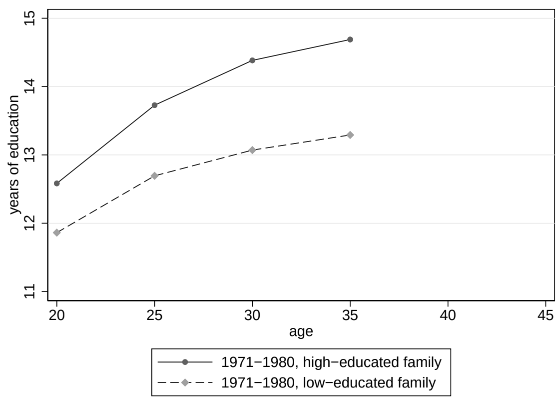
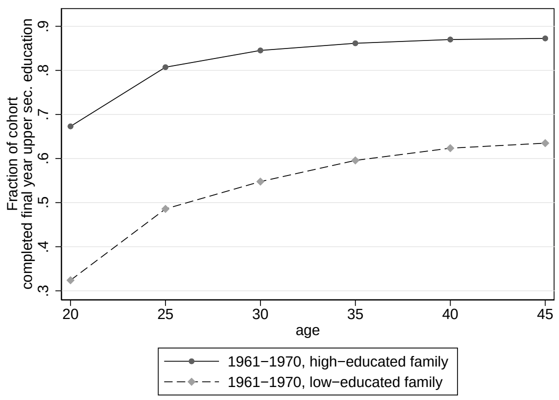


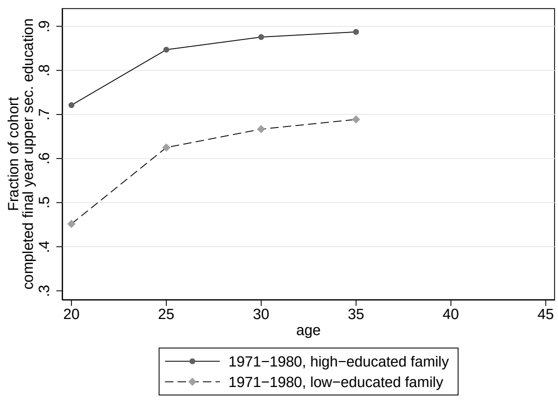
Figure plots the high school completion rate/years of education over the life cycle for birth cohorts 1961–1980 for females by the level of family education. Low-educated family: highest parental education is less than high school. High-educated family: highest parental education is any post-secondary education.

Figure F.2: Completion of High School/Years of Education Males, by Highest Parental Education

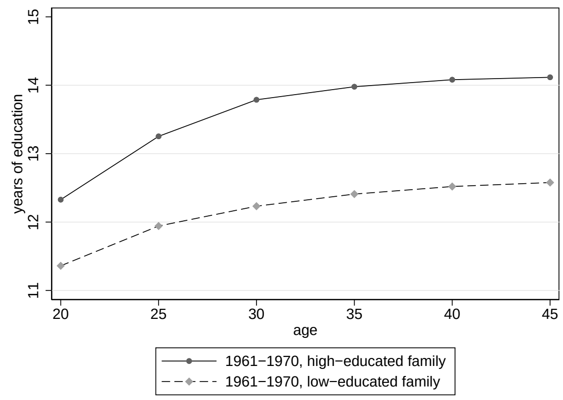
(a) 1961–1970



(b) 1971–1980



(c) 1961–1970



(d) 1971–1980

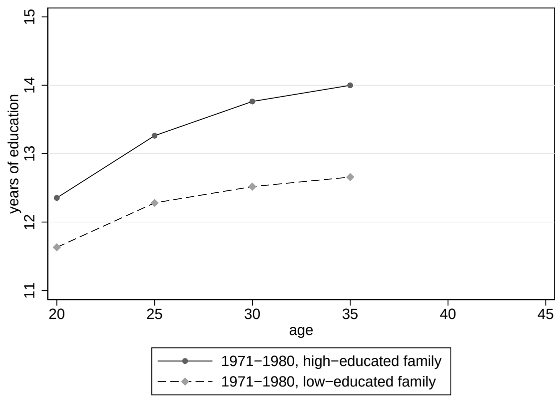
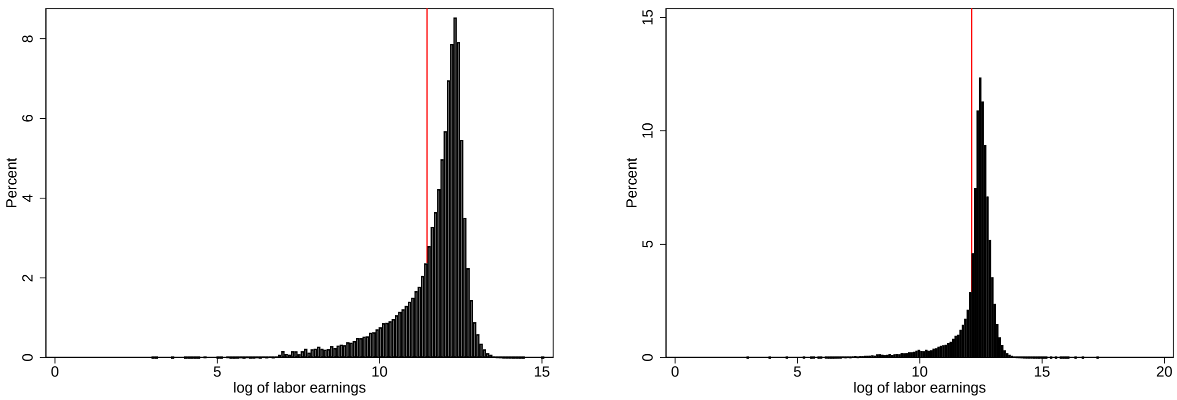


Figure plots the high school completion rate/years of education over the life cycle for birth cohorts 1961–1980 for males by the level of family education. Low-educated family: highest parental education is less than high school. High-educated family: highest parental education is any post-secondary education.

G National Distribution of Labor Earnings Prior to Education Reform

Figure G.1: National Distribution of Labor Earnings in 1999 by Gender

(a) Female (b) Male

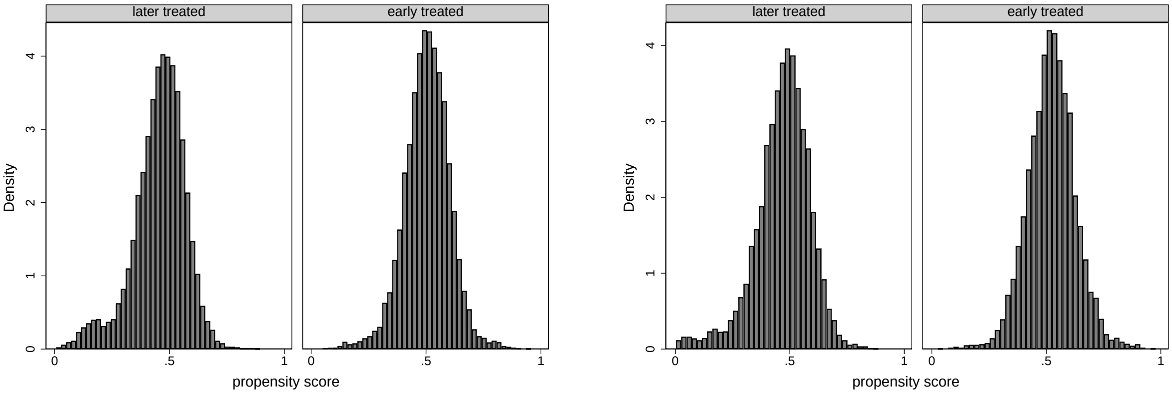


Vertical line corresponds to average log of labor earnings in the estimation sample as described in Table I. Average log of labor earnings corresponds to 28$^{\text{th}}$ percentile for women and 22$^{\text{nd}}$ percentile for men. Sample corresponds to any person aged 30–33 in 2000 (birth cohorts 1967–1970), irrespective of previous educational attainment.

