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Fertility Effects of College Education: Evidence from the German Educational Expansion

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Fertility Effects of College Education: Evidence from the German Educational Expansion

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Abstract

We estimate the effects of college education on female fertility – a so far understudied margin of education, which we instrument by arguably exogenous variation induced through college expansions. While college education reduces the probability of becoming a mother, college-educated mothers have slightly more children than mothers without a college education. Unfolding the effects by the timing of birth reveals a postponement that goes beyond the time in college – indicating a negative early-career effect on fertility. Coupled with higher labor-supply and wage returns for non-mothers as compared to mothers the timing effects moreover suggest that career and family are not fully compatible.

JEL Classifications: C31, H52, I21, J12, J13.

Keywords: Fertility, family planning, education.

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1 Introduction

Among the many changes that have affected developed societies in the past 60 years, two certainly belong to the most significant ones: the educational expansion – describing the substantial upsurge in higher education enrollment, especially that of females – and the fertility transition, characterized by declining fertility rates that have fallen below replacement rates. The resulting consequences of both these evolutions have affected many dimensions of social interaction such as the demographic change – which today constitutes an urgent concern from a policy perspective. While policies that aim at increasing education have been introduced in all parts of the world, many developed countries have also set up policies to boost fertility rates. Although both kinds of policies are often comparatively well-understood due to ample research, the link between these policies – that is, how education affects fertility – is still mostly understudied. The negative correlation between education and fertility, sometimes referred to as the "baby gap" between high- and low-educated individuals, may hint at the potential side-effects education policies may have on fertility.[1] By analyzing the upsurge in higher education in Germany triggered by a massive build-up of colleges, we contribute to the understanding of whether increased education causes lower fertility or whether individuals merely choose to have more education and smaller families simultaneously.

Researchers have been concerned with the consequences of education policies for decades. While there are still some "unknowns" with respect to the optimal margin of education and potential effect heterogeneities, education is often found to increase labor market performance (for the case of higher education see, e.g., the literature reviews of Barrow and Malamud, 2015, and Oreopoulos and Petronijevic, 2013). Although there is the reasonable suspicion that the non-pecuniary returns to education are positive as well (see Oreopoulos and Salvanes, 2011), evidence of the causal long-term effects on these outcomes is rather scarce. Most studies that analyze the effect of education on fertility utilize variation in compulsory schooling laws to address the selection problem.[2] While such changes to the law affect a large share of students in many countries, it seems a priori unlikely that the effects for secondary schooling also hold true for other margins of education, such as college education. The results of the literature on the effectiveness of family policies that induce financial incentives for bigger families in general may be summarized as mixed

[1] The ambiguity that education policies may reduce fertility while family policies in developed countries are targeted at increasing fertility becomes most visible in developing countries where education policies are often implemented in order to reduce family size. Due to the context and the margin of education we focus on the situation in developed countries. See Duflo et al. (2015) and the literature therein for the case in developing countries.

[2] See, for instance, Cygan-Rehm and Maeder (2013) for Germany, Black et al. (2008) for the US and Norway, Geruso and Royer (2014) for the UK, Monstad et al. (2008) for Norway, Grönqvist and Hall (2013) for Sweden, and Fort et al. (2016) for the UK and pooled Continental European countries. McCrary and Royer (2011) consider changes in the school entry age that cause variation in education.

(see Gauthier, 2007, for a review and Haan and Wrohlich, 2011, and Riphahn and Wiynck, 2017, as well as Raute, 2016, for evidence on Germany). The absence of such silver bullets to increase fertility using existing family policies emphasizes the need to gain a better understanding of how education affects fertility decisions.

We are not aware of any study that explicitly investigates the causal link between college education and fertility in a developed economy[3] although the college margin provides a presumably interesting addition to the more often considered fertility effect of secondary schooling for four reasons: First, college education is taught more extensively – in Germany the formal duration of college education in the time under review was 4.5 years compared to changes in compulsory schooling that, at most, account for one or two years. Second, while compulsory schooling affects individuals at the lower end of the education (and presumably skill) distribution, college affects individuals at the upper end who may react differently. Third, college education falls well into the prime reproductive age of women (and potential fathers) while the largest effects of additional years of compulsory schooling have been found on in-school and teenage pregnancies. Fourth, college education is presumably the most important margin that drives the changes in the educational composition of developed societies in the future. By launching the Higher Education Pact 2020, for instance, Germany has recently made large public funds available in order to further increase access to college education. These points emphasize the complementary value of analyzing tertiary education: investigating effects at the college margin may help to gain a better and highly policy-relevant understanding of the previous findings.

This study examines the effect of college education on the number of biological children a woman has throughout her fertile ages (so-called completed fertility) as well as the extensive and intensive margins of fertility (probability of becoming a mother versus number of children once a woman is a mother). Moreover, we study two intriguing aspects of fertility decisions: the timing of births and socioeconomic channels that may help to explain the observed fertility patterns. By unfolding our main effects via the timing of their occurrence, we shed light on potential postponement and catch-up and possibly even biological effects. While the postponement of motherhood may emerge rather mechanically, e.g., through an "incarceration" in college (see Black et al., 2008), the degree of the catch-up is likely to reflect the preferences, for instance, for a family or a career. A biological effect may unfold through age-related fertility problems if the catch-up effect occurs too late to reach the desired family size. Whereas a social planner would wish to prevent the biological effect from playing a role (as women may well want, but cannot have, children), implications are less clear for catch-up effects in general as they may evolve through a college-induced change in preferences. To differentiate further whether catch-

[3] Currie and Moretti (2003) analyze the effect of maternal education on the offspring's health in the US but consider the number of children merely as a potential channel. A recent working paper by Tequamem and Tirivayi (2015) analyzes the fertility effects of higher education in Ethiopia and find a reduction in family size.

up effects – that may result in a decline in completed fertility – are driven by decreased family preferences (relative to career preferences), or by an incompatibility of work and family life, we investigate the effect of college education on career opportunities (assessed through labor supply and wages) and preferences and opportunities for family life (marriage, assortative mating, and offspring's education).

A pivotal prerequisite of these analyses is to separate correlative patterns from the underlying causal relationship. Women with initial preferences for large families might be more reluctant to sort into college education, for instance, because they expect the investment in their skills to have less time to pay off. Women with initial preferences for a career, on the other hand, might be very prone to study, since it fuels their labor market opportunities. These conflicting preferences exemplify the need to address selection into college education. To do so, we exploit arguably exogenous variation in the college expansion in Germany by means of an instrumental variables approach (see also Kamhöfer et al., 2017, who rely on the same instrument). Several higher education policies at the federal level and within the states caused the number of colleges in Germany to double between the 1960s and 1980s and led to an upsurge in the number of available college spots. At the same time, the local bargaining of the districts with the state governments and with each other plus the balancing of local interests caused regional variation between and within states. This process changed the opportunity to access college in a period of excess demand for college education. Quantitative evidence from an explorative study of the local determinants of college openings indeed indicates that differences in the opportunity to study are to a large degree exogenous.

Our results suggest that college education reduces the probability of becoming a mother by one-quarter, but college-educated women who do become mothers have, on average, 0.27 more children (about 13 percent) compared to their peers without college education. Looking at the timing of the effects (that is, the age of childbearing) indicates that a biological effect does not trigger the negative effect of college education on overall fertility: the increased (catch-up) fertility of college-educated women fades out before an age-related decline in fertility usually matters. The effects of college education on potential mediators suggest that the increased probability of working full-time due to college (compared to working half-time or not at all) and the college wage premium are higher for non-mothers; they are also less likely to be married, but do equally well in terms of positive assortative mating. From a policy perspective, these effects of college education on quantitative fertility outcomes can have crucial implications that are at least twofold. First, college education seems to trigger the demographic transition solely through its effect on childlessness, but not through the number of children per mother. If so, promising policies should aim at this margin. This is in line with an increasing number of economists, among others, who call for policies targeted at raising the compatibility between work and family life. Policies that, for instance, enable more flexible working hours and the opportunity of working from home may decrease the labor market burden of becoming a mother (see, e.g., Goldin, 2014). Moreover, family policies that are specifically aimed at higher educated women, such as means-tested maternity leave benefits (as analyzed by Raute, 2016) seem to be a step forward toward closing the baby gap. A second implication for further policies to consider arises through the positive effect at the intensive margin and evidence of a positive educational transmission that affects the socioeconomic composition of fertility. This has important long-term implications for societies (e.g., in terms of fiscal net effects), especially in societies with a low social or educational mobility (Raute, 2016).

The remainder of the paper is as follows: Section 2 briefly presents the general trends in fertility and higher education in Germany. Section 3 provides an overview of the college expansion and exploits both the qualitative and quantitative reasons that led to this expansion. The data and the empirical strategy are presented in Section 4. The main results on quantitative fertility effects are presented in Section 5. Subsequently, Section 6 sheds light on the timing and socioeconomic factors that potentially shape the detected fertility patterns before Section 7 concludes.

2 Trends in fertility and education in Germany

Using official statistics for the whole population, Figure 1 depicts the development in female college education and fertility over time in Germany. The horizontal axis states the birth cohort. The violet line gives the trend in the share of women per birth cohort who were enrolled in college at the age of 20 (referring to the vertical axis on the left-hand side). While only 5 percent of all women born in 1943 were enrolled in higher education in 1963, the number increased tenfold until the birth cohort 1972. After the baby-booming years succeeding World War II, the average number of births per women dropped from 1.8 to 1.5. The average number of children is assessed at the woman's age of 40 for the birth cohort of the horizontal axis and plotted by the orange line (referring to the vertical axis on the right-hand side).

At first sight, Figure 1 suggests that the initial reduction in fertility was a prerequisite for the boom in female college enrollment. While this may be true, a further, substantial reduction in fertility occurred just after female college enrollment rates soared the most. As preferences for smaller families grew and contraceptive pills (whose commercial launch in Germany was in 1961, just after the cohort of 1940 decided whether to enroll in college) made it easier to meet the preferred number of children and females could "more accurately anticipate their work lives" (Goldin, 2006, p.8), which made human capital investments for women more valuable. This emphasizes how close fertility and female education are interrelated. Using variation in the availability of higher education, the empirical analysis in the following sections addresses the underlying causal relationship.

