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Valtion taloudellinen tutkimuskeskus
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Abstract

We examine the causal effect of parental higher education on their offspring's education, using quasi-experimental variation from the significant regional convergence in parents' access to university occurring in Finland between 1955 and 1975, which was advanced by political decisions to expand the university system to all parts of the country. Our differences-in-differences estimates suggest that, for the children of parents affected by the changes in university accessibility, there is a strong positive intergenerational relationship in higher education attainment. We explore the potential mechanisms behind the intergenerational effects and find that, due to assortative mating, the effect of a mother's higher education may be greatly overstated if estimated separately from that of a father's higher education.

Keywords: intergenerational transmission of education, higher education, university accessibility

JEL classes: I23, J62

Contents

1. Introduction

The children of highly educated parents are frequently observed to outperform children from lower-educated families in educational attainment. However, this positive intergenerational association in education does not necessarily imply that children truly benefit from higher parental education, as the correlation could merely reflect a sorting of genetically or otherwise similar individuals into similar educational levels. As summarized by Holmlund et al. (2011), the results of the recent literature indeed suggest that the intergenerational associations in education are largely driven by selection, while the causal effect of parental education is often found to be of minor significance.[1]

In contrast to much of the previous literature, the quasi-experimental evidence presented in this paper indicates a strong positive causal relationship between the education of parents and their offspring. This conclusion arises from the observation that higher geographical access to university education results in increases in both individuals' own and their offspring's educational attainment. Our differences-in-differences instrumental variables analysis exploits Finnish full-population register data and a natural experiment arising from the considerable regional convergence in university accessibility that took place in Finland between 1955 and 1975, advanced by central government's decisions to expand the previously south-coast-concentrated university system to all parts of the country. We show that the changes in university accessibility were substantial and rapid, contained strong regional policy elements and hence were unlikely to have been anticipated two decades earlier, i.e. when the cohorts of the new university enrollees in 1955–75 were born. Therefore, relating the changes in university accessibility to these cohorts' birth locations and expected years of entry to higher education constitutes a close-to-ideal natural experiment for examining the intergenerational effects of higher education.[2]

Our paper contributes to the empirical literature on the intergenerational effects of education in three main ways. First, we examine the intergenerational transmission of educational attainment at the margin of parents' higher education attainment, hence differing from previous quasi-experimental studies

[1] To identify the causal effects of parental education on child outcomes, previous studies have relied on three different approaches: comparisons of the children of monozygotic twins (Behrman and Rosenzweig, 2002; Holmlund et al., 2011), examining parent-child associations among adopted children (Plug, 2004; Björklund et al., 2006; Sacerdote, 2007; Holmlund et al., 2011) and instrumental variables approaches that treat educational reforms or other events affecting parents' educational access as natural experiments (Currie and Moretti, 2003; Black et al., 2005b; Oreopoulos et al., 2006; Maurin and McNally, 2008; Holmlund et al., 2011; Carneiro et al., 2013). The results of these studies have varied from insignificant to those indicating modest positive effects from parental education, with the results being markedly different across datasets and methods (Holmlund et al., 2011).

[2] Previously, Toivanen and Väänänen (2016) examined the effect of education on inventions using variation in the distance to technical university education in the same period of Finland's history.

investigating reforms that extend the length of parents' comprehensive schooling (Black et al., 2005b; Holmlund et al., 2011). The observation that our estimated intergenerational relationships are higher than those in the comprehensive school reform studies suggests that the marginal returns on parental education may be higher at high levels of parental education. Second, while the previous evidence on the effects of parental higher education has only concerned children's short-term outcomes, including birth outcomes (Currie and Moretti, 2003) and grade repetition (Maurin and McNally, 2008), we also examine children's long-term educational outcomes, such as university enrolment and years of education.[3] Third, aside from Currie and Moretti (2003), our paper appears to be the only one providing evidence of the intergenerational effects of parents' geographical access to higher education. We contribute to this topic by discussing the measurement of accessibility in greater detail. While we examine, similarly to Currie and Moretti, the local (sub-region-level) impacts of university openings, our more precise estimates rely on a gravity-model-based accessibility measure, which accounts for parents' distances to all Finnish universities, rather than only the nearest one, as well as student intake and potential competition in these universities. We show that this approach provides similar but more precise estimates than the use of the simpler distance-to-nearest-university instrument.

The remainder of the paper is structured as follows. Section 2 describes the events that led to the regional convergence in access to higher education in Finland between 1955 and 1975. Section 3 discusses the data and measurement of accessibility and describes regional trends in parents' and children's education. Section 4 describes the formal empirical approach. Section 5 presents the results, first showing evidence of the intergenerational effects of university openings occurring in 1959–69 and then moving to our main results obtained by using more general accessibility measures. To shed light on the factors driving our estimates, sub-sections 5.3 and 5.4 also present various robustness checks and supplemental analyses using alternative parent and child outcomes. Our concluding remarks are given in Section 6.

[3] Our empirical approach closely resembles that of Currie and Moretti (2003), who relate a mother's education to the number of colleges (adjusted by the size of the relevant cohort) available in the past, during the mother's adolescence, in the offspring's county of birth. By virtue of having information on mothers and fathers' municipalities of birth, we are able to construct our instrument in an arguably more exogenous manner by relating parents' education to changes in university accessibility occurring in their municipalities of birth 19 years after their birth.

2. Development of access to higher education in Finland, 1955–1975

Our study focuses on Finnish parents born between 1936 and 1956. During the adolescence and early adulthood of these parents, the Finnish university system began a transformation from an elite education system, reserved only for a small group of early-tracked students, to a mass education system, in which both the demand for and supply of higher education were substantially higher than before. At the same time, the system rapidly spread from the south coast of Finland, the cities of Helsinki and Turku, to the whole country as a consequence of central government decentralization policies. As a result of these changes, two individuals born in the same area but in different years could, in many cases, be in markedly different positions with regard to access to higher education. For instance, graduating from an upper secondary school near Helsinki or Turku in the 1950's guaranteed almost certain access to bachelor's or master's studies in one of the old universities located in these cities, whereas similar graduates one or two decades later had to meet high entry requirements to obtain university admission. Meanwhile, citizens in more sparsely populated regions, who had previously lived far from a university, suddenly found themselves raising a family in the proximity of one.

The identification strategy of our paper builds on the temporal and geographical variation in parents' access to university arising from these events. In this section, we describe the institutional background and give an overview of the supply and demand expansions across time and regions. We also discuss how the new university locations were determined by complicated political processes, which made the changes in university accessibility difficult to predict years beforehand, and therefore these were probably exogenous with respect to families' residential location choices made prior to the birth of the cohorts of 1936–56.[4]

2.1 Institutional context and the demand for and supply of higher education

Before entering post-compulsory education, the cohorts of 1936–56 passed through a two-track schooling system where one had to make a decision on whether to apply for a general secondary school at the age of 11 or to continue studies in a primary school.[5] If one did not enter a general secondary school, the later options for post-compulsory education, starting at age 16, were mainly

[4] For another description of the historical events in English, see Toivanen and Väänänen (2016).

[5] In 1972–77, the old two-track system was replaced by a uniform 9-year comprehensive school (see Pekkarinen et al., 2009; Pekkala Kerr et. al., 2013). A large majority of the children in our estimation samples participated in the reformed schooling system.

limited to vocational education in vocational schools and colleges. Those who chose to go to a general secondary school could, at age 16, continue studies in a three-year upper secondary school to obtain formal eligibility for university education leading to higher academic degrees (bachelor's, master's, licentiate and doctoral degrees).[6]

The number of upper secondary school graduates, i.e. the pool of prospective university students, was very low in Finland in the first decades of the 20th century. Between 1920 and 1930, the annual number of graduates increased from one to two thousand, which was still less than three per cent relative to the size of the 19-year-old cohort. It was not until the late 1950's that the expansion of upper secondary education truly began. At the time, the large cohorts born after World War II entered the schooling system, which caused pressure to expand the primary and secondary school network to guarantee equal access to education for all. As a consequence of both increasing demand for and supply of upper secondary education, the number of upper secondary graduates started to increase rapidly, which is demonstrated in Figure I: the total number of upper secondary graduates increased from 4,700 in 1955 to 24,800 graduates in 1975.

Originally, all upper secondary graduates could, adhering to the old traditions of European universities, enroll at university (Numminen, 1987: 129). However, because of the increasing number of upper secondary graduates, and the resulting congestion in university campuses and lecture halls, admission practices started to change already in the 1930's. At first, the faculties of medicine and natural sciences of the University of Helsinki started to apply a *numerus clausus* principle, according to which new students were selected based on their matriculation examination grades, their scores in additional entrance examinations, or both. These admission practices further spread to the other faculties and institutions so that the last faculty to adopt the *numerus clausus* system was the faculty of social sciences of the University of Helsinki in 1962 (Numminen, 1987: 130–132). The universities' serious capacity constraints are demonstrated in Figure I, which shows that the number of first-year university students increased from 4,400 in 1955 to 13,200 in 1975, i.e. at a much slower pace than the number of upper secondary graduates. In fact, the number of new students temporarily stagnated, and even slightly decreased, between 1967 and 1972 due to universities limiting their admission quotas. Thus, by treating the

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[6] There were also some options for university entry for those who did not have an upper secondary diploma: conditional on having a technical diploma from a vocational college one could apply to the University of Technology in Helsinki starting from 1928; conditional on having a business diploma from a vocational college one could apply to the university-level business schools starting from 1958; conditional on being a primary school teacher and passing a language test, further studies in the Jyväskylä College of Education were allowed as of 1954. The Civic College in Helsinki did not require students to be upper secondary school graduates, and after its relocation to Tampere in 1960, the so-called teaching sections of the school (*opetusjaostot*) applied the same policy. (Kaarninen and Kaarninen, 2002: 251–252)

numbers of first-year university students and upper secondary graduates as rough approximates of the supply of and demand for higher education, it appears that the supply-demand ratio of higher education declined from 0.95 to 0.53 over the twenty-year period.

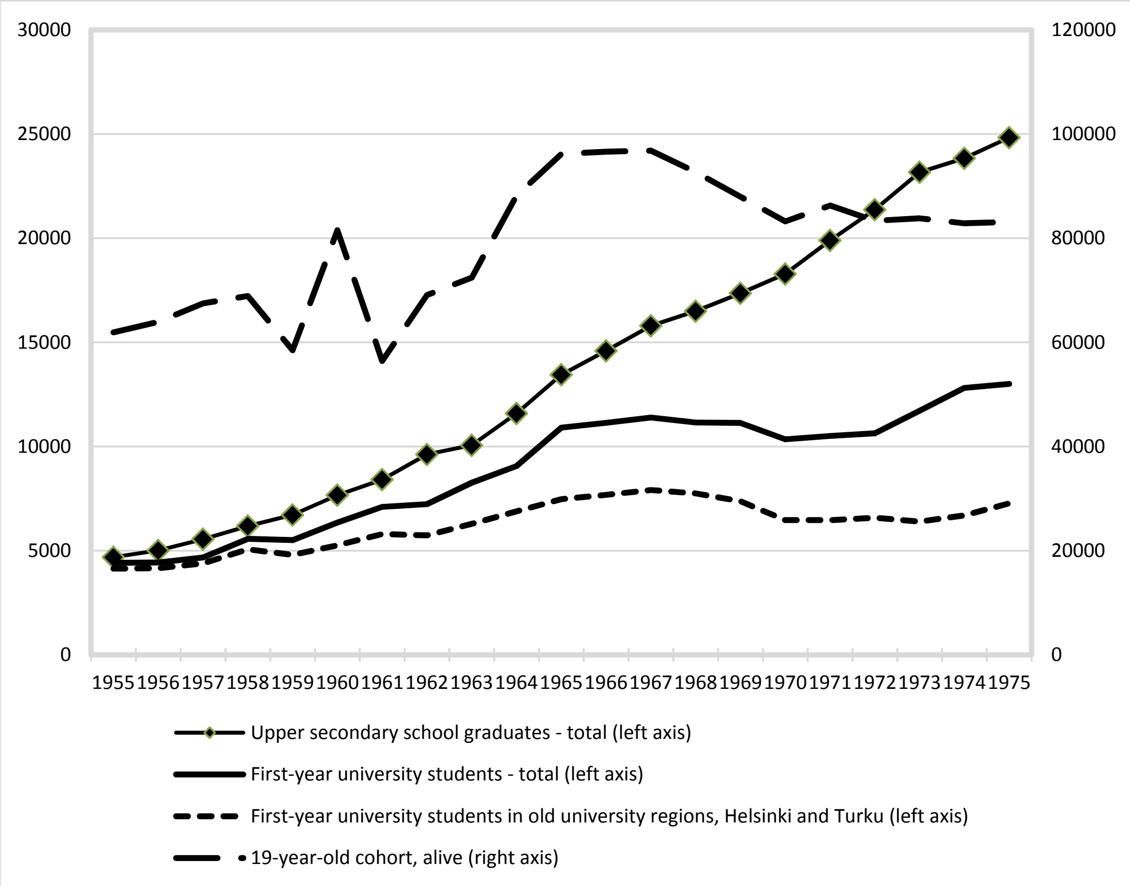

FIGURE I

Aggregate demand for and supply of higher education in Finland, 1955–1975: annual numbers of 19-year-olds, upper secondary school graduates and first-year university students.

The volatility in the number of 19-year-olds between 1959 and 1961 is due to the unusually large number of births in the interim peace period (1940–1941) between the Winter War and the Continuation War. Source: OSF (1969, 1973, 1982) and Statistics Finland (1950–1979).

Figure 1 further shows that there were also considerable changes in the geographical structure of higher education supply: in the late 1950's nearly all of the supply was concentrated in the two old university cities, Helsinki and Turku, whereas most of the increase in supply in the 1960's and early 1970's occurred in other cities. Table I breaks down the annual intake of new university students by region, showing that the increase in intake was particularly fast in Jyväskylä, Oulu and Tampere, which rose to become serious competitors for Helsinki and Turku in the higher education market in the 1960's. Then again, the cities that gained a new university in the late 1960's or early 1970's – Vaasa, Lappeenranta, Joensuu and Kuopio – still played a relatively small role in the total supply of higher education in the 1970's.