H Estimated Propensity Scores

Figure H.1: Distribution of the estimated propensity score

(a) Female (b) Male

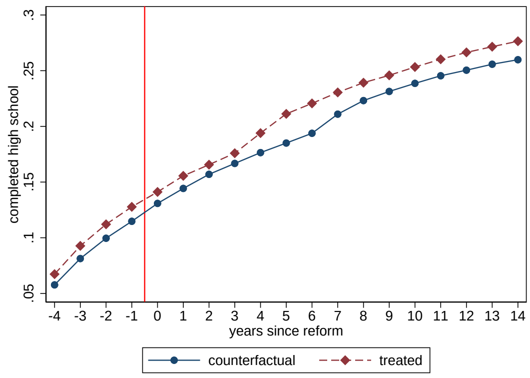


We estimate the propensity score by matching early and later treated individuals in $time = -1$ on: 3 binary variables indicating at least one highly educated parent, first birth at age 25 or younger, and married; binary variables for age of first drop outs (5 categories, 16–20); binary variables for broad field of study left high school with (10 broad categories); the number of children (including zeros); birth municipality; 2 digit industry dummies; and base age.

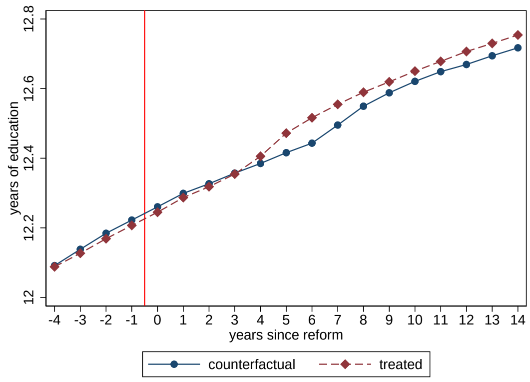
I The Impact of the Reform on Education—Raw Averages

Figure I.1: Age-Education Profile of Estimation Sample in Event Time

(a) Completion of High School



(b) Years of Education



(c) Completion of Higher Education

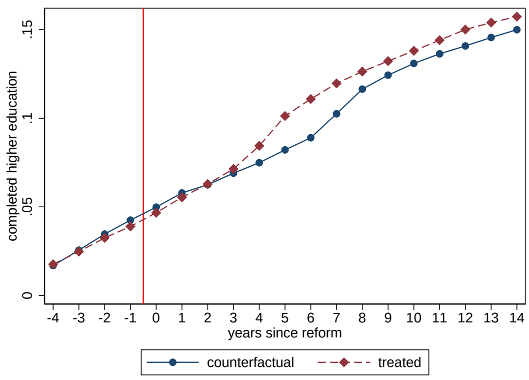
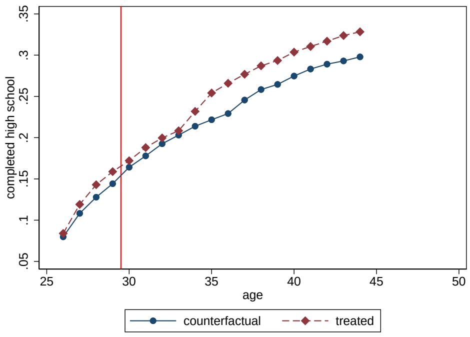


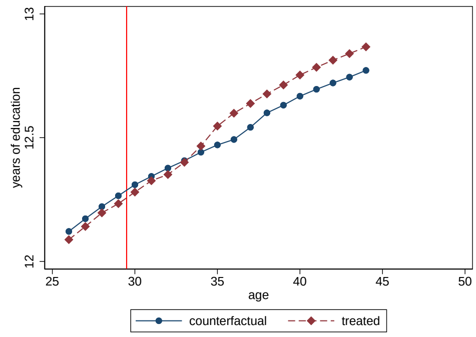
Figure plots the age-education profiles of early and later treated women in event time from −4 to +14. Raw averages reported.

Figure I.2: Age-Education Profile of Estimation Sample, Comparing Treated and Counterfactual Cohorts

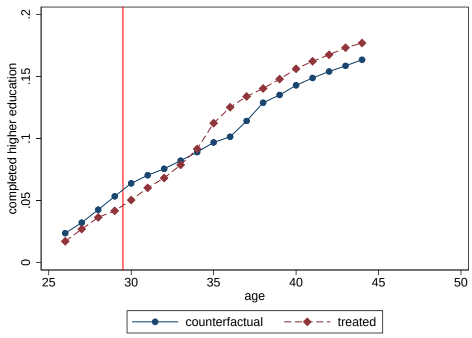
(a) High School, 1970 (treated) and 1967 (counterfactual)



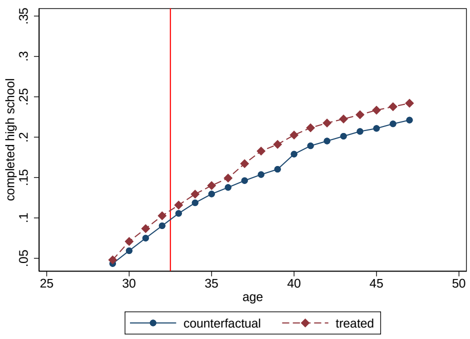
(b) Years of Education, 1970 (treated) and 1967 (counterfactual)



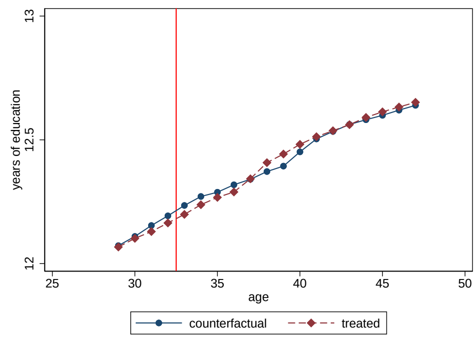
(c) Higher Education, 1970 (treated) and 1967 (counterfactual)



(d) High School, 1967 (treated) and 1964 (counterfactual)



(e) Years of Education, 1967 (treated) and 1964 (counterfactual)



(f) Higher Education, 1967 (treated) and 1964 (counterfactual)

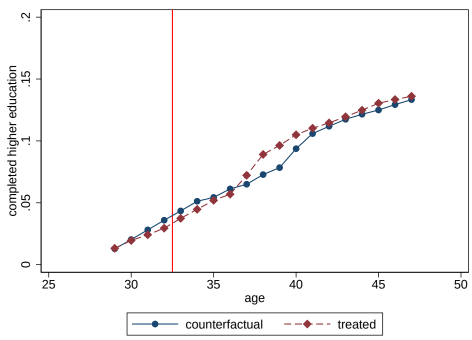


Figure plots the age-education profiles of two different treated birth cohorts (1970 and 1967) and their respective different counterfactual birth cohorts (1967 and 1964) for the completion of high school, years of education, and higher education. Raw averages reported.

J Does the Education Reform Impact Occupational Choice?

Table J.1: Distribution of Occupations in +14 by Early/Later Treated

	later treated	early treated
Managers	3.72	3.93
Professionals	11.66	12.04
Technicians and associate professionals	12.17	11.47
Clerical support	10.33	8.87
Service and sales	33.14	35.50
Skilled agriculture, forestry, and fishery	0.29	0.29
Craft and related trades	0.45	0.45
Plant and machine operators	1.66	1.66
Elementary occupations	2.75	2.70
No occupation (not employed)	23.83	23.08
Total	100.00	100.00
N	12565	11358

Table J.2: Distribution of Public/Private Sector in +14 by Early/Later Treated

	later treated	early treated
private sector	42.16	43.36
public sector	57.84	56.64
Total	100.00	100.00
N	9571	8737

Occupations grouped according to Norwegian standard classification of occupations. Sample of those who are employed in an occupation in Table J.1.