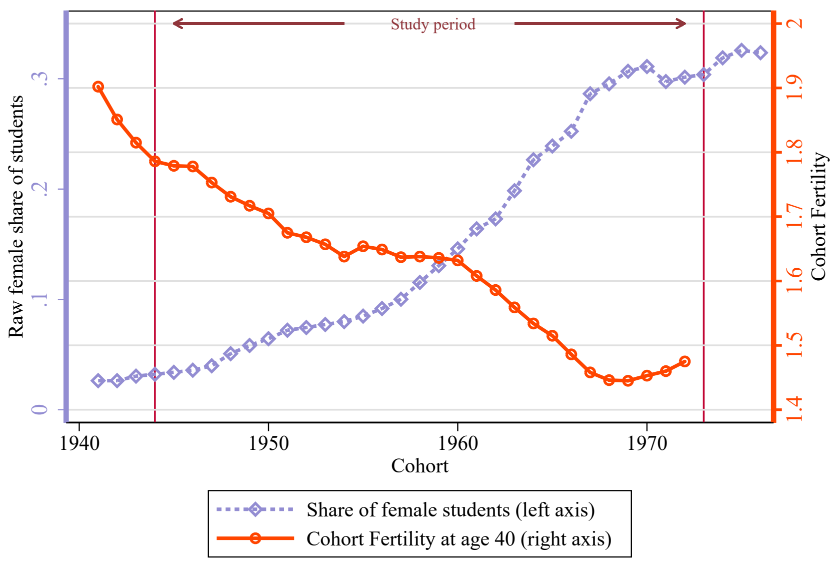


Figure 1: Trends in fertility and college enrollment by birth cohort in Germany

Notes: Own calculations using data from Max Planck Institute for Demographic Research and Vienna Institute of Demography (2014) and German Federal Statistical Office (2016). The orange line refers to the axis on the right-hand side states the average number of children per women at the age of 40 by birth cohort. The violet line illustrates the share of women of the birth cohort that are enrolled in higher education at the age of 20 and corresponds to the vertical axis on the left-hand site. To transform the number of female students in the enrollment year into the cohort share of female students, we deduct 20 years from the enrollment year and take into account that only about one-fifth of women studying in a certain year are freshmen. We divide the resulting number of female students in total by the average study length of 4.5 years to get the number per year. Finally, we divide the number of female students in a certain year by the female cohort size in this year. Note that this is only a crude adjustment. However, as we are primarily interested in the change of this share over time, we are confident of capturing most of the changes.

Another piece of suggestive evidence on the college education-fertility nexus is the relationship between the share of women in higher education and the average age at the time of the first marriage as depicted in Figure 2. In the time under review, marriage was an important gatekeeper for fertility and births out of wedlock were rare events. The violet line (referring to the left vertical axis) gives the share of all women enrolled in higher education in a certain year. Unlike Figure 1, Figure 2 compares the share of females in higher education and the age at first marriage per calender year (and not by birth cohort). While the average age at the time of the first marriage decreased until the mid-1970s to 22.5 years, it increased by 2.5 years in the following 15 years (orange line on the right vertical axis). Based on the descriptive pattern in Figure 2, two things are important to note for the empirical analysis: First, marriage may mediate the effect of college education on fertility as the college enrollment decision predates the mean age at the first marriage in the figure. Second, the trend in the age at first marriage changes only a few years after the boost in the share of women in higher education, suggesting that college enrollment had an impact on fertility.

Moreover, Figure 2 also bears suggestive evidence of the empowerment of women. The delay in marriage indicates that the share of women that transitioned directly from living

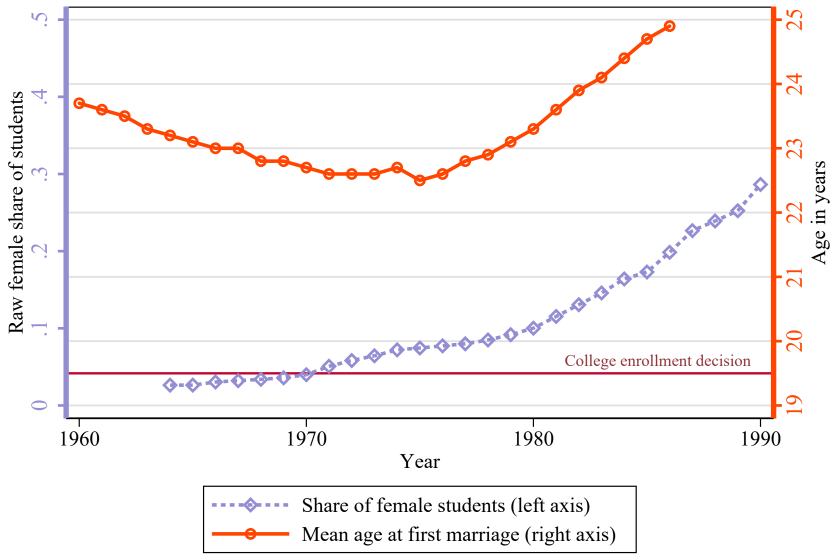


Figure 2: Mean age at first marriage and college enrollment by year in Germany

Notes: Own calculations using data from Max Planck Institute for Demographic Research and Vienna Institute of Demography (2014); German Federal Statistical Office (2016). The violet line gives the share of women aged 20 per year and is shown in the vertical axis on the left-hand site. In 1970 this shows, for instance, the number of female students in higher education divided by the number of women at this time. The orange line referring to the right-hand site axis gives the average age of women at the time of the first marriage per year.

at home (where the parents presumably took care of subsistence) to living with the husband (and relying on his subsistence) decreased. In other words, Figure 2 suggests that the share of women who took care of their own subsistence (through working for pay or student loans introduced in 1971) increased over time.

3 The college expansion

3.1 Background and developments

Higher education in Germany

After graduating from secondary school, adolescents in Germany either enroll in higher education or start an apprenticeship training.[4] The latter consists of part-time training-on-the-job in a firm and part-time schooling. This vocational education usually takes three years and individuals often enter the firm (or another firm in the sector) as a full-time employee afterwards. To be eligible for higher education in Germany, individuals need a university entrance degree (*Abitur*). In the years under review, only academic secondary schools (*Gymnasien*) with nine years secondary schooling (and four years elementary schooling) could award this degree. The tracking from elementary school to secondary school took (and still takes) place rather early at the age of 10. However, it is

[4]The general description of education in Germany and the college expansion is closely related to Kamhöfer et al. (2017) and has been adjusted for the purpose of the analysis conducted here.

generally possible to switch secondary school tracks after any term. Moreover, students could enroll into academic schools after graduating from the other tracks (with four to five years basic track schooling or six years of intermediate track schooling) in order to receive three additional years of schooling and be awarded a university entrance degree.

In Germany, higher education is, in general, free of tuition fees and several institutions offer tertiary education – even though the distinction of the different types is not always straightforward. We limit our analysis to the larger and most established institutions: universities and technical universities. We refer to the union of these institutions interchangeably as "universities" or "colleges." We neglect two groups of higher education institutions. First, small institutions that specialize in teacher education, religious education and fine arts with no more than 1,000 students at the time under review. The second group are universities of applied science (*Fachhochschulen*). They emerged in the 1980s (see Lundgreen and Schwibbe, 2008) and are usually smaller than regular universities, specialize in one area of education, have a less theoretical curriculum, and the style of teaching is more similar to secondary schools. In the time under review, the degree awarded was also distinct.

Build-up of new colleges and the rise in higher education enrollment

While the educational system as described above did not change in the years under review, the number of academic-track secondary schools and colleges significantly increased – providing us with an arguably powerful and exogenous source variation in educational opportunities. In this subsection, we describe the supply-sided expansion in the number of colleges and their capacities in terms of student spots as this is a prerequirement for the trends in college enrollment outlined above. This so-called period of "educational expansion" (*Bildungsexpansion*) started in the 1960s and peaked in the 1970s. In the years under review, 1958–1990 (determined by the birth cohorts in our survey data), the number of districts with at least one college (only very few districts had more than one college) increased from 27 to 54 (out of 325 districts) and the total number of students increased by over 850,000 from 157,000 in 1958 to more than one million in 1990 (see Figure 3a). The number of female students in total in the colleges in the sample in Figure 3b is similar to the corresponding number in Figure 1. This indicates that our college panel captures the bulk of the higher education institutions in Germany (although we do not have any data on smaller institutions, see above). Figure A1 in the Appendix shows the spatial variation over time. Following the reasoning of Card (1995) and many others since then (e.g., Currie and Moretti, 2003, Carneiro et al., 2011, and Nybom, 2017), we argue that availability of higher educational opportunities in large parts of the country led to a decrease in the opportunity costs of education due to the changed distances to college. While newly opened academic schools enabled secondary school students in rural areas to receive a university entrance degree, college openings in smaller cities allowed a broader group of secondary school graduates from both rural areas and cities to take up higher education. That is, the opening of new colleges allowed individuals to commute instead of moving to a city with a college (which causes higher costs) or decreased the commuting time. As indicated in Figure 3b, women especially benefited from this development as the share of women relative to men doubled from 20 to 40 percent in the time under review.

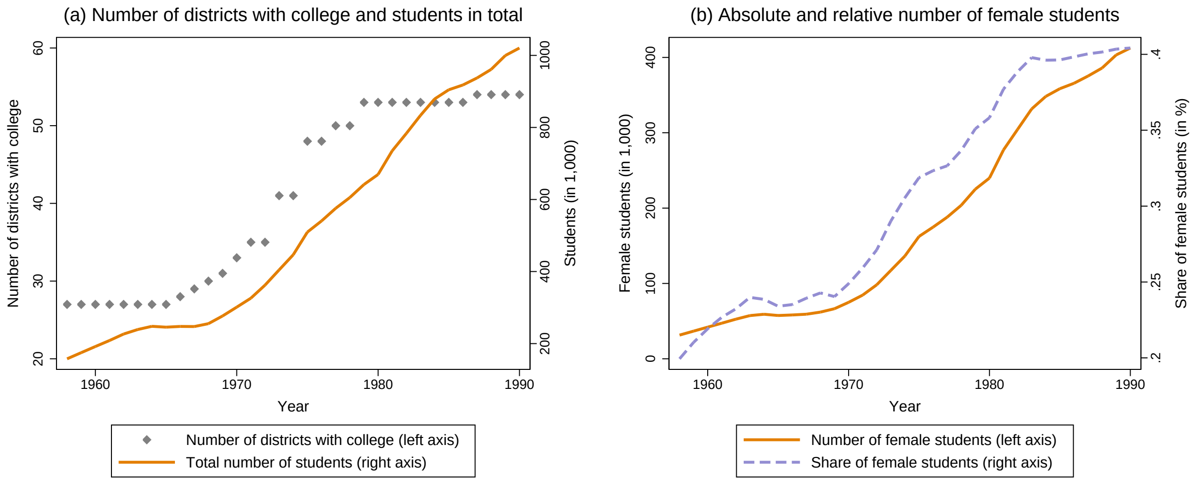


Figure 3: Colleges and students over time and by gender

Notes: Own illustration. College opening and size information are taken from the German Statistical Yearbooks 1959–1991 (German Federal Statistical Office, various issues, 1959–1991). The information on students refer to the college included in the left panel of the figure. More specialized higher education institutes that are smaller in size are disregarded as information on them are often missing.

