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Women's Missing Mobility and the Gender Gap in Higher Education: Evidence from Germany's University Expansion

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Abstract

This paper shows that the *local* availability of universities acted as a catalyst in the catch-up of women in higher education that has been documented for developed countries in the latter half of the 20th century. It uses the foundation of new universities in the 1960s and 1970s in West German regions which previously did not have a university as a case study to understand how women's mobility and education decisions interact. I first document women's low regional mobility in post-war West Germany along with their low educational attainment. Second, I exploit that the university expansion exogenously brought universities to women's doorsteps in a difference-in-differences (DiD) strategy. Comparing regions which experienced a university opening within 20 km to those where no university was opened, I show that women benefited more than men from a close-by university opening, closing the local gender gap in university education by about 72%. Third, I provide evidence that local universities partly increased university education through reduced costs, while part of the effect is due to higher expected returns, highlighting an important second channel through which universities promote education to local youths.

Keywords: college gender gap, geographic mobility, university expansion **JEL Codes:** I23, I24, I28, J16

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1 Introduction

The past 50 years have seen a dramatic increase in women's educational attainment in developed countries, in particular in higher education. For every 100 male students enrolled in tertiary education in OECD countries in 1970, there were only 65 female students. This relationship flipped so that the male-female ratio became 1.12 in 2018 (World Bank, 2021), suggesting that women have not only caught up with but even overtaken men in higher education. A similar pattern is observed for West Germany for the birth cohorts 1940 to 1975, as depicted in Figure 1. There has been a steady decline in the male-female difference in university graduation rates which was driven by the increasing participation of women in higher education.

I argue that the increased *local* availability of higher education institutions acted as a catalyst in this catch-up of women. Women's low regional mobility with respect to higher education meant that access to universities was severely restricted for many young women in the 1950s and 1960s. Several studies have shown that the distance to university matters for the decision to enrol in higher education as the costs of university attendance increase with distance (Card, 1995; Frenette, 2004; Spiess and Wrohlich, 2010; Carneiro et al., 2011; Nybom, 2017). But the gendered aspect of this relationship has not been fully understood yet—a gap I aim to fill with this paper. At the onset of their educational catch-up with men, women were less likely than men to move for university education and, hence, the distance to the next university was a greater barrier to them. As countries heavily expanded their tertiary education sectors and started to build universities in areas where there were none before—see, for example, Currie and Moretti (2002, 2003) for college expansions in the United States (US) and Carneiro et al. (2023) for the Norwegian expansion in the 1970s—, this brought universities to women's doorsteps. Did these new local institutions help decrease the gender gap in higher education? If so, was it because of the reduced costs to accessing university? Or did the openings advertise higher education to women by promoting a more accurate picture of the university experience, its returns and their likelihood to succeed?

In this paper, I aim to answer these questions using the expansion of the university sector in West Germany (hereafter also simply "Germany") in the 1960s and 1970s as a case study to understand how local university openings helped overcome women's mobility barriers to higher education. The German expansion was particularly large and quick. Starting with 27 universities in 1964, Germany built 26 new universities until 1978, almost doubling the number of universities in West Germany within less than 15 years. Thereby, improving regional access to university education was an explicit goal of the reform, and universities were opened in regions which previously did not have a university. As a consequence, the average distance to the next university decreased by 38%, from 45 to 28 km.

The analysis builds on rich, individual level data from a representative survey, the National Educational Panel Study (NEPS). The data allow me to observe a person's place of birth at the district level (*Kreis*), a small German administrative unit at the NUTS3 level, comparable to counties in the US. The data further contain comprehensive educational information. This enables me to conduct a detailed analysis on various outcomes along the education distribution, such as high school completion and highest vocational degree, as well as to investigate local effects of universities across different distances. In addition, I have information on the education of parents and whether a person has siblings, allowing for some (albeit crude) measures of family background. The main sample comprises individuals born between 1944 and 1960. Thus, for 1972—the year with the most university openings—, I am able to observe 9 cohorts prior to and 8 cohorts post an opening.

I first document women's low mobility in post-war Germany along with their low educational attainment. While both young men and women were rather immobile in the pre-refom period with 65% of both staying within 40 km of their hometown when starting their first job, differences start to emerge beyond this "comfort zone" of 40 km. For example, while 77% of men stay within 100 km, this is true for 82% of women. These differences in the middle of the distance distribution are meaningful. In 1964, just before the start of the reform period, 55% of districts did not have a university within 40 km, and this translates to a lower probability to attend university for women. While around 21% of men and 16% women born in the 1940s receive a university degree when there is a university within 20 km, a much sharper gender gap emerges when looking at districts further away from a university. Whereas men's probability to obtain a university degree remains relatively stable, women are only half as likely to study at university when the next university is more than 40 km away.

In a second step, I exploit that the German university expansion reform exogenously reduced women's distance to the next university in a difference-in-differences (DiD) strategy, applying a state-of-the-art heterogeneity-robust estimator suggested by Borusyak et al. (2024). Comparing regions which experienced a university opening within 20 km to those where there was no university throughout the sample period and those which had a pre-existing university, I show that women in particular benefited from a close-by university. Local young women's probability to obtain a university degree increased by 15.3 percentage points. For local young men, on the other hand, I find a much lower estimated effect of 8.7 percentage points. Comparing the estimated gender gap in the treatment effect of 6.6 percentage points to pre-reform differences in university education in regions without a university suggests that the openings helped close the local gender gap by around 72%. Indeed, the openings shifted women's entire education distribution upwards, including higher high school graduation rates, while men more often switched from applied university degrees to degrees from regular universities.

The key identifying assumption of my design is that the locations of the new universities were as good as randomly assigned. Indeed, historians argue that "political power balances rather than reasons of regional and education planning" (Führ and Furck, 1998) decided on the precise locations, and I provide some supporting data for this claim. As such, the German education expansion has been used as a source of exogenous variation in other studies, estimating non-monetary returns to education (Kamhöfer et al., 2019) as well as its effect on women's fertility (Kamhöfer and Westphal, 2019) and lifelong-learning (Kramer and Tamm, 2018). To further probe whether my chosen control group represents the counterfactual situation of treated districts well, I conduct several robustness checks for the validity of my design, including a placebo regression only using untreated observations and varying the control group.

I interpret my findings through the lens of a stylised framework which models the vocational education decision of high school graduates as a joint decision of the type of education (apprenticeship training vs. university education) and of the place of where it is obtained (at home or further away). An important feature of this model is that there is uncertainty about the (monetary and non-monetary) returns to university education. This uncertainty depends on the availability of a local university as direct contact to university students and graduates likely helps high school graduates gain a more accurate view on the overt returns to higher education, such as higher income. In addition, a local university can also lower the subtle barriers to university education which a high school student faces when they know scarcely anybody like themselves who attended university. These subtle barriers likely result in lower expected returns to university education, for example because of low expectations on the utility derived from the university experience or because of too low estimates on the individual chances of succeeding at university. Based on this model, I differentiate two channels through which a local university opening can affect the decision of local youths to enrol in university, first through reduced costs and second through updated expected returns. While students who react to the reduced costs will attend the local university, this is not clear for students who react because of updated beliefs on the returns.

I expect women to react more strongly along both margins. First, social norms at the time meant that women expected shorter, more interrupted work histories if they wanted to get married and have a family (Goldin, 2006). In addition, the high occupational segregation of women into lower-paying jobs, possibly also in anticipation of their lower labour market attachment (Blau and Kahn, 2017), and potential discrimination (e.g. Goldin and Rouse, 2000) meant that women might have expected lower life-time labour market returns than men regardless of career interruptions. Taken together, these expectations would have lowered women's willingness to invest in education compared to men (Becker, 1962), especially when the monetary and non-monetary costs were high, such as when they needed to move in order to attend university. Second, the subtle barriers to university might have been particularly high for women. Given that female high school graduates were only half as likely as male ones to know a university student of their own sex, it is likely they underestimate their own chances of succeeding at university, leading them to disregard university education as a possible choice for their further education.

In a third step, I provide descriptive evidence disentangling the channels through which universities increase the educational attainment of local youths. Looking at the place of university of treated students, I first show that around 21% of men attended the local university compared to 35% of women, in line with the argument that women were less willing to move for university education. This can either be due to lower returns to university education or a larger home bias, i.e. a higher preference for women to stay close to home. Investigating mobility patterns of students, I provide suggestive evidence that a the home bias was more binding for women than for men as they more often relied on public transport rather than individual transport, increasing the travel time home when moving further away and decreasing the possible commuting distance. Second, I investigate in how far local universities advertised higher education through updated expected returns lowering the subtle barriers to university education. A simple back-of-the-envelope calculation suggests that 50% of female university students from treated districts decided to opt for university because of updated beliefs on the returns, compared to 32% of men. This highlights another important channel of how local institutions can affect the educational attainment of local youths than has yet been underexplored in the literature.