K The Correlation Between Pre-Reform Employment and Children

Figure K.1: Relationship Between Employment and Children for Women

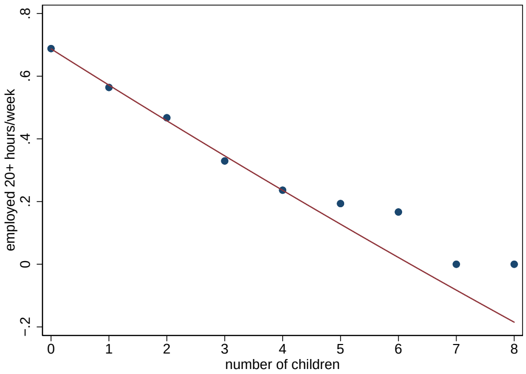
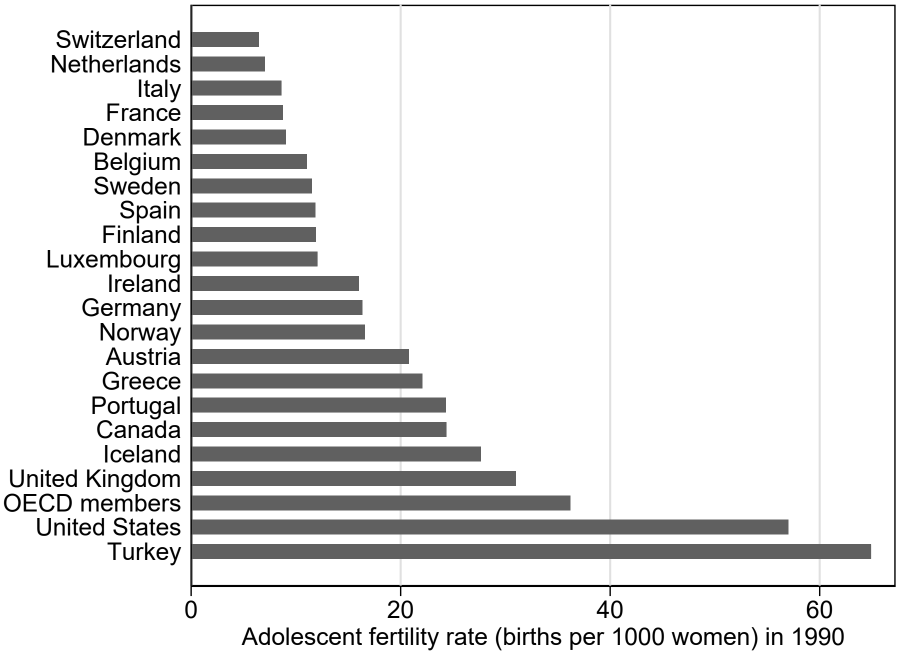


Figure plots the correlation between pre-reform employment (time -1) and the number of children. Sample of women as described in Table I. Employed defined as employment of 20 or more hours per week.

L Adolescent Fertility Across OECD Founding Member States & Finland

Figure L.1: Fertility Rates of 15–19 Year Olds in 1990



Births per 1000 women aged 15–19 in 1990. Source - World development indicators, World Bank, (https://datacatalog.worldbank.org/dataset/world-development-indicators). World bank defines adolescent as ages 15–19. Founding OECD member countries and Finland reported, OECD average calculated as average across all OECD members in 1990.

M Fields of Study Which Increase as a Result of Education Reform

Table M.1: Highest Attained Degree by Narrow Field of Study Post-Reform

	Most common degrees, percent of sample
Bachelor, Nursing and carework	5.17
High School, General (leading to higher education)	2.32
High School, Nursing and carework	2.25
Bachelor, Pre-school/kindergarten teacher education	1.63
Bachelor, Social services	1.42
Bachelor, Primary/middle school teacher education	1.14
Bachelor, Health and welfare, other	1.14
High School, Health and welfare, other	0.99
Bachelor, Business and administration	0.98
Preparatory course for higher education	0.74
Bachelor, Vocational teacher training	0.67
High School, Manufacturing and extraction	0.52
High School, Business and administration	0.51
Bachelor, Supplementary education for teachers	0.48
High School, Therapy	0.42

Table reports the 15 most common narrow field of study degrees among sample of women who have attained (at least) a high school diploma by time +14.

Table M.2: The Estimated Impact of the Reform on Higher Education by Narrow Field of Study, Averaged Over Post-Reform Period

	(1) Higher Education Any Field	(2) Higher Education Health	(3) Higher Education Teacher	(4) Higher Education All Other Fields
Early Treated × Post	0.0105**	0.0067**	0.0004	0.0034
	(0.0043)	(0.0031)	(0.0019)	(0.0022)
N	189720	189720	189720	189720
Avg. Outcome in −1	0.041	0.021	0.011	0.009

Sample of early and later treated women, base ages 30–33, from +8–+14, also including the pre-reform period −1. Each column regresses one of 4 outcomes on the interaction between early treated and a post-reform indicator equal to 1 from time +0–+14. Column (1) measures the completion of higher education, irrespective of field of study. Column (2) measures the completion of higher education in healthcare. Column (3) measures the completion of higher education in teaching. Column (4) measures the completion of higher education in all other fields of study. Coefficients interpreted relative to omitted −1. Estimating regression: $y_{ijlt} = \beta earlytreated_i + \phi post_{it} + \delta earlytreated_i \times post_{it} + \tau_t + \psi_j + \gamma_l + u_{ijlt}$.

N Heterogeneity of the Impact of the Education Reform on Education

N.1 The importance of SES and early fertility

Figure N.1: Estimated Impact on Years of Education by Subgroups

(a) Parental Education

(b) Age of First Birth

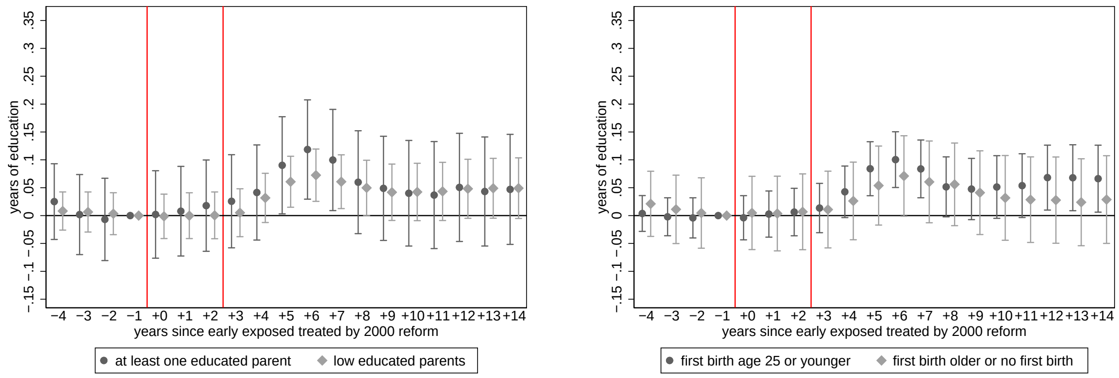
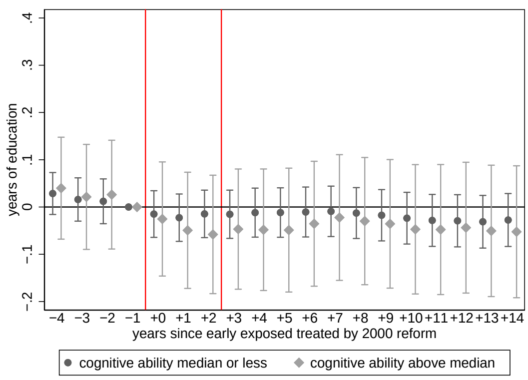


Figure plots estimates of equation (1), weighted by estimated propensity score in −1 as described in Section 3.3.2. Panel (a) plots separate estimates by educated/low educated parents for females. Panel (b) plots separate estimates by age of first birth for females. Sample of females of base ages 30–33. 95% confidence interval reported.

N.2 The importance of cognitive ability

Figure N.2: Years of Education, Separating by Cognitive Ability

(a) Male

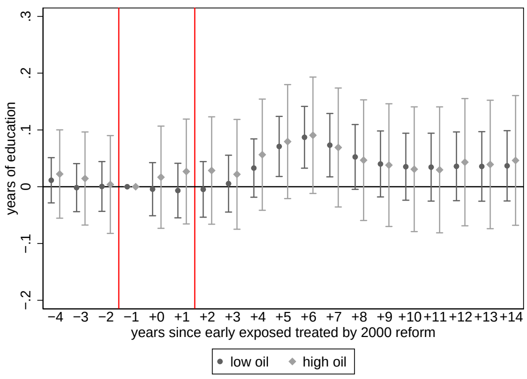


Panel (a) plots separate estimates by above/below cognitive ability for males. Data only available for males.

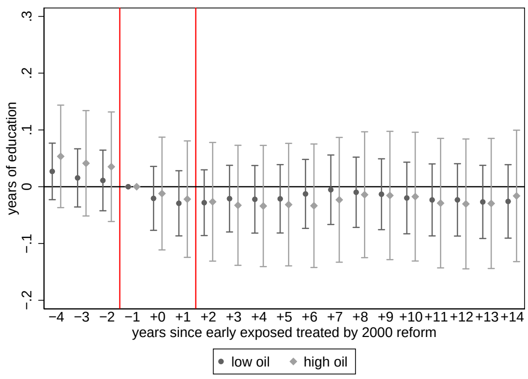
N.3 The importance of the Norwegian oil boom

Figure N.3: Years of Education, Separating by Oil

(a) Female



(b) Male



Panel (a) plots separate estimates by oil exposure at birth local labor market for females. Panel (b) plots separate regression estimates by oil exposure at birth local labor market for males. High, middle, and low oil defined as in Bütikofer, Dalla-Zuanna, and Salvanes (2018) as a local labor market with employment in oil industry in 1980 greater than 10%, between 7.5 and 10%, and less than 7.5% respectively. 46 local labor markets as defined in Bhuller (2009).