3.2 Determinants of the college expansion

According to the analysis of Bartz (2007) of the history of higher education in Germany, mainly four factors triggered the college expansion: (*i*) The two world wars and the National Socialists' "anti-intellectualism" led to a low educational attainment for large parts of the population – as also argued in (Picht, 1964, p.66).[5] Therefore, large parts of society may have had an urge to catch up in terms of education. (*ii*) The industry demanded more qualified workers that were able to cope with new production technologies (see the review of the history of the first post-war era colleges of Weisser, 2005). (*iii*) As argued in Jürges et al. (2011) and Picht (1964), political decision-makers saw education both as an outcome and a means in the rivalries with the communist East Germany. (*iv*) All these reasons also led to an increase in academic track secondary schools – as analyzed by, e.g.,

[5]Even today, more than 70 years later, the share of college students in Germany still does not meet OECD standards, see OECD (2015) – even so this is at least in part due to the prominent role of the apprenticeship training system in Germany. To close this gap and increase participation in higher education the German federal government and the state governments launched the Higher Education Pact 2020 (*Hochschulpakt 2020*) in 2007 and funded it with 38.5 billion Euros until 2023.

Kamhöfer and Schmitz (2016) and Jürges et al. (2011) – which then led to an increase in the number of individuals eligible for higher education.[6]

It was partly because of these reasons that the federal government introduced the German Council of Science and Humanities (*Wissenschaftsrat*) in 1957, see Bartz (2007). In its 1960, 1966, and 1970 reports the expert council advised that college capacities should be largely increased (see Wissenschaftsrat, 1960, 1966, 1970). However, the council's authorities were (and still are) limited to making suggestions. The governments of the federal states in Germany are in charge of educational policies. The coordination between the states (which are usually ruled by several parties or coalitions of them and have elections at different points in time) mainly focuses on a standardization and mutual recognition of degrees. Figure A3 in the Appendix shows the number of colleges and shares of female students over time across the states. The timing of the educational expansion exhibits large differences between the states. In our analysis we use the variation in the timing between the 325 German districts (smaller administrative units, e.g., cities, that are nested in the federal states). Combining administrative data on the college expansion with survey data on individuals that face the college decision spread over more than 30 years, yields a panel structure in college availability. Eventually, this allows us to control for district fixed effects (as well as district-specific time-trends) and still observe a sufficient amount of variation in college availability.

In the following parts of this section we provide qualitative and quantitative evidence that this variation is exogenous with respect to individual fertility and marriage preferences.

Qualitative evidence

While the decentralized decision-making process makes it hard, if not impossible, to trace back the exact political reasons that led to each college opening or expansion in college size, we found evidence of the political reasoning behind some college openings. The first post-war college opening – the University of Bochum in the most-populated state of North Rhine-Westphalia in 1966 – was based on a state's parliament decision in 1961. According to Weisser (2005), the first negotiations between the city of Bochum and the state government were even partly held in secret. This offended officials of the city of Dortmund – that also hoped to get the college – but was unable to provide a construction site that fulfilled the requirements. Facing state elections, the decision to open a college in Dortmund was made only one year after the announcement to open a college in Bochum.

[6]Figure A2 in the Appendix the trend in academic-track secondary schooling. Two facts stand out: First, even in the expanding academic secondary schooling the share of female students rose disproportionately until women outnumbered men at academic secondary schools in 1990. Second, even in 1950 the share of women leveled at some 40 percent. The excess in the number of women eligible to take higher education compared to the number of women actually enrolled in colleges suggests that the academic school expansion might have been an important reason for the surge in female college participation but that it was certainly not the only one.

The decision to open six new so-called comprehensive colleges (*Gesamthochschulen*) in North Rhine-Westphalia at the beginning of the 1970s was accompanied by a more intensive public debate. After several parliamentary hearings, the suggestion of the state's minister for educational affairs to construct new colleges in areas without existing ones was agreed on, see NRW (1971b,c). Four of the six colleges were opened in industrialized cities (Duisburg, Essen, Hagen, and Wuppertal) and two colleges were opened in more rural areas (Paderborn and Siegen). The college openings in these districts were supposed to actively "promote" education ("*Bildungswerbung*") and allow a larger range of secondary school graduates to enroll in higher education, see NRW (1971a).

All in all, we neither know of any law that relates college openings to potential reasons (like population size) nor could we find a pattern in the discussions to open colleges. On the contrary, the length of the political process and time from the opening decision to the start of the teaching exhibits a lot of variation. To investigate further which factors are associated with college openings, we conduct an additional quantitative analysis.

Quantitative evidence

Our concern regarding the exogeneity of college expansion is that certain characteristics, such as average fertility, age and living arrangements plus employment structure, systematically differ between regions with a college opening through the educational expansion and a region that had not experienced a college opening. To investigate this, we combine the data on college openings presented above with administrative data from the German Micro Census in 1962 (a 1 percent sample of the whole population, see Lengerer et al., 2008). Because the Micro Census data is on a slightly broader level we observe 249 regions (in which the 325 districts are nested). While 22 of these regions already had a college before 1962 and 206 regions had no college until 1990 or later, a college was opened in 21 regions in the years under review.

Table 1 shows the 1962 means of the regional characteristics that potentially triggered a college opening. Column 1 states the mean for regions that never experienced a college opening and column 2 gives the corresponding mean for regions that experienced a college opening in the time under review. Column 3 gives the difference in means between the two. This reveals no significant difference between the regions in terms of number of children, marital status, share of females or other socioeconomic indicators such as share of migrants and unemployment rate. The share of students is lower in regions with an opening and where the employment structure differs slightly (more primary sector employment in districts with opening). This illustrates that colleges were often opened in order to foster accessibility for rather educationally alienated groups. In column 4 of Table 1, we regress an opening on all characteristics simultaneously. The stated coefficients give the difference of the factors in regions with and without a college opening while

Table 1: Balancing test of regions with and without a college opening in the time under review using administrative data

	(1)	(2)	(3)	(4)
	Regions…			
	…w/o college opening	…w/ opening 1962-1990		Predict opening using regression
Potential college determinant	Mean	Mean	Diff.	OLS
Number of kids per capita (total population)	10.497	10.437	−0.15	−0.033
	(0.522)	(0.283)	(0.121)	(0.052)
…students	0.016	0.011	−0.008*	−10.723
	(0.019)	(0.011)	(0.004)	(10.653)
…divorced	0.023	0.017	−0.005	−1.00
	(0.069)	(0.006)	(0.016)	(40.185)
…widowed	0.088	0.091	0.007**	20.035
	(0.015)	(0.008)	(0.003)	(20.357)
…females	0.525	0.528	0.002	−20.918
	(0.041)	(0.013)	(0.01)	(10.851)
…migrational background	0.021	0.018	−0.006	−10.698
	(0.022)	(0.017)	(0.005)	(10.545)
…unemployed	0.002	0.002	0.001**	250.484
	(0.001)	(0.001)	(0.00)	(190.743)
Sectoral composition of employment				
- primary	0.029	0.046	0.023*	0.39
	(0.055)	(0.053)	(0.013)	(0.497)
- secondary	0.543	0.551	0.008	0.147
	(0.088)	(0.069)	(0.02)	(0.367)
# of regions	206	21	227	227

Notes: Own calculation using German Micro Census data from 1962 (see Lengerer et al., 2008). Information on colleges are taken from the German Statistical Yearbooks 1959–1991 (German Federal Statistical Office, various issues, 1959–1991). Due to data policy restrictions Micro Census data are aggregated on regions defined through the degree of urbanization (*Gemeindegrößenklasse* indicators) and broader administrative units (*Regiergungsbezirk* level). This aggregation results in 206 regions that never experienced a college opening until 1990 or later (the mean value of the considered characteristics in these regions is given in column 1), 21 regions with a college opening between 1962 and 1990 (mean value in column 2), and 22 regions that already had a college in 1962 (data of these regions is not considered in the table). Due to a different aggregation of the Micro Census data, these numbers do not exactly correspond to those on the district level. The difference in column 3 is calculated by a simple regression of a college opening indicator on the potential characteristic and an intercept. Column 4 shows the coefficients of the characteristics in a multiple regression. The number of regions with and without a college opening differs slightly from Kamhöfer et al. (2017) as we restrict our analysis to universities that had 1,000 or more students in at least one of the years under review. Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

holding the mean differences in the other characteristics constant. The regression does not find any single factor in 1962 that significantly predicts an opening in the years until 1990. These auxiliary results are encouraging for our identifying assumptions, although differences in levels are in any case controlled for by the fixed effect in our analysis. How exactly we utilize the variation in college availability presented in this section is given in the following section.

4 Data and empirical strategy

4.1 Survey data and important variables

German National Educational Panel Study

Our main data source are individual-level data from the German National Educational Panel Study (NEPS), see Blossfeld et al. (2011).[7] NEPS data map the educational trajectories of more than 60,000 individuals in total. The data set consists of a multi-cohort sequence design and samples six age groups: newborns and their parents, preschool children, fifth graders, ninth graders, college freshmen students, and adults. These age groups are referred to as Starting Cohorts and are followed over time. That is, each Starting Cohort consists of a panel structure.

For the purpose of our analysis we make use of the Adult Starting Cohort that covers individuals born between 1956 and 1986 in, so far, seven waves between 2007/2008 (wave 1) and 2014/2015 (wave 7)[8], see LIfBi (2015). Starting with about 8,500 women, the final sample includes 4,300 women who (*i*) were educated in West Germany, (*ii*) are aged 40 or older, and (*iii*) have complete information in key variables. One of those key variables is the district of residence at the time of the college decision or earlier, which we use to assign our instrument. Besides detailed information on education and fertility, including the years of childbearing, the data includes retrospective information on the respondents' labor market history and early living conditions at age 15, for instance, the number of siblings, secondary school grades, and parental education. As those factors are potentially confounding the effect of education on fertility, we consider them as control variables, see Table A1 in the Appendix for details.

The explanatory variable "college degree" takes the value 1 if an individual has any higher educational degree, and 0 otherwise. Dropouts are treated as all other individuals without college education. About one-fifth of the sample have a college degree, while four-fifth do not.

[7] This paper uses data from the National Educational Panel Study (NEPS): Starting Cohort Adults, doi:10.5157/NEPS:SC6:7.0.0. From 2008 to 2013, NEPS data was collected as part of the Framework Program for the Promotion of Empirical Educational Research funded by the German Federal Ministry of Education and Research (BMBF). As of 2014, NEPS is carried out by the Leibniz Institute for Educational Trajectories (LIfBi) at the University of Bamberg in cooperation with a nationwide network.

[8] For every individual we use only the most recent observation.

Dependent variables

The key dimensions along which we analyze fertility are the extensive margin (probability of becoming a mother) and the intensive margin (number of children conditional on being a mother). Table 2 gives the mean values of the dependent variables by college education. From the one-fifth of college-educated women about three-quarters have at least one child. For women without a college education, the share of mothers is about nine percentage points higher. Interestingly, once a woman decides to become a mother, the average number of children is almost the same for women with and without a college education (if anything, college-educated mothers have slightly more children). In other words, the main difference in the descriptives between college-educated and non-college-educated women is on the extensive rather than the intensive fertility margin.