The importance of local opportunities is widely discussed, also when it comes to higher education. For example, recently, the Danish prime minister has suggested bringing tertiary education to 25 places across Denmark (Myklebust, 2021). Looking at the urban-rural divide in education participation, local schools (Duflo, 2001) and local colleges (Siegler, 2015; Russell et al., 2022) have been shown to increase the education participation of the local youths, thereby decreasing regional inequality. My findings imply that underrepresented groups are most likely to benefit from local openings because their mobility barriers are likely higher due to subtle barriers which cause them to underestimate their returns to higher education. Thereby, my paper adds another dimensions to this debate: Local opportunities can be an important driver for more equal opportunities across the population and can be discussed as complementary policy tools to other interventions, for example to student aid schemes which aim to reduce financial constraints.

My work contributes to the growing literature on women's constrained mobility and their success in the labour market. It has long been shown that family ties restrict women's mobility in their working life with women being either tied movers or tied stayers (see Blau and Kahn, 2017; Cooke, 2008, for an overview). More recently, the literature has examined how women's lower willingness to commute negatively impacts their careers (Petrongolo and Ronchi, 2020; Skora et al., 2020; Le Barbanchon et al., 2021; Bütikofer et al., 2022) and Marcén and Morales (2021) provide evidence that this is driven by gender norms. There is also recent evidence that education decisions are affected by mobility considerations. Benson (2014) argues that women select into geographically flexible occupation, i.e. those where job opportunities are not tied to specific locations, perhaps in anticipation of their future family migration decision problem. Farré and Ortega (2021) show that female college graduates make less ambitious further educational choices if that means moving abroad, and this is partly due to stronger family ties. This paper adds to the literature by showing how mobility behaviour can affect women's education and careers even earlier, right after high school, through the decision to enrol in tertiary education.

My study furthermore adds to the large literature evaluating higher education expansions. I focus on education as an outcome here, while spillovers to other outcomes have also been investigated extensively. A major part of the literature concerning education attainment is concerned with the question whether expansions help decrease the gap between adolescents from different parental backgrounds. Generally, this does not seem to be the case in both developed (Blanden and Machin, 2004; Blanden and Macmillan, 2016; Bratti et al., 2008; Oppedisano, 2011) and developing countries (Ou and Hou, 2019; Méndez, 2020). Few studies focus on equality of opportunity between genders.[1] The evidence is mixed with no gender differences in effects found for Canada (Frenette, 2009) and Turkey (Derebasoglu et al., 2023) in more recent expansions, while Goldin and Katz (2011) find more pronounced effects for the US before the 1930s and Elsayed and Shirshikova (2023) for Egypt in the 1960s and 1970s. Looking at the field of study, the set of results is equally mixed, some studies showing that women chose different majors in response to local institutions more often than men (Knutsen et al., 2020; Braakmann, 2008) while some do not (Rogne et al., 2023). However, these results need to be interpreted in light of their respective historic and social context. The literature agrees, though, that the women who benefit from tertiary education can expect positive wage returns at least as much as men (Devereux and Fan, 2011) or even higher (Walker and Zhu, 2008; Choi, 2015; Kyui, 2016). This paper first adds to the literature by explicitly examining how mobility barriers can results in gendered responses to education expansions. More broadly, I contribute to the literature by disentangling the channels through which local institutions promote educational equality, highlighting the yet underexplored channel of advertising education to the local youths.

By looking at the impact of educational policies on women's higher education partici-

[1]In a related study, Siegler (2015) evaluates whether the German education expansion helped increase local demand for higher education. He finds that a local university or applied university (*Fachhochschulen*) increases the probability that a person holds a university degree by 7 percentage points, and this relationship is somewhat more pronounced for women. In contrast to Siegler (2015) who uses a sample of immobile adults who still live in their place of birth in order to assign treatment at age 22, I directly observe the place of birth for everybody in my sample, enabling me to estimate effects for a broader population and, importantly, look at mobility patterns directly. Siegler (2015) also looks at both universities and applied universities together, showing that most of the effects in his sample are driven by applied universities. I, on the other hand, focus on regular universities because applied universities are not directly comparable. They "rank below universities in terms of pay and status" (Berlingieri et al., 2017, p) so that degrees are not comparable. In addition, very few applied universities were newly founded, but instead local schools of engineering, design etc. were converted into applied universities in the early 1970s. Therefore, it is unclear by how much the local supply of higher education really changed when applied universities were introduced.

pation, I add a new angle to the literature on the rise of women in higher education that has been documented, e.g. by Buchmann and DiPrete (2006); Goldin et al. (2006); Riphahn and Schwientek (2015); Zimmermann et al. (2016). Several factors have been identified as contributing factors to this rise, mostly concerning the changing roles of women in the family and in the labour market.[2] Most related to this paper, changes in the college wage premium (Charles and Luoh, 2003) as well as in the overall standard-of-living gains from college, also comprising marriage market returns (Goldin, 1992, 1997; Diprete and Buchmann, 2006), have been proposed as further reasons for women's rising tertiary education levels. I add to this literature by analysing how, at the onset of these developments, local universities helped speed up the process of women's higher participation in tertiary education by helping them overcome mobility barriers.

The rest of the paper is structured at follows: Section 2 describes the institutional background and the university expansion. I continue to describe the data in section 3, before introducing a stylised framework of joint education and location choice through which I also describe pre-reform mobility patterns in section 4. I describe how I use the expansion as a case-study in section 5 and outline the results in section 6. Section 7 provides evidence on the underlying channels. Section 8 concludes.

[2]These factors start with better fertility control (Goldin and Katz, 2002; Bailey, 2006; Hock, 2007; Ananat and Hungerman, 2012; Bailey et al., 2012) leading to larger career planning horizons of women and changing self-image of women (Goldin, 2006), including women's better preparation for university at high school (Cho, 2007). This was accompanied by changes in labour market opportunities for women (Katz and Murphy, 1992; Blau and Kahn, 2007) brought about by legislation decreasing women's discrimination in the labour market (Goldin, 1991; Neumark and Stock, 2006; Bailey et al., 2023) and in higher education (Rim, 2021), skill- and gender-biased technological change (Black and Juhn, 2000; Weinberg, 2000; Welch, 2000; Black and Spitz-Oener, 2010), as well as a change in norms associated with working married women (Fernández et al., 2004; Fernández, 2013; Fortin, 2015).

2 Reform Background: West Germany's Education Expansion

I argue that the barriers to higher education decreased substantially in the late 1960s and early 1970s in West Germany. This is due to a heavy expansion of higher education institutions during that time. Most relevant in the context of this study are the foundations of new universities which considerably reduced the distance to the next university for many students. In the following, I will describe the expansions against the institutional background of higher education as well as the political climate at the time.

Post-compulsory Education System. After compulsory secondary education, pupils had the choice to continue their education with an apprenticeship training which typically lasted for three years and was paid. Upon completing this, they would be fully qualified to enter the workforce. Alternatively, pupils could decide to attend or continue with secondary education in the academic track (*Gymnasium*, I refer to this as high school) and obtain a university entry qualification.

After obtaining a high school degree (*Abitur*), students could again decide to continue with an apprenticeship training or enrol in higher education. Higher education was generally taught at universities. From the late 1960s, there were also universities of applied sciences (*Fachhochschule*, I also refer to these as applied universities). These were smaller institutions specialised in subjects directly applicable to the labour market, such as engineering, and entry requirements were lower. As such, they fall somewhere between apprenticeship training and regular university education in terms of status and pay (Berlingieri et al., 2017). In this paper, I focus on regular universities only. Appendix B gives more details on applied universities. In 1980, the mean time for obtaining a higher education degree was 5.4 years across all subjects (not weighted by student number), ranging from 3.9 years for economics and social sciences to 7.4 years for medicine (Lundgreen, 2008).[3] There were no tuition fees

[3]Data taken from GESIS Datenarchiv, Köln. histat. Studiennummer 8202, version 1.0.0

but students had to cover their own living costs.

Political Landscape. In the 1960s, educational policy was seen as a priority, and increasing access to higher education was a key component of the political debate. Several developments led to this: First, there was an increasing demand for higher education. This was due to a combination of previous low education levels due to the "anti-intellectualism" (Picht, 1964, p. 66) of the Third Reich, larger cohorts, an influx of migrants, aspirations of the middle class for intergenerational mobility, and an increasing demand for high-skilled work (Führ and Furck, 1998). In addition, exemplified by the Sputnik shock in 1957 when the Soviet Union launched its first satellite (Layard, 2014), it became increasingly apparent to the German public that the educational system needed to be expanded in order to keep up with the East (Bartz, 2006). Last, investments into academic secondary schools meant that a larger share of each cohort was eligible to enrol in higher education (Führ and Furck, 1998; Jürges et al., 2011; Kamhöfer and Schmitz, 2016).