TABLE I

First-year university students and matriculation examination candidates by region and year

Region	1955	1960	1965	1970	1975
Helsinki	3 423	4 039	5 816	4 528	5 347
	(1 318)	(2 222)	(4 045)	(4 736)	(6 123)
Turku	713	1 221	1 659	1 940	1 922
	(459)	(768)	(1 163)	(1 573)	(2 149)
Jyväskylä	201	375	994	1 154	1 127
	(217)	(387)	(829)	(1 101)	(1 311)
Oulu	73	349	740	852	1 036
	(266)	(556)	(964)	(1 659)	(2 357)
Tampere	..	369	1 695	1 473	1 851
	(408)	(679)	(1 290)	(1 718)	(2 289)
Vaasa	..	..	..	149	288
	(174)	(251)	(361)	(524)	(742)
Lappeenranta	..	..	..	43	149
	(154)	(201)	(394)	(536)	(768)
Joensuu	..	..	..	208	440
	(187)	(260)	(441)	(675)	(985)
Kuopio	..	..	..	..	223
	(244)	(372)	(636)	(945)	(1 429)
Total number of first-year students	4 410	6 354	10 904	10 347	13 004
Total number of candidates	4 797	7 878	13 895	18 869	25 692
Students per candidate	0.92	0.81	0.78	0.55	0.51

The numbers of matriculation examination candidates in the regions surrounding the university cities are in parentheses (Helsinki: Uusimaa; Turku: Southwest Finland and Åland Islands; Jyvaskyla: Central Finland; Oulu: Northern Ostrobothnia and Kainuu; Tampere: Pirkanmaa; Vaasa: Ostrobothnia; Lappeenranta: South Karelia; Joensuu: North Karelia; Kuopio: Northern Savonia). The aggregate number of first-year university students in 1975 also accounts for the first-year students at the teacher training centers of Hämeenlinna, Rauma, Kajaani, Savonlinna and Rovaniemi. *Source:* Official Statistics Finland (1969, 1973, 1983), Registers of the Finnish Matriculation Examination Board.

2.2 Politics behind the expansion of higher education

It can be argued that, even in the early 1950's, there were very few signs indicating the dramatic changes in the demand for and supply of higher education that Finland experienced in the next decade. At the time, annual university enrolment still roughly matched the slowly increasing number of new upper secondary graduates, while national higher education policy was in the hands of the old universities, particularly the University of Helsinki and University of Technology, whose autonomous discretion in academic matters was highly respected. The era's *status quo* was present in the work of the Myrberg committee that was appointed by the state in 1952 to come up with a general plan for developing the university system (see Eskola, 2002: 224–226). The committee, being entirely composed of universities' leading academics, mainly concentrated on plans for strengthening the existing institutions, while considering geographical aspects less important. However, one of the committee members, Professor Pentti Kaitera of the University of Technology, was strongly in favor of opening a multidisciplinary university in his former home town Oulu in the northern Finland, 540 kilometers from Helsinki. Interestingly, Professor Kaitera's committee membership was originally advocated by the multiple-minister Johannes Virolainen of the Centre Party, a leading political party that obtained its electoral support from outside the largest cities and favored decentralization. Although the committee did not approve the idea of creating new multidisciplinary universities, Professor Kaitera managed to get through a proposal to create a 'university-like institution' specialized in science and technology in Oulu. By the time the final report of the committee was published in 1956, the Centre Party-controlled Ministry of Education had already begun preparing laws to establish a university in Oulu and expand the small and specialized College of Education in Jyväskylä, 240 kilometers from Helsinki, with a new faculty of philosophy (Kivinen et al., 1993: 33; Kannas, 1992: 202). Despite strong criticism from government bodies, the Minister of Education, Kerttu Saalasti managed, with support from President Urho Kekkonen (also from the Centre Party), to convince the government to back up the proposals, which were accepted by the parliament in 1958. These decisions led to the opening of the University of Oulu in 1959 and a gradual expansion of the College of Education and its transformation into the University of Jyväskylä in 1966.

Another opportunity for decentralization appeared in the 1950's when the social-sciences-oriented Civic College in Helsinki encountered problems due to its poor economic situation, lack of facilities and greater competition between local institutions. Relocating and merging the institution with the University of Turku or adding new facilities in Helsinki were initially considered as solutions to the situation. However, the merger plans were turned down by left-wing supporters of the school who were concerned at the school coming under right-wing influences, whereas no additional support from the city of Helsinki was granted. In this situation, the local politicians and authorities of the city of Tampere, 160 kilometers from Helsinki, saw an opportunity to relocate the Civic College in their city. In 1956, after strong lobbying from Tampere, both the Finnish parliament and the school's supporting organizations gave the green light to the relocation, which took place in 1960. In Tampere, the Civic College soon started to expand into a multidisciplinary institution and was renamed the University of Tampere in 1966. (Eskola, 2002: 229–230)

The political decisions in the late 1950's led to the rapid expansion of higher education in Jyväskylä, Oulu and Tampere as shown in Table I. Furthermore, the increased political influence and the breakdown of the old universities' hegemony in higher education decision-making opened a window of opportunity for other cities in western and eastern Finland to begin demanding that universities be opened in their regions. Many cities established a higher education association to do political lobbying for their cause. The city of Vaasa on the west coast was the first to receive a higher education institution – a business school – in 1968, which later developed into a university. Vaasa began to campaign for a business school already in 1961, but its proposals were dismissed by a government-appointed business school committee the next year. However, the government of the then Prime Minister, Johannes Virolainen, which was pursuing further decentralization, accepted Vaasa's proposal in 1966. In eastern Finland, the choice of a location for a possible new university was less clear and became a complicated process taking most of the 1960's. Joensuu, Kuopio and Lappeenranta were the cities campaigning most actively to receive the university. In 1961, Professor Pentti Kaitera, the then recently appointed Rector of the University of Oulu, suggested that the new university could be divided between several cities. At the time, this proposal was not generally very popular, but it was well received by the so-called community planning technocrats, among whom the Centre Party had strong influence. In the mid 1960's, central government ordered a special committee to study the location question. The committee recommended unanimously that, instead of small institutions in multiple locations, eastern Finland should have one unified university. The committee was unable to designate the location of the new university but recognized that a technical institution could be established in Lappeenranta. Finally, in 1965, the government used its own discretion and decided that the university would be split between Joensuu, Kuopio and Lappeenranta. Consequently, an institution for technical education was set up in Lappeenranta in 1969, a liberal arts institution was founded in Joensuu the same year, and an institution focusing on medical education was set up in Kuopio in 1972. (Eskola, 2002: 234–244)

Figure II summarizes the geographical expansion of the university system between 1955 and 1975.[7] The above-described historical details demonstrate that the expansion of the system was heavily driven by the interplay between the Centre Party-controlled central government and regional actors, which brought strong regional policy elements into higher education decision-making. The great contrast between the ideas and opinions of the academic expert committees and

[7] Apart from the geographical expansion reforms, a significant reform of teacher training was implemented in the period. The reform, which was implemented in the early 1970's, concentrated all school teacher training within universities' faculties of education. Before the reform, school teachers were trained in several types of institutions, including teacher training schools, temporary teacher colleges and universities. The reform resulted in the closure of most of the teacher training schools. However, some of the schools – those in Hämeenlinna, Kajaani, Rauma and Savonlinna – were, by 1974, transformed into university branch campuses responsible for teacher training. At the same time, the University of Oulu established a teacher training campus in Rovaniemi, which, in 1979, became an independent, multidisciplinary institution (University of Lapland).

the expansion that took place emphasizes the unexpected nature of the events, which made it difficult for ordinary citizens to anticipate the trends in university accessibility in their neighborhoods years beforehand.

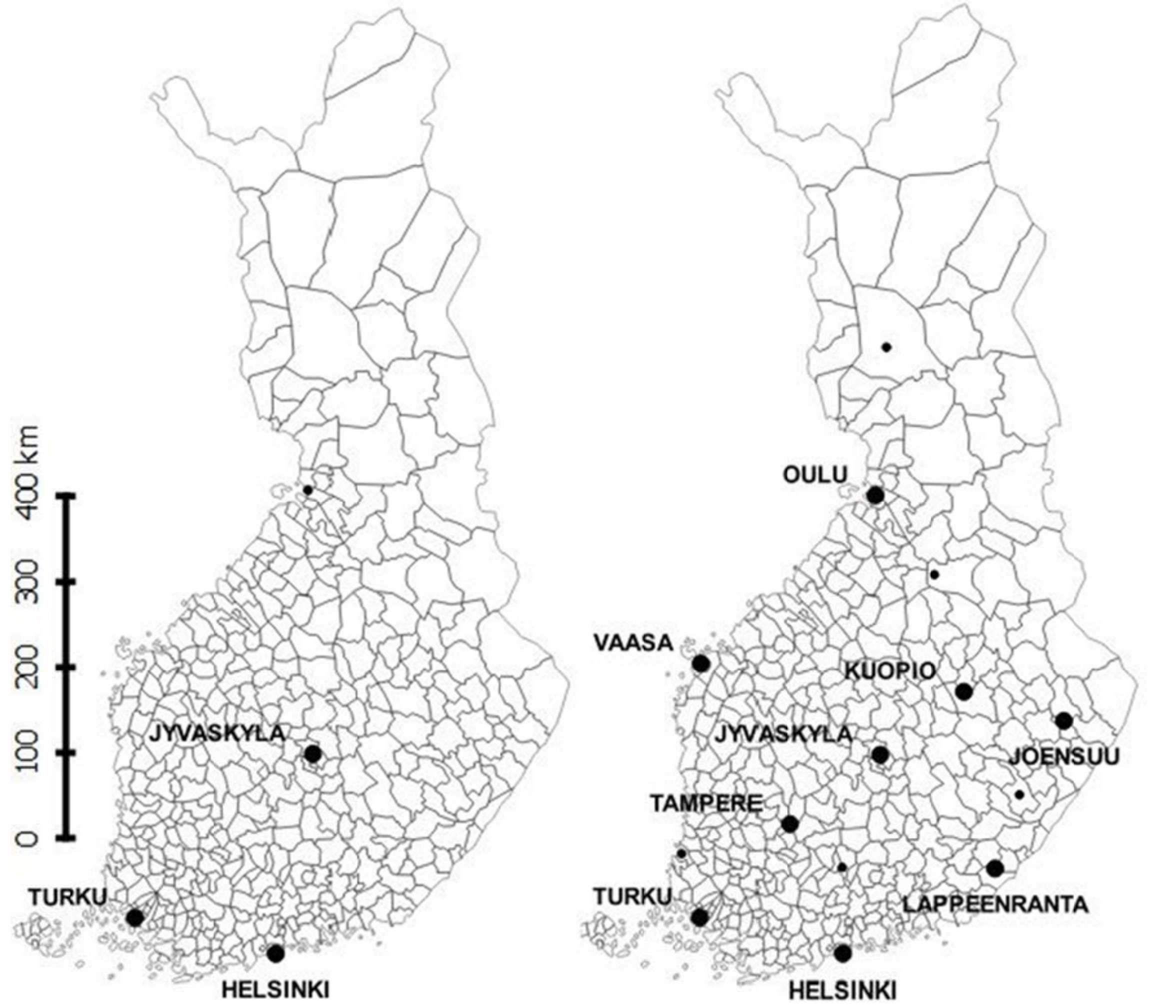

FIGURE II
Geographical expansion of the Finnish university system

This figure depicts how the university system expanded geographically between 1955 (left) and 1975 (right). In 1955, the system consisted of several multidisciplinary and specialized universities located in Helsinki and Turku, a college of educational sciences in Jyväskylä (later University of Jyväskylä) and temporary teacher training colleges in Helsinki, Turku and Oulu. In 1975, there were universities already in ten cities, while universities' teacher training centers had branch campuses in five other cities. The new universities were established in Oulu (1959), Tampere (1960) Vaasa (1968), Lappeenranta (1969), Joensuu (1969) and Kuopio (1972). The municipality borders have been drawn according to the 2007 classification. The named large dots mark the cities with at least one university main campus, while the smaller dots mark the locations of the additional teacher training campuses.

3. Data and descriptive evidence

3.1 Parent-child dataset

Our dataset is based on longitudinal full-population register data collected by Statistics Finland. The dataset contains all persons registered as residents of Finland between 1970 and 2016 and includes information on each resident's date and municipality of birth, completed educational qualifications, enrolment in higher education and various other characteristics and outcomes.[8] To examine intergenerational relationships, we link each individual to his or her mother and father using the parent-child link available in the data. The parent-child link, which is fully representative for the cohorts of children born after the early 1950's, does not reveal whether the mother or father is one's biological parent. Therefore our estimation samples contain both biological and non-biological parent-child pairs.

In our quasi-experimental analysis, we relate municipality- and year-specific measures of access to university to each parent's municipality of birth and the year of the parent's 19th birthday. The underlying hypothesis is that educational access measured in this manner is likely to be relevant for one's post-secondary educational choices, as a large fraction of Finns graduate from upper secondary school the year they turn 19, while still residing in their municipality of birth or nearby, because of the limited mobility of families.[9] The employed municipality-by-year variation in 19-year-olds' educational access arises from the above-described events occurring between 1955 and 1975. Therefore we restrict our sample to parent-child observations for which the parent's year of birth is between 1936 and 1956. As a small number of parents born in the areas surrendered to the Soviet Union in 1940 and 1944 do not, generally, live close to their municipality of birth at age 19, we exclude these parents from the estimation samples. Furthermore, as a large fraction of individuals younger than 23 do not have a genuine opportunity to attend or complete higher education, we exclude parents and children who passed away before the end of the year of their 23rd birthday and children who turned 23 later than 1992 from our estimation

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[8] As our data are based on the censuses conducted in 1970 and later, the data do not include individuals who passed away or moved away from Finland permanently before 1970. Evidently, the most important source of sample attrition, particularly regarding the parents' sample, arises from the emigration of Finns to Sweden, which significantly accelerated in the end of the 1960's. If this sample attrition varies across parents' municipalities of birth in a way related to parents' and children's education, it might cause sample selection bias in our estimates.

[9] Appendix 2 shows the sensitivity of the first-stage results with respect to selecting the age at which parents' access to university is measured. As the true timing of the decision to enrol in higher education varies across individuals, and as there is serial correlation in our accessibility measure, we obtain significant estimates even when accessibility is measured at ages 14 and 24. However, when moving further away from age 19, to ages 9 and 29, the first-stage estimates logically become insignificantly different from zero.

samples. In total, the mother-child and father-child samples consist of 626,783 mothers, 606,531 fathers and 1,556,951 children.[10] Additionally, for the analyses controlling for assortative mating, we use a mother-father-child sample consisting of children both parents of whom were born in 1936–56; this subsample consists of 516,922 mothers, 514,906 fathers and 1,081,731 children.

Our information on parents' and children's completed educational qualifications is based on the educational degree register of Statistics Finland, which consists of retrospective information on residents' education collected during the 1970 census and annually updated information for the period 1970–2015. Our main parental outcome and one of the examined child outcomes is an indicator of whether the individual is a university graduate. As our instruments measure access to 'traditional' higher education programs arranged by universities and former teacher colleges, our definition of a university graduate only includes graduates from the bachelor's, master's, licentiate and doctoral degrees available in these institutions, while excluding graduates from lower-level vocational programs completed usually in vocational colleges and polytechnics. For both parents and children, we also construct a continuous measure of higher education attainment – years of higher education – based on each individual's highest completed post-secondary educational degree in the following manner: 0 years for no post-secondary degree, 2 years for a short-cycle tertiary degree, 4 years for a bachelor's degree, 6 years for a master's degree and 10 years for a PhD or licentiate degree. Additionally, we define the total years of schooling to be the years of higher education plus 12 years for those with any post-compulsory qualification and 9 years for individuals without post-compulsory education.