Table 2: Descriptive statistics of dependent variables

	(1)	(2)	(3)	(4)
	College stauts			
	all women	with college	w/o college	share w/ college
Motherhood				
all women (num. obs.)	4,288	924	3,364	21.6
mothers (num. obs.)	3,485	685	2,800	19.7
non-mothers (num. obs.)	803	239	564	29.8
share of mothers (in %)	81.3	74.1	83.2	
Number of children				
all women (incl. 0 kids)	1.65	1.52	1.69	
mothers (i.e., kids≥1)	2.05	2.10	2.04	
Age at first birth if mother	27.0	29.9	26.3	

Notes: Own calculations based on NEPS–Adult Starting Cohort data.

As we consider the timing of birth as a crucial mechanism through which college transmits into fertility, Table 2 also gives the age of first birth. Mothers with a college education have, on average, their first child at the age of 30. Mothers without a college education are, on average, four years younger at the time of the first birth. Given a regular study duration of 4.5–5 years in order to receive a than-common *Diplom* degree, we interpret the descriptive evidence as pointing toward a strong role of college education.

Instrument

The processes of the college expansion discussed in Section 3 provide, on the one hand, a powerful shift in the availability of higher education for many individuals. On the other hand, the multi-faceted college expansion that took place over several decades is hard to boil down into one or a few still powerful instruments.[9] This is especially the case as we observe college openings. Using, for instance, a scalar for the distance to the closest college as suggested by Card (1995) might in the case of college openings even be misleading as newly opened colleges are in the initial years often too small to affect an individual's college decision. Moreover, the generally local nature of the IV results (see next subsection) makes it desirable to have an instrument that affects as many individuals as possible and therefore als captures, for instance, the expansion in the capacities of the already existing colleges. To achieve such a powerful instrument, we follow Kamhöfer et al. (2017) and create an index that weights the non-linear effect of the college distance with the relative number of students in the 325 West-German districts:

$$Z_{it} = \sum_{j}^{325} K(dist_{ij}) \times \left(\frac{\#students_{jt}}{\#inhabitants_{jt}} \right). \tag{1}$$

This college availability index Z_{it}, that is, the instrument, basically includes the total number of college spots (measured by the number of students) per inhabitant in district j (out of the 325 districts), individual i faces in year t weighted by the distance between i's home district and district j. Weighting the number of students by the population of the district takes into account that districts with the same number of inhabitants might have colleges of a different size. This local availability is then weighted by the Gaussian kernel distance $K(dist_j)$ between the centroid of the home district and the centroid of district j. The kernel gives a lot of weight to close colleges and a very small weight to distant ones. Since individuals can choose between many districts with colleges, we calculate the sum of all district-specific college availabilities within the kernel bandwidth. Using a bandwidth of 250km, this basically amounts to $K(dist_j) = \phi(dist_j/250)$ where ϕ is the standard normal pdf. While 250km sounds like a large bandwidth, this implies that colleges in the same district receive a weight of 0.4, while the weight for colleges that are 100km away is 0.37, which is reduced to 0.24 for 250km. Colleges that are 500km away only get a very low weight of 0.05. A smaller bandwidth of, say, 100km would mean that already colleges that are 250km away receive a weight of 0.02 which implies the assumption that individuals basically do not take them into account at all. Table A2 in the Appendix gives an overview of the variation in the instrument as well as providing some descriptives on some main driving forces behind this variation (changes in the distance to the nearest college, within a 100km radius and changes in college spots).[10]

[9] Westphal et al. (2017) use the same source of variation in an IV setting but assess the most powerful instruments of many potential indicators using machine learning techniques.

[10] For alternative specifications of the instrument, see Kamhöfer et al. (2017).

4.2 Empirical strategy

The most natural starting point is an ordinary least square (OLS) estimation where we regress our fertility measures Y_{itd} for individual i who graduated from high school in district d and year t on a binary college indicator D_{itd} (that takes on the value 1 for college, and is 0 otherwise) and a vector of control variables $\boldsymbol{X}'_{itd}$:

$$Y_{itd} = \beta_0 + \beta_1 D_{itd} + \boldsymbol{X}'_{itd}\boldsymbol{\beta}_2 + u_{itd}. \tag{2}$$

In order to separate the general trend in college education from the reverse trend in fertility (as depicted in Figure 1), the vector of confounders, $\boldsymbol{X}'_{itd}$, also includes district-specific linear trends in addition to general time and district fixed effects. The district-specific trends accommodate temporal confounding factors, for instance, because of global and district-specific trends in secondary school graduation (see, e.g., Figure A2 in the Appendix and Westphal, 2017).

However, if individuals simultaneously select themselves into education and desired fertility beyond some underlying trend, β_1 is still likely to be biased. The direction of the bias is a priori unclear and depends on the effect of the omitted confounder on fertility and its correlation with education. If the omitted factors are, for instance, career preferences or preferences for a traditional family model that are already established before college, OLS would overestimate the true college effect.[11] On the other hand, OLS may underestimate the true effect if factors such as the family's wealth are omitted from the model.[12] Also, general preferences for having a family do not necessarily lead to an overestimation of OLS, as females with these preferences may very well decide to study (as college is considered to be one of the largest marriage markets).

In order to address the selection of individuals in education and fertility along unobserved preferences we exploit the variation in college availability using the index of college availability we define in Eq. 1 as an instrumental variable in a two-stage least-squares (2SLS) approach. The first stage of the 2SLS approach reads:

$$D_{itd} = \delta_0 + \delta_1 Z_{td} + \boldsymbol{X}'_{itd}\boldsymbol{\delta}_2 + v_{itd}. \tag{3}$$

[11]In the case of career preferences women may sacrifice children for a career-boosting education. If women prefer a traditional family model, they may forgo college education in favor of starting a family at an earlier age.

[12]Although the observable confounders include the parents' education, we cannot directly control for the family income at the time of the college decision. If the family income buys high-quality child care and the woman's education beyond what is captured by through the control variables, this would downward-bias OLS. Another potential unobservable confounder that would bias OLS in the same direction is a high degree of openness – one of the so-called Big Five personality traits in psychology – describing the appreciation and curiosity for a variety of experiences, e.g., college life and having children.

Our main identifying assumption is that conditional on $\boldsymbol{X}'_{itd}$, variation in our college accessibility measure (Z_{td}) randomizes the otherwise endogenous decision to go to college, that is, variation in Z_{td} does no depend either on the error term, v_i, or on general preferences about or other unobserved characteristics with respect to fertility.

To make this assumption as plausible as possible, we condition on district fixed effects to effectively use only the openings of new colleges and within-district increases in college seats. With the additional assumption that any instrument-specific shift in D only affects some of our employed fertility measures via college graduation (i.e., the exclusion restriction), we can attribute the reduced-form effect of the instrument solely to college graduation, ruling out any other channel. Technically, this is done by regressing the first-stage fitted value $\widehat{D}_{itd}$ on the fertility measures, Y_{itd}:

$$Y_{itd} = \beta_0 + \beta_1 \widehat{D}_{itd} + \boldsymbol{X}'_{itd}\boldsymbol{\beta}_2 + u_{itd}, \quad (4)$$

Given our identifying assumptions, β_1 is the causal effect of college education. Imposing a monotonicity assumption on the instrument, β_1 is a causal effect for a specific group of women: those who would potentially go to college because of the instrument (called compliers). Because this group is typically a subset of all individuals, β_1 is referred to as the local average treatment effect (LATE, see Imbens and Angrist, 1994). In our example, the compliers are most likely those who could go to a university because either a university opened up in their proximity or because existing universities in the neighboring districts expanded. As this process potentially affected many people, one would expect the share of compliers to be rather large – a claim we are going to investigate in the following section.

Before turning to the results, we want to briefly assess whether our assumptions are plausible. The conditional independence assumption would be violated by district-specific, non-linear fertility trends that are correlated with an opening. These trends could be caused by different access to modern contraceptives like the combined oral contraceptive pill that was introduced in Germany at the beginning of the 1960s. If women in regions with a stronger increase in college availability also had better access to the pill, we may falsely attribute the contraceptive effect to education (to alleviate this concern, we include district-specific trends). We consider this as rather unlikely because Table 1 suggests that the levels of aggregate fertility measures are uncorrelated with the opening of a university. What is more likely is that college-educated women were more willing to use contraceptives in order to regulate fertility (see Oddens et al., 1993), which would be a channel of the effect rather than a violation of the identifying assumptions.

5 Baseline results

5.1 The effect of the college expansion on educational participation

First-stage evidence from Micro Census data

Before looking into the effect of the college expansion on the probability of studying using the survey data that includes fertility measures, we look at the effect of the college build-up on educational participation in the German Micro Census from 1962 to 1969 (the first years available). The openings of the first four post-war era colleges (in the cities of Bochum, Dortmund, Konstanz, and Regensburg) fall into these years. To shed some light on the exact impact of college openings, we conducted an event study to see the relative change in the share of students within a 100km radius relative to the timing of the opening of these colleges (time of opening centered to 0).

The results are depicted in Figure 4 which shows a twofold takeaway. First, there is no evidence on pre-trends, indicating that the colleges were not opened in regions where already existing colleges were expanding relatively more than the colleges in regions without an opening. Second, the figure reveals a relatively sharp discontinuity: after a college was opened in $t = 0$, there was a rather large and significant increase in the relative share of students in the region even two years after the opening. Given that the colleges had just opened, this is a remarkable effect. As we take all students in regions within a 100km radius, the increase in the number of students not only captures the somewhat mechanical effect in the region of the opening itself but it also suggests that individuals from neighboring regions were also affected by the opening, for instance, because the newly built college was within commuting distance. We take this as evidence that there was an excess demand of secondary school graduates who wanted to go to college.

First-stage evidence from survey data and the complying subpopulation

The regression results of the first stage from Eq. 3 using NEPS data are shown for both the final sample and for certain subgroups in Table 3. The overall first-stage effect is very strong and is precisely estimated. To ease the interpretation of the compound instrument (defined in Eq. 1), we illustrate the first-stage effect with an example: a college is newly opened in a district with 250,000 inhabitants and 15,000 students are enrolled in the college five years after the opening. In this case, the probability of studying increases for a woman who graduates from high school in this district by about 6 percentage points (pp) based on the results in Table 3: 2.08 (coefficient from the table) $\times K(0) \times {}^{15}/_{250} = 2.08 \times 0.4 \times 0.06 = 5$pp (rounded, see Eq. 1). With an overall baseline probability of studying of 21.5 percent for women, the first stage is not only statistically significant (the resulting F-statistic is well above the rule-of-thumb value of 10) but is also substantial in size.