Bartz (2007) dates the beginning of the expansion of higher education to 1964 when Picht (1964) proclaimed an "educational catastrophe" to describe the state of the German education system. The discussion soon after entered a second phase, initiated by Ralf Dahrendorf, in which the individual aspect of educational decisions was stressed. Education was now seen as a "citizen's right" (Dahrendorf, 1965). In particular, inequalities by parental background became the centre of attention. The public phrased terms such as "Catholic worker's daughter from the countryside" (*Katholische Arbeitertochter vom Land*) symbolising the four dimensions of inequality with respect to education that were emphasised in the debate: children from a working class background, girls, children from rural areas, and to some extent Catholic children (Führ and Furck, 1998, p. 92).

University Openings. As a result, the states introduced a whole package of higher education policies. A key measure was the foundation of new universities across West Germany in regions where there was no university before. Appendix B outlines other policy measures regarding higher education which were implemented during this time. Figure 2a shows the number of universities open for teaching and the share of female students over time from 1945 to 1990. While there were 27 universities in 1964, this number had almost doubled to 53 universities in 1978. The share of female students started rising in the early 1950s, which was accelerated from the early 1970s onward, when most new universities were opened and hence the local access to universities was considerably improved. The mean distance to the next university from any given West German district decreased substantially during the reform period as can be seen from Figure 2b. While it was around 45 km in the 1950s, distance to university fell to just under 28 km by 1978. As can be seen from the map in Figure A1 in the appendix, access in particular improved for the densely populated Ruhr Area in the West, and rural areas in Northern Germany and Bavaria. Note that the quality of teaching of the new universities was not perceived as worse since, generally, differences between universities, which were almost exclusively state-owned, were rather small (Führ and Furck, 1998, p. 420).

The university openings happened rather quickly. For example, in 1966, the city of Trier put itself forward as a potential location for a university opening, after which several reports were conducted on this potential location choice. In 1969, the state decided in favour of opening a university in Trier, and the university was formally founded in 1970. Starting from the academic year 1970/1971, the first students were taught at the new university (Küppers et al., 1976). Similarly, the state of North Rhine-Westphalia decided to build a new university in Bochum in 1961, and teaching could start from the academic year 1965/66 (Weisser, 2014).

Location Choice. In contrast to expansion periods in other countries, such as Norway in the 1970s (see e.g. Carneiro et al., 2023), there was no overall regional plan for Germany, and the decision process where to build a new university differed by each individual establishment. The authority to establish new universities lay with the states and the role of the state in the decision process varied widely. While in some cases states decided on a specific city before getting scientific reports on the appropriate micro location within the city (e.g. Trier), in other instances, there were also reports on competing macro locations (e.g. Bochum vs Dortmund) (Arbeitsgruppe Standortforschung, 1971). Even among the scientific reports, different criteria were used to evaluate the quality of a location.[4] In addition, several other political players were involved. The local cities were often involved, too. In their handbook on the history of the German education system, Führ and Furck (1998) go so far as to say that "political power balances rather than reasons of regional and education planning"[5] decided the location of new universities.

In order to better understand the drivers of the location choice, I compare pre-reform characteristics in 1960/61 of districts with pre-existing universities (column (1)), districts with a university opening until 1990 (column (2)), and districts with no university until 1990 (column (3)) in the state of North Rhine-Westphalia (NRW), as presented in Table 1. Most university openings (10 out of 33) happened in this state. As expected, universities are located in more urban areas. This is also mirrored by the industry structure displayed in Panel B. Districts with a university opening have a lower industry share for agriculture. The share working in manufaturing is particulary high in these districts in NRW due to the openings in the Ruhr area. Likewise, the local gross domestic product (GDP) is highest in places with a pre-existing university, whereas districts with an opening fall in the middle between those and districts without a university. However, the GDP growth rate between 1961 and 1970 is very similar between districts with an opening and without any university, indicating that districts were not chosen as locations for new universities on the basis of their (expected) economic development.

[4]Most reports discussed the size and topography of the area to be used, in particular for those universities which were planned as a central campus In addition, most reports mentioned the criteria of accessibility, such as distance to public transport and highways. Many reports also commented on the expected costs but criteria ranged from costs of buying the land to costs of infrastructure. Last, some reports touched upon urban development issues (Arbeitsgruppe Standortforschung, 1971).

[5]Own translation of the German "Die Gründungsentscheidungen der Landtage folgten eher den politischen Kräfteverhältnissen als Gesichtspunkten der Raumordnung und Bildungsplanung." found in (Führ and Furck, 1998, p. 434).

Looking at communal finances in Panel D of Table 1, districts with an opening are very similar to districts with an old university while per capita tax income and expenditure is lower in districts without an openings. However, the new universities were funded by the states, and also partly by federal funds (Stoltenberg, 1969). Therefore, local funding opportunities are unlikely to be the drivers of the location decision. In addition, the results in Panel E show that districts with an opening and without a university were similar in terms of the attainment of secondary education of local youth, making it unlikely that local demand for university education was the key driver of the location choice.

However, a clear pattern emerges, when looking at differences in voting behaviour between districts, presented in panel G of Table 1. Districts with old universities predominantly voted for the Christian Democratic Union of Germany [German: *Christlich Demokratische Union Deutschlands*] (CDU), Germany's main liberal-conservative party in the communal elections of 1961. Between districts with and without an opening, those with an opening voted less for the CDU and more for the Social Democratic Party of Germany [German: *Sozialdemokratische Partei Deutschlands*] (SPD), Germany's main social-democratic party. While the SPD only won the local election in 1961 in 41% of the districts without an opening, this was true for 70% of districts with a university opening. This is important as the state was ruled by an SPD government from 1966 onward, and it is plausible to think that districts governed by SPD politicians were favoured in the university location choice through their more direct personal contact with the state government. Hence, there is some suggestive evidence for Führ and Furck (1998)'s notion that political power balances were a key driver of the location decision for new universities.

3 Data

3.1 Individual Data

For the main analysis, I use individual-level panel data from the National Educational Panel Study (NEPS) (NEPS Network, 2020)[6], see Blossfeld and Roßbach (2019) for details. The NEPS data comes from a nationally representative survey, asking respondents of different age groups about their educational and career trajectories, both current- and retrospectively. The data contain rich information on educational decisions and measures of competencies, making them ideally suited to study the German university openings. I focus on Starting Cohort 6, who were sampled as adults when the survey started (FDZ-LIfBi, 2020). For this age group, interviews are available from 2007/2008 (first survey) to 2018/2019 (wave 10) in the data version I use.

Variables. A key advantage of the NEPS is that it includes detailed regional information, both during childhood and adulthood. Notably, the place of birth is available on the district (*Kreis*) level, a small German administrative area at the NUTS3 level which is comparable to counties in the US. In 2001, the year whose administrative boundary definitions are used in the NEPS, there were 326 districts in West Germany. Information on the place of birth allows me to compute the distance to the next university. I compute distances between district centroids based on a Shapefile for Germany containing the administrative boundaries of 31 December 2001 obtained from GeoBasis-DE/BKG (2013).

In addition, the data set contains detailed educational information, including the timing and place of each education spell. Based on this, I compute a range of outcome variables. Most importantly, based on the highest educational attainment of a person, I define bi-

[6]This study uses data from the National Educational Panel Study (NEPS): Starting Cohort Adults (SC6) (NEPS Network, 2020). 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 has been carried out by the Leibniz Institute for Educational Trajectories (LIfBi) at the University of Bamberg in cooperation with a nationwide network. I use version 11.1.0.

nary indicators for whether that person has a university degree, a degree from an applied university, or an apprenticeship degree with or without a high school degree.

To investigate mobility patterns I compute the distance between the place of birth and the place of the first job, excluding apprenticeship training. For those with a university degree, I also compute the distance between the place of birth and the place where they (first) attended university. Again, distances are computed as distances between district centroids.

The NEPS data also contain information on the family background of respondents. I use two sets of information in particular. First, based on the education of the parents, I divide respondents into those for whom at least one parent has a high school degree and those whose parents do not have a high school degree. Second, I use information of siblings to determine whether the person was an only child or not.

Sample and Summary Statistics. From respondents of the adult starting cohort, I select those born between 1944 and 1960 in West Germany, excluding Berlin, and for whom I have the information on whether or not they obtained a university degree. These cohorts typically finished high school between 1963, i.e. just before the reform period starts, and 1979, i.e. towards the end of the reform period and before major changes to student aid in the 1980s. This leaves me with a sample of 4835 people, 2390 of which are female (49.43%). Table A1 in the appendix shows the summary statistics for the sample, split up by gender (columns (1) and (2)), and split up by treatment groups (columns (3) to (5)).