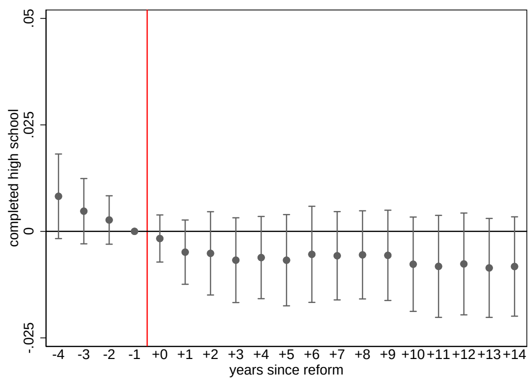
O Baseline Results for Men—Education

Figure O.1 presents the estimated impacts of the education reform on men. In general, the estimated effects are small in magnitude and imprecise. If a linear trend is assumed throughout the entire sample period for men, the estimated effects of the reform on education for men remain imprecise.

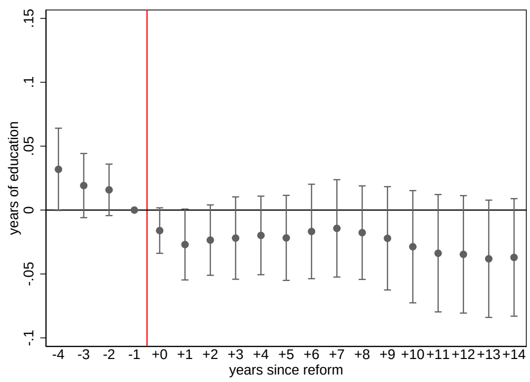
Figure I provides insight into why: a substantial fraction of male high school dropouts already return to high school at earlier ages in the life cycle compared to women. As men are substantially more likely to return to high school from 20–30 compared to women, it is unsurprising that men are not induced to return to high school education in their early 30s. For instance, for those born 1966–1970, the early treated birth cohorts, the high school completion rate of men is 7.4 percentage points less than that of women at age 20. However, by age 30, the gap has reversed and men are 1.6 percentage points more likely to have completed high school.

Figure O.1: Education

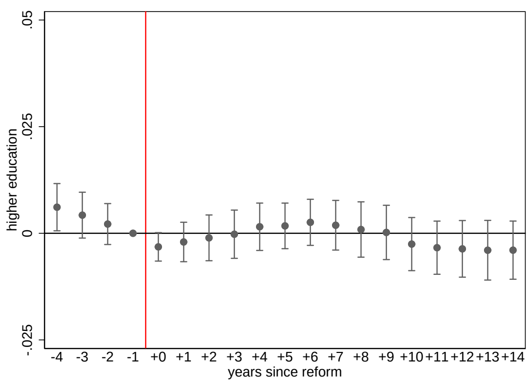
(a) Completion of High School



(b) Years of Education



(c) Completion of Higher Education



P Baseline Results for Men—Labor Market Outcomes

Table P.1: The Estimated Impact of the Reform on Labor Market Outcomes, Averaged Over Post-Reform Period

	Labor Earnings		Employment			
	(1) Log Annual Earnings	(2) Log Hourly Earnings	(3) Outside of L.F.	(4) Employed less than 20 hrs/week	(5) Employed 20–29 hrs/week	(6) Employed 30+ hrs/week
Reduced-Form Regression:						
Early Treated × Post	0.0081	0.0027	-0.0001	0.0007	-0.0020	0.0028
	(0.0120)	(0.0091)	(0.0058)	(0.0030)	(0.0029)	(0.0059)
First-Stage (Years of Educ.):						
Early Treated × Post	-0.0249	-0.0247	-0.0249	-0.0249	-0.0249	-0.0249
	(0.0158)	(0.0222)	(0.0158)	(0.0158)	(0.0158)	(0.0158)
N	271876	221456	291042	291042	291042	291042
Avg. Reduced Form Outcome in −1	12.162	5.015	0.255	0.045	0.031	0.670

Sample of early and later treated men, base ages 30–33, from −1–+14. Reduced-form regresses one of 6 labor market outcomes on the interaction between early treated and a post-reform indicator equal to 1 from time +0–+14. First-stage regresses years of education on the same interaction using the sample from the reduced-form regressions. Column (1) measures labor earnings as the total annual earnings from employment. Column (2) measures hourly labor earnings, $(\frac{\text{annual earnings}}{\text{annual hours worked}})$. Column (3) measures outside the labor force as equal to 1 if working 0 hours. Columns (4)–(6) measure employment as equal to 1 if working less than 20, 20–29, and more than 30 hours per week respectively. Coefficients interpreted relative to omitted −1. Employment outcome variables measured as hours worked per week in a worker's main employment relationship at end of November.

Q Robustness of Main Results

Q.1 Robustness to Varying Delta

Figure Q.1: The Estimated Impacts of the Reform on Education, Varying Delta

(a) High School (b) Higher Education

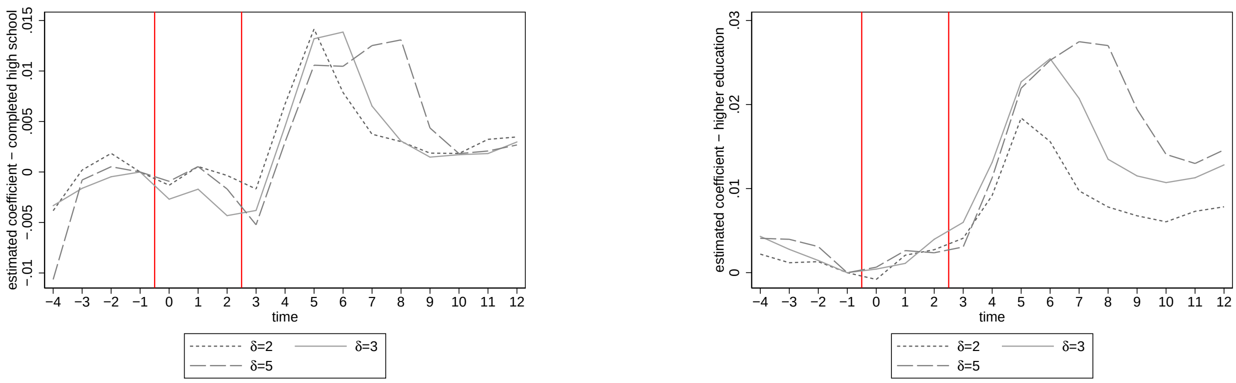


Figure plots estimates of equation 1 varying the level of δ, the number of years between early and treated cohorts for $\delta = 2$, $\delta = 3$ (the baseline used throughout the paper), and $\delta = 5$. Each point represents the difference in the outcome variable between early and later treated cohorts at a specific point in time, relative to the same difference in -1. Panel (a) defines education as the completion of high school, panel (b) defines education as the completion of higher education. Sample of females of base ages 30–33. 95% confidence intervals reported.