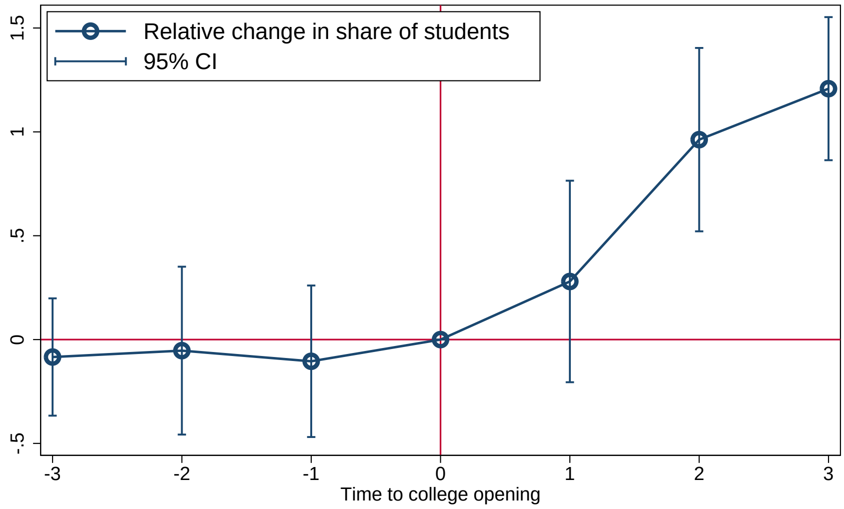


Figure 4: Relative change in the share of students in counties within 100km of college opening between 1962 to 1969

Notes: Own representation based German Micro Census data from 1962-1969 (see Lengerer et al., 2008) and German Statistical Yearbooks (see German Federal Statistical Office, various issues, 1959–1991). The figure depicts the coefficients β_τ from the following "event-study" regression where β_0 is set to zero:

$$\ln(\#\text{students}_{bt}) = \alpha_t + \sum_{\tau \in \{-7,-1\}} \beta_\tau \mathbb{1}\left[\max(t - t_b^{\text{opening}}, -3) = \max(\tau, -3)\right] + \sum_{\tau \in \{1,7\}} \beta_\tau \mathbb{1}\left[\min(t - t_b^{\text{opening}}, 3) = \min(\tau, 3)\right] + \gamma_b + \epsilon_{bt},$$

where $\ln(\#\text{students}_{bt})$ is the log number of students in region b and year t (1962-1969). α_t are year fixed effects. t_b^{opening} equals the the year in which a college opened in region b. To control for differences in levels between these regions, region fixed effects γ_b are included. Regions include all regions within a 100km radius surrounding the centroid of the region where the new colleges are located. The reason for the choice of this radius is that we want to go beyond a somewhat mechanical effect which emerges by the influx of students in the region of the opening. A sufficiently large radius partials out this effect for two reasons. First, it captures the bulk of the catchment area of a college and therefore only a minority of students do not come from the area defined by the radius. Second, within each region that exhibited an opening of a college (Bochum, Dortmund, Konstanz, Regensburg) there are already well-established existing colleges (Münster, Cologne, Freiburg or Nuremberg). Hence, there had been possibilities to enroll into a college in the defined area also in the absence of a college opening in period 0.

This first stage determines the share of individuals for which the second-stage conditions the effect on college education (that is, the compliers). By comparing the first-stage effect of increased college availability on the probability of studying across different subgroups, it is possible to gauge whether certain individuals were more likely to comply with the college expansion and, thereby, be captured by the second stage. To this end, we repeat the first-stage estimation along three potentially important characteristics by which we separate our data. The first subgroup is defined by the school degree of the father. This separation may be informative since it sheds light on the question of whether the educational expansion increased educational mobility. High-educated fathers are defined as having at least an intermediate track education, and hence more than the most common educational degree of that time. The shares of both subgroups are approximately balanced. However, the first stage is much stronger for women with lower-educated fathers as is evident from Table 3. Calculating the relative frequency of compliers of low-educated fathers relative to high-educated fathers ($0.63/0.37 = 1.7$, see table notes for

Table 3: First stage and some characteristics of complying mothers

	(1) Coefficient of the First Stage	(2) Share of the population	(3) Share of compliers	(4) Obs.
Overall first stage	2.08***	1	1	4,288
	(0.11)			
First stage by education of father[a]				
– High-educated fathers	1.63***	0.48	0.37	2,045
	(0.16)			
– Low-educated fathers	2.49***	0.52	0.63	2,243
	(0.15)			
First stage by year of birth (median separation)				
– Before 1960	1.78***	0.47	0.41	1,996
	(0.23)			
– 1960 or later	2.19***	0.53	0.59	2,292
	(0.12)			
First stage by urban-rural separation				
– Urban	2.12***	0.76	0.78	3,275
	(0.12)			
– Rural	1.89***	0.24	0.22	1,013
	(0.23)			

Notes: Own calculations based on NEPS–Adult Starting Cohort data. The shares of compliers are calculated as follows: For mutually exclusive groups (denoted by subscripts 1 and 2), the overall first stage coefficient is a weighted average of the respective subgroups if the group indicator is also interacted with the set of controls. In this case, weights are determined by the group shares ω_1 and ω_2 of the overall population. Thus, $\widehat{\delta_{\text{overall}}} = \widehat{\delta}_1\omega_1 + \widehat{\delta}_2\omega_2$. Accordingly, the shares of compliers can be determined as $\pi_j = \widehat{\delta}_j/\widehat{\delta_{\text{overall}}} \times \omega_j$, for $j \in \{1, 2\}$. In this table, the group indicators are not interacted with all the controls, in order to present the same first stage result as employed for the main results. Therefore, the weighted average may not hold with equality until we normalize the weights π_j such that $\pi_1 + \pi_2 = 1$. This procedure has also been applied in Akerman et al. (2015). Standard errors in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

[a] High-educated fathers are defined to have at least an intermediate track education, and hence more than the most common educational degree of that time.

details) indicates that a woman with a father we define as low educated is nearly twice as likely to comply with the college expansion as a woman with a high-educated father. Hence, in the example above, the college opening is supposed to increase the probability of studying by $0.06 \times 1.7 = 10.2$pp for daughters of lower educated fathers.

Splitting the sample by the women's year of birth one can calculate the corresponding complier shares. The results show that the first-stage effect and, hence, also the share of compliers, is only slightly larger for women born after 1960, suggesting that our instrument has power throughout the educational expansion. This piece of evidence is moreover likely to be informative regarding the external validity of the results. As the first-stage effect does not seem to be confined to certain years in the time under review, it is not implausible to conjecture that more recent policies have also had similar effects on promoting educational education.

The last dimension by which we analyze the first stage is the degree of urbanization. The first-stage coefficient is slightly higher in urban regions compared to the overall effect. Yet, as most college openings occur in cities, this urban-rural gradient of the educational expansion should not come as a surprise.[13] But in rural regions there is a substantial share of compliers that is nearly as high as the share of rural high school graduates in the overall population.

All in all, we interpret the finding of the subgroup analysis as suggesting that the complying population, although modestly selected, is not confined to any specific subgroup.

5.2 The effect of college education on fertility

Starting with overall completed fertility, shown in panel A in column 1 of Table 4, the OLS effect (that is, the association) of college education on the number of children is -0.1. In other words, given controls, women who went to college have, on average, 0.1 fewer children than women without a college education. Taking into account selection that goes beyond the observable factors, the 2SLS estimate in panel B yields a reduction in the average number of children of -0.3. Given an average number of 1.7 children in Table 2, this corresponds to a reduction of 19 percent – a rather sizeable effect. With 4.5 years of college education, the per-year reduction that goes along with college education is, on average, 0.02 children in the OLS model and 0.05 children in the 2SLS specification.

Taking a closer look at the composition of the overall effect, we take the fertility margins as dependent variables. The OLS point estimate of college education on the extensive margin (that is, motherhood) is -0.08 (-0.02 per year of college). Put differently, women who went to college are 8pp less likely to ever bear a child, given the controls. Addressing endogeneity, the 2SLS estimate in panel B yields a reduction in the probability of becoming a mother through college education of about 21pp (5pp per year). Again, the effect is precisely estimated and is large in size (the baseline probability is 83.2 percent for females without college).

Turning to the intensive margin in column 3 of Table 4, we see that the negative effect from the extensive margin does not propagate here. The differential in the number of children is slightly positive when it is controlled for observables. Going to the structural estimate, college-educated mothers have, on average, 0.267 children more than their peers without college education. Given that mothers have an average of 2.1 children, the relative

[13] That regions with college openings have, on average, a larger share of primary industries - and are thereby more rural - may seem to contradict the result of Table 1. However, the degree of urbanization used here is only based on the number of inhabitants, not on the population density.

Table 4: Baseline regression results

	(1)	(2)	(3)	(4)
	Total Effect	Fertility margins		Timing
	# of children for all women	Extensive: motherhood indicator	Intensive: # of children for mothers	Maternal age at 1st birth
Panel A: OLS regression				
College degree	-0.106^{*}	-0.081^{***}	0.123^{*}	2.752^{***}
	(0.052)	(0.019)	(0.051)	(0.232)
Panel B: Second-stage 2SLS regression				
College degree	-0.313^{*}	-0.209^{***}	0.267^{*}	6.463^{***}
	(0.149)	(0.054)	(0.134)	(0.741)
Number of observations:	4,288	4,288	3,316	3,259

Notes: Own calculations based on NEPS–Adult Starting Cohort data. Control variables include full sets of year of birth and district fixed effects as well as state-specific trends. Standard errors in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

effect amounts to a 12.7 percent increase in the number of children of college-educated mothers. Although only statistically significant at the 10 percent level, the effect size is substantial. However, this result for the intensive margin may be taken with a grain of salt as it refers to the selected sample of women who decide to have children. The composition of this sample in terms of the desired family size may depend on the individual effect of college education on motherhood. Put differently, the estimate for the intensive margin only yields the causal effect of college education if the desired family size does not systematically differ for college-educated mothers compared to women who do not become mothers because of college education. Keeping this limitation in mind, we still deem the countervailing signs of the effects on the two margins an interesting finding that we ought to have a closer look at in the following section.

Before building the bridge to potential mechanisms that may contribute to explaining the results, the rather new margin of education considered here calls for a careful comparison of our findings with the literature on the secondary schooling effects on fertility. For Germany, the OLS estimate for the effect of an additional year of secondary schooling on the average number of children provided by Cygan-Rehm and Maeder (2013) is -0.020 – this is remarkable close to our per-year OLS estimate of -0.024. Instrumenting secondary education with compulsory years of schooling, Cygan-Rehm and Maeder (2013) find an effect ranging from -0.10 to -0.17 depending on the specification. This is more than twice as big as the pre-year effect of college education. The bigger effect may seem contradictory at first sight, given that college education is probably more relevant for later career opportunities and affects individuals in their prime reproductive ages. However, while interpreting the effect size, one has to keep in mind that the compulsory schooling reform affects individuals at the lower end of the educational distribution and – given the baby gap in education – the average number of children is higher at this margin. Accordingly, the 2SLS effect on childlessness by Cygan-Rehm and Maeder (2013), about 5pp (compared to a baseline probability of 18 percent) exceeds our effect of college education on motherhood by about 5.7 percent (that is, (-0.209/0.813)/4.5 years=0.057). Fort et al. (2016) find similarly large effects of compulsory schooling on the number of children and childlessness for England and pooled Continental European countries.