As an additional source of educational information, we utilize the university student database of Statistics Finland, which contains information on all students registered at Finnish universities between 1975 and 2015. With this information, we construct a dependent variable indicating whether the child enrolled in university early, by age 23 (more specifically, by the end of the year of the child's 23rd birthday). Compared to the variables based on completed degrees, the early enrolment indicator has the advantage of not suffering from the downward measurement error due to many individuals reaching their highest educational level at a fairly old age.

Aside from children's education, in a supplemental analysis we examine children's grades, including the grade-point average, first language grade and math grade, at the end of comprehensive school (usually the year the child turns 16) to gain understanding of the effects of parent's education on intermediate

[10] From the mother-child sample, we exclude 694 observations because of the mother or child passing away before the year of the 23th birthday and an additional 18,397 observations because of the child's late year of birth (1993 or later). The corresponding exclusions result in the loss of 1,344 and 58,283 observations in the father-child sample.

educational outcomes. The information on school-leaving grades originates from the yearly registers of Finland's centralized secondary school application system, which has existed since the late 1970's. Unfortunately, only two application registers for the period prior to 1991 – those for 1985 and 1989 – were available from Statistics Finland, and therefore our grade information is nationally representative only for a part of the children's cohorts (children born in 1969, 1973, 1975 or later).

In the data, we observe parents' location of birth at the municipality level. As a large number of municipal mergers have taken place in Finland since the oldest cohort's year of birth (1936), we harmonize the municipality-of-birth information across years using the municipality classification for the year 2007. As a result, we have 416 different birth locations for the parents' sample. When constructing measures of access to university, described in Section 3.2., we measure distances between parents' municipalities and universities, and between universities and upper secondary schools, using geodesic distances calculated by a user-written STATA command *vincenty*. Apart from the municipalities, we occasionally utilize three broader types of geographical units in our analysis: the 5 large areas (*suuralue*), the 19 regions (*maakunta*) and the 70 sub-regions (*seutukunta*) of Finland.

Table II describes the average educational and other characteristics of the parents' and children's samples. A comparison of parents' and children's educational attainment, as indicated by the average years of education and university graduation and enrolment probabilities, reveals two important prevailing trends in education: a significant increase in the average educational attainment of the population and a more rapid increase in women's educational attainment compared to that of men. In fact, we see that, in only one generation, the previously educationally disadvantaged female gender became the educationally advantaged one. The parent-child correlations in educational attainment are systematically close to 0.3, demonstrating that both mothers' and fathers' educational attainment is frequently transmitted from one generation to another. The distributions of parents' and children's birth locations, examined at the large-area level, further indicate significant changes in the geographical concentration of the Finnish population between the two generations. Namely, the proportion of births in Helsinki-Uusimaa grows rapidly, from 13 to 23 percent, while the proportions of West, East and North Finland decrease. At the same time, the frequency of the parent and the child being born in the same large area is, according to the parent-child correlations, clearly smaller for Helsinki-Uusimaa than for the remaining large areas. These findings demonstrate the general tendency of the Finnish population to move from the sparsely populated parts of the country to the south, particularly to the capital region.

TABLE II

Parents born in 1936-56 and their children. Sample means, standard deviations and parent-child correlations of selected variables

	Mothers	Mothers' daughters		Mothers' sons		Fathers	Fathers' daughters		Fathers' sons	
	Mean	Mean	Mother-daughter correlation	Mean	Mother-son correlation	Mean	Mean	Father-daughter correlation	Mean	Father-son correlation
Year of birth	1947	1974	0.753	1974	0.752	1947	1976	0.717	1976	0.716
Finnish speaker	0.945	0.947	0.841	0.945	0.832	0.941	0.948	0.784	0.946	0.802
Swedish speaker	0.054	0.051	0.853	0.053	0.846	0.058	0.051	0.792	0.053	0.810
Other first language	0.001	0.002	0.297	0.002	0.270	0.001	0.001	0.312	0.001	0.336
Born in Helsinki-Uusimaa	0.129	0.232	0.495	0.234	0.493	0.137	0.232	0.536	0.234	0.536
Born in southern Finland	0.209	0.211	0.586	0.208	0.582	0.210	0.214	0.619	0.212	0.614
Born in western Finland	0.294	0.255	0.668	0.257	0.666	0.295	0.258	0.692	0.260	0.690
Born in eastern/northern Finland	0.365	0.282	0.660	0.279	0.659	0.354	0.278	0.689	0.276	0.687
Born in Åland Islands	0.003	0.003	0.748	0.004	0.772	0.004	0.003	0.794	0.004	0.800
Born abroad	.	0.016	.	0.017	.	.	0.015	.	0.015	.
Years of education	11.71	14.10	0.316	13.21	0.298	11.91	14.14	0.299	13.22	0.321
University graduate	0.101	0.219	0.259	0.147	0.256	0.104	0.219	0.270	0.146	0.290
Enrolled in university by age 23	.	0.200	0.278[1]	0.159	0.287[1]	.	0.206	0.287[1]	0.162	0.323[1]
N	626,783	659,579		685,700		606,531	632,382		661,024	

[1] Correlation measured between child's university enrolment and parent's university graduation.

3.2 Measuring access to university

Previous studies utilizing instrumental variables related to access to higher education have relied on somewhat crude measures of accessibility, such as the availability of colleges in prospective students' neighborhoods (Currie and Moretti, 2003) or the distance to the nearest university (Toivanen and Väänänen, 2016). In our analysis, we also consider these types of measures as potential instruments for parental education (see Sections 5.1 and 5.3). However, while these measures are highly correlated with parental education, these relationships turn out to be statistically rather weak after adjusting our regression models for municipal fixed effects and clustering standard errors at the municipality level, which we consider to be important adjustments due to unobserved regional heterogeneity. To obtain a less noisy measure of university accessibility, and consequently a stronger instrument, we borrow ideas from geographical studies measuring accessibility of services[11] and use a competition-adjusted gravity-model-based measure, which accounts for two potentially important features of accessibility: 1) the supply of university education in all university locations, instead of only the nearest location, and 2) potential competition or demand for university education in the proximity of each university. The university accessibility in municipality m and year t is, therefore, given by:

$$A_{mt} = \sum_{k=1}^{K} \frac{S_{kt}}{C_{kt} d_{km}^{\alpha}}, \tag{1}$$

where S_{kt} is the supply of university education in municipality k and year t; d_{km} is the distance between municipalities k and m, and α is a distance-decay parameter, which indicates the degree of immobility, i.e. the extent to which individuals place greater weight on nearby educational opportunities relative to distant ones. An important feature of the accessibility measure is the adjustment of the supply by the amount of potential demand for university education in municipality k and year t, which we define by:

$$C_{kt} = \sum_{l=1}^{L} \frac{N_{lt}}{d_{kl}^{\alpha}}, \tag{2}$$

where N_{lt} is the number of potential university students in municipality l and year t, and d_{kl} is the distance between municipalities k and l.

To approximate the location-specific supply of university education, we use data on the number of first-year students at each university in 1955–75 available in the old Statistics Finland publications entitled *Higher Education* (Statistics Finland, 1969, 1973, 1983). Because of the high demand for universities' student seats in the 1950's, 60's and 70's, and the consequent entry restrictions applied by the institutions, we consider the number of first-year students as a reasonable

[11] For a review of the methods used for measuring accessibility, see, e.g. Guagliardo (2004).

approximation of the institution-level supply of student places.[12] To approximate the number of potential university students in each municipality, we utilize information collected from the registers of the Finnish Matriculation Examination Board regarding the year- and school-specific numbers of matriculation examination candidates in upper secondary schools in each spring-term examination in 1955–75. As a large proportion of the candidates in the spring-term matriculation examinations apply for higher education straight after the examination, the size of this group is a significant determinant of the demand pressure encountered by the universities in the following academic year.[13] In principle, the densities of first-year university students and matriculation examination candidates in the proximity of a parent's municipality of birth could correlate with a parent's unobserved characteristics, such as innate ability. Therefore, we also construct a less likely endogenous university accessibility measure that utilizes 1) the number of universities as a proxy for the supply of university education in each university location and 2) the number of 19-year-olds as a proxy for the number of potential university students in each municipality.[14] As demonstrated in Sections 5.2 and 5.3, the instrumental variables estimates obtained using these alternative access-to-university instruments are highly similar.

One practical issue in constructing the accessibility measure is that setting a too low or high value for the distance-decay parameter α, relative to its true value, can result in measurement error bias in the estimated effects of accessibility and a loss of precision in the instrumental variables analysis. Based on the observation that individuals often migrate long distances to enroll in university, it is likely that the true value of α is relatively low. In the case of measuring accessibility based on individuals' birth locations, instead of location in later childhood, the possibility of a small distance-decay value is, arguably, even higher due to the mobility of families after children's birth. Based on the first-stage F-statistics obtained for the instrument using different values for α (see Appendix 1), we select 0.50 as the preferred value applied throughout the analysis.

[12] As discussed in Section 2, in the late 1950's, the numerus clausus system was not yet applied by all of the universities' faculties, but it became a standard by the early 1960's. Therefore, the numbers of first-year students for the early years can, in the case of certain faculties, reflect the demand for rather than the supply of student places. However, this type of measurement error in accessibility is unlikely to pose a major problem for the identification, as our full-sample results are very similar to those obtained by using variation in the number of first-year students only from the period 1965–75, during which admission was already highly restricted in all institutions.

[13] The Finnish matriculation examination is arranged both in spring and fall. However, during the period examined (from the 1950's to the 1970's), the main examination round was arranged in spring, while the fall-term examination was intended for those who could not, e.g. for health reasons, participate in the spring-term examination and for those who wanted to retake the examination. To avoid double-counting candidates, we exclude the fall-term candidates from our calculations.

[14] The numbers of 19-year-olds in each municipality and year are based on projections from the municipality-level cohort sizes collected in the 1950 and 1960 censuses and yearly population register data from 1970 onwards.

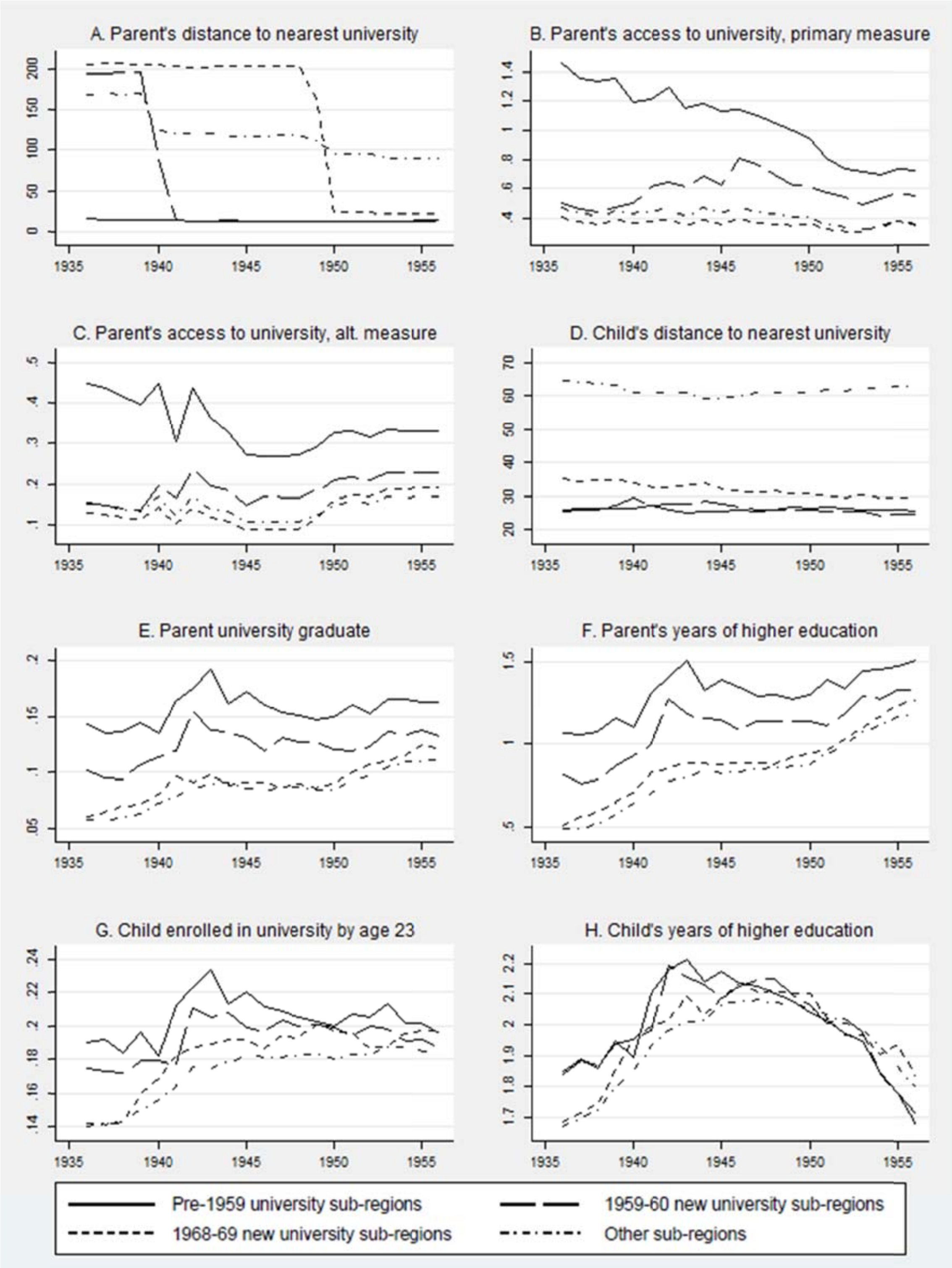

FIGURE III
Parents' access to university and parents' and children's average higher education attainment by parents' sub-region and year of birth

Pre-1959 university sub-regions: Helsinki, Turku and Jyväskylä; 1959–60 new university sub-regions: Oulu and Tampere; 1968–69 new university sub-regions: Vaasa, Joensuu and Lappeenranta. Primary accessibility measure: S=#first-year university students, N=#matriculation candidates; alternative accessibility measure: S=#universities, N=#19-year-olds.

3.3 Graphical analysis of sub-regional trends

Figure III provides the first crude picture of the relationships between changes in parents' access to university and parents' and children's educational attainment, showing parents' birth cohort trends for four sub-region groups: the pre-1959 university sub-regions (Helsinki, Turku and Jyväskylä), the 1959–60 new university sub-regions (Oulu and Tampere), the 1968–69 new university sub-regions (Vaasa, Joensuu and Lappeenranta) and other sub-regions, including all of the remaining 62 sub-regions. Sub-figures A, B and C show the trends in parents' access to university using three different accessibility measures: the distance to the nearest university and the primary and alternative gravity model-based measures. Regardless of the measure used, the figures indicate significant convergence in access to university between parents born in the pre-1959 university sub-regions and other parents. The first sub-figure demonstrates that the immediate reductions in the average distance to the nearest university were approximately 200 kilometers in the sub-regions that received their first university in 1959–69. However, as the established universities were, at first, small in size relative to the potential demand in their proximity, the changes in accessibility implied by the primary gravity-model-based measure are much more subtle and partly negative due to the rapid increase in the number of potential university students. In fact, we only observe an increasing trend in accessibility, lasting until the cohort born in 1946, for parents born in the first two new university sub-regions. As for parents born in the pre-1959 university sub-regions, the primary accessibility measure predicts a declining trend in access to university for most of the period due to the clearly disproportionate changes in supply and demand in these sub-regions, particularly in the Helsinki sub-region.