3.2 Data on University Openings

For data on universities, I rely on the German Statistical Yearbooks from 1953 to 1990 (German Federal Statistical Office, 1953). These contain official statistics on the number of male and female students enrolled at each West German university. I take part of the data from Kamhöfer et al. (2019) who digitised the total student numbers, and I add data on female students. For 1975, there are no student numbers in the Statistical Yearbooks, and I therefore augment the dataset by information from a different publication by the German Statistical Office which also publishes university-level student numbers since 1975 (German Federal Statistical Office, 1977). In addition, for the state of Saarland, student numbers from 1952 to 1963 are only contained in the Statistical Handbook for this state (Statistisches Amt des Saarlandes, 1952), which I add to my main university data.

I only keep regular universities in the data, i.e. I exclude those which are highly specialised such as those training pastors, reserved for the military, or those offering art and music education. In addition, I exclude institutions which exclusively train teachers (*Pädagogische Hochschulen*) and universities of applied sciences (*Fachhochschulen*). Thus, I am left with higher education institutions which offer a wide variety of subjects, typically comprising humanities, social sciences, sciences, and engineering.

Based on when I first observe students in a given university, I infer the year the university was first open for teaching. I cross-checked the histories of all universities to make sure that I capture well the year they opened the university for students. In some cases I made adjustments, for example the university of Düsseldorf was a medical academy, in which students who had completed their first phase theoretical education could receive practical training, before it was turned into a university offering a wider range of subjects at all levels, and so I only treat it as a university from when it actually became one even though I can observe medical students in the data before. For universities founded in the early 1970s, I often have to rely on their publicly available histories as student data for the academic years starting 1972 and 1973 are missing in the statistical yearbooks.

I assign universities to districts based on their current (or last) address which I geocoded using the map services by datasciencetoolkit.org. The current address is mainly taken from the German Rectors' Conference [*Hochschulrektorenkonferenz*] (HRK) which provide a list of all current members on their homepage hochschulkompass.de (obtained on 11 January 2018). In case a university has two campuses, I assign a university to each district based on when the respective campus was opened. Table A2 in the appendix shows the districts with universities and opening years which I use in the analysis.

3.3 Further Data

District characteristics in 1960s. I compile a new dataset of district-level characteristics in 1960/61 for all districts in the state of North Rhine-Westphalia (NRW) to investigate how districts with an opening differ from other districts. To that end, I digitise administrative data from NRW's Statistical Yearbooks for 1961 and 1962 (Statistisches Landesamt Nordrhein-Westfalen, 1961, 1962) as well as from a joint report on the local GDP published by the statistical offices of the federal states (Statistische Landesämter, 1973). I enrich this dataset by the local age structure provided by Klaudat (2018).

Student mobility in 1970s. I complement the analysis using two sources of survey data to learn about mobility behaviour of university students in the 1970s. First, I rely on a mobility survey conducted by the German Federal Ministry for Digital and Transport (BMDV) in 1976, the so-called Continuous Survey on Behavior in Traffic 1976 (KONTIV 76) (Bundesanstalt für Straßenwesen, Köln and Socialdata, Institut für Verkehrs- und Infrastrukturforschung, München, 1987). The data contain detailed information on all trips a person makes on a given day, including time of travel, distance and mode of transport. It further includes background characteristics, including the current employment which allows me to identify students. Second, I use the 1978 German Microcensus which is a representative household survey of 1% of the entire (West) German population conducted by the statistical offices of the states. Households drawn for the survey are required to respond by law, ensuring a high data quality (for details, see Lechert et al., 2008). I use the scientific use file which is a 70% random sample of the full sample (Forschungsdatenzentren der Statistischen Ämter des Bundes und der Länder, 2018). In 1978, the questionnaire contained specific questions about the commute to the place of work or place of study for students, respectively, including time and distance of travel and mode of transport. Together, these two data sources allow me to paint a comprehensive picture of students' commuting behaviour in the 1970s.

4 Stylised Framework of Education and Location Choice

To guide the following discussion, I next develop a stylised framework inspired by Kennan and Walker (2011) which jointly models the decision for vocational education as well as high school graduates' location choice. I interpret pre-reform gender differences in university education through the lens of this model, showing women's missing mobility when it comes to higher education. Based on the model, I continue to outline two channels through which local university openings can affect this decision: through reduced costs, either monetary or non-monetary, and through reduced subtle barriers which cause high school graduates to underestimate the returns to university education.

4.1 Simplified Model

Set-up. Suppose a high school graduate's payoff to vocational training $u(s, l, H(\cdot, l))$ depends on (i) whether they decide to study at university ($s = 1$) or do an apprenticeship training ($s = 0$) and (ii) on whether they stay at home ($H = 1$) during that period. The latter decision is restricted by the availability of a local university ($l = 1$) for those who decide to attend university. The payoff then takes the following form:

$$u(s, l, H(s, l)) = E[Y_s|l] + \alpha H(s, l) - \gamma_0 \mathbf{1}\{s = 1\} - \gamma_1(1 - H(s = 1, l)) \quad \text{where } j, l \in \{0, 1\}. \tag{1}$$

The payoff associated with each choice is comprised of an expected return component $E[Y_s|l]$ and utility derived from staying at home captured in $H(s, l)$. The return component $E[Y_s|l]$ includes both monetary returns, such as lifetime earnings, as well as a non-monetary returns. For example, attending university might be a rewarding experience in itself, for example because it allows for a unique lifestyle or because having an academic education matters for self-perception, such as wanting to follow the family tradition. α is a preference parameter capturing whether or not a high school graduate values moving staying at home, and it can be either positive (home bias) or negative ("itchy feet").

Lastly, each choice is associated with a financial cost. γ_0 captures the general costs associated with attending university (relative to apprenticeship training), such as having to pay for books or a bus ticket. γ_1 then captures the costs that arise in addition if the high school graduate decides to move away from home, such as paying for rent[7].

In this model, there is uncertainty about the returns to university education. This can be regarding both return dimensions—the monetary and non-monetary returns. Importantly, how high school graduates form an expectation about these depends on the availability of a local university. A local university increases the probability to meet or hear of university graduates and their lifestyle, allowing high school students to update the expected returns to tertiary education. When high school students have no contact to university graduates, they might underestimate the monetary value of university education. Regarding the non-monetary returns, the student way of life may become more salient and appealing to students by being able to observe it directly. In addition, the local availability might open up a high school student's choice set to include university at all. Without a local university, local high school students might underestimate their own chances of succeeding because of missing role models, decreasing expected returns to university education. Following Blau and Winkler (2018), I also refer to this as subtle barriers to university education.

This model makes the simplifying assumption that the returns to education are the same regardless of where the education is obtained. Focusing on university education, this simplifies the decision process along two dimensions. First, given heterogeneous returns to

[7]Note that I abstract from liquidity constraints here. From 1971 onward, there was a general student aid scheme which introduced a legal claim for all students to means-tested financial aid. See Appendix 8 for details. Before that, there was a merit-based student aid scheme which was granted to 15-16% of all students in the first half of the 1960s (Stephany, 1967). In addition, due to the flexible curricula, many students worked part-time to finance their studies. Therefore, liquidity constraints do not seem to be the main driver of high school students deciding against enrolling in university.

subjects, this is similar to assuming all subjects can be studied at all universities. I have restricted the analysis to large universities which feature all major study areas, typically including subjects in the humanities, social sciences, sciences, and engineering. Thus, this does not seem like an overly restrictive assumption in this context. Second, the reputation of universities might differ between locations. However, focusing on the monetary returns, these differences seem to be small in Germany compared to other countries. The public discussion, supported by descriptive survey evidence, rather stresses the field of study and the place of the first job as determinants for entry-level wages of university graduates (Lissok, 2016). Therefore, it is unclear to what extent high school students are even aware of differences in the reputation of different universities and whether they factor these in as major determinants in their education choices. Overall, it thus seems reasonable to abstract from differences in returns to university education across institutions.

Decision-making. Going backwards, high school students first decide whether to stay at home or move away for each of the vocational training options, university education or apprenticeship training. For simplicity, I assume that apprenticeship training is always done at home as the location choice of apprentices is not the margin of interest in this paper, i.e. $H(s = 0) = 1$. Empirically, German apprentices in the pre-reform period were surprisingly immobile: 54% (65%) of all apprentices stay within 20 km (40 km) of their hometown[8]. For university education, high school students from places with a local university must decide whether to study at home or to move away if they were to study at all. $H(s = 1, l)$ is hence defined as

$$H(s=1,l) = \begin{cases} \mathbf{1}\{\alpha \geq -\gamma_1\} & \text{if } l = 1, \\ 0 & \text{if } l = 0. \end{cases} \tag{2}$$

[8]Figure A2 in the appendix shows the whole distribution of the distance between the place of birth and the place of vocational training for men and women at the start of the reform period (birth cohorts 1944 to 1947). Overall, around 65% of young people behave similar across genders, staying very local. However, at 40 km distance, the distributions begin to diverge, with women being less mobile. Interestingly, 40 km still seems to be a relevant cut-off for higher education participation decisions for Canadian students in the 1990s as (Frenette, 2006).