Moreover, our results confirm another interesting pattern found by several studies on the secondary schooling effect (e.g., Cygan-Rehm and Maeder, 2013, Fort et al., 2016 and Monstad et al., 2008): the OLS results underestimate the 2SLS effects in absolute terms. This indicates that the bias in the OLS results stems from omitted variables such as unaccounted family income and openness to new experiences rather than from pre-college career preferences or preferences for a traditional family (where more children are preferred to a mother's college education). Another explanation as to why OLS underestimates the 2SLS result might be that OLS captures the average treatment effect while the 2SLS model yields the LATE for the complying subpopulation. However, as the complier analysis in Section 5.1 indicates that college expansion is not limited to particular groups of individuals, the local nature of the 2SLS estimate seems rather unlikely to drive the pattern of the results presented here.

Moving on to potential explanations of the education-fertility nexus, the most obvious effect of college education on fertility is through the timing of births. If the distribution of the age at the first birth is simply shifted by the time women spend in college (usually 4.5 to 5 years in Germany), some women may become too old to bear a child, which may then explain the negative effect on the extensive margin. This is investigated in column 4 of Table 4. Whereas the average observable-adjusted difference on age at first birth is 2.8 years between college-educated and non-college-educated mothers, the 2SLS effect is higher. Because of college, mothers defer their first birth by nearly 6.5 years, which is even higher than the time they usually spend in college. Because this effect is more than a mechanical shift, unraveling the exact timing of its occurrence seems to be promising for giving a more complete picture of the fertility pattern.

6 Heterogeneity and potential mechanisms

6.1 Effect heterogeneity along age

Unfolding the college effect by age

By its very nature, the decision to go to college affects an individual's life differently while the individual is in college (investment period) and after she leaves college (consumption period). Such effect heterogeneity in the returns to college education along women's fertile ages is not only informative in its own right but it may also help to explain the findings of the previous section. To describe the effect of education on "the desire/time/opportunity to have a child" while in school, Black et al. (2008, p.1044) coin the term "incarceration effect." Although they look at the fertility returns to education at the secondary schooling margin, such an incarceration effect is likely to matter at the college margin as well since the time in college is, on the one hand, often characterized not only through more flexible working hours, but also through an increased workload and pressure as well as tighter budget constraints. To detect this kind of heterogeneity, we estimate our baseline models for the extensive and the intensive fertility margins fully saturated by women's age to get age-specific effects. To this end, we reshape the data from individual level i to individual-age level ig, where g now indicates the age of the woman for each year from 17 to 40. The second stage of the 2SLS model is then:[14]

$$\begin{aligned} d_{ig} &= \beta_0 + \beta_1 \widehat{D}_i + \sum_{g=17}^{40} \eta_g \mathbb{1}(age_{ig} = g) \\ &\quad + \sum_{g=17}^{40} \left[\gamma_g \mathbb{1}(age_{ig} = g) \times \widehat{D}_i \right] + \boldsymbol{X}_i' \boldsymbol{\beta}_2 + u_{ig}. \end{aligned} \tag{5}$$

The indicator functions $\mathbb{1}(\cdot)$ return the value 1 if the observation refers to individual i at age g, and 0 for other fertile ages but g. In other words, the first sum gives a full set of age fixed effects and the second sum interacts the age fixed effects with the college indicator. The interpretation of the dependent variable d_{ig} and, thereby, the interpretation of the coefficients of interest differs depending on whether fertility is measured at the extensive or the intensive margin:

- At the extensive margin, d_{ig} is a binary indicator that takes on the value 1 if woman i becomes a mother at age g (and 0 otherwise), given that she does not have a child until age $g-1$. The age fixed effects η_g give the baseline hazard rate of having the first child (given that one does not already have a child) at age g. The coefficients of

[14] For the sake if simplicity, the subscripts for the time and the district are now implicit. The standard errors are clustered on an individual level as shocks are likely to be time persistent.

interest γ_g give the effect of college education on the baseline hazard. That is, they answer the question "How does college education affect the probability of bearing the first offspring at age g, conditional on having never given birth before?"

- At the intensive margin, d_{ig} is 1 if woman i gives birth at age g (and 0 otherwise) – independent of whether woman i already has a child or not. Accordingly, η_g is the baseline rate of having any child at age g given the woman is going to have a child by the age of 40 (as the sample for the intensive margin only consists of women who become mothers). The coefficients γ_g answer the question "How does college education affect the probability of giving birth at age g for women who have at least one child by the age of 40?"

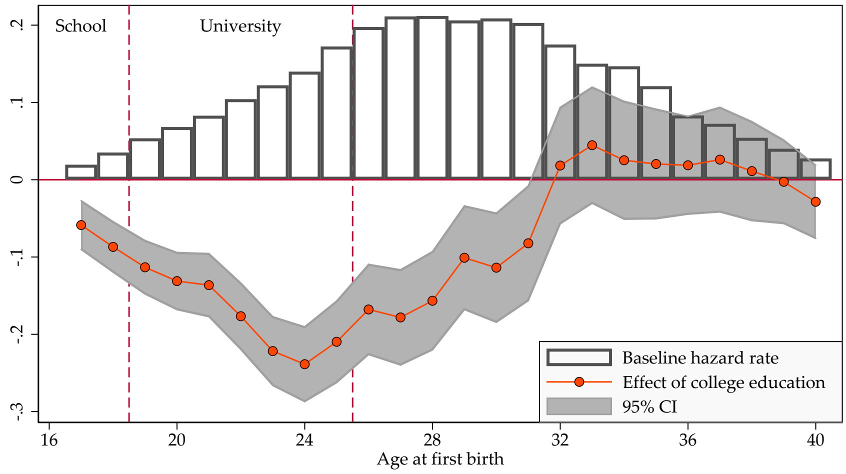
Pre-, in- and post-college effects on fertility

Figure 5 shows the estimation results of Eq. 5 for the extensive margin of fertility in panel (a) and intensive margin in panel (b).[15] The bars state the baseline hazard rate of becoming a mother and the baseline probability of giving birth at a certain age in panel (a) and (b), respectively.[16] The oranges lines give the effect of college education on these baseline probabilities. For the sake of interpretation, we may think of the fertile ages as three phases for which we expect distinct effects: pre-college teenage years, years in college, and post-college years. In the first phase, giving birth (that is, teenage motherhood) is rather unlikely at both margins – as indicated by the small left-most bars in both panels of Figure 5. Interestingly, women who go to college a couple of years later already have lower probabilities of giving birth at pre-college ages (indicated by the orange lines below zero). An explanation for this may be that some women have such a strong family preference established prior to college age that they sacrifice additional education in favor of early motherhood and become a mother immediately after leaving secondary school. These women are never-takers of the college expansion.

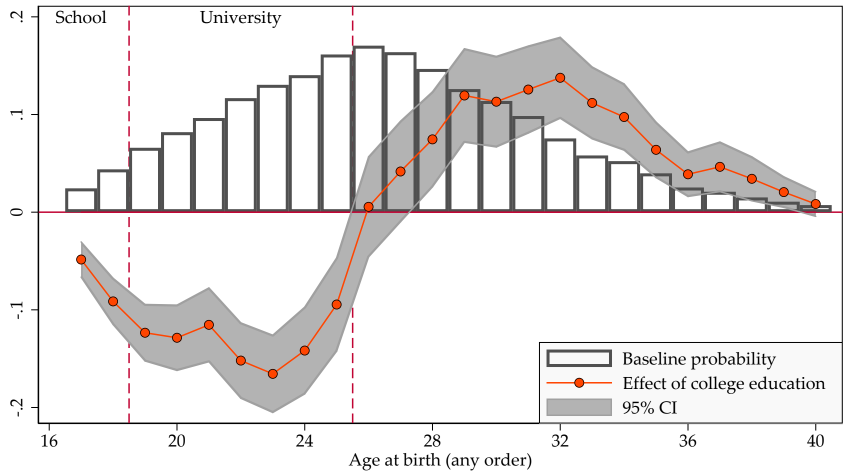
The next phase in fertile ages are the years in college around the ages 19 to 25 when women with a college education are in college and those without a college education usually complete their apprenticeship training and start working. Both baseline probabilities of motherhood/giving birth increase from year to year in this phase. Unsurprisingly, the negative effect of college education is most pronounced in the in-college years. While the baseline hazard of becoming a mother in panel (a) increases from 5 to 18 percent, the

[15]As the age-specific estimates in panel (a) after age 17 refer to the hazard of giving birth to the first child conditioning on not yet being a mother, the estimates may not be taken for the unconditional causal effect of becoming a mother at a certain age. Similarly, the estimates in panel (b) may not state the causal effects if the number and timing of children depends of the effect of college education on motherhood.

[16]Note, the baseline rates plotted in Figure 5 state the unconditional means. On the contrary, η_g in Eq. 5 are the conditional means after adjusting for college education and controls for non-college-educated women. We interpret the effect size (depicted by the orange line) relative to the unconditional mean as conventional for linear probability models.



(a) Extensive margin: effects on hazard rates of becoming mother



(b) Intensive margin: effects of bearing offspring for mothers

Figure 5: Timing of births

Notes: Both panels depict the age-specific regression coefficients from the second stage of the 2SLS model in Eq. 5 that capture the effect of college education. Panel 5a reports the effects of college education on the hazard rate of becoming a mother by age. Panel 5b depicts the respective effects on the probability of giving birth conditional on being a mother.

hazard rate for women in college is 11 to 25pp lower. Similarly, the baseline probability of giving birth in panel (b) ranges between 7 and 17 percent, while college education reduces the probability up to 17pp. It may at first sight be puzzling that the college effect exceeds the baseline probabilities. However, the baseline hazard rate/probability is much stronger for women who do not go to college (up to 14pp at age 25 when the baseline hazard for becoming a mother in college is just 7 percent, see Table A3 in the Appendix). Indeed, the increase in the hazard/probability of childbirth for women without a college education together with an increasing negative college effect in the in-college years, supports the incarceration explanation. While non-college-educated women completed their vocational training-on-the-job and gain in financial security from year to year in their mid-20s, the workload and stress level of women in college increases as they face their final examinations.

The third and final phase in fertile ages starts when individuals with a college education leave college – around the age of 25. At these ages college-educated women will reveal their preferences about fertility. Among the college-educated women who have not yet had a child, some may decide to remain childless (as indicated by the negative extensive margin in the baseline results), while others who postponed motherhood start a family. At this phase the pattern differs considerably between the extensive margin in panel (a) and the intensive margin in panel (b). At the extensive margin, the post-college ages can be further divided into two stages. First, from ages 26 to 32, the negative effect of college education decreases but college-educated women remain significantly less likely of becoming a mother. In other words, some college-educated women catch up with their non-college peers and give birth to their first child. Still, the college effect remains negative as some women who would have become mothers without a college education decide against children because of college education. At the second stage of the post-college fertile ages, starting around age 32, there is no significant difference in the probability of college- and non-college-educated women becoming mothers. Put differently, there is no catch-up effect in the first birth after the age of 32. The pattern in panel (a) suggests two things: First, the negative effect at the extensive margin in the baseline results is driven through the lower fertility of college-educated women during the years in college and about seven years after leaving college – that is, the time in which they build a working career. Second, the reduction in the negative college effect for women at the end of their 20s and the indistinguishable hazard rates (zero effects of college education) afterwards indicate that women who wish to catch up in terms of becoming a mother do catch up. Form a policy perspective this absence of an age-related reduction in fertility (we refer to this as the "biological effect") is a noteworthy finding. It indicates that the catch-up effect not meeting the incarceration effect is driven by preferences or opportunities for a career or family life. On the contrary, a constant relative increase in the hazard rate of the first birth of college-educated women at the end of their 30s would indicate that some women may wish to catch up but are not able to do so before age-related fertility problems become an issue.