A potential concern in using the regional convergence in parent's access to university to draw conclusions about the effects of parental education is that a similar regional pattern might show up in children's educational access, leaving us unable to distinguish between the effects of parental education and geographical access to education. However, sub-figure D demonstrates that, in the current context, we do not observe significant convergence in children's access to university, as indicated by children's distance to the nearest university at age 19.[15] This finding is logical, as a large majority of the children reached the age of university enrolment after the geographical expansion of the Finnish university system was already concluded, i.e. after the opening of the University of Lapland in 1979. Therefore, even if the changes in university accessibility had certain effects on parents' residential location choices (as indicated by our findings in Section 5.4), the consequences for children's access to university

[15] Although we determine supply, i.e. the locations of the universities, in the year of the child's 19th birthday, we measure distance based on the child's municipality of residence two years earlier (at age 17). This is because, by age 19, many of the children have already migrated away from their parental home.

were rather insignificant due to the already highly decentralized university system.

In support of our empirical strategy, the sub-regional patterns in parents' university graduation and years of higher education in sub-figures E and F do, to some extent, resemble those in parents' access to university. While the average educational level is persistently higher for parents born in the five pre-1968 university sub-regions among all parents' cohorts, the growth in educational level is also slowest and even partly negative for these parents, which results in a significant regional convergence when moving toward the youngest parents' cohorts. Coinciding with the first two university openings in 1959 and 1960, we can observe some convergence in parental education between the pre-1959 university sub-regions and the 1959–60 new university sub-regions. The timing of the later 'catch-up' by parents' born in the smaller sub-regions also appears to coincide with the three university openings that took place in 1968 and 1969. Thus, based on these similarities, the differing regional trends in parents' access to university could serve as a relevant source of exogenous variation for studying the effects of parental higher education.

Sub-figures G and H describe parents' offspring's average probability of enrolling in university by age 23 and average years of higher education by parent's cohort and sub-region. Logically, the differences in children's education by parent's sub-region are, due to imperfect intergenerational transmission of education, more modest than the corresponding differences in parents' education. Nevertheless, there is some correlation between the parents' and children's patterns: among the oldest parents' cohorts, parents born in the pre-1968 university sub-regions have children with markedly higher enrolment probability and average higher education attainment than parents born in other sub-regions, but these differences diminish, and in the case of children's years of higher education are even reversed, when moving to the youngest parents' cohorts.[16] These resemblances provide a reason to suspect that the changes in parents' access to university and parents' and children's higher education attainment are causally linked.

[16] The decreasing pattern in children's years of higher education among the children of the youngest parents' cohorts reflects the downward measurement error in this variable arising from the fact that these children were unable to reach their highest educational level by 2015 due to their young average age. This conclusion is supported by the observation that children's early university enrolment probability remains rather stable across the parents' cohorts born after the mid 1940's.

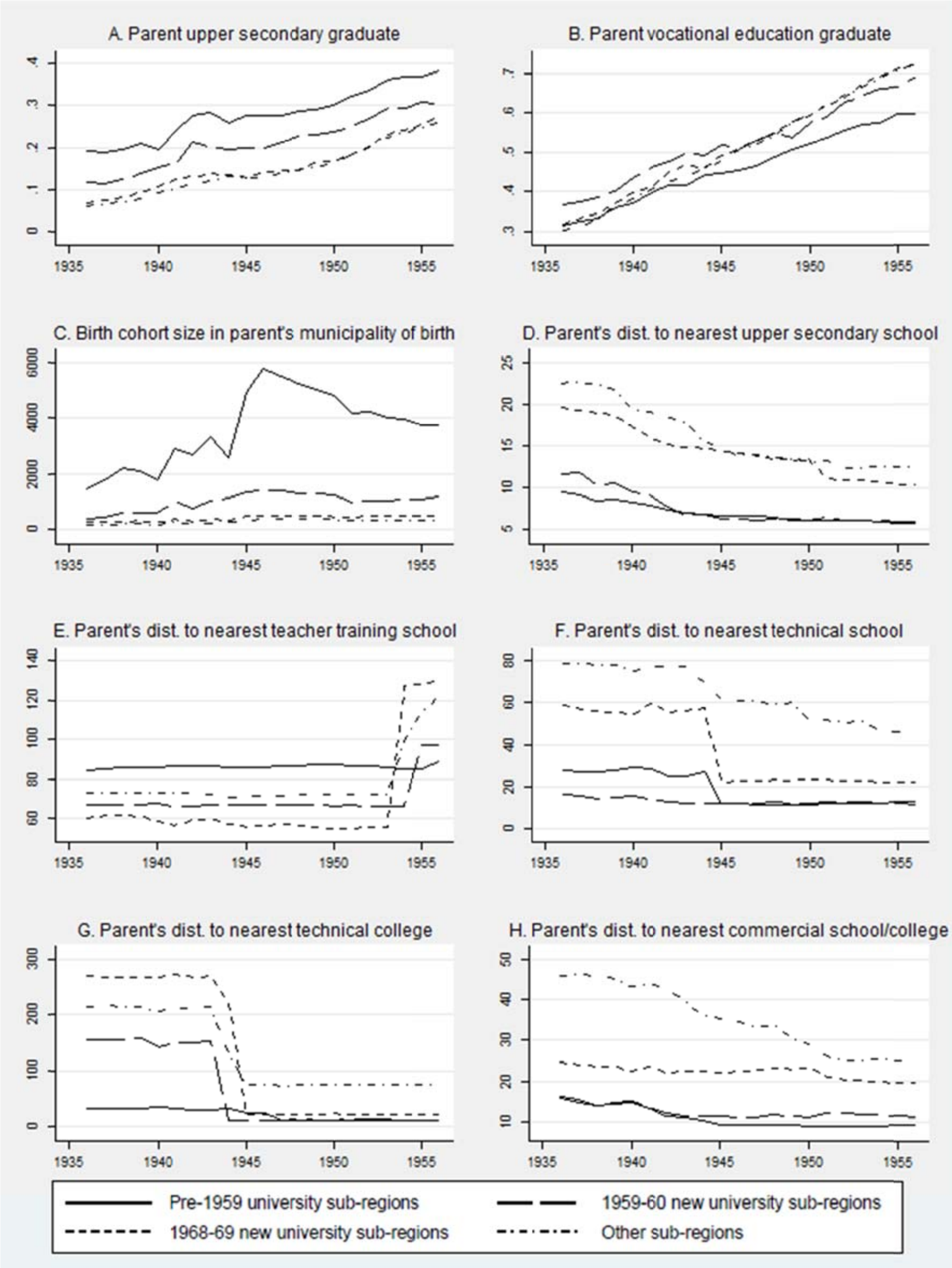

FIGURE IV
Other trends by parents' sub-region of birth

Pre-1959 university sub-regions: Helsinki, Turku and Jyväskylä; 1959–60 new university sub-regions: Oulu and Tampere; 1968–69 new university sub-regions: Vaasa, Joensuu and Lappeenranta.

One piece of evidence supporting the independence of the sub-regional changes in parents' access to university from those in other individual or regional characteristics affecting parents' sorting into university education is provided in Figure IV, sub-figure A, showing the trends in parents' probability of obtaining an upper secondary school diploma, i.e. formal eligibility for university education. We observe that the average probability of parents' upper secondary graduation increases roughly monotonically in all of the sub-region types because of the strong, positive country-level trend. However, the sub-regional differences in this probability remain highly stable across the parent's cohorts, with this probability being markedly higher for parents born in the pre-1959 university sub-regions than for other parents. Thus, unlike in parents' access to university or higher education attainment, there is no clear regional convergence in parents' probability of completing the academic track in pre-tertiary education, which can be expected to correlate with many potential confounders, such as parents' innate ability and demand for university education as well as parents' geographical access to upper secondary education.

However, as a cautious note, the remaining sub-figures in Figure IV demonstrate that there are other trends, coinciding with those in parents' access to university, which could provide alternative explanations for the changes in children's higher education attainment. In particular, sub-figure B shows that, coinciding with the positive trends in upper secondary and university education, there is a significant boom of vocational education, as the proportion of vocationally educated parents grows steadily from 30 to 70 per cent between cohorts 1936 and 1956. Moreover, we see that, while all of the sub-region-specific trends in parents' vocational education graduation are somewhat smooth, the growth is markedly more sluggish for parents born in the pre-1968 university sub-regions than for the two other sub-region groups. As these trend differences do, to some extent, correlate positively with those in parents' access to university, it is conceivable that the changes in children's education could partly reflect changes in parents' vocational education, rather than university education.

Figure IV provides at least two likely explanations for the differing sub-regional trends in parents' vocational education. First, as demonstrated in sub-figure C, the average size of a parent's local birth cohort, i.e. the number of children born in the same municipality and year as the parent, grows much faster in the pre-1968 university sub-regions than in other sub-regions. Therefore, the relatively sluggish growth in vocational education in the pre-1968 university sub-regions can partly arise from the high demand for and under-provision of vocational education in these localities. Second, as a large number of new vocational schools were opened across the country between the late 1950's and early 1970's, we can also observe regional convergence in parents' access to vocational education. In particular, sub-figures F, G and H demonstrate that the rapid expansions of technical and commercial education in the 1960's resulted in significant reductions in the average distances to the nearest technical and commercial institutes (measured at age 16), particularly for parents originating from outside the largest university sub-regions.[17] However, although the various trends in Figure IV do correlate, to some extent, with those in parents' access to university, we show, in Section 5.3, that our IV estimates regarding the intergenerational effects of higher education remain large and significant even after adjusting the models for various types of individual- and municipality-level controls and heterogeneous trends.

[17] As the Statistics Finland register of educational institutions was only established in 1971, we had to collect the pre-1971 information on the location of vocational schools, upper secondary schools and teacher training schools from fragmented sources, including the *Applied and Admitted* publications of the Ministry of Employment (1964–1970), the registers of the Matriculation Examination Board, the archives of the Ministry of Trade and Industry, the *People's Education* publications of Statistics Finland and individual school histories.

4. Empirical approach

Our baseline instrumental variables (IV) results rely on the following linear model estimated by two-stage least squares for the relationships between parent's access to university, parent's education and child's education:

$$E_{ijmc} = \beta_0 + \beta_1 P_{ijmc} + \beta_2 X_{ijmc} + \theta_m + \mu_c + \varepsilon_{ijmc} \quad (3)$$

$$P_{ijmc} = \alpha_0 + \alpha_1 A_{mc} + \alpha_2 X_{ijmc} + \gamma_m + \delta_c + \vartheta_{ijmc}, \quad (4)$$

where subscripts i, j, m and c identify the child, parent, parent's municipality of birth and parent's birth cohort, respectively; P_{ijmc} and E_{ijmc} are the parent's and child's educational outcomes (university enrolment/graduation or years of education); A_{mc} is parent's access to university at age 19, serving as the instrument for parental education; X_{ijmc} is a vector of control variables; terms θ_m, γ_m, μ_c and δ_c control for the fixed differences in the outcomes by parent's municipality and year of birth; and ε_{ijmc} and ϑ_{ijmc} are the error terms clustered at the level of parent's municipality of birth.[18] We estimate the model separately for mother-child and father-child pairs, while controlling for child's gender.[19]

The key assumption in identifying parameter β_1 in model (3)–(4) is that, conditional on the controls included the model, parent's access to university only correlates with child's education via parental higher education. By controlling for the municipal and cohort fixed effects, we address the problem that the level of parent's access to university likely correlates with confounding factors through time variation in the overall supply and demand for higher education and distances from parent's municipality to universities. Yet, we have to assume that the non-parallel municipal trends in parent's access to university only correlate with those in child's education because of parental higher education. As a parent's access to university at age 19 is determined based on his or her municipality of birth, rather than the actual place of residence at age 19, we can rule out the possibility that the correlation in the municipal trends arises because parents' families of origin relocate after the parent's birth based on the anticipated municipal trends in access to university.[20] Nevertheless, even in the absence of systematic residential sorting, it is possible that there are other coinciding region- or municipality-level trends, for instance in a parent's innate

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[18] Clustering by parent's municipality accounts for the fact that the IV estimates are identified through municipality-year level variation in accessibility, which is serially correlated.

[19] The separate IV estimates for daughters and sons, reported in Appendix 3, are very similar.

[20] As our data only include yearly information on the municipality of residence from 1970 onwards, we cannot observe parents' actual residential location at the age of 19 for most of the parents' sample. However, for parents' cohorts 1952–1956, we see that 65 per cent of the individuals still resided in their municipality of birth, 75 per cent resided in their sub-region of birth and 80 per cent resided in their region of birth at the end of the year of their 18th birthday.

ability, general educational access or migration patterns that generate the correlation between the instrument and child's education. However, our sensitivity analyses, presented in Section 5.3, suggest that our main conclusion – a large positive relationship between parents' and children's higher education attainment – is robust to various types of coinciding trends.

One identification problem that the estimation of model (3)–(4) does not solve is the correlation between mother's and father's education arising from assortative mating. That is, part of the IV estimate of coefficient β_1 is likely to reflect the omitted other parent's education. To solve this problem, we follow the approach of Oreopoulos et al. (2006), in which mother's and father's education and the fixed effects of parents' cohorts and municipalities of birth are simultaneously included in the main estimation equation as follows:

$$E_{ijkmncd} = \beta_0 + \beta_1 M_{ijmc} + \beta_2 F_{iknd} + \beta_3 X_{ijmc} + \beta_4 X_{iknd} + \theta_m + \mu_n + \pi_c + \rho_d + \varepsilon_{ijkmncd}, \quad (5)$$

where subscripts j, m and c denote the mother, mother's municipality of birth and mother's year of birth, while k, n and d are the corresponding subscripts for the father; M_{ijmc} and F_{iknd} are mother's and father's education. To allow for the endogeneity of mother's and father' education, we restrict our sample to children both of whose parents were born between 1936 and 1956 and use both mother's and father's access to university as instruments. In this model, the reduced-form effects of mother's and father' access are identified through parents born in different municipalities and/or years. A problem in model (5) is that, because the instruments for mother's and father's education are, also in our data, highly correlated,[21] the IV estimates of β_1 and β_2 are systematically imprecise and partly ambiguous (e.g. very large coefficients for mother's and father's education with opposite signs). Therefore, similar to Oreopoulos et al. (2006), we prefer results from models where certain restrictions are applied to the mother's and father's effects, yielding more precise estimates. In particular, when examining the effects of parents' years of higher education, we consider a model where β_1 and β_2 are restricted to be equal, i.e. we estimate the effect of the sum of parents' years of higher education. Similarly, when examining the effects of parents' university graduation, we base our conclusions on the effects of having at least one university-educated parent, rather than separate estimates for mother's and father's university education.