Q.2 Robustness to varying base ages of the estimation sample: 30–37

Figure Q.2: The Estimated Impacts of Reform on Education, Ages 30–37

(a) Completion of High School (b) Completion of Higher Education

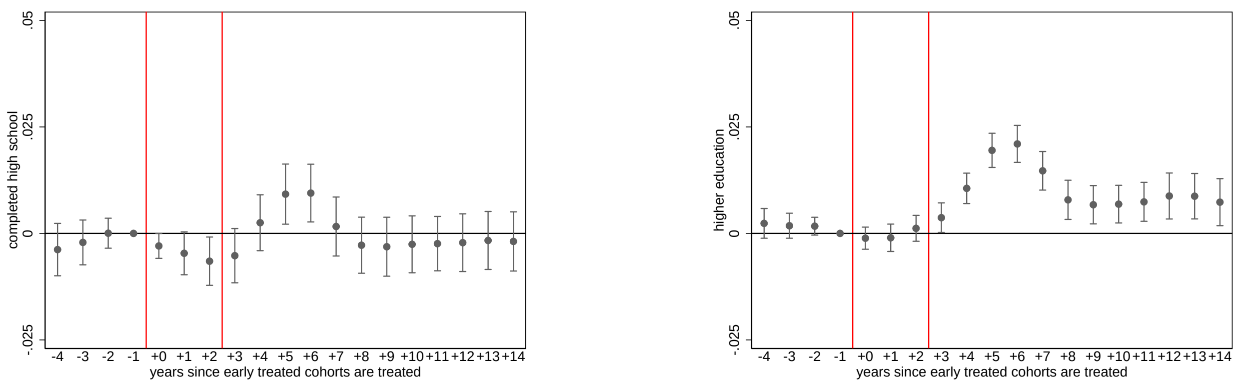
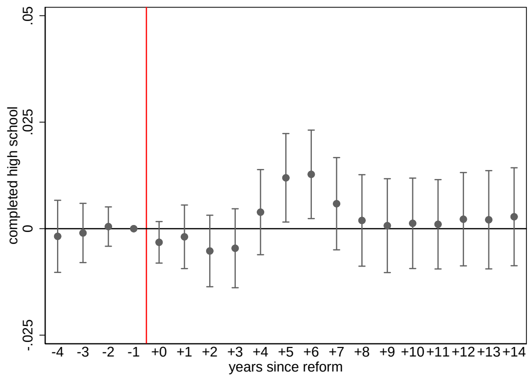


Figure plots estimates of equation 1. Each point represents the difference in the outcome variable between early and later treated cohorts at a specific point in time, relative to the same difference in -1. Panel (a) defines education as the completion of high school, panel (b) defines education as the completion of higher education. Sample of females of base ages 30–37. 95% confidence intervals reported.

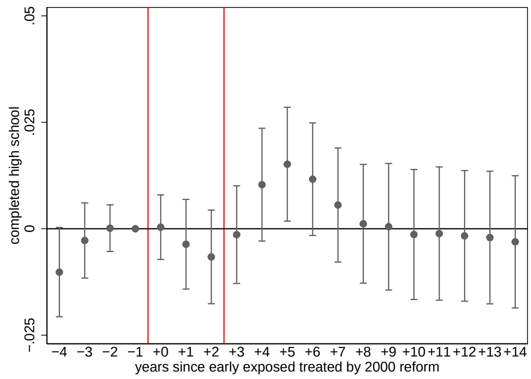
Q.3 Robustness to varying base ages of estimation sample: comparing 30–33 to 38–41

Figure Q.3: The Estimated Impacts of Reform on Education, Comparing Ages 30–33 to 38–41

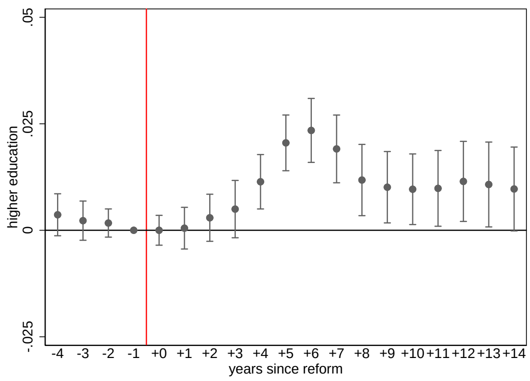
(a) Completion of High School, 30–33



(b) Completion of High School, 38–41



(c) Completion of Higher Education, 30–33



(d) Completion of Higher Education, 38–41

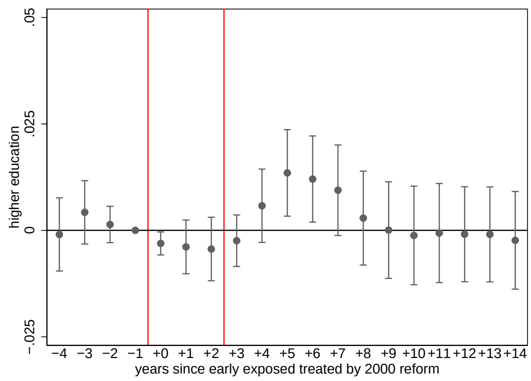


Figure plots estimates of equation 1. Each point represents the difference in the outcome variable between early and later treated cohorts at a specific point in time, relative to the same difference in −1. Panels (a)–(b) define education as the completion of high school, panels (c)–(d) define education as the completion of higher education. Sample of females of base ages 30–33 (panels a and c) and base ages 38–41 (panels b and d). 95% confidence intervals reported.

Q.4 Robustness to varying base ages of the estimation sample: 26–33

Figure Q.4: The Estimated Impacts of Reform on Education, Ages 26–33

(a) Completion of High School

(b) Completion of Higher Education

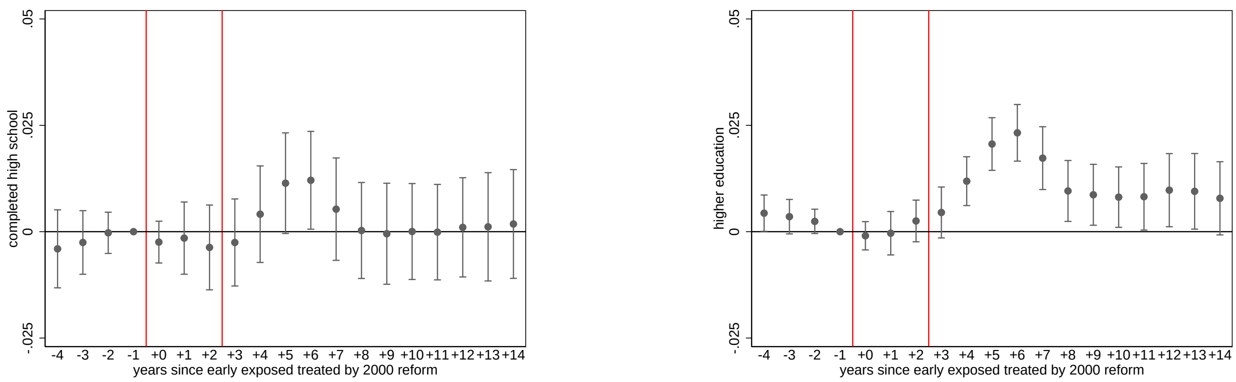


Figure plots estimates of equation 1. Each point represents the difference in the outcome variable between early and later treated cohorts at a specific point in time, relative to the same difference in -1. Panel (a) defines education as the completion of high school, panel (b) defines education as the completion of higher education. Sample of females of base ages 26–33. 95% confidence intervals reported.

Tables and Figures

Figure I: Age-Education Profile for the Completion of High School Over the Life Cycle

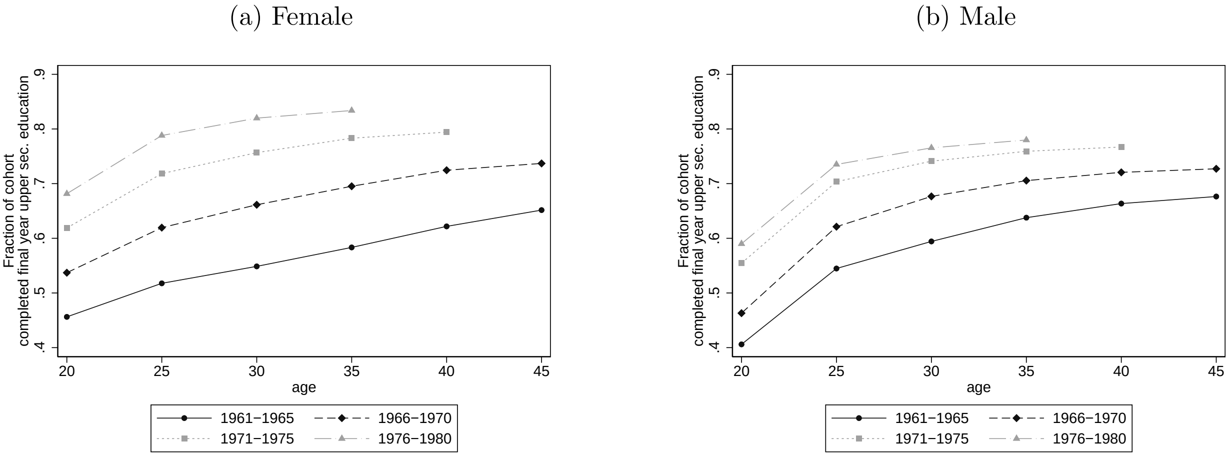
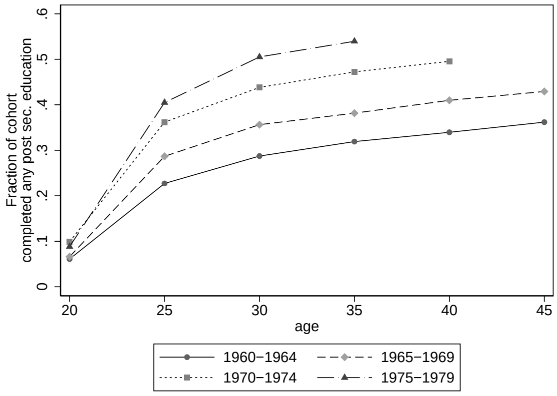


Figure plots the high school completion rate over the life cycle for birth cohorts 1961–1980 for women and men respectively. Sample is balanced to include those observed at all points from age 20 onward. 1976–1980 cohorts are followed until age 35 and 1971–1975 cohorts are followed until age 40 in the data.