At the intensive margin, the baseline probability of giving birth is more pyramid-shaped with lower probabilities at older ages compared to the extensive margin. As for the extensive margin, the effect of college education on childbirth in the post-college ages can be divided into two stages. The first stage, until age 32, is characterized by a catch-up effect that already starts in the last years of college education, at around 23. Compared to the extensive margin, the catch-up effect is much more pronounced at the intensive margin and college-educated women are significantly more likely to give birth from age 28 onwards. However, the positive effect shrinks between age 32 to the end of the 30s (although college-educated mothers are still more likely to have a child than their non-educated peers, see Table A3). Thus, for women who decide to become a mother, the negative effect of incarceration in college in the first half of their 20s is compensated by an increased fertility until the end of the 30s. The effect remains positive and significant after the age of 30. The probability that a college-education women will give birth is around 10 percent at age 34 and falls to 5 percent at age 37 and 2 percent at age 39. This indicates that a biological effect can potentially restrict the desired fertility of college-educated mothers because if infertility affects both women at the same rate, college-educated mothers are more affected since they are still trying to catch up at those ages. If such an effect exists (it is, for instance, unclear whether the drop in the probability childbirth between 37 and 39 is already affected by fertility problems or not), it is rather humble in size, however.

Summing up the results for both margins, it seems likely that there are different types of college-graduated females – those who catch up in their fertility immediately after leaving college and those who postpone childbearing even further after the in-college incarceration and may never have children. For the latter group, the prolonged postponement and the seemingly absent age-related fertility decline raises the question of other causes for this lower fertility? Or, put differently, what shapes the smaller catch-up effect? Black et al. (2008) consider a "human capital effect" – that is, college education increases wages and, thereby, opportunity costs of family life. Besides such a career channel, the literature on secondary schooling and fertility suggests that education may change the preferences for and opportunities of family life. Education can enable women to find a more-educated and higher-earning partner and to have not only more but also better-educated offspring that could in turn affect the desired fertility (see, e.g., McCrary and Royer, 2011, for assortative mating and Currie and Moretti, 2003, for the intergenerational transmission of education). We now go on to investigate the effects of college on career and family variables for women with and without children that might explain the catch-up effects.

6.2 Opportunities and revealed preferences for career and family life

Table 5 presents the effect of college education on the post-college career path. Although an effect of college education does not allow us to conclude whether and, if so, to which extent the potential mediators actually affect the fertility patterns, the analysis of labor market factors might be insightful for two reasons. First, labor market returns to college education change the family's resources in terms of financial means as well as available time. Second, a heterogeneity in the returns between mothers and non-mothers potentially reveals different career opportunities or preferences. Table 5 states the effect of college education on a working full-time indicator and the log hourly wage. There is a clear association between college education and working full-time (as opposed to working part-time or not at all) in the OLS model in column 1: college-educated women are 8pp more likely to work full-time. For the 2SLS estimate the effect increases to 13pp; however, a larger standard error diminishes the statistical significance of the relationship to the 10 percent level. Before coming to wages, column 2 reestimates the effect of college education on the full-time indicator using the subsample of mothers.[17] This corresponds to going from the extensive to the intensive fertility margin. While college education is still positively associated with working full-time, the magnitude is smaller. In fact, the 2SLS effect is only half as big when compared to the entire sample and not statistically different from zero at the conventional levels.

Going on to the hourly wage, we find a strong and statistically significant relationship between college education and earnings. In the OLS estimates (in columns 3 and 4) the wage increase amounts to about 25 percent. As is common in the labor economics literature, the 2SLS coefficients exceed the OLS ones in size (although one would expect to find that OLS overestimates the true effect, see Westphal et al., 2017, for a careful discussion of the heterogeneity in the labor market returns), amounting to nearly 50 percent of the full sample (or equivalently 10 percent per year of college education) and 40 percent among mothers. Thus, mothers not only expand their labor supply less than non-mothers but they also face a smaller college premium in the hourly wage. A reason for the smaller labor market returns might be different – and maybe more family-friendly – occupations college-educated mothers choose compared to college-educated non-mothers. Mothers, for example, tend to choose occupations with a greater flexibility of working shorter hours, which may lead to a wage penalty (Goldin, 2014). Taken together with the small and postponed catch-up effect in fertility at the extensive margin, the bigger labor market returns for non-mothers speak for a college-induced early-career effect that prevents some women from becoming mothers.

Table 6 considers the effect of college education on revealed family characteristics that may shape a fertility-career trade-off. As marriage often serves as a gatekeeper for planned fertility, the increasing trend in the age at first marriage (as depicted in Figure 1) could, if triggered by education, constitute an important mechanism as to why individuals put a stronger focus on family life or career opportunities. Columns 1 and 2 of Table 6 show the effect of a regression of an indicator for being married at the age of 40 on college education for all women and mothers, respectively. In the OLS model, college education is associated with reducing the probability of being married by about 6pp while the effect is more than twice as strong when estimated with 2SLS. When looking only at mothers, these relationships vanish. Given a baseline probability of 84 percent, college seems to be an important determinant of marriage preferences, which may have direct repercussions on family life. In other words, the college effect on motherhood already manifests itself in marriage. A reason why college education may prevent marriage – and a potential mediator of education-fertility nexus – may be assortative mating. While men are often

[17] As before, if the tendency to become a mother in spite of a college education correlates with labor supply or wage returns, the subsample analysis may not identify the causal relationship. Moreover, as working women are a subgroup of all women, the wage estimates may suffer a selection bias – although Westphal et al. (2017) provide evidence that such a bias seems humble in the time under review.

Table 5: Post-college career outcomes as potentially mediating forces

	(1)	(2)	(3)	(4)
	Working full-time		Log wage	
	all women	only mothers	all women	only mothers
Descriptives				
Sample mean	0.175	0.153	2.83	2.79
OLS regression				
College degree	0.080***	0.062**	0.266***	0.258***
	(0.018)	(0.020)	(0.038)	(0.048)
Second-stage 2SLS regression				
College degree	0.131*	0.075	0.499***	0.407***
	(0.052)	(0.059)	(0.086)	(0.107)
# observations:	4,288	3,485	1,500	1,213

Notes: Own calculations based on NEPS–Adult Starting Cohort data. Control variables include full sets of year of birth and district fixed effects as well as state-specific trends. Standard errors in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

said to prefer to "marry down," women who went to college may be more selective when looking for a suitable partner. Columns 3 and 4 of Table 6 indicates that women with a college degree seem indeed to be 36pp more likely to have a partner who also went to college – independent of the woman being a mother or not. Given that men with college education earn more than their peers without a college education (see Westphal et al., 2017), we interpret this as evidence that a lower fertility of college-educated couples is unlikely to be driven by the financial need for the mother to work.

Finally, maternal education may change not only the preferences about the offspring's education but also the capability of transmitting a better education to the children. For example, if there is a trade-off between child quality and quantity (Becker and Lewis, 1973), it could mean that the effects on the intensive margin would be even higher in the absence of this trade-off. Moreover, looking at the effect on the educational outcomes of the child is important because it shows (together with the quantitative effects) how maternal college education affects the socioeconomic composition of fertility (Raute, 2016). Column 5 of Table 6 gives the effect of the mother's college education on an indicator that shows whether the firstborn visits or has visited an academic track secondary school (compared to a less academically demanding school track). We find strong positive effects here which may emphasize the importance of college education on the socioeconomic composition of fertility and/or that the effects of the intensive margin are likely to be hypothetically higher in the absence of this effect.

To summarize the mediator analysis, we find evidence of a lower college wage premium for mothers. However, for more educated partners (who potentially earn more than their less-educated peers) it seems unlikely that financial reasons alone prevent college-educated women from having children.

Table 6: Post-college family characteristics as potentially mediating forces

	(1)	(2)	(3)	(4)	(5)
	Marriage: married age 40		Assortative mating: partner college		Child quality
	all women	only mothers	all women	only mothers	academic track
Descriptives					
Sample mean	0.842	0.916	0.316	0.310	0.526
OLS regression					
College degree	-0.058^{**}	-0.025	0.362^{***}	0.382^{***}	0.250^{***}
	(0.018)	(0.016)	(0.021)	(0.025)	(0.025)
Second-stage 2SLS regression					
College degree	-0.124^{*}	-0.018	0.690^{***}	0.750^{***}	0.639^{***}
	(0.051)	(0.041)	(0.062)	(0.072)	(0.081)
# observations:	4,288	3,491	4,127	3,427	3,316

Notes: Own calculations based on NEPS–Adult Starting Cohort data. Control variables include full sets of year of birth and district fixed effects as well as state-specific trends. Standard errors in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

7 Conclusion

In this paper, we analyze the nexus between education and fertility – two fundamental decisions in life that, when considered on an aggregated level, have greatly changed societies within the past 60 years. These dynamics are unlikely to be confined to the past – particularly with regard to recent policies such as the Higher Education Pact 2020 in which the German states committed to further increase access to higher education. This emphasizes the need to understand the long-term consequences of higher education that go beyond the monetary effects. The aspect of fertility is especially interesting in this context as higher education affects women – unlike previously studied secondary schooling

– within their prime reproductive age. To analyze how education impacts individual fertility decisions in the in-college years and afterwards we make use of arguable exogenous variation in the accessibility of college education in Germany. We find that the overall quantitative fertility effects are driven by the extensive margin: the probability of becoming a mother is reduced by one-quarter. In contrast, women who decide to be a mother despite a college education, have, on average, more children.

We shed light upon the sources of these effects by unraveling the timing of childbearing along the extensive and intensive margin. This analysis indicates that there is a postponement of fertility in the early years of the working career that goes beyond the "incarceration" in college. However, this college-induced postponement in fertility does not seem to push planned children toward ages where biological infertility might become an issue. From a policy perspective, this is a noteworthy finding as a biological effect would restrict a woman's choice set when she maximizes her utility. On the other hand, the decision to forgo marriage and/or childbearing is per se not undesirable when disregarding the negative externalities for the society. The absence of such biological effects together with the overall decline in completed fertility points toward changed preferences for motherhood and/or a career because of college education. Wage and working-time differentials between college-educated mothers and non-mothers suggest an early-career path that shapes fertility and labor market returns to college education.

Although we find evidence that the massive college expansion and effect of college education on the probability of becoming a mother at least partly fueled the demographic transition in recent decades, the positive effect of college education on the number of children for mothers indicates that education does not per se decrease fertility. We consider this to be an important policy implication of this study. Policies that particularly aim at triggering college-educated women into motherhood, for instance, through more flexible working hours or means-tested materiality leave benefits, seem promising for reducing the baby gap between women with and without a college education.