If the effects of parental higher education were homogeneous, we would expect the ordinary least-squares (OLS) estimates of the parent-child relationships in

[21] In the mother-father-child sample, parents born in the same municipality cover 24 per cent of the observations, while 14 per cent of the parents were born in the same year. However, in only 3 per cent of the cases, mother and father belong to the same municipality-cohort cell. The correlation in mother's and father's access to university is 0.44.

education to exceed the IV estimates, for instance, because of positive correlation in parents' and children's unobserved innate ability. However, given the possibility of heterogeneous effects, we are inclined to interpret the estimated IV coefficients of parental education as local average treatment effects (LATE), i.e. average effects for the children of 'complier parents' whose educational attainment responded to the changes in university accessibility. These 'complier parents' are likely to be relatively immobile individuals whose families of origin remained in the close proximity of the parent's location of birth and who attached a relatively high importance to the educational opportunities offered close by.[22] Depending on the importance of parental higher education among the children of these parents, the difference between the IV and OLS estimates could be either positive or negative. The LATE interpretation does require assuming that the effect of parent's access to university on parental education is systematically non-negative (the monotonicity assumption), which cannot be convincingly tested. However, given that our instruments are strongly related to the costs of applying for and enrolling in university, and that the first-stage estimates of the instruments systematically point to the same direction, we do not consider the monotonicity assumption particularly unreasonable.

[22] In the data, the set of parents' innate or early-life characteristics is very limited, and we are therefore unable to extensively study the characteristics of the complier parents. However, by examining the reduced-form effect of parent's access to university on the interaction of parent's first language and university graduation, we observe that Swedish-speakers are clearly overrepresented among the compliers. At the same time, we observe that the probability of remaining in the region of birth at age 34 is 0.80 for Swedish-speaking mothers and 0.82 for Swedish-speaking fathers, whereas the corresponding probabilities for Finnish-speakers are considerably lower, 0.56 and 0.60. Thus, there is some evidence to suggest that the group of compliers consists of relatively immobile individuals.

5. Estimation results

5.1 Local intergenerational effects of university openings

Before the more formal analysis, we present evidence of the intergenerational effects of the university openings occurring in 1959 in Oulu, 1960 in Tampere, 1968 in Vaasa and 1969 in Lappeenranta and Joensuu. For this analysis, we use subsamples consisting of parents born in the new university sub-regions between 14 and 24 years prior to the university openings.[23] Thus, the samples include five cohorts of parents that turned 19 – and, with a high probability, became eligible for higher education – before the university openings and six cohorts that turned 19 during the opening year or afterwards. Additionally, as control groups, we use samples of parents born in the regional centers of the regions non-adjacent to the new university regions.[24] The rationale behind these control groups is that the university openings did not have a significant impact on the proximity of university education in the non-adjacent regions. Therefore, the local effects of the university openings, arising through the reduced distances, can be reasonably well separated from the country-wide effects and possible other shocks by this comparison. Naturally, the control group is unlikely to be perfect, as the university openings coincided with other regional changes in parents' access to higher education, for instance due to growth of the existing universities and cohort size changes. Furthermore, as the treatment assignment based on parent's location of birth and year of the 19th birthday inevitably contains measurement error – many parents made their decision on university education in a different location and year – the implied effects of university openings are to be interpreted cautiously.

Figure V presents an event study of the intergenerational effects of the university openings, showing the average cohort differences (pooled and weighted across the four opening years) in mother's and father's university graduation probabilities and their children's early university enrolment probabilities for the treatment and control groups. For both the treated mothers and fathers, we can observe a positive trend in university graduation after the cohort born 20 years before the university opening (t–20), which suggests that the openings are positively associated with parental higher education. This association is more significant and stable across time for mothers than for fathers, and the trend for the treated fathers actually becomes downward after the cohort t–17. No clear or

[23] Although we otherwise restrict our parents' samples to cohorts 1936–56, in the case of analyzing the 1959 university opening in Oulu, we also use cohort 1935 to obtain the full 11 consecutive cohorts.

[24] In the case of the 1959 and 1960 university openings in Oulu and Tampere, the control group comprises parents born in the sub-regions of Helsinki, Kouvola, Lappeenranta, Mikkeli, Joensuu and Vaasa. As for the 1968 university opening in Vaasa and the 1969 university openings in Joensuu and Lappeenranta, the control group includes parents born in the sub-regions of Helsinki, Turku, Tampere, Hämeenlinna, Lahti, Jyväskylä, Oulu and Rovaniemi.

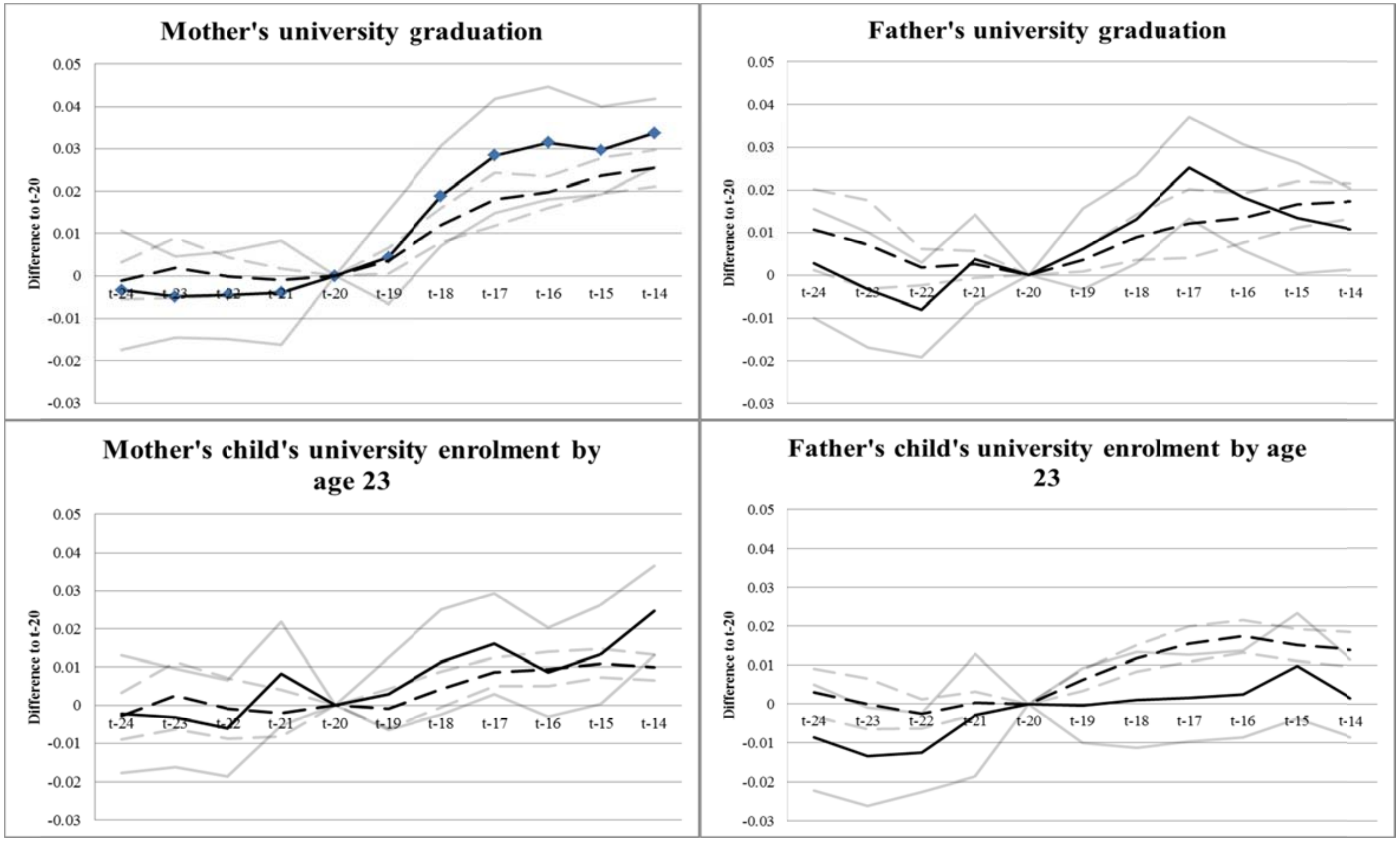

FIGURE V

Differences in parents' and children's university education by parent's cohort for cohorts born 14–24 years before the 1959–69 university openings (t)

The solid lines are for the treatment group (parents born in the new university sub-regions and their children), and the dashed lines are for the control group (parents born in the regional centers of non-adjacent regions and their children).

significant pre-treatment trends can be observed in mother's or father's university graduation, which suggests that the changes in parental education in the treatment groups are indeed caused by events taking place at year t. However, the results of the event study further suggest that the openings likely had significant country-level effects, as the patterns are remarkably similar across the treatment and control groups. Although the estimated post-treatment trends are, as a weak sign of local effects, somewhat steeper for the treated parents, the cohort-specific estimates clearly do not statistically differ between the treatment and control groups given the wide, overlapping confidence intervals. Thus our investigation does not provide strong evidence of local effects arising through reduced distances. The cohort differences in children's university enrolment probabilities in the treatment and control groups are somewhat volatile and, thus difficult to interpret. Among the children of the treated mothers, we observe a positive, if non-monotonic, trend in early university enrolment, which is mainly slightly above that of the control group. Thus we see some evidence of positive intergenerational effects arising from the university openings and mother's university education. However, these effects do not – apart from those measured for cohort t–14 – statistically differ between the treatment and control groups. As for the children of the treated fathers, the cohort differences are again systematically close to zero and insignificant, whereas there is a positive post-treatment trend for the control group. Therefore, the analyses with the children of mothers and fathers provide certain mixed results.[25]

Table III presents the estimates regarding the effects of a parent being born in a university sub-region no more than 19 years prior to the first university opening separately for each of the four opening years, 1959, 1960, 1968 and 1969. The simple before-after estimates, obtained by using only parents born in the new university sub-regions, suggest that the university openings are associated with a 1.8–3.6 percentage points higher mother's university graduation probability. The before-after estimates for fathers are somewhat smaller, 0.9–2.1 percentage points, and the estimate for the 1968 university opening in Vaasa even has a negative sign. Again, by introducing the control group – parents born in the regional centers of non-adjacent regions – to the analysis paints a different picture of the local effects of the university openings: the differences-in-differences estimates of the effects of the 1959 and 1960 university openings on mother's university graduation are not significantly different from zero, suggesting that the before-after estimates are driven by country-wide rather than local trends in mother's education. Nevertheless, the effects of the later openings in 1968 and 1969 on mother's university graduation remain positive and

[25] The partly ambiguous results regarding father's education may be, to some extent, related to measurement problems: in Finland, men typically begin their post-secondary studies later than women due to compulsory military service, because of which 19 may be too early an age for measuring father's access to university. This problem is indicated by the notable pre-treatment volatility in father's education in Figure V.

TABLE III
The effect of parent being born in a university sub-region no more than 19 years prior to the first university opening

	Mother-child sample		Father-child sample	
	Mother university graduate	Child enrolled in university by age 23	Father university graduate	Child enrolled in university by age 23
Oulu 1959				
Before-after estimate	0.0206***	0.0220***	0.0087	0.0050
	(0.0052)	(0.0066)	(0.0057)	(0.0067)
Differences-in-differences estimate	-0.0080	-0.0037	-0.0171***	-0.0253***
	(0.0055)	(0.0069)	(0.0061)	(0.0071)
Tampere 1960				
Before-after estimate	0.0322***	0.0139***	0.0212***	0.0215***
	(0.0043)	(0.0054)	(0.0044)	(0.0052)
Differences-in-differences estimate	0.0063	-0.0101*	-0.0031	-0.0060
	(0.0046)	(0.0057)	(0.0049)	(0.0057)
Vaasa 1968				
Before-after estimate	0.0359***	0.0098	-0.0106*	-0.0082
	(0.0065)	(0.0082)	(0.0063)	(0.0080)
Differences-in-differences estimate	0.0330***	0.0147*	-0.0024	-0.0082
	(0.0069)	(0.0080)	(0.0070)	(0.0079)
Joensuu and Lappeenranta 1969				
Before-after estimate	0.0180***	0.0026	0.0096***	0.0060
	(0.0029)	(0.0038)	(0.0030)	(0.0040)
Differences-in-differences estimate	0.0089**	0.0078*	0.0115***	0.0078*
	(0.0037)	(0.0043)	(0.0039)	(0.0043)

The before-after estimates are for parents born in the new university sub-regions 14-24 years before the university openings. The differences-in-differences estimates utilize parents born in the regional centers of non-adjacent regions as control groups. The regression models control for child's gender, parent's municipality of birth and year of birth (DID only). Standard errors in parentheses are clustered by parent's municipality of birth. Statistical significance: * ($p<0.1$), ** ($p<0.05$), *** ($p<0.01$).

significant – 0.033 and 0.009, respectively – suggesting that the effect of these openings was, to a large extent, of local nature. The differences-in-differences estimates regarding father's university graduation are approximately zero and insignificant for the 1960 and 1968 university openings, while significantly negative (–0.017) and positive (0.012) for the 1959 and 1969 openings, respectively. As for the intergenerational effects, we see that the estimated effects of the university openings on parent's university graduation and offspring's university enrolment probability work in the same direction whenever a significant first-stage relationship is observed. Therefore, the implied causal relationship between parent's and child's university education is systematically positive. The ratios between the parents' and children's estimates are, in most cases, also notably large. For instance, the differences-in-differences estimates regarding the 1968 university opening in Vaasa indicate a ratio of 0.45 between child's early university enrolment and mother's university graduation. According to our additional two-stage least squares estimates, this ratio is, however, statistically rather imprecise (with a standard error of 0.23) and significant only at the 10 per cent level. Likewise, the estimates regarding the effects of the 1969 university openings in Joensuu and Lappeenranta on father's and child's university education indicate a considerable parent-child relationship (0.32), which is, however, even less precisely estimated (the standard error being 0.37).

5.2 Baseline instrumental variables results

To obtain more precise estimates of the relationship between parents' and children's education, we now turn to differences-in-differences models, estimated for the full sample of parents born in 1936–56, that exploit our primary gravity-model-based accessibility measure. Table IV, examining the relationships between parent's access to university, parent's university graduation and child's university enrolment and graduation, shows that the accessibility measure is strongly and positively associated with all of the examined outcomes in the reduced-form models controlling for child's gender and parent's municipality and year of birth.[26] In line with the results of the previous sub-section, the first-stage results in Table IV indicate that the effect of access to university is somewhat larger for mothers than for fathers. As a result, the first-stage F-statistic, indicating the relevance of the instrument, is clearly higher in the mother-child sample (43.4) than in the father-child sample (10.6).[27] When estimating the effects of mother's and father's access to university simultaneously using the mother-father-child sample, the effect of mother's access on the probability of at least one parent being a university graduate appears larger and more significant compared to father's access. Nevertheless, used together, these variables appear to serve as fairly strong instruments, the first-stage F-statistic for their joint significance being 71.4.