Thus, high school students decide to attend the local university rather than studying further away if they have a home bias ($\alpha > 0$) or if their preference for moving away (α¡0) is smaller than the moving cost γ_1 in absolute terms.

In a second step, high school students then decide between university education and apprenticeship training, choosing university if $u(s = 1, l, H(s = 1, l)) \geq u(s = 0, l, H(s = 0))$, which yields

$$E[\Delta Y|l] \geq \gamma_0 + (\gamma_1 + \alpha)(1 - H(s = 1, l)), \tag{3}$$

where Δ refers to differences between attending university and apprenticeship training. The left-hand side captures the expected benefits of choosing tertiary education, increased lifetime earnings and differences in the non-monetary "experience" returns. The right-hand side comprises the costs associated with studying, which are first the direct monetary costs (γ_0) and, for those who do not study at home, the monetary (γ_1) and non-monetary (α) moving costs of not being able to stay at home.

4.2 Pre-reform Gender Differences

German women born in the 1940s have a probability of less than 10% to obtain a university degree, whereas this is more than 20% for young men (see Figure 1). Based on the stylised model, several reasons arise which could explain this pattern. Starting with the benefits, both the true monetary and the non-monetary benefits of university education might be lower for women. The monetary returns might be lower in light of women's interrupted career trajectories at the time[9]. In addition, gender differences in the utility derived from the university experience might also play a role, for example because social expectations for men to have an academic education are higher. These differences in the actual benefits might make attending university too costly, in particular when facing additional moving costs when there is no local university.

[9]However, given that university was also a marriage market, it is not clear that this was true when taking household income into consideration (see e.g. Chiappori et al., 2017; Goldin, 1997).

If high school students had unbiased expectations about the returns and gender differences in the actual returns to university drove the gender differences in university attendance before the reform, we would expect women to have lower university rates than men regardless of whether or not they grew up close to a local university. Figure 3 plots the probability of obtaining a university degree for men and women by whether or not there is a university close to their hometown. While around 20% of men receive a university degree when there is a university within 20 km, women are 4.7 percentage points less likely to obtain one, indeed suggesting differences in the expected returns to university education by gender. A much sharper gender gap emerges when looking at districts further away from a university. Women are only half as less likely as men—a gap of 9 percentage points—to obtain a university degree when the next university is more than 40 km away.

Based on the stylised model, several reasons could explain this missing mobility of women when it comes to university education. First, this could mean that the actual returns are so much lower for women than for men that the additional financial moving costs are not worth it for about half of the women who would otherwise decide to attend university. However, results on the returns to higher education for the US high school class of 1972 show very similar returns for both men and women (Kane and Rouse, 1995), casting doubt on the interpretation of actual returns as the sole driver of observed gender differences in university education. This is particularly true when bearing the German context in mind which featured no tuition fees at the time.

Second, women might face subtle barriers to higher education causing them to underestimate their returns to university education. In particular, given the lower likelihood to know university students and graduates of their own sex, women might perceive university as a male-dominated domain in which they are less likely to succeed—similar to how a lack of role models decreases women's probability to major in male-dominated subjects at university, see Porter and Serra (2020). Third, the non-monetary moving costs in the form of home bias (captured in α) may be higher for women. This could either due to a preference for staying home, for example because friendship networks and family ties are more important for women—as shown for Spanish undergraduate students in the 2010s (Farré and Ortega, 2021)—, or due to social expectations, for example (future) care responsibilities. While its reasons cannot be distinguished in this descriptive analysis, the fact of women's missing mobility suggests considerable scope for local university openings to improve the gender parity among university graduates by bringing universities to women's doorsteps.

4.3 Post-reform Predictions

When a local university opens, this changes a high school graduate's considerations in Equation 3 along two margins: First, moving costs are removed. For some high school students who were on the margin of opting for university education, this will make a difference. In particular for those with a large home bias (captured in α), attending university without the need to move will make university a more attractive choice. A testable implication is that compliers to this channel, i.e. students who only decide to attend university because they can now stay at home, are expected to attend the local university. In addition, given that women seem to have a higher home bias (Farré and Ortega, 2021), I expect women to react more strongly to a local university opening through this channel.

Second, a local university can change the expected benefits of university education—which I also call "advertising higher education". As described above, high school students may have too low expectations on the financial returns to university education if they do not have contact to university graduates in their social circle. In addition, the subtle barriers to university education might be higher without a local university as high school students underestimate their chances of success or the university experience in general when they do not know any (former) university students similar to themselves. In particular, women may face large subtle barriers when no local university is available. As shown in Figure 3, in their social environment, mainly men decide to attend university which could lead women to think that university education is more appropriate for men or they could fear being an outsider in a male-dominated environment. In contrast to removing moving costs, high school students who do decide to attend university after the openings due to updated expected benefits do not necessarily decide to study locally.

Given these considerations, I expect women to benefit more from a local university opening which I will test in Section 6 empirically. I will then provide descriptive evidence disentangling the two adjustment margins—removing moving costs and advertising higher education—in Section 7.

5 Empirical Strategy

Given the sharp gender gaps in university attendance in regions without a local university, did a local university opening help increase the higher education participation of women? In order to answer this question, I exploit the university openings in West Germany in the 1960s and 1970s in a dynamic difference-in-differences (DiD) design, employing a new estimator suggested by Borusyak et al. (2024) to address potential concerns about staggered treatment and dynamic treatment effects.

Treatment definition. To investigate the effects of university openings, I compare adolescents in places with and without university openings. The idea is that adolescents in regions which do not experience a change in access to a university throughout are a good counterfactual to what would have happened to those in regions which experienced an opening. Specifically, I define treatment districts as those which experienced a university opening between 1965 and 1990 within 20 km, where distances are measured as distances between district centroids. The control group is comprised of two types of districts: those which had a university within 20 km before the reform period and those who never a university within 20 km in the reform period.

I chose 20 km as my baseline measure of how far the reach of a university goes in a data-driven way. Specifically, I estimated a separate DiD specification for three types of treatment districts—districts with an opening, with an opening within 20 km and those with an opening between 20 and 40 km—, comparing each district type with those districts which never have a university within 50 km (control). The results, which are presented in section 6, suggest that university openings had a rather local effects no further than 20 km. Figure A3 in the appendix, shows how the average distance to the next university evolves for treated, always-treated and never-treated districts according to the definition of treatment and control groups in the main specification. It can be seen that the distance to the next university was very similar between treated and never-treated districts before the openings but, from the start of the reform, the districts in the treatment group experience stark decrease in the distance to the next university, whereas this is much smaller for never-treated districts.

On the individual level, I define as treated those adolescents who have access to a local reform university within 20 km of their hometown in the year they turn nineteen. Nineteen is a reasonable age as this is the age students typically graduate from high school. However, since it is possible to start university at a later age, and men in particular were more likely to do so due to mandatory military service, I exclude those who turned 20 and 21 in the year of the university opening from the analysis as their treatment status is unclear.

The BJS estimator. In my main specification, I follow Borusyak et al. (2024) who suggest an imputation estimator (which I also refer to as the BJS estimator) which is robust to dynamic treatment effects under staggered treatment adoption – a key concern with the standard two-way fixed effects implementation. The opening of a university could affect different cohorts differently as universities grow over time and, possibly, norms around university education change. If so, a static two-way fixed effects DiD design is not appropriate as already-treated regions may be used as the control group for just-treated units. This can results in biased results and even in sign-reversal (Goodman-Bacon, 2021; Borusyak et al., 2024). I chose the estimator suggested by Borusyak et al. (2024) among the variety of newly suggested estimators as it uses all pre-treatment periods and the control units to compute the counterfactual, making it particularly well-suited to small samples such as mine (for a more detailed comparison of new estimators, see Roth et al., 2023).

Specifically, suppose the following true relationship for person i born in district j in year t:

$$Y_{ijt} = d_j + d_t + \tau_{jt} D_{j,t+19} + u_{ijt} \ , \tag{4}$$

where Y_{ijt} are outcomes for person i of cohort t born in district j. d_j and d_t are district and cohort fixed effects, respectively. $D_{j,t+19}$ is the treatment indicator equal to one if a university is open in a person's hometown when they turn nineteen. Thus, τ_{jt} is the treatment effect of interest, identified by individuals in districts which experience a local university opening. For the main outcome, whether or not a person has a university degree, it captures by how much the probability to have a university degree changes when a local reform university is open in the year a person turns nineteen. Note that this specification allows for treatment effects τ_{jt} that vary by district and cohort, capturing the possibility of dynamic treatment effects. u_{ijt} is the error term.