Figure II: Age-Education Profile for the Completion of Higher Education Over the Life Cycle

(a) Females



(b) Males

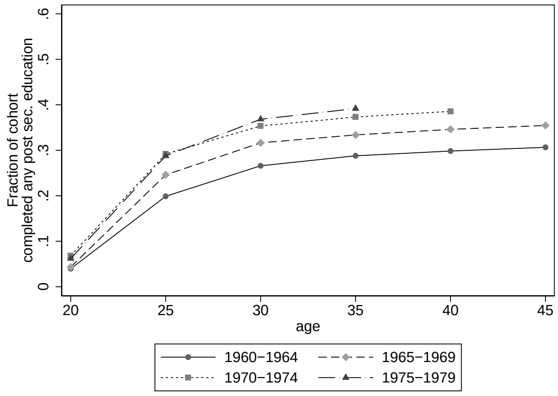
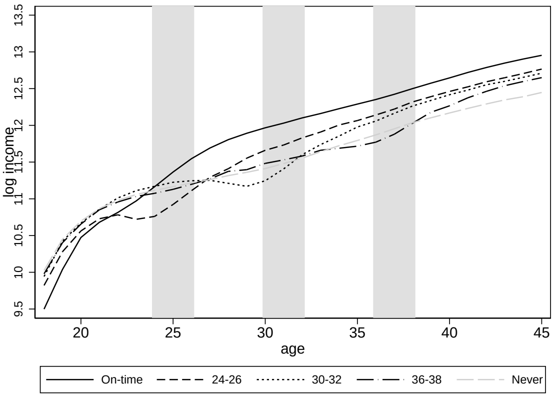


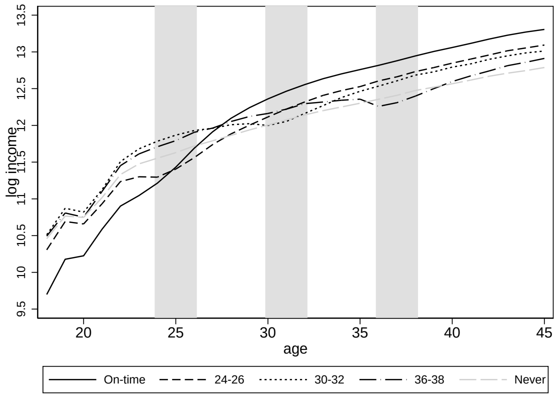
Figure plots the higher education completion rate over the life cycle for birth cohorts 1961–1980 for women and men respectively. Sample is balanced to include those observed at all points from age 20 onward. 1976–1980 cohorts are followed until age 35 and 1971–1975 cohorts are followed until age 40 in the data.

Figure III: The Age-Earnings Profiles by Different Ages of High School Completion

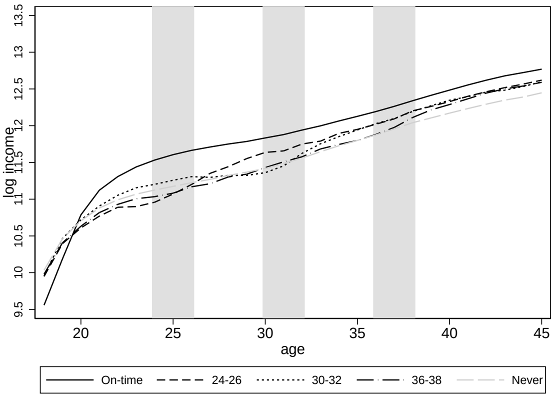
(a) Females, Including Higher Education



(b) Males, Including Higher Education



(c) Females, Excluding Higher Education



(d) Males, Excluding Higher Education

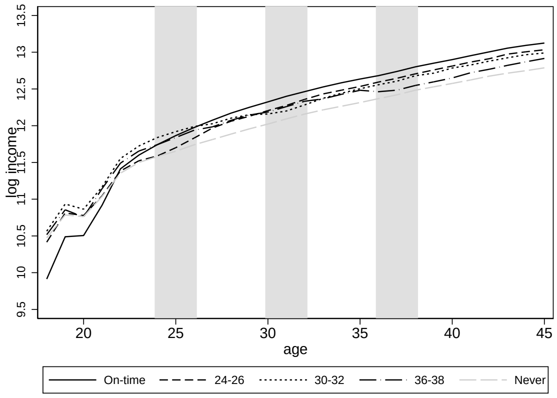
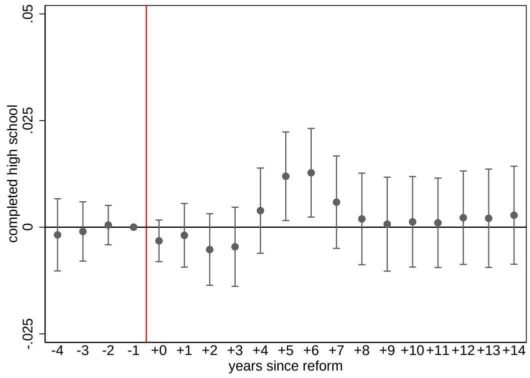


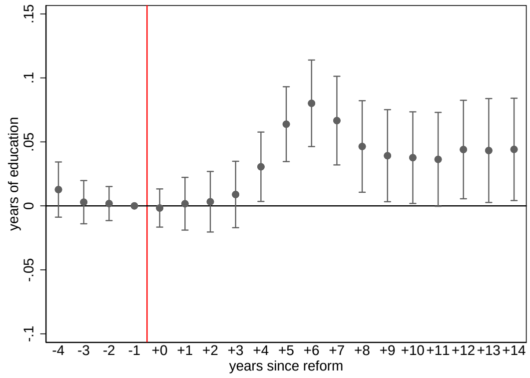
Figure plots, for women and men respectively, average of log earnings for on-time high school graduates (20 or younger), late graduates aged 24–26, 30–32, 36–38, and those who never complete high school by 45. Panels (a) and (b) exclude any person who continues after the completion of high school with a post-secondary degree, while panels (c) and (d) include all high school graduates irrespective of their eventual final degree by age 45. Birth cohorts 1964–1970.

Figure IV: The Estimated Impact of the Reform on Female Education

(a) Completion of High School



(b) Years of Education



(c) Completion of Higher Education

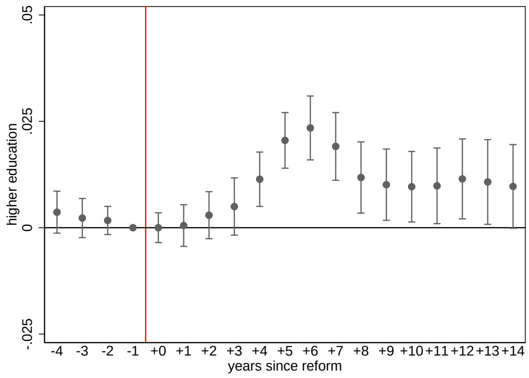


Figure plots estimates of equation (1), weighted by estimated propensity score in -1 as described in Section 3.3.2. Each point represents the difference in the outcome variable between early and later treated cohorts at a specific point in time, relative to the same difference in -1. Panel (a) defines education as equal to 1 if completed the final year of high school. Panel (b) defines education as the number of years of education. Panel (c) defines education as equal to 1 if completed higher education. Sample of females of base ages 30–33. 95% confidence interval reported.