In the mother-child and father-child samples, the estimated effects on child's early university enrolment and university graduation are very large, indicating a crude one-to-one relationship between parent's and child's university education, with the estimated effects of father's education being somewhat smaller than the effects of mother's education. However, when mother's and father's access to university are included simultaneously in the IV models estimated for the mother-father-child sample, the implied effect of parents' university education approximately halves, which suggests that the large effects obtained for the

[26] As the magnitudes of the reduced-form estimates are somewhat difficult to interpret, we have also included estimates that represent one-standard-deviation changes in parents' access to university in Appendix 1.

[27] In Section 5.4., we see that the F-statistic for father's access to university can be increased considerably by employing additional controls or by restricting the number of fathers' cohorts used, while the IV estimates regarding the effect of father's university graduation remain highly similar. Therefore, the low F-statistic for this instrument in Table IV is not particularly worrying.

mother-child and father-child samples are, to a large extent, driven by the omitted other parent's education. The indicated effects of having at least one university-educated parent are, nevertheless, large: 0.59 on child's early university enrolment and 0.51 on child's university graduation. These IV estimates clearly exceed the corresponding OLS coefficient estimates for the parent-child relationships, also reported in Table IV, which range from 0.33 to 0.38. A similar observation – IV estimates exceeding OLS estimates – has been made in many of the previous instrumental variables studies on the effects of parental education (e.g. Currie and Moretti, 2003; Oreopoulos et al., 2006; Maurin and McNally, 2008). A potential interpretation of the difference between the IV and OLS estimates is that the changes in access to university affect a particular – likely relatively immobile – group of parents at the margin of acquiring higher education for whose children the average intergenerational effect of university education is larger than for the average child.

TABLE IV

Baseline IV and OLS results for the relationship between parent's and child's university education

	First-stage model		Child enrolled in university by age 23		Child university graduate	
	OLS coeff.	F-stat.	OLS coeff.	IV coeff.	OLS coeff.	IV coeff.
Mother-child sample (N=1,345,279)						
Mother's access to university	0.048***	43.4	0.060***		0.051***	
	(0.007)		(0.009)		(0.010)	
Mother university graduate			0.360***	1.246***	0.332***	1.055***
			(0.002)	(0.110)	(0.002)	(0.091)
Father-child sample (N=1,293,406)						
Father's access to university	0.030***	10.6	0.029***		0.025***	
	(0.009)		(0.007)		(0.008)	
Father university graduate			0.377***	0.945***	0.345***	0.825***
			(0.002)	(0.108)	(0.002)	(0.077)
Mother-father-child sample (N=1,081,731)						
Mother's access to university	0.089***	71.4	0.047***		0.040***	
	(0.020)		(0.012)		(0.013)	
Father's access to university	0.024*		0.024***		0.019*	
	(0.014)		(0.008)		(0.010)	
Mother and/or father university graduate			0.352***	0.593***	0.326***	0.505***
			(0.003)	(0.048)	(0.003)	(0.035)

Each model controls for child's gender and parent's year and municipality of birth. Standard errors in parentheses are clustered by parent's municipality of birth. Statistical significance: * (p<0.1), ** (p<0.05), *** (p<0.01).

TABLE V

Baseline IV and OLS results for the relationship between parent's and child's educational attainment

	First-stage model		Child's years of education		Child's years of higher education	
	OLS coeff.	F-stat.	OLS coeff.	IV coeff.	OLS coeff.	IV coeff.
Mother-child sample (N=1,345,279)						
Mother's access to university	0.323***	63.7	0.478***		0.442***	
	(0.040)		(0.094)		(0.081)	
Mother's years of higher education			0.480***	1.480***	0.421***	1.370***
			(0.003)	(0.138)	(0.003)	(0.111)
Father-child sample (N=1,293,406)						
Father's access to university	0.389***	19.0	0.206**		0.235***	
	(0.089)		(0.081)		(0.070)	
Father's years of higher education			0.420***	0.531***	0.371***	0.605***
			(0.002)	(0.093)	(0.003)	(0.054)
Mother-father-child sample (N=1,081,731)						
Mother's access to university	0.864***		0.371***		0.328***	
	(0.215)	79.8	(0.110)		(0.100)	
Father's access to university	0.381***		0.116		0.168***	
	(0.118)		(0.076)		(0.063)	
Sum of parents' years of higher education			0.293***	0.397***	0.260***	0.396***
			(0.001)	(0.022)	(0.002)	(0.020)

Each model controls for child's gender and parent's year and municipality of birth. Standard errors in parentheses are clustered by parent's municipality of birth. Statistical significance: * ($p<0.1$), ** ($p<0.05$), *** ($p<0.01$).

Table V further shows the results obtained using continuous measures for parent's and child's education, i.e. parent's and child's years of higher education and child's total years of education. The results for the mother-child and father-child samples suggest that mother's higher education has a considerably larger effect on child's years of education than father's education, the respective estimates being 1.48 and 0.53. Using child's years of higher education as the dependent variable, the estimates are very similar, 1.37 and 0.61, and somewhat more precisely estimated. Thus it appears that the positive effects of parents' higher education on children's education almost exclusively work via children's post-secondary-level attainment. When using the mother-father-child sample and both parents' access to university as instruments, the estimated average effect of a one-year increase in the sum of parents' years of higher education on child's education is 0.40, regardless of whether examining child's total educational attainment or only higher education attainment. The large differences between the one-parent-child and two-parent-child estimates once again suggest that a large proportion of the estimated one-parent-child effects are, particularly in the case of the mother-child sample, driven by assortative mating. Nevertheless, all of the IV estimates are again markedly larger than the corresponding OLS estimates.[28]

5.3 Robustness of the results

In this section, we examine the sensitivity of our IV estimates with respect to alternative instruments, model specifications and sample restrictions. For conciseness, we focus on the results obtained using child's early university enrolment and years of higher education as the dependent variables.[29] A concern in using our primary accessibility measure is that the supply and demand information used in its construction might be correlated with unobserved determinants of parents' and children's education, such as innate ability, even after accounting for the year- and municipality-of-birth fixed effects. Therefore, as the first robustness check, we re-estimate the full-sample models by replacing the primary accessibility measure with either parent's distance to the nearest university or a gravity-model-based measure that utilizes the number of universities and number of 19-year-olds as the alternative supply and demand proxies. Table VI shows that, while the distance to the nearest university is generally a weak instrument for parental higher education, the first-stage F-statistics for the alternative gravity-model-based measure appear sufficiently high, i.e. exceed the threshold of 10, in the mother-child and mother-father-child samples. The IV results obtained using these measures are mainly well in line with the baseline results. In particular, the IV estimate regarding the effect of having at least one university-educated parent on child's early university enrolment is, regardless of the instrument used, very close to the baseline estimate of 0.6. Highly imprecise and/or ambiguous IV estimates are only obtained when using the father-child sample and father's distance to the nearest university as an instrument. However, in these cases, the first-stage results show that the instrument is too weak for reliable inference.

In the second robustness check, presented in Tables VII and VIII, we assess to what extent other regional trends in education coinciding with those in parents'

[28] The standard errors reported for the IV and OLS estimates of the mother-father-child sample are clustered based on mother's municipality of birth. We also calculated the standard errors for our main estimates using a more complex two-way clustering strategy by clustering by both mother's and father's municipality of birth using STATA's *ivreg2* command. The resulting two-way-clustered standard error for the IV relationship between parents' university graduation and child's early university enrolment is 0.062 (versus 0.048 using one-way clustering), whereas the two-way-clustered standard error for the IV relationship between parents' and child's years of higher education is 0.021 (versus 0.020 using one-way clustering). Thus, the differences between the one-way- and two-way-clustered standard errors are clearly not large enough to alter our conclusions.

[29] The sensitivity results for two other examined outcomes, child's university graduation and total years of education, are highly similar and available from the authors by request.

TABLE VI

IV results using alternative instruments for parental higher education

	Child enrolled in university by age 23					
	Mother-child		Father-child		Mother-father-child	
IV:						
Mother/father university graduate	1.738***	1.374***	1.652	1.322***	0.630***	0.658***
	(0.555)	(0.163)	(2.368)	(0.256)	(0.190)	(0.077)
First stage:						
Mother's distance to nearest university (per 100 km)	-0.003*				-0.006	
	(0.002)				(0.004)	
Father's distance to nearest university (per 100 km)			-0.001		-0.003*	
			(0.002)		(0.001)	
Mother's access to university (alternative measure, per 1000)[1]		0.131***				0.221**
		(0.037)				(0.088)
Father's access to university (alternative measure, per 1000)[1]				0.060		0.075**
				(0.037)		(0.032)
F-statistics for the instrument(s)	2.9	12.3	0.2	2.6	3.2	20.4

	Child's years of higher education					
	Mother-child		Father-child		Mother-father-child	
IV:						
Mother's/father's years of higher education	0.871*	1.396***	-0.136	0.475***	0.122	0.366***
	(0.480)	(0.197)	(0.829)	(0.156)	(0.205)	(0.044)
First stage:						
Mother's distance to nearest university (per 100 km)	-0.022*				-0.053	
	(0.013)				(0.038)	
Father's distance to nearest university (per 100 km)			-0.021		-0.024*	
			(0.019)		(0.014)	
Mother's access to university (alternative measure, per 1000)[1]		0.828***				1.893*
		(0.242)				(0.967)
Father's access to university (alternative measure, per 1000)[1]				0.988**		1.273***
				(0.416)		(0.236)
F-statistics for the instrument(s)	3.1	11.7	1.2	5.7	2.4	24.7

Each model controls for child's gender and parent's year and municipality of birth. Standard errors in parentheses are clustered by parent's municipality of birth. Statistical significance: * (p<0.1), ** (p<0.05), *** (p<0.01). [1] The supply of university education approximated by the numbers of universities; the number of potential university students approximated by the number of 19-year-olds.

access to university and higher education attainment can cause problems for identifying the intergenerational effects of parents' higher education. In particular, the differing regional trends in parents' vocational education observed in the graphical analysis of Section 3.3 (Figure IV) might result in a violation of the exclusion restriction if parents' vocational education affects the studied child outcomes. Table VII shows the reduced-form effects of the access-to-university instrument on parents' highest education level (ranging from 'no post-compulsory education' to 'higher tertiary education') and graduation from three types of post-compulsory education: general upper secondary education, vocational education and university education. Based on these results, there are reasons for concern as, in the baseline models only controlling for parent's year and municipality of birth, mother's and father's access to university are not only positively related to parents' tertiary-level education and university education, but also to parents' probability of ending up with only secondary-level education and of graduating from vocational education. Additionally, mother's access to university is significantly and positively related to mother's graduation from upper secondary education.

Based on our sensitivity analyses, the local cohort size variation in parent's municipality of birth is the most important observed factor explaining the positive relationships between parents' access to university and parents' secondary-level and vocational education. This finding is sensible: as capacity constraints exist both in university and vocational education, changes in cohort sizes affect competition in both educational sectors, creating a connection between the access-to-university instrument and parents' vocational education.[30] Furthermore, as described earlier in Section 3.3 (Figure IV), the trends in parents' vocational education are clearly different for the five oldest, pre-1968 university sub-regions (Helsinki, Turku, Tampere, Jyväskylä and Oulu) than for other sub-regions. Therefore, allowing for these trend differences in the reduced-form models helps to further reduce the correlation between the instrument and parents' secondary-level and vocational education. Table VII demonstrates that, after including either the birth cohort size or the size of the local 19-year-old cohort in parent's municipality of birth together with a pre-1968-university-sub-region-specific quadratic trend in the reduced-form models, the associations between parents' access to university and the distribution of parental education are closer to the expected ones: the associations between the instrument and parents' secondary-level, upper secondary and vocational education are systematically statistically insignificant and have partly negative signs, while most of the associations between the instrument and parents' tertiary-level/university education remain positive and significant. Table VIII shows that, because the identifying variation employed being considerably restricted, the controls for the municipality-level cohort size and differential trends in the IV

[30] It is also possible that the positive association between parents' access to university and vocational education is partly of causal nature, as low access to university in a given area can induce potential university students to seek vocational education, which again increases competition in the vocational education sector. In the period studied, these types of spillovers were likely to exist, as the number of upper secondary graduates not admitted to university and seeking vocational education increased substantially (Klemelä, 1999: 286). In additional reduced-form analyses, we find that the positive association between parents' access to university and vocational education is entirely driven by parents without an upper secondary diploma. Thus there is some suggestive evidence that our instrument is related to students without an upper secondary diploma being crowded out from vocational education.

TABLE VII

Sensitivity of the reduced-form effects of parent's access to university on the distribution of parental education

Mother's/father's education	Mother-child sample			Father-child sample			Mother-father-child sample[1]					
	Effect of mother's access to university			Effect of father's access to university			Effect of mother's access to university			Effect of father's access to university		
No post-compulsory education	-0.177*	-0.057	-0.058	-0.177*	-0.066	-0.083	-0.150*	-0.077	-0.082	-0.124*	-0.057*	-0.068*
	(0.041)	(0.060)	(0.070)	(0.037)	(0.054)	(0.066)	(0.036)	(0.048)	(0.057)	(0.016)	(0.015)	(0.016)
Secondary education only	0.078*	-0.001	-0.001	0.084*	0.031	0.029	0.027	-0.008	-0.008	0.053*	-0.006	-0.009
	(0.028)	(0.046)	(0.050)	(0.021)	(0.040)	(0.042)	(0.014)	(0.027)	(0.028)	(0.012)	(0.017)	(0.017)
Lower tertiary education (ISCED 5-6)	0.084*	0.043*	0.037	0.067*	0.028	0.027	0.077*	0.028	0.025	0.085*	0.035*	0.035*
	(0.014)	(0.021)	(0.022)	(0.016)	(0.022)	(0.023)	(0.025)	(0.028)	(0.032)	(0.013)	(0.011)	(0.013)
Higher tertiary education (ISCED 7-8)	0.014*	0.014*	0.022*	0.026*	0.006	0.026*	0.066*	0.043*	0.054*	0.012	0.000	0.017
	(0.002)	(0.004)	(0.005)	(0.007)	(0.008)	(0.013)	(0.016)	(0.016)	(0.023)	(0.015)	(0.015)	(0.017)
General upper secondary education	0.028*	0.018	0.030	-0.006	-0.006	0.010	0.063*	0.033	0.044	0.022	0.014	0.029
	(0.009)	(0.015)	(0.021)	(0.008)	(0.010)	(0.012)	(0.024)	(0.027)	(0.034)	(0.015)	(0.017)	(0.019)
Vocational education	0.139*	0.048	0.039	0.168*	0.079	0.081	0.053*	-0.002	-0.009	0.085*	0.007	0.016
	(0.034)	(0.055)	(0.061)	(0.033)	(0.058)	(0.063)	(0.022)	(0.030)	(0.032)	(0.011)	(0.015)	(0.016)
University education	0.048*	0.025*	0.031*	0.030*	0.006	0.025	0.089*	0.050*	0.061*	0.024	0.006	0.023
	(0.007)	(0.010)	(0.013)	(0.009)	(0.010)	(0.017)	(0.020)	(0.019)	(0.027)	(0.014)	(0.014)	(0.016)
Birth cohort size in parent's municipality	No	Yes	No	No	Yes	No	No	Yes	No	No	Yes	No
19-year-old cohort size in parent's municipality	No	No	Yes	No	No	Yes	No	No	Yes	No	No	Yes
Pre-1968 university sub-region X quadratic trend	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes

Each model controls for child's gender and parent's year and municipality of birth. Standard errors in parentheses are clustered by parent's municipality of birth. *: estimate statistically significant at the 5 percent level. [1] The estimates for the mother-father-child sample represent the effects on mother and/or father belonging to the educational category.