I am interested in obtaining an average $\overline{\tau}$ for all individuals who were treated by a university opening. The imputation by Borusyak et al. (2024) follows three steps to obtain an estimate for this. First, it uses the control group as well as not-yet treated cohorts born in treatment regions to estimate the fixed effects d_j and d_t. Second, for each treated observation, it computes their imputed treatment effect, $\hat{\tau}_{ijt} = Y_{ijt} - \hat{d}_j - \hat{d}_t$. Third, it obtains an (unweighted) average of the individual imputed treatment effects $\hat{\tau}_{ijt}$.

I follow the conservative inference procedure suggested by Borusyak et al. (2024) and impose equality of estimates for all treated individuals for the computation of standard errors. Standard errors are computed from individual deviations from this average (excluding a unit's own cluster). Due to the small sample size, I chose the largest possible average effect for standard error computation in order to avoid overfitting. However, this is likely the most conservative choice given that there might be heterogeneities in the true treatment effect, for example across cohorts. I cluster standard errors on the place of birth level.

Since I am interested in investigating gender differences, I relax equation 4, by including gender-specific trends and covariates, where g indexes a person's gender:

$$Y_{igjt} = d_j + d_{j \in TG,g} + d_{j \in NT,g} + d_{gt} + d_g + \tau_{gjt} D_{j,t+19} + \beta' X_{igjt} + u_{igjt} \ . \tag{5}$$

To capture the pre-existing gender differences in university attendance between always-treated, never-treated and treatment districts, equation 5 allows for lower baseline levels of university attendance of women in districts in the treatment group $d_{j \in TG,g}$ and in never-treated districts $d_{j \in NT,g}$. In addition, it allows for year fixed effects which differ by gender d_{gt} to capture differential trends in educational attainment irrespective of the openings, as well as for overall gender differences in university education d_g. In the main specification, I also include a vector of individual family background characteristics X_{igjt}, specifically parental education, measured as a dummy of whether at least one parent has a high school degree, and whether or not a person has siblings. The gender-specific average treatment effect $\overline{\tau}_g$ can then be obtained by simply averaging the individual effects for each gender g.

Identifying assumption. The main identifying assumption is that the openings of universities were random with respect to other local developments which would have impacted educational attainment. In other words, both regions with and without openings would have had the same trend in educational attainment in the absence of the openings. I argue this is plausible for several reasons. First, the political decision process described in section 2 implies that the decision where exactly to locate a new university was unsystematic. If anything, universities were targeted at underdeveloped regions which would imply a downward bias in my results. Second, university openings were not planned a long time in advance. From anecdotal evidence on single openings, the duration from announcement to opening was less than five years (Küppers et al., 1976; Weisser, 2014), i.e. the people who were treated at age nineteen were already born. By focusing on the place of birth, I avoid the problem of strategic sorting of parents into regions with universities because they have higher educational aspirations for their children. The treatment effect I estimate can thus be interpreted as an intention-to-treat (ITT) effect. For most students, the place of birth captures treatment well, however. For 73 percent of adolescents in my sample the place where they attend school at age fourteen is the same place as their place of birth, and for 79 percent this is within 20 km.

To investigate the plausibility of the common trend assumption, researchers usually analyse the development of treated and control regions before the treatment start, so-called pre-trends. This BJS estimator also allows for pre-trend testing. Estimating a fully dynamic two-way fixed effects specification to test for the existence of pre-trends, as commonly done, is problematic as this suffers from a similar problem as outlined above if there are heterogeneous treatment effects (Sun and Abraham, 2021). In addition, Roth (2022) outlines two further problems: Those tests may have low power and conditioning on passing those tests, can lead to an increase in the estimation bias. Intuitively, selecting only specifications that pass the condition of no detected pre-trends, restricts the sample in a non-random way. Given that the conventional tests for pre-trends might miss important pre-treatment differences with a non-negligible probability, the resulting estimates from this non-random sample might be even more biased. Borusyak et al. (2024) show that clearly dividing the testing and estimation stages can circumvent the problems that arise with conventional pre-trend testing. I follow them and test for pre-trends by the following regression (abstracting from the gender differences of the full specification in equation 5 for simplicity)

$$Y_{ijt} = d_j + d_t + \sum_{p=-P}^{-1} \gamma_p \mathbb{1}\left[t + 19 = E_j + p\right] + v_{ijt} \ , \tag{6}$$

where $\mathbb{1}\left[t + 19 = E_j + p\right]$ indicate that a university will be opened in district j in p periods relative to the year a person turns nineteen, i.e E_j indicates the year of the local opening in district j. v_{ijt} denotes the error term. I estimate equation (6), using observations from the control group as well as observations from not-yet treated regions. I both plot $\hat{\gamma}_p$

and perform a joint F-test of $\gamma_p = 0$.

The TWFE estimator. In the robustness checks, I also estimate the following conventional two-way fixed effects (TWFE) implementation of the DiD strategy

$$Y_{igjt} = d_j + d_{j \in TG,g} + d_{j \in NT,g} + d_{gt} + d_g + \rho D_{j,t+19} + \beta' X_{igjt} + \varepsilon_{igjt} \ , \tag{7}$$

where everything is defined as above in equation (5) and ε_{igjt} is the idiosyncratic error term. ρ is the main parameter of interest in this specification, capturing the treatment effect of a university opening on the university education of local high school graduates. I also estimate equation 7 by allowing for an interaction of the treatment in $D_{j,t+19}$ and the gender indicator d_g to investigate differential treatment effects by gender. As above, I cluster standard errors on the place of birth level.

6 Results: Reaction to Local University Opening

Event Study. I first present graphic evidence on the pre-trends and treatment effects, pooling both men and women and using an event study design following Borusyak et al. (2024). Figure 4 shows the effect of a university opening on the probability to obtain a university degree across age cohorts. I define those turning 19 in the year of the opening as just treated ($t = 0$), while younger cohorts are treated subsequently longer. The red points on the left-hand side represent the estimated pre-trend coefficients estimated from the sample of the control group (never-treated and always-treated) and the not-yet treated only. I exclude those aged 20 and 21 in the year of the opening as their treatment status is unclear. No clear pre-trend is visible, indicating that cohorts 22 and older at the time of a university opening had a similar likelihood to obtain a university degree as cohorts in other regions, conditioning on baseline differences between districts. If anything, this likelihood is somewhat lower, in line with the idea that universities were opened in underdeveloped regions. This would result in a lower bound estimate of the treatment effects. The F-test for the joint significance of the pre-trend parameters is 1.76 with a p-value of 0.136, indicating that the test cannot reject the null of all pre-trend coefficients jointly being equal to zero. Overall, this evidence supports the assumption that regions without university openings are a good counterfactual for regions with an opening, lending credibility to the dynamic DiD design.

The blue points of Figure 4 show the estimated treatment effects from the imputation procedure. It can be seen that obtaining separate estimates for the years since opening is demanding on the data. Yet, the estimates seem to be centred around the mean overall effects, plotted as the dashed line. There is no evidence of dynamic treatment effects, changing with the time since opening. I therefore continue with pooling the post year effects in my main estimates.

Baseline Estimates. Table 2 presents the results from the DiD analysis applying the BJS estimator based on equation 5, averaged for all post years. Column (1) includes the gender-specific trends and controls from equation 5 but excludes covariates on the family background, whereas column (2) adds these. Panel A shows the results averaged over both men and women, corresponding to the event study graph presented before. Overall, a local university opening increases the probability to have a university degree by around 12 percentage points. This is a sizeable effect of 76.5% if evaluated against the pre-reform probability of 15.8% of obtaining a university degree (defined for cohorts born 1944-1949 who turned 19 in treated regions before the opening or who are from never-treated districts).

Looking at gender differences, I average the individual treatment effect estimated using the BJS estimator by gender. It can be seen in Panel B of Table 2 that women in particular benefited from a local university opening. Without controlling for family background, I estimate a difference in the treatment effect of 9.1 percentage points, significant at the 10% significance level, while this difference drops to 6.6 percentage points when including controls for family background and is less precisely estimated.[10] Compared to the gender gap of 9.1 percentage points in university education in districts without a local university in the 1960s (cf. Figure 3), these estimates suggest that the local university openings helped close that gap by around 72%.

Reach of a Local University. How far do the effects of a local university opening reach? To investigate this, I define three types of treatment: a university opening within the district, a university opening outside the district but within 20 km, and university opening between 20 and 40 km. I then re-estimate equation 5 separately for each treatment type, using districts without a university within 50 km throughout the observation period as the control group. Table 3 summarises the results. It can be seen that university openings exhibit a very localised effect, which is strongest when a university opens within the home district, to which women react particularly strong. Similar patterns have been found for the 1970s university expansion in Sweden (Markus, 2023). The estimates in Table 3 also provide suggestive evidence for some effects within 20 km of a university opening, but no effects beyond 20 km. Therefore, in my main specification, I define the treatment districts by an opening within 20 km.