Figure V: The Estimated Impact of the Reform on Female Labor Market Outcomes

(a) Log of Labor Earnings (b) Employed Full-Time

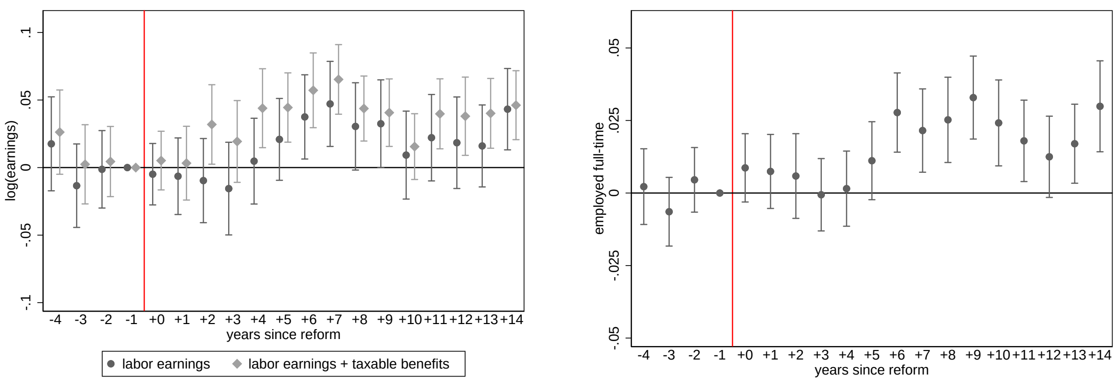
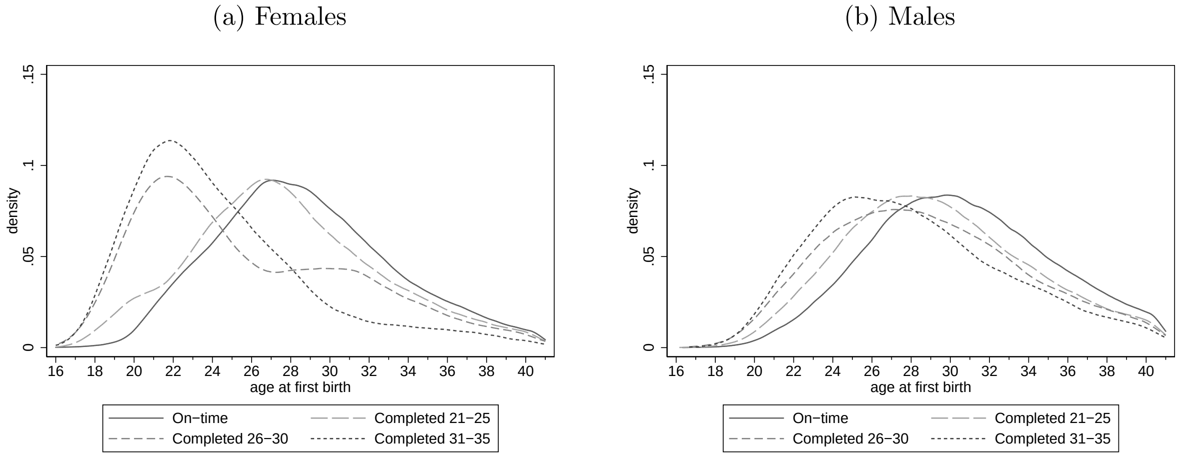


Figure plots estimates of equation (1), weighted by estimated propensity score in −1 as described in Section 3.3.2. Each point represents the difference in the outcome variable between early and later treated cohorts at a specific point in time, relative to the same difference in −1. Controls for *municipality* × *year* and *initial field of study* × *year* fixed effects as described in Section 3.3.2. Two earnings measures in panel (a) correspond to the log of annual labor earnings and the log of annual labor earnings also including sickness, unemployment, and parental leave benefits. Panel (b) defines employment as equal to 1 if working at least 30 hours per week. Sample of females of base ages 30–33. 95% confidence interval reported.

Figure VI: Distribution of Age at First Birth for Different Ages of High School Completion



Figures plots the age distribution of age at first birth separately for females and males by four groups of age of high school completion: on-time (age 20 or younger), 21–25, 26–30, and 31–35. Includes all first-births between 16 and 41, birth cohorts 1961–1970.

Figure VII: The Estimated Impact of the Reform on Female Fertility

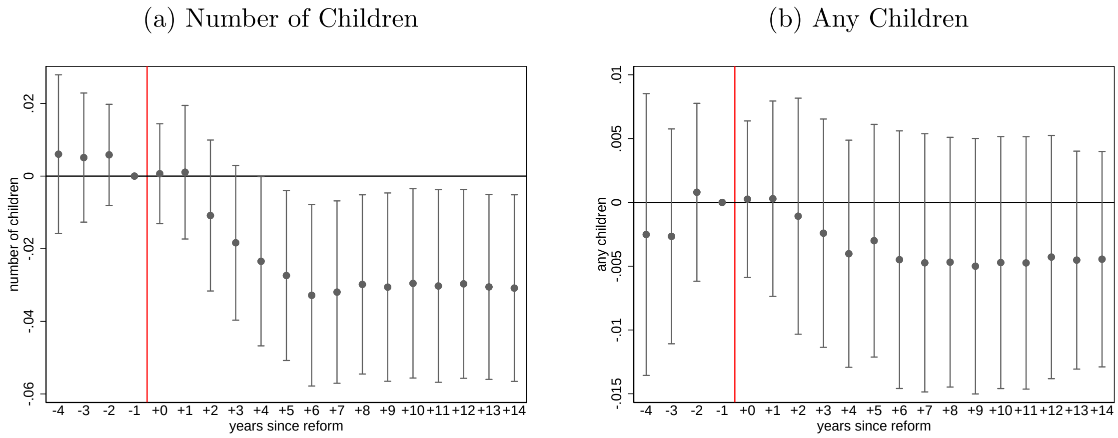


Figure plots estimates of equation (1), weighted by estimated propensity score in −1 as described in Section 3.3.2. Each point represents the difference in the outcome variable between early and later treated cohorts at a specific point in time, relative to the same difference in −1. Panel (a) defines children as the number of children, including zeros. Panel (b) defines children as any children, equal to 1 if a parent has at least one child. Sample of females of base ages 30–33. 95% confidence interval reported.

Figure VIII: The Gender Earnings Gap as Predicted by Reduced Form Regression

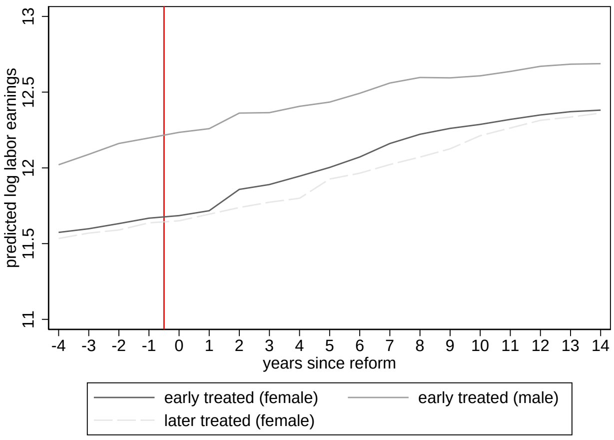


Figure plots the log of annual labor earnings (including taxable benefits), as predicted by estimation of equation (1), for early treated females, early treated males, and late treated females (for comparison). Gender gap in log earnings is 0.53 log points in -1.

Table I: Describing the Estimation Sample

	Female		
	(1) Early Treated	(2) Late Treated	(3) Both
Parental Education:			
Frac. at least one parent highly educated	0.327	0.288	0.306
	(0.469)	(0.453)	(0.461)
Fertility and Household:			
Frac. first birth age 25 or younger	0.563	0.546	0.554
	(0.496)	(0.498)	(0.497)
number of children	1.559	1.550	1.554
	(1.053)	(1.055)	(1.054)
Frac. with children	0.802	0.798	0.800
	(0.398)	(0.402)	(0.400)
Frac. married	0.436	0.475	0.457
	(0.496)	(0.499)	(0.498)
Base Ages:			
Frac. base age 30	0.233	0.243	0.238
	(0.423)	(0.429)	(0.426)
Frac. base age 31	0.248	0.255	0.252
	(0.432)	(0.436)	(0.434)
Frac. base age 32	0.253	0.247	0.250
	(0.435)	(0.431)	(0.433)
Frac. base age 33	0.266	0.255	0.260
	(0.442)	(0.436)	(0.439)
Labor Market:			
employed 20+ hours/week	0.502	0.516	0.509
	(0.500)	(0.500)	(0.500)
log of labor earnings	11.47	11.46	11.46
	(1.102)	(1.061)	(1.081)
Education:			
years of education	12.21	12.22	12.22
	(1.033)	(0.942)	(0.987)
Frac. completed HS	0.128	0.115	0.121
	(0.334)	(0.319)	(0.326)
age first dropped out	17.90	17.89	17.90
	(1.142)	(1.178)	(1.161)
Individuals	11358	12565	23923

Sample: women of base ages 30–33 who dropped out of high school as described in Section 3.3.1. All variables measured at time −1, unless otherwise indicated. Sample of column (1) corresponds to birth cohorts who are treated early in life (treatment cohorts). Sample of column (2) corresponds to birth cohorts who are treated later in life (counterfactual cohorts). Column (3) combines both samples. Table reports the sample average, with standard deviation in parentheses.