TABLE VIII

Sensitivity of the IV estimates to additional controls

	Child enrolled in university by age 23			
Mother university graduate	1.069***	1.289***	1.097***	1.285***
	(0.172)	(0.414)	(0.166)	(0.352)
	F=13.9	F=6.8	F=7.9	F=5.6
Father university graduate	0.738***	1.061	0.668***	0.719***
	(0.207)	(1.144)	(0.111)	(0.203)
	F=3.3	F=0.4	F=3.2	F=2.2
Mother and/or father university graduate	0.500***	0.448***	0.515***	0.496***
	(0.072)	(0.141)	(0.057)	(0.100)
	F=21.7	F=5.5	F=27.7	F=11.1
	Child's years of higher education			
Mother's years of higher education	1.165***	1.070***	1.054***	0.937***
	(0.209)	(0.338)	(0.220)	(0.295)
	F=22.9	F=13.4	F=11.3	F=8.8
Father's years of higher education	0.593***	0.314	0.509***	0.340*
	(0.141)	(0.381)	(0.118)	(0.206)
	F=6.8	F=3.1	F=4.7	F=3.6
Sum of parents' years of higher education	0.376***	0.325***	0.350***	0.293***
	(0.033)	(0.091)	(0.029)	(0.059)
	F=27.1	F=7.6	F=27.8	F=14.8
Additional controls:				
Birth cohort size in parent's municipality	Yes	Yes	No	No
19-year-old cohort size in parent's municipality	No	No	Yes	Yes
Pre-1968 university sub-region X quadratic trend	No	Yes	No	Yes

Each model controls for child's gender and parent's year and municipality of birth. First-stage F-statistics for the significance of the instruments reported below the estimates. Standard errors in parentheses are clustered by parent's municipality of birth. Statistical significance: * (p<0.1), ** (p<0.05), *** (p<0.01).

models clearly weaken the instrument and makes the estimates less precise. The implied relationships between parents' and children's higher education are also mostly somewhat smaller than previously but nevertheless remain large and significant. For instance, the estimated effect of having at least one parent with a university degree on child's early university enrolment varies between 0.45 and 0.52, and the estimated effect of a one-year increase in the sum of parents' years of higher education on child's years of higher education varies between 0.29 and 0.38. Therefore, although the access-to-university instrument is positively correlated with parents' secondary-level and vocational education due to the contemporaneous regional trends in vocational education, we are fairly well able to control for these trends and show that our conclusions remain similar.

In the first four columns of Table IX, we investigate the sensitivity of the IV estimates to additional controls associated with parents' educational access, including parent's first language, graduation from upper secondary school and shortest distances to different types of pre-university schools at age 16, including a teacher training school, upper secondary school, technical school, technical college and commercial school/college. Altogether, adding these controls does not dramatically change our conclusions. The implied effects of father's university education and having at least one university-educated parent reduce to some extent (to 0.64 and 0.45, respectively) when all of the controls are included in the model, whereas the remaining estimates increase. A noteworthy observation is that controlling for father's upper secondary education or access to pre-university schools significantly improves the strength of father's access to university as an instrument and, consequently, the precision of the estimates regarding father's university education. In the last three columns of Table IX, we control for time-variant regional heterogeneity directly by augmenting the models with parents' region-by-year-of-birth fixed effects or sub-region-of-birth-specific linear and quadratic trends. We observe that the IV estimates remain large and significant even after considerably restricting the identifying variation employed. The most noteworthy changes occur in the estimates regarding the effects of mother's university education and having at least one university-educated parent, which become somewhat lower (e.g. 0.80 and 0.35 in the model controlling for the region-by-year fixed effects).[31]

In another set of robustness checks, reported in the first three columns of Table X, we examine to what extent out results are sensitive to reducing the number of consecutive parents' cohorts used in the analysis. Even when using only 11 consecutive parents' cohorts, i.e. cohorts 1936–46, 1941–51 or 1946–56, in most cases we obtain large first-stage F-statistics for the instruments and highly significant and positive IV estimates for the effects of parents' university graduation and years of higher education. Only in the case of the oldest sub-sample (cohorts 1936–46), the access-to-university instrument is systematically rather weak, which results in highly imprecise and unstable IV estimates for this sub-sample. These findings suggest that the identifying variation for our full-sample estimates mainly arise from changes in parents' access to university for the younger parents' cohorts. This conclusion is in line with the Section 5.1 results regarding the short-term local effects of university openings, which were found to be more significant and robust for the later university openings in 1968 and 1969 than for the earlier ones in 1959 and 1960.

[31] We also attempted to control for municipality-specific linear trends. A problem with this approach is that, due to the smoothness of the regional trends in university accessibility, controlling for the municipality trends leaves very little variation in our instrument: the R squared for a linear regression explaining parent's access to university with the basic controls and the municipality trends is 0.99. Therefore, the municipality trends, by construction, make the first stage redundant.

TABLE IX
Sensitivity of the IV estimates to additional control variables

	Child enrolled in university by age 23						
Mother university graduate	1.245***	1.453***	1.077***	1.350***	0.802***	0.781***	0.845***
	(0.126)	(0.111)	(0.098)	(0.192)	(0.141)	(0.225)	(0.162)
	F=38.2	F=53.4	F=38.6	F=26.5	F=24.7	F=18.0	F=22.6
Father university graduate	0.865***	0.902***	0.757***	0.635***	0.636***	0.976***	1.051**
	(0.118)	(0.064)	(0.072)	(0.093)	(0.221)	(0.340)	(0.423)
	F=7.5	F=27.7	F=17.2	F=18.8	F=11.7	F=6.6	F=3.5
Mother and/or father university graduate	0.525***	0.668***	0.537***	0.445***	0.350***	0.358***	0.349***
	(0.051)	(0.072)	(0.049)	(0.104)	(0.074)	(0.092)	(0.094)
	F=61.0	F=39.8	F=61.3	F=22.1	F=27.7	F=10.5	F=13.9
	Child's years of higher education						
Mother's years of higher education	1.417***	1.631***	1.350***	1.916***	1.360***	1.111***	1.300***
	(0.124)	(0.185)	(0.125)	(0.231)	(0.222)	(0.260)	(0.252)
	F=58.8	F=73.1	F=49.3	F=38.9	F=23.1	F=19.3	F=18.1
Father's years of higher education	0.589***	0.595***	0.662***	0.648***	0.552***	0.672***	0.769***
	(0.063)	(0.058)	(0.057)	(0.062)	(0.108)	(0.121)	(0.152)
	F=16.7	F=32.2	F=21.0	F=21.1	F=22.5	F=20.4	F=14.8
Sum of parents' years of higher education	0.383***	0.437***	0.430***	0.490***	0.393***	0.436***	0.463***
	(0.022)	(0.031)	(0.028)	(0.052)	(0.040)	(0.062)	(0.065)
	F=69.2	F=54.2	F=62.6	F=29.8	F=28.9	F=15.0	F=14.2
Parent's first language	Yes	No	No	Yes	No	No	No
Parent upper secondary graduate	No	Yes	No	Yes	No	No	No
Parent's distances to nearest pre-university schools	No	No	Yes	Yes	No	No	No
Parent's region of birth X year of birth	No	No	No	No	Yes	No	No
Parent's sub-region of birth X linear trend	No	No	No	No	No	Yes	No
Parent's sub-region of birth X quadratic trend	No	No	No	No	No	No	Yes

Each model controls for child's gender and parent's year and municipality of birth. First-stage F-statistics for the significance of the instruments reported below the estimates. Standard errors in parentheses are clustered by parent's municipality of birth. Statistical significance: * (p<0.1), ** (p<0.05), *** (p<0.01).

TABLE X

Sensitivity of the IV estimates to sample restrictions and controls for grandparents' education

	Parents born 1936-46	Parents born 1941-51	Parents born 1946-56	Parents born 1936-46, non-missing grandparent		Parents born 1946-56, non-missing grandparent	
	Child enrolled in university by age 23						
Mother university graduate	1.809*	1.493***	0.960***	0.657***	0.651***	0.778***	0.759***
	(0.953)	(0.158)	(0.233)	(0.130)	(0.121)	(0.191)	(0.162)
	F=8.4	F=27.8	F=44.0	F=40.6	F=84.5	F=31.9	F=83.5
Father university graduate	-2.168	0.767***	-1.071	0.567***	0.571***	0.446*	0.530***
	(3.295)	(0.095)	(6.489)	(0.089)	(0.068)	(0.265)	(0.117)
	F=0.7	F=17.9	F=0.0	F=22.1	F=43.8	F=5.8	F=25.2
Mother and/or father university graduate	-0.086	0.700***	0.310**	0.432***	0.415***	0.401***	0.429***
	(0.761)	(0.056)	(0.153)	(0.061)	(0.072)	(0.114)	(0.108)
	F=2.1	F=31.3	F=25.9	F=166.8	F=165.8	F=36.0	F=58.1
	Child's years of higher education						
Mother's years of higher education	1.715*	1.412***	1.398***	0.826***	0.795***	1.038***	0.977***
	(0.956)	(0.144)	(0.131)	(0.068)	(0.054)	(0.095)	(0.078)
	F=12.7	F=24.1	F=79.9	F=62.1	F=124.0	F=49.1	F=94.8
Father's years of higher education	0.496	0.596***	1.232***	0.580***	0.541***	0.897***	0.679***
	(0.578)	(0.041)	(0.330)	(0.058)	(0.043)	(0.164)	(0.083)
	F=2.1	F=21.0	F=11.1	F=42.8	F=72.1	F=29.3	F=65.5
Sum of parents' years of higher education	0.423	0.394***	0.496***	0.324***	0.318***	0.440***	0.385***
	(0.261)	(0.037)	(0.096)	(0.039)	(0.037)	(0.058)	(0.039)
	F=0.7	F=29.6	F=29.0	F=162.2	F=179.7	F=37.2	F=62.8
Grandparents' education controlled	No	No	No	No	Yes	No	Yes
Mother-child observations	622,323	741,680	800,288	678,216	678,216	604,751	604,751
Father-child observations	606,548	736,878	764,522	767,716	767,716	629,770	629,770
Mother-father-child observations	387,390	519,339	573,813	468,783	468,783	391,594	391,594

Each model controls for child's gender and parent's year and municipality of birth. First-stage F-statistics for the significance of the instruments reported below the estimates. Standard errors in parentheses are clustered by parent's municipality of birth. Statistical significance: * (p<0.1), ** (p<0.05), *** (p<0.01).

In columns (4)–(7), we further examine the sensitivity of the results to controls for grandmother's and grandfather's education, measured by categorical variables describing the combination of the grandparent's educational level (5 levels + category 'no post-compulsory education') and broad field (max. 10 fields per level).[32] When, in columns (4) and (5), we restrict our sample to the parent-child pairs with at least one non-missing grandparent, we see that the mother-child, father-child and mother-father-child samples are considerably reduced, by 50, 41 and 57 per cent, respectively, due to the grandparent-parent link being non-representative for the oldest parents' cohorts. However, the grandparent-child link becomes more representative and the sample attrition reduces considerably (to 24, 18 and 32 percent), when focusing on parents' cohorts 1946–56 in columns (6) and (7). Comparing the results with and without grandparent controls, we find that these controls, in most cases, considerably increase the first-stage statistics for the instruments and reduce the standard errors of the IV estimates, while having little impact on the estimated IV coefficients. The only noteworthy drop (from 0.90 to 0.68) occurs in the estimated relationship between father's and child's years of higher education. However, given the large standard error of the initial estimate (0.16), this change is hardly statistically significant.

5.4 Channels for the effects of parental higher education

In the final step of the analysis, we explore potential mechanisms behind the estimated positive relationships between parents' and children's higher education attainment. At first, in Table XI, we examine the effects of access to university at age 19 on alternative individual outcomes, including fertility, assortative mating, longevity, residential location and income. At this stage, we examine both the full samples of men and women born in 1936–56 and sub-samples comprising the parents included in the mother-child and father-child samples. With regard to fertility effects, the results in columns (1) and (2) suggest that access to university does not significantly affect women's probability of becoming a mother but is still negatively related to the number of women's offspring.[33] The implied fertility effects for men are somewhat different, as we observe a positive effect on the probability of fatherhood but no significant effect on the number of offspring in the full sample of men's cohorts 1936–56. A negative and significant effect on men's total fertility is, however, observed in the fathers' sample. It is, therefore, possible that the positive effects of parents' access to university on

[32] In our samples, the average educational level of grandparents is fairly low: only 10 per cent of the children have at least one grandparent with a tertiary-level degree; 13 per cent have at least one parent with a secondary-level degree but no highly educated parents; the remaining 77 per cent have grandparents with compulsory education only.

[33] According to the data, 80 per cent of women and 75 per cent of men born in 1936–56 became parents by 2013, while the average number of children per parent was 2.2.

children's education are partly driven by the smaller family size of highly educated parents, i.e. the well-known child quantity-quality trade-off.[34]

The positive and significant estimates regarding the association between parent's access to university and child's other parent's university education and years of higher education (columns (3) and (4)) confirm that a significant amount of assortative mating occurs between highly educated men and women. However, we find that mother's access to university is much more strongly linked to father's university education than vice versa. Thus the estimated mother-child relationships are likely to be somewhat upward biased – and more biased than the father-child relationships – due to assortative mating, which offers an explanation for the mother-child estimates being systematically larger compared to the father-child and mother-father-child estimates. The stronger assortative mating effects for mothers likely reflect the fact that the marriage markets of highly educated individuals were, during the early adulthood of cohorts 1936–56, still male-dominated. Therefore, women affected by the changes in accessibility were more likely to find a spouse of similar educational background than their male counterparts.

Examining the estimated effects of access to university on the probability of being alive at ages 50 and 60 (columns (5) and (6)), we see certain evidence of positive longevity effects. For both the full sample of women and the mothers' sample, we find a moderate positive effect on the probability of turning 60, whereas the estimates at the age-50 margin are approximately zero. For the full sample of men, positive and significant effects on longevity are found at both age margins, whereas the estimates for the fathers' sample are not significantly different from zero. Based on the mainly small and insignificant estimates obtained for the mothers' and fathers' samples, it appears unlikely that possible adverse effects from mother's or father's early death would significantly explain the effects on children's education.