Shift across the Educational Distribution. At what point in a person's education did the universities openings kick in? To better understand how treated cohorts are shifted across the educational distribution, I look at several educational outcomes in Table 4 and how they change with a local university opening. For men, I find no effect on the overall years of education, a measure which incorporates all formal education, including apprenticeship

[10]While this difference of 6.6 percentage points is no longer statistically significant at conventional significant levels, the estimate for women is still 75% larger than for men in the most demanding specification. Bearing in mind the conservative standard errors which I chose, the demanding estimation specification given the small data, and the robustness of the gender gap across specifications which I will discuss in the following, it thus seems unlikely that the gender gap in treatment effects is entirely a product of noise in the data.

training.[11] For women, local university openings resulted in sizable increases in the total years of education, namely almost 9 months or around 5.7% compared to pre-reform cohorts in treatment and never-treated regions (12.9 years). There is a clear shift of women into obtaining a high school degree, with an almost 10 percentage points higher likelihood after a local opening.[12] Looking at the highest education degree a person acquires, both men and women experience a shift out of apprenticeship training and into university education, which is stronger for women. Men are also less likely attend applied university instead of a regular university. Taken together, the university openings pushed local women into considerably more education, comprising both higher secondary education and university education, suggesting that the entire education distribution was shifted upwards. For local men, on the other hand, the university openings resulted in changes at the upper end of the education distribution, replacing apprenticeship training and applied university degrees by regular university degrees.

Looking at the effect of a university opening on university attendance versus graduation in columns (5) and (6) of Table 4, it can be seen that the effect on university attendance is very similar to the effect on obtaining a university degree. Hence, it seems local youths mostly graduated when given the chance to attend university. Given the retrospective collection of the data, these results need to be interpreted with caution, however.

[11] I use the years of education based on the highest Comparative Analysis of Social Mobility in Industrial Nations (CASMIN) level a person achieves (variable *tx28102*). See Zielonka and Pelz (2015) for details.

[12] I use high school degree to refer to the general university entry qualification, the *Abitur*. At the time, there were two ways to qualify for university enrollment. After compulsory secondary education, ending after 9 or 10 years, pupils could either attend a regular high school (*Gymnasium*) and graduate with a high school degree which allowed them to study any subject at university (*Abitur*). Alternatively, pupils could continue at a specialised school of higher secondary education (e.g. *berufliches Gymnasium*) and graduate with a subject-specific high school degree (*Fachhochschulreife*) which allowed them to study certain subjects at university similar to what they studied in school. In addition, this qualification allowed for enrolling in any degree programme in an applied university (*Fachhochschule*). In the entire sample, 25% of all high school degrees are subject-specific (29% for men, 21% for women). Also note that an increase in high school completion does not mean fewer dropouts in the German context. Rather, it was common to graduate from secondary school at the end of compulsory schooling with age 15 or 16 and then continue with an apprenticeship training.

6.1 Robustness

Model Choice. I investigate the robustness of my findings along two dimensions of model choice, the choice of the control group and the choice of estimator. Table 5 presents the results when using different control groups. In columns (2) and (3), I use as control districts those districts which always had a university within 20 or 30 km. In columns (4)-(6), I use alternative control group of districts which never have access to a university within 20, 30 or 50 km, respectively. From the stability of the results, it becomes clear that the choice of the control group is not the main driver of the baseline estimates.

Next, in Table 6 I compare the BJS estimator in column (1) to the standard TWFE estimator of the DiD strategy in column (2). The estimators as well as the estimated gender gap in the treatment effect are very similar. The TWFE estimates are somewhat smaller, as expected with treatment effects which increase dynamically over time. Overall, this comparison makes clear, that the main estimates are not the artefact of a certain choice of estimator but seem to be stable across specifications.

Common Trends. I now turn to probing the assumption of common time trends between control and treatment district in a more detailed manner. The results are displayed in Table 7. In column (2), I start by allowing differential trends for districts which always had a university within 20 km and the other districts as local norms might be different because of the pre-existing universities, resulting in different trends. In column (3), I add state-year fixed effects to equation 5, so that I only use variation due to openings within a state and year. Note that this also deals with potential concerns of biases arising from short school years.[13] The results remain qualitatively the same over these specifications.

[13]In 1964, the German states also decided to harmonise the start of the school year to August. In most states, the school year started after Easter before. In order to achieve this transition, many states opted for short school years so that they could squeeze two entire school years into the time from April 1966 to July 1967. Hamburg and Berlin opted for a long school year instead, and nothing needed to change in Bavaria. Afterwards, all school years started in August and lasted for one year. Hence, depending on the state of residence, birth cohort and school track attended cohorts born 1947 and 1960 might have been affected by one or two short school years (see Pischke, 2007, for more details). It is unclear whether children subject to short school years are more or less likely to attend university. In principle, it is plausible that they are

In column (4) of Table 7, I present the results from a placebo regression. I re-estimate equation 5 on the sample of individuals being born in the 1940s. For treatment districts, I only keep observations before the real university opening, i.e. who were 22 and older when the university opened. I then assign placebo openings to treatment districts by randomly shifting back the real opening by 3 to 7 years. The estimate on a placebo opening would hence capture potential differences in time trends. As can be seen from the table, there is no significant relationship between a placebo opening and the likelihood to have a university degree.

Taken together, the results in this section show that local universities increased the participation in university education of local youths, and women were affected more strongly. Indeed, the openings shifted women's entire education distribution upwards, while men rather substituted applied university degrees for degrees from regular universities. A back-of-the-envelope calculation suggests that the university openings helped reduce the local gender gap in university education by 72%.

7 Channels: Lowering costs vs. advertising higher education

Why do university openings increase the educational attainment of local youths? The model outlined in Section 4 distinguishes between two broad channels. First, being able to stay at home while attending university reduces both the monetary as well as the non-monetary costs (home bias) associated with university. Second, a local university might impact the returns high school students expect to gain from attending university, ranging for more accurate expectations on the financial returns to lower subtle barriers to participating in

less likely to attend university as they have obtained less years of schooling. Indeed, Pischke (2007) finds that less children attend high school because of short school years. On the other hand, he also shows that employment and earnings later in life are not affected. This could indicate that able students attended high school and university in any case, while less able students were deterred from attending high school. But these students would not have enrolled in university even had they not been exposed to a short school year.

university education.

Table 8 provides descriptive evidence to disentangle those two mechanisms. It shows outcomes on university education for men (column (1)) and women (column (2)) who turned nineteen in treated districts after the openings. The first take-away from this table is that women study more locally than men. 21% of male high school students who obtained a university degree attended the local university compared to 35% of women. This pattern is also mirrored in the distance to the first university which is 95 km for men and 63 km for women.

The higher importance of moving costs for women compared to men can either be due to women expecting lower returns to university education or to women having a larger home bias. Since I cannot disentangle these in the causal analysis presented before, I rely on additional survey data which indicates that women's home bias is more binding than men's. Looking at the commuting patterns of university students in the 1970s in Table 9, it can be seen that men and women commute for around half an hour to university, on average, and that men commute a bit further (15 km vs 13 km), but not substantially so. Instead, women rely much more often on public transport and go by foot rather than using individual transport, such as a car or a motorcycle (which 45% of men use compared to 25% in 1976). This is in line with the lower share of female students with a driving licence—only 46% of women have one compared to 78% of men. These differences become meaningful for longer distances. For example, based on the mobility survey, I compute that going 20 km by public transport took 52 minutes compared to 31 minutes. This means that men are able to commute to a university further away holding commuting time constant. In addition, moving away from home might feel less costly as it was easier and quicker for men to return home, e.g. to keep contact with their social network on the weekends.

However, the removal of moving costs does not seem to be the only factor driving women's higher participation in tertiary education after a local university is opened. To see this, I compute the share of compliers to the university opening (as point estimate from the baseline specification in Table 2, column (2) divided by the share of those obtaining a university degree in the treated regions after the opening, displayed in Table 8). The computed shares are displayed in Table 8 in the bottom panel. Given the higher effect of a local opening for women, the share of compliers is higher for women—85.5%, compared to 52.4% for men. The second take-away from Table 8 is thus that local university openings also increased the expected returns to university education. For both men and women, the share of compliers is much lower than the share of those attending the local university, indicating that some high school students have opted for university education because of a local opening, but not because of the lower costs. A back-of-the-envelope calculation suggests that women chose university education because of updated expected returns to university education more often than men. Assuming that all local students are compliers to the reduced costs of university education, 50.4% (=85.5%-35.1%) of female university students from the reform districts after openings decided to study at university because of the resulting changes in expected returns compared to 31.8% (=52.4%-20.6%) of men. This implies that for both men and women around 60% of compliers opted for university education due to updated beliefs on the expected returns, highlighting the important role of local institutions for advertising higher education.