Table II: The Estimated Long-Run Impact of the Reform on Female Labor Market and Education Outcomes, Averaged Over Post-Reform Period from +8–+14

	Labor Market Outcomes			Education
	(1) Log Annual Earnings	(2) Log Hourly Earnings	(3) Employed Full Time	(4) Years of Education
Early Treated × Post	0.0311***	0.0112	0.0234***	0.0414**
	(0.0100)	(0.0111)	(0.0063)	(0.0176)
N	150654	150654	189301	189301
Avg. Reduced Form Outcome in −1	11.813	4.892	0.361	12.215

Sample of early and later treated women, base ages 30–33, from +8–+14, also including the pre-reform period −1. Column (1) additionally restricts to women who have positive hours worked in a given year. Each column regresses one of 3 outcomes on the interaction between early treated and a post-reform indicator equal to 1 from time +0–+14. Column (1) measures annual earnings from employment and column (2) measures hourly labor earnings, ($\frac{\text{annual earnings}}{\text{annual hours worked}}$). Column (3) measure employment as equal to 1 if working more than 30 hours per week. Column (4) measures years of education. Coefficients interpreted relative to omitted −1. Employment outcome variables measured as hours worked per week in a worker's main employment relationship at end of November. Estimating regression: $y_{ijlt} = \beta earlytreated_i + \phi post_{it} + \delta earlytreated_i \times post_{it} + \tau_t + \psi_j + \gamma_l + u_{ijlt}$.

Table III: The Estimated Long-Run Impact of the Reform on Different Margins of Female Employment, Averaged Over Post-Reform Period from +8–+14

	(1) Outside of L.F.	(2) Employed less than 20 hrs/week	(3) Employed 20–29 hrs/week	(4) Employed Full Time
Early Treated × Post	-0.0062	-0.0135**	-0.0009	0.0234***
	(0.0070)	(0.0057)	(0.0054)	(0.0063)
N	189301	189301	189301	189301
Avg. Reduced Form Outcome in -1	0.311	0.180	0.148	0.361

Sample of early and later treated women, base ages 30–33, from +8–+14, also including the pre-reform period -1. Each column regresses one of 4 outcomes on the interaction between early treated and a post-reform indicator equal to 1 from time +0–+14. Column (1) measures outside the labor force as equal to 1 if working 0 hours. Columns (2)–(4) measure employment as equal to 1 if working less than 20, 20–29, and more than 30 hours per week respectively. Coefficients interpreted relative to omitted -1. Employment outcome variables measured as hours worked per week in a worker's main employment relationship at end of November. See Table II for the regression equation.

Table IV: The Estimated Long-Run Impact of the Reform on Female Fertility, Averaged Over Post-Reform Period from +8–+14

	(1) Any Children	(2) Number of Children
Early Treated × Post	-0.0042	-0.0299**
	(0.0048)	(0.0124)
N	189301	189301
Avg. Reduced Form Outcome in −1	0.800	1.553

Sample of early and later treated women, base ages 30–33, from +8–+14, also including the pre-reform period −1. Reduced-form regresses one of 2 outcomes on the interaction between early treated and a post-reform indicator equal to 1 from time +0–+14. Column (1) measures the presence of any children, column (2) measures the number of children. Coefficients interpreted relative to omitted −1. Employment outcome variables measured as hours worked per week in a worker's main employment relationship at end of November. See Table II for the regression equation.

Table V: Implied Long-Run Local Average Treatment Effect of Later Life Education

	(1) Employed Full Time	(2) Log Annual Earnings	(3) Log Hourly Earnings
Local Average Treatment Effect	0.5631***	0.5156***	0.1865
	(0.1515)	(0.1655)	(0.1844)
N	189301	150654	150654

Sample of early and later treated women, base ages 30–33, from +8–+14, also including the pre-reform period −1. Each column regresses one of 4 outcomes on the interaction between early treated and a post-reform indicator equal to 1 from time +0–+14, scaling the estimated reduced form by the estimated impact of the reform on years of education. Years of education increases by 0.0416 in the sample of column (1) and by 0.0603 in the sample of columns (2)–(3). Coefficients interpreted relative to omitted −1. Employment outcome variables measured as hours worked per week in a worker's main employment relationship at end of November.

Table VI: Long-Run Post-Reform Employment Response by Pre-Reform Labor Market Attachment

	(1) Outside of L.F.	(2) Employed less than 20 hrs/week	(3) Employed 20–29 hrs/week	(4) Employed Full Time
Low attachment in -1:				
Early Treated × Post	-0.0410***	0.0053	0.0226***	0.0127
	(0.0131)	(0.0093)	(0.0075)	(0.0102)
N	62587	62587	62587	62587
Avg. Outcome in -1	0.809	0.106	0.031	0.054
Some attachment in -1:				
Early Treated × Post	-0.0115	-0.0241*	-0.0016	0.0450***
	(0.0102)	(0.0124)	(0.0127)	(0.0108)
N	62530	62530	62530	62530
Avg. Outcome in -1	0.106	0.409	0.350	0.135
Strong attachment in -1:				
Early Treated × Post	0.0036	-0.0243***	-0.0263***	0.0471***
	(0.0075)	(0.0065)	(0.0071)	(0.0116)
N	64509	64509	64509	64509
Avg. Outcome in -1	0.026	0.030	0.065	0.879

Sample of early and later treated women, base ages 30–33, from +8–+14, also including the pre-reform period -1. Top panel corresponds to women with low attachment to the labor force prior to the reform in time -1, defined as having worked less than 477 hours in -1. Middle panel corresponds to women with some attachment to the labor force in -1, defined as having worked 477–1505 hours in -1. Bottom panel corresponds to women with strong attachment to the labor force in -1, defined as working more than 1505 hours in -1. Entire sample divided into 3 quantiles shown in each of 3 panels. Outcome variable measured as hours worked per week in a worker's main employment relationship at end of November. See Table II for the regression equation.

Table VII: Long-Run Post-Reform Employment Response by Pre-Reform Number of Children

	(1) Outside of L.F.	(2) Employed less than 20 hrs/week	(3) Employed 20–29 hrs/week	(4) Employed Full Time
0 Children in −1:				
Early Treated × Post	0.0028	-0.0155*	-0.0040	0.0151
	(0.0131)	(0.0093)	(0.0096)	(0.0156)
N	37930	37930	37930	37930
Avg. Outcome in −1	0.211	0.101	0.101	0.586
1 child in −1:				
Early Treated × Post	-0.0291**	-0.0171	-0.0093	0.0552***
	(0.0134)	(0.0108)	(0.0101)	(0.0124)
N	46189	46189	46189	46189
Avg. Outcome in −1	0.289	0.147	0.145	0.418
2 children in −1:				
Early Treated × Post	0.0068	-0.0160	0.0055	0.0090
	(0.0108)	(0.0101)	(0.0089)	(0.0112)
N	73371	73371	73371	73371
Avg. Outcome in −1	0.315	0.218	0.174	0.294
3+ children in −1:				
Early Treated × Post	-0.0102	0.0002	-0.0055	0.0209
	(0.0176)	(0.0154)	(0.0140)	(0.0152)
N	32136	32136	32136	32136
Avg. Outcome in −1	0.451	0.233	0.148	0.168

Sample of early and later treated women, base ages 30–33, from +8–+14, also including the pre-reform period −1. Four panels correspond to women who have 0, 1, 2, and 3 or more children in −1 respectively. Outcome variable measured as hours worked per week in a worker's main employment relationship at end of November. See Table II for the regression equation.