The estimates in column (7) show that higher access to university is positively related to one's probability of remaining in the region of birth as an adult, examined here at age 34. Although this result is at odds with the usual observation that higher education increases mobility (e.g. Böckerman and Haapanen, 2013), in our setting it is logical to assume that better local access to higher education mitigates one's need to migrate after graduation from secondary education and, consequently, can also affect one's later mobility. The estimates in column (8) further suggest that while access to university has a positive impact on women's probability of living in a university sub-region at age 34, this impact only applies to women not belonging to the mothers' sample. For men,

[34] The recent empirical evidence on the existence of the quantity-quality trade-off has been rather mixed, with negative family size effects found in some studies (e.g. Li and Zhang, 2017) and insignificant effects found in others (e.g. Black et al., 2005a).

TABLE XI

Reduced-form results using alternative individual outcomes

	Parent-hood (1)	Number of offspring (2)	Common offspring with a university graduate (3)	Other parent's years of higher education (4)	Alive at age 50 (5)	Alive at age 60 (6)	Living in the region of birth at age 34 (7)	Living in a university sub-region at age 34 (8)	Log annual income at age 50 (9)
All women born 1936-56									
Access to university	0.005	-0.150***	0.075***	0.553***	0.001	0.007***	0.032***	0.026***	0.113***
	(0.003)	(0.030)	(0.011)	(0.090)	(0.002)	(0.002)	(0.007)	(0.006)	(0.025)
N	773,332	773,332	606,554	606,554	773,332	773,332	770,212	770,212	709,641
Mothers' sample[1]									
Access to university		-0.194***	0.074***	0.551***	0.001	0.006***	0.024***	0.002	0.096***
		(0.032)	(0.011)	(0.091)	(0.002)	(0.002)	(0.007)	(0.008)	(0.021)
N		626,783	603,215	603,215	626,783	626,783	625,239	625,239	595,747
All men born 1936-56									
Access to university	0.039***	0.012	0.014***	0.116***	0.009***	0.017***	0.043***	-0.018***	0.156***
	(0.007)	(0.018)	(0.005)	(0.034)	(0.002)	(0.003)	(0.007)	(0.007)	(0.033)
N	812,545	812,545	611,567	611,567	812,545	812,545	802,593	802,593	722,911
Fathers' sample[1]									
Access to university		-0.085***	0.016***	0.136***	-0.000	0.003	0.044***	-0.031***	0.127***
		(0.019)	(0.005)	(0.034)	(0.002)	(0.002)	(0.007)	(0.008)	(0.026)
N		606,531	601,202	601,202	606,531	606,531	602,737	602,737	561,103

Each model controls for child's gender and parent's year and municipality of birth. Standard errors in parentheses are clustered by parent's municipality of birth. Statistical significance: * (p<0.1), ** (p<0.05), *** (p<0.01). 1 The samples only include parents who were alive in the year of the 23rd birthday and whose offspring turned 23 by the end of 2015.

the estimated impact is again systematically negative. The final column of Table XI, examining effects on individuals' logarithmic annual income at age 50, further suggests that there are sizeable positive monetary returns to higher access to university. Scaling these returns by the reduced-form effects on parents' years of higher education indicate a more than 30 per cent return on an additional year in higher education for both mothers and fathers. Therefore, higher family income might also be a driving factor behind the estimated intergenerational effects.

Further suggestive evidence of the potential mechanisms is presented in Table XII, examining effects on child-level dependent variables. At this stage, we focus on the results for the mother-father-child sample, showing both the reduced-form and IV estimates for easier interpretation. Somewhat surprisingly, the results suggest that acquiring higher education advances women's child-bearing, as mother's access to university is negatively related to child's year of birth, regardless of whether looking at all children or only firstborn children. Father's access to university is also negatively related to child's year of birth among the full children's sample, but this effect diminishes to zero when focusing on firstborn children. The negative effect arising from mother's access to university naturally contradicts the usual evidence suggesting that educational attainment postpones women's child-bearing decisions (e.g. Black et al., 2008). One possible explanation for the result is that access to university contributes to women's probability of finding a suitable partner by increasing the quality of their marriage market. This conjecture is consistent with the substantial assortative mating effects found for women. Nevertheless, while child's year of birth might affect his or her educational attainment, we can obtain at least two pieces of evidence to suggest that this outcome is not a major determinant of the relationship between parents' and children's education. First, our main estimates are not sensitive to controlling for child's year of birth directly. Second, unlike our main estimates (see Section 5.3), the reduced-form estimates in columns (1) and (2) are clearly sensitive to adjusting the models for the sub-region-specific quadratic trends, which makes the estimates slightly positive and mainly statistically insignificant. Thus it is possible that the correlation between the instrument and child's year of birth is simply spurious.

Consistently with the results regarding parent's residential location, parents' access to university is not systematically related to child's probability of being born in one of the 10 university sub-regions or the probability of living in such an area at age 17. However, we find that father's access (but not mother's access) to university is significantly negatively related to child's distance to the nearest university at age 19, measured from child's municipality of residence at age 17. The implied average effect is, nevertheless, rather small: having at least one university-educated parent decreases child's distance to the nearest university by 23 kilometers. Therefore, in our context, it does not appear to be the case that parents' higher access to university or educational attainment substantially

TABLE XII

The effects of parental higher education on alternative child outcomes

	Year of birth (1)	Year of birth, firstborn only (2)	Born in a university sub-region (3)	Living in a university sub-region at age 17 (4)	Child's distance (km) to nearest university at age 19[1] (5)	Compulsory school grade-point average (6)	Compulsory school first language grade (7)	Compulsory school math grade (8)
Reduced form:								
Mother's access to university	-0.858***	-0.811***	-0.016**	-0.016**	-0.255	0.137***	0.166***	0.098***
	(0.192)	(0.155)	(0.007)	(0.007)	(0.740)	(0.018)	(0.014)	(0.025)
Father's access to university	-0.373***	0.017	0.024***	0.024***	-3.318***	0.064**	0.058***	0.026
	(0.087)	(0.093)	(0.008)	(0.008)	(0.569)	(0.025)	(0.021)	(0.026)
IV:								
Mother and/or father university graduate	-10.501***	-7.675***	-0.001	-0.031	-23.017*	0.975***	1.099***	0.619***
	(3.200)	(1.934)	(0.070)	(0.096)	(11.797)	(0.169)	(0.122)	(0.163)
Sum of parents' years of higher education	-0.990***	-0.694***	0.003	-0.000	-2.484**	0.091***	0.102***	0.057***
	(0.286)	(0.166)	(0.007)	(0.010)	(1.185)	(0.015)	(0.010)	(0.014)
N	1,081,731	542,236	1,081,714	1,081,731	1,077,365	705,175	701,426	708,044

Each model controls for child's gender and parent's year and municipality of birth. Standard errors in parentheses are clustered by parent's municipality of birth. Statistical significance: * (p<0.1), ** (p<0.05), *** (p<0.01). [1] The distance measured from child's municipality of residence at age 17.

improves child's geographical access to university through the residential sorting of highly educated families close to university campuses.

The last three columns of Table XII further show that parents' access to university and higher education attainment are also positively and significantly related to child's comprehensive-school-leaving grades. The estimated effects indicate that parent's graduation from university increases child's grade-point average and first language grade approximately by one grade, while the effect on child's math grade is somewhat smaller (0.62). The reduced-form estimates suggest that these positive effects, for the most part, arise through mother's access to university. Thus, another plausible explanation for the significant intergenerational transmission of higher education is that parents' higher education already affects children's early school performance, making children more eligible and better prepared for higher education.

6. Conclusions

In this paper, we have investigated the causal effect of parental higher education on children's education in Finland using the changes in parents' access to university in 1955–75 as the identifying quasi-experimental variation. Contrary to many previous findings, our instrumental variables results indicate a strong positive causal relationship between parents' and children's educational attainment. We arrive at this conclusion both when examining the sub-region-level effects of university openings and when estimating models with more general accessibility measures, including gravity-model-based measures and the distance to the nearest university. Our sensitivity analyses suggest that the baseline IV estimates may, to some extent, overstate the intergenerational effects of parent's university education because of the correlated regional trends in vocational education. However, after adjusting the models for these trends, even our most conservative estimate still suggests that the average relationship between parent's and child's years of higher education is large, 0.29, which exceeds the baseline OLS estimate (0.26). The estimated effects are sizeable compared to the previous IV estimates from the Nordic countries reported by Black et al. (2005b) and Holmlund et al. (2011), who find mainly insignificant effects. A possible explanation for these differences is that, whereas the comprehensive schooling reforms studied in the previous analyses cause variation in parental education at the bottom tail of the education distribution, our university accessibility instrument shifts parental education at higher levels of schooling where the marginal returns on parental education are potentially larger.

A limitation of our study is that our estimates likely only identify local average effects for a group of children whose parents are relatively immobile and, therefore, are affected by the changes in geographical access to university. Another limitation is that we can but speculate on the mechanisms behind these local effects. Our analyses with alternative dependent variables nevertheless provide certain interesting conjectures. In particular, we find evidence that greater access to university significantly increases women's probability of having children with highly educated men. Therefore, assortative mating likely results in overstating the effect of mother's higher education on child outcomes, which is consistent with our observation that the separately estimated mother's effect is much higher than the estimated average contribution of one parent when instrumenting mother's and father's education simultaneously. Furthermore, we observe that parental higher education is negatively related to family size, but positively related to parents' earnings and children's grades in comprehensive school. It is, therefore, conceivable that highly educated parents have more time and monetary resources to invest in their children and are able to enhance their children's learning already early in life.

From a policy perspective, it is noteworthy that the estimated effects of university accessibility are not systematically large but rather heterogeneous and partly modest or insignificant. Our results suggest that, in the period studied, women's educational attainment was more significantly affected by the local changes in access to university than men's attainment. Moreover, our results on the short-run effects of university openings suggest that only the later openings in 1968-69 had distinct local effects on educational attainment, whereas the earlier university openings in 1959-60 appear to have had mainly country-level effects. It is, however, likely that our approach to measuring access to university based on one's residential location at birth to some extent results in understating the local effects of universities, as these effects also accrue to children and young people migrating to the university sub-regions from other areas.

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Appendix

APPENDIX 1

The reduced-form effect of parent's access to university with different distance-decay values and with and without standardizing the accessibility measure

	Distance-decay parameter			
	0.25	0.50	0.75	1.00
A. Mother university graduate (mother-child sample)				
Mother’s access to university	0.093***	0.048***	0.033***	0.025***
	(0.017)	(0.007)	(0.007)	(0.008)
Mother’s access to university (per one SD)	0.016***	0.014***	0.014***	0.013***
	(0.003)	(0.002)	(0.003)	(0.004)
	F=31.3	F=43.4	F=21.9	F=9.4
B. Father university graduate (father-child sample)				
Father’s access to university	0.058***	0.030***	0.020***	0.015*
	(0.021)	(0.009)	(0.008)	(0.008)
Father’s access to university (per one SD)	0.010***	0.009***	0.009***	0.008*
	(0.004)	(0.003)	(0.003)	(0.004)
	F=7.5	F=10.6	F=7.1	F=3.7
C. Mother and/or father university graduate (mother-father-child sample)				
Mother’s access to university	0.170***	0.089***	0.061***	0.045**
	(0.045)	(0.020)	(0.017)	(0.018)
Father’s access to university	0.042	0.024*	0.018**	0.014**
	(0.028)	(0.014)	(0.009)	(0.006)
Mother’s access to university (per one SD)	0.028***	0.025***	0.024***	0.023**
	(0.007)	(0.005)	(0.007)	(0.009)
Father’s access to university (per one SD)	0.007	0.008*	0.008**	0.008**
	(0.005)	(0.004)	(0.004)	(0.004)
	F=59.4	F=71.4	F=38.2	F=20.7

Each model controls for child's gender and parent's year and municipality of birth. First-stage F-statistics for the significance of the instruments reported below the estimates. Standard errors in parentheses are clustered by parent's municipality of birth. Statistical significance: * (p<0.1), ** (p<0.05), *** (p<0.01).

APPENDIX 2

Reduced-form results with alternative measurement ages for parents' access to university

	Mother-child and father-child samples		Mother-father-child sample	
	Mother /father university graduate	Mother's/father's years of higher education	Mother and/or father university graduate	Sum of parents' years of higher education
Mother's access o university measured at				
Age 9 (cohorts 1946-56)	0.021	0.180	0.035	0.417
	(0.021)	(0.134)	(0.035)	(0.376)
Age 14 (cohorts 1941-56)	0.050***	0.309***	0.078**	0.755**
	(0.017)	(0.105)	(0.039)	(0.373)
Age 24 (cohorts 1936-51)	0.053***	0.340***	0.095***	0.906***
	(0.004)	(0.025)	(0.017)	(0.150)
Age 29 (cohorts 1936-46)	0.006	0.018	0.011	0.060
	(0.007)	(0.081)	(0.021)	(0.157)
Father's access to university measured at				
Age 9 (cohorts 1946-56)	-0.013	-0.002	-0.004	-0.124
	(0.018)	(0.144)	(0.016)	(0.151)
Age 14 (cohorts 1941-56)	0.036*	0.387**	0.043**	0.493***
	(0.021)	(0.177)	(0.020)	(0.173)
Age 24 (cohorts 1936-51)	0.052***	0.568***	0.038**	0.633***
	(0.006)	(0.050)	(0.017)	(0.123)
Age 29 (cohorts 1936-46)	-0.027**	0.021	-0.019	0.172
	(0.011)	(0.063)	(0.024)	(0.248)

Each model controls for child's gender and parent's year and municipality of birth. Standard errors in parentheses are clustered by parent's municipality of birth. Statistical significance: * ($p<0.1$), ** ($p<0.05$), *** ($p<0.01$).

APPENDIX 3

IV results by child's gender

	Child enrolled in university by age 23		Child university graduate	
	Daughters	Sons	Daughters	Sons
Mother university graduate	1.321***	1.184***	1.127***	0.995***
	(0.152)	(0.094)	(0.111)	(0.105)
Father university graduate	0.962***	0.932***	0.811***	0.838***
	(0.133)	(0.132)	(0.105)	(0.136)
Mother and/or father university graduate	0.600***	0.595***	0.524***	0.490***
	(0.055)	(0.050)	(0.047)	(0.035)
	Child's years of education		Child's years of higher education	
	Daughters	Sons	Daughters	Sons
Mother's years of higher education	1.340***	1.633***	1.316***	1.432***
	(0.146)	(0.140)	(0.130)	(0.099)
Father's years of higher education	0.422***	0.617***	0.581***	0.620***
	(0.159)	(0.064)	(0.097)	(0.052)
Sum of parents' years of higher education	0.361***	0.435***	0.399***	0.396***
	(0.038)	(0.029)	(0.029)	(0.028)

Each model controls for child's gender and parent's year and municipality of birth. Standard errors in parentheses are clustered by parent's municipality of birth. Statistical significance: * (p<0.1), ** (p<0.05), *** (p<0.01).