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Appendix

Figures

Figure A1: Spatial variation of colleges across districts and over time

Notes: Own illustration based on the German Statistical Yearbooks 1959–1991 (German Federal Statistical Office, various issues, 1959–1991). The maps show all 326 West German districts (*Kreise*, spatial units of 2009) but Berlin in the years 1958 (first year in the sample), 1970, 1980, and 1990 (last year in the sample). Districts usually cover a bigger city or some administratively connected villages. If a district has at least one college, the district is depicted darker. Very few districts have more than one college. For those districts the number of students is added up in the calculations but multiple colleges are not depicted separately in the maps.

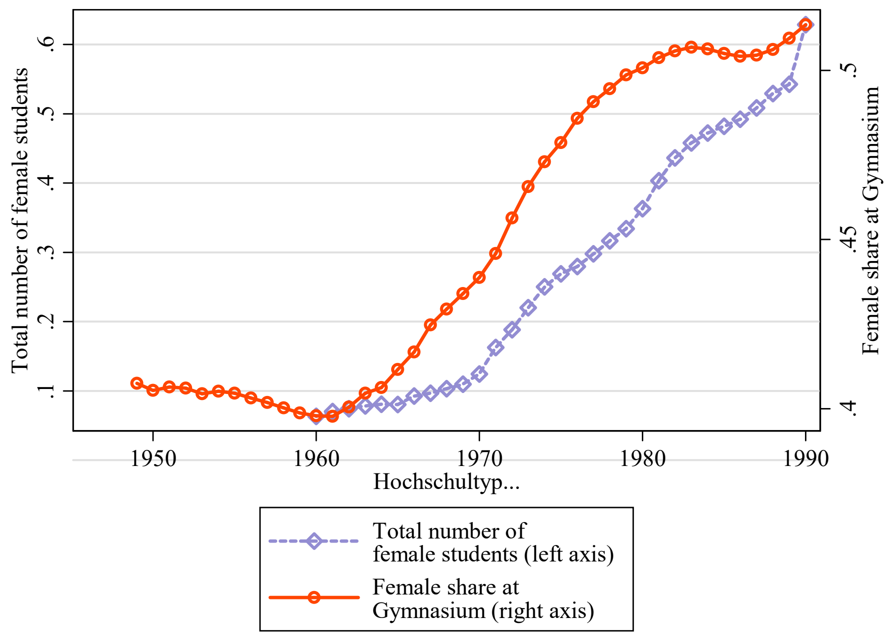

Figure A2: Trends in academic secondary school and college education for females

Notes: Own calculations using data from Köhler and Lundgreen (2014).

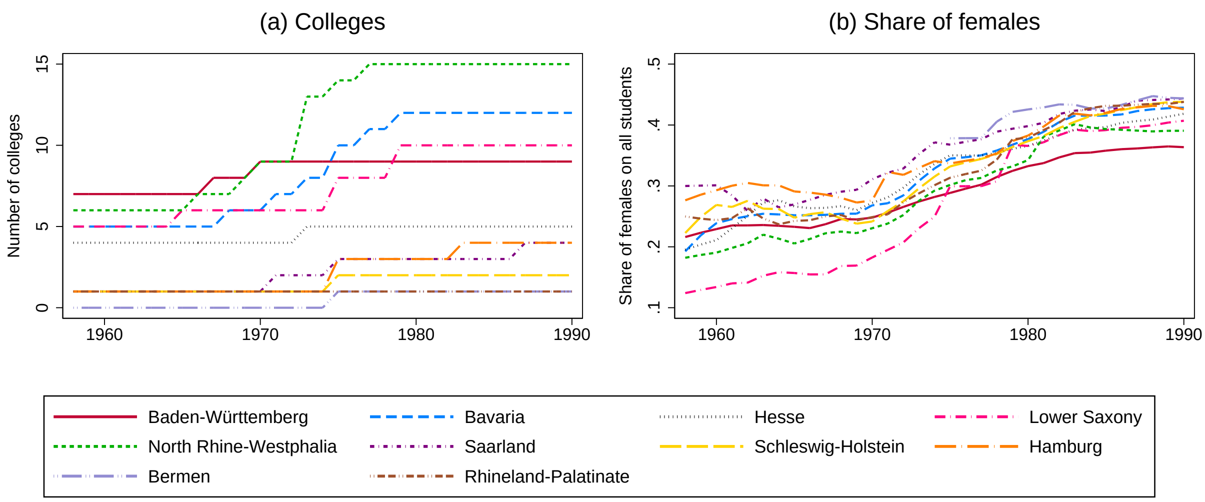

Figure A3: Trends in colleges and female students across federal states

Notes: Own calculations using data from the German Statistical Yearbooks 1959–1991 (German Federal Statistical Office, various issues, 1959–1991).

Tables

Table A1: Control variables and means by university degree

Variable	Definition	Respondents	
		with univ. degree	w/o univ. degree
General information			
Year of birth (FE)	Year of birth of the respondent	1959.62	1959.61
Migrational background	=1 if respondent was born abroad	0.007	0.009
No native speaker	=1 if mother tongue is not German	0.002	0.003
Mother still alive	=1 if mother is still alive in 2009/10	0.676	0.626
Father still alive	=1 if father is still alive in 2009/10	0.472	0.420
Pre-college living conditions			
Married before college	=1 if respondent got married before the year of the college decision or in the same year	0.010	.005
Parent before college	=1 if respondent became a parent before the year of the college decision or in the same year	0.002	0.003
Siblings	Number of siblings	1.555	1.814
First born	=1 if respondent was the first born in the family	0.325	0.283
Age 15: lived by single parent	=1 if respondent was raised by single parent	0.0633	0.057
Age 15: lived in patchwork family	=1 if respondent was raised in a patchwork family	0.013	0.027
Age 15: orphan	=1 if respondent was a orphan at the age of 15	0.009	0.022
Age 15: rural district	=1 if district at the age of 15 was rural	0.181	0.249
Age 15: mother employed	=1 if mother was employed at the respondent's age of 15	0.583	0.610
Age 15: mother never unemployed	=1 if mother was never unemployed until the respondent's age of 15	0.448	0.487
Age 15: father employed	=1 if father was employed at the respondent's age of 15	0.985	0.964
Age 15: father never unemployed	=1 if father was never unemployed until the respondent's age of 15	0.931	0.894
Pre-college health and education			
Final school grade: excellence	=1 if the overall grade of the highest school degree was excellent	0.034	0.015
Final school grade: good	=1 if the overall grade of the highest school degree was good	0.231	0.185
Final school grade: satisfactory	=1 if the overall grade of the highest school degree was satisfactory	0.141	0.185
Final school grade: sufficient or worse	=1 if the overall grade of the highest school degree was sufficient or worse	0.006	0.009
Repeated one grade	=1 if student needed to repeat one grade in elementary or secondary school	0.163	0.166
Repeated two or more grades	=1 if student needed to repeat two or more grades in elementary or secondary school	0.018	0.011
Parental characteristics (M: Mother, F: Father)			
M: year of birth (FE)	Year of birth of the respondent's mother	1930.87	1931.70
M: migrational background	=1 if mother was born abroad	0.063	0.047
M: at least inter. edu	=1 if mother has at least an intermediate secondary school degree	0.298	0.092
M: vocational training	=1 if mother's highest degree is vocational training	0.256	0.245
M: further job qualification	=1 if mother has further job qualification (e.g., *Meister* degree)	0.063	0.024
F: year of birth (FE)	Year of birth of the respondent's father	1927.76	1928.561
F: migrational background	=1 if father was born abroad	0.063	0.047
F: at least inter. edu	=1 if father has at least an intermediate secondary school degree	0.298	0.092
F: vocational training	=1 if father's highest degree is vocational training	0.256	0.245

Continued on next page

Table A1 – *continued*

Variable	Definition	Respondents	
		with univ. degree	w/o univ. degree
F: further job qualification	=1 if father has further job qualification (e.g., *Meister* degree)	0.061	0.024
Number of observations		941	3,389

Notes: Information taken from NEPS–Starting Cohort 6. Mean values refer to the health satisfaction sample. In the case of binary variables, the mean gives the percentage of 1s. FE = variable values are included as fixed effects in the analysis. [a] Only available for males who did military eligibility test (2,359 observations).

Table A2: Descriptive statistics of instruments and background information

	(1)	(2)	(3)	(4)
	Statistics			
	Mean	SD	Min	Max
Instrument: College availability	0.459	0.262	0.046	1.131
Background information on college availability (implicitly included in the instrument)				
Distance to nearest college	27.580	26.184	0	172.269
At least one college in district	0.130	0.337	0	1
Colleges within 100km	5.860	3.401	0	16
College spots per inhabitant within 100km	0.034	0.019	0	0.166

Notes: Own calculations based on NEPS–Adult Starting Cohort data and German Statistical Yearbooks 1959–1991 (German Federal Statistical Office, various issues, 1959–1991). Distances are calculated as the Euclidean distance between two respective district centroids.

Table A3: Baseline fertility rates and college effects by age

	(1)	(2)	(3)	(4)	(5)	(6)
	Extensive margin			Intensive margin		
Age	Baseline hazard		Effect	Baseline probability		Effect
	no college	college		no college	college	
17	0.024	0.002	−0.059	0.030	0.003	−0.048
18	0.045	0.002	−0.087	0.054	0.003	−0.091
19	0.067	0.006	−0.113	0.080	0.009	−0.123
20	0.084	0.015	−0.131	0.097	0.021	−0.129
21	0.102	0.019	−0.136	0.114	0.026	−0.115
22	0.128	0.030	−0.177	0.135	0.041	−0.152
23	0.147	0.047	−0.222	0.147	0.063	−0.166
24	0.167	0.061	−0.239	0.155	0.081	−0.142
25	0.210	0.070	−0.210	0.179	0.089	−0.095
26	0.233	0.109	−0.168	0.179	0.135	0.005
27	0.243	0.138	−0.178	0.164	0.164	0.042
28	0.241	0.150	−0.157	0.142	0.164	0.075
29	0.216	0.186	−0.101	0.110	0.191	0.119
30	0.213	0.201	−0.114	0.096	0.188	0.113
31	0.198	0.213	−0.082	0.079	0.177	0.126
32	0.161	0.202	0.018	0.057	0.151	0.138
33	0.141	0.168	0.045	0.045	0.110	0.112
34	0.135	0.170	0.025	0.040	0.101	0.097
35	0.105	0.153	0.020	0.029	0.084	0.064
36	0.068	0.116	0.019	0.017	0.057	0.039
37	0.059	0.102	0.026	0.014	0.047	0.046
38	0.044	0.077	0.011	0.011	0.034	0.034
39	0.031	0.060	−0.003	0.007	0.025	0.021
40	0.022	0.040	−0.029	0.005	0.016	0.008

Notes: Own calculations based on NEPS–Adult Starting Cohort data. The effects are those depicted in Figure 5 and estimated according to Eq. 5. Unlike the figure, the baseline hazard and the baseline probability are stated by college status.

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