Taken together, these descriptive results imply that local universities help promote university education among local youths both by lowering the costs to university education and by advertising higher education through updated beliefs on its (monetary and non-monetary) return—the latter being a yet underexplored channel. Local universities further helped close the local gender gap in university education because female high school students reacted more strongly through both channels.

8 Conclusion

In this paper, I argue that the local availability of universities helped overcome mobility barriers faced by women in the 1960s and 1970s which prevented them from participating in higher education if there was no university close to their hometown. I use the expansion of universities in West Germany as a case study to understand these patterns better. I first demonstrate women's lower pre-reform mobility that went along with their lower university education. While there is a gender gap in university education of 4.7 percentage points of youths from a districts with a university within 20 km, this gap doubles to 9.1 percentage points when the next university is more than 40 km away. Whereas men's higher education participation remains relatively stable, women are only half as likely as men to study at university in these districts.

Can local university openings help reduce these gender gaps in higher education? To answer this, I exploit the fact that the West German university expansion brought universities to women's doorsteps. Starting with 27 universities in 1964, the number of universities almost doubled in less than 15 years to 53 institutions in 1978 while new universities were opened in regions which previously did not have good access to a university. In a DiD framework, comparing districts which experienced a reform opening to those where there was no opening (both the always- and the never-treated districts), I analyse how the probability to obtain a university degree changes when a reform university is open in the year a person turns nineteen. I show that the probability to obtain a university degree increased by 15.3 percentage points for women, compared to 8.7 percentage points for men. Indeed, the openings shifted women's entire education distribution upwards, including higher high school graduation rates, while men more often substituted applied university degrees for degrees from regular universities. A back-of-the-envelope calculation suggests that the university openings helped reduce the local gender gap in university education by 72%.

I continue by analysing the underlying channels. Building on a stylised framework which models the vocational education and location decision as a joint decision, I deduct testable implications for two channels through which a local opening can affect the likelihood of local youths to enrol in higher education. First, the reduced costs to accessing university can shift the cost-benefit trade-off in favour of university education. Second, a local university can result in more accurate expectations on the returns to university education, including the expected utility from the university experience and the chances of success—reducing the subtle barriers to university education which a high school student faces when they know scarcely anybody like themselves who attended university. I provide descriptive evidence that women reacted more strongly along both margins, highlighting an important role of local universities which has previously been understudied in the literature: advertising higher education to the local youths.

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Figure 1: Trends in higher education

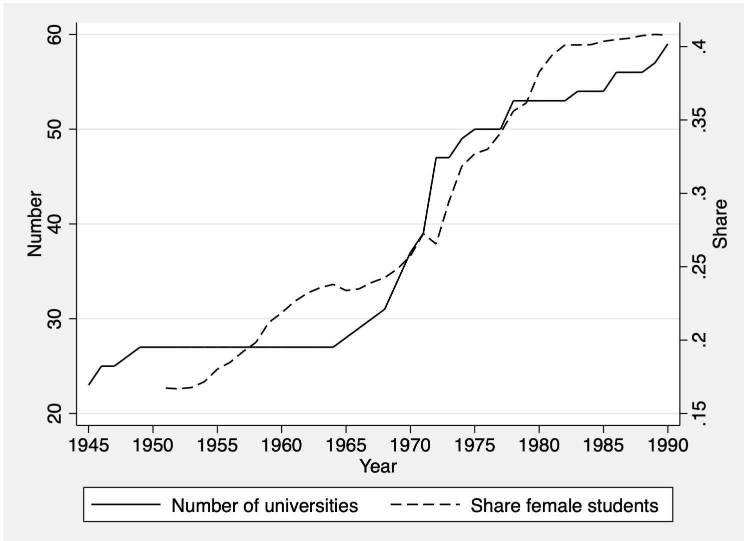
(a) Share with university degree

(b) Gender difference in share

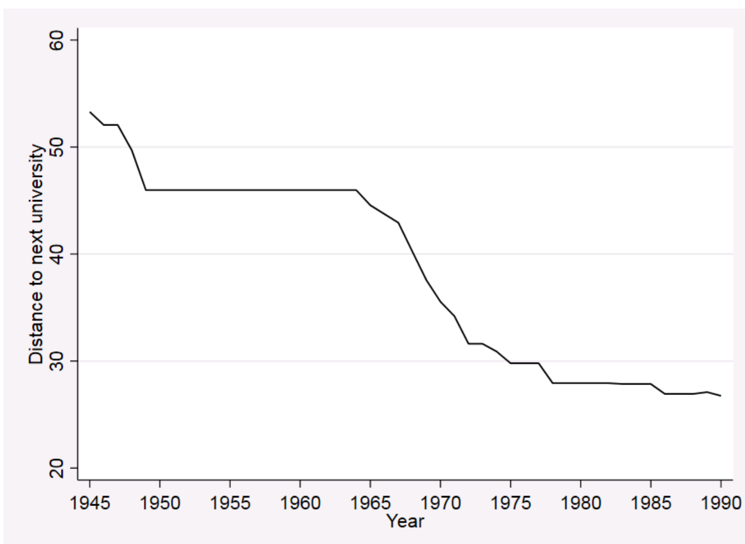
Notes: Part (a) depicts the share of men (solid line) and women (dashed line) with a university degree over birth cohorts 1940-1975 (aged 18 1958-1993). Part (b) show the male-female difference in this share. Both panels show three-year moving averages. The vertical lines marks cohort aged 18 in 1965, i.e. the start of the reform period.

Source: Special analysis of the publication *Bildungsstand* by the German Statistical Office based on the 2017 German Microcensus for people in West Germany born 1940-1975.

Figure 2: German universities over time



(a) Number of universities and share female students

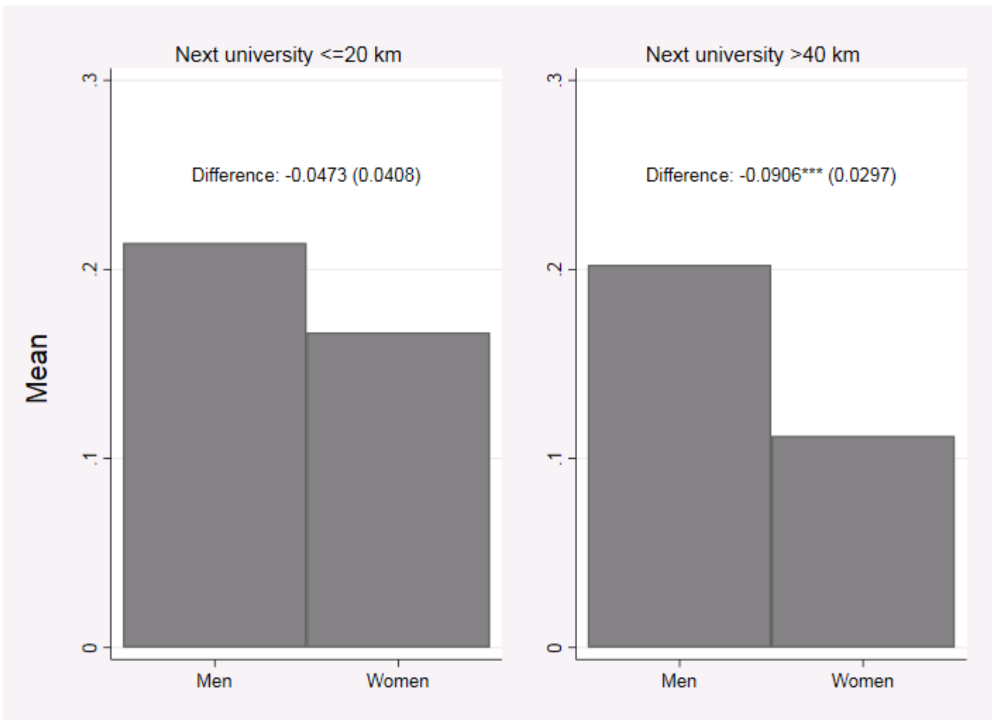


(b) Mean distance to next university

Notes: Part (a) shows the number of universities in West Germany from 1945-1990 (solid line). The dashed line shows the share of women among all students enrolled in West Germany between 1951 and 1990. Part (b) shows the mean distance to the next university for all West German districts between 1945 and 1990. Distances are computed as differences between district centroids.

Source: University and student data taken from the German Statistical Yearbooks 1952-1990 and augmented as described in section 3. Distance computation is based on a Shapefile for Germany in the administrative boundaries of 31 December 2001 obtained from GeoBasis-DE/BKG (2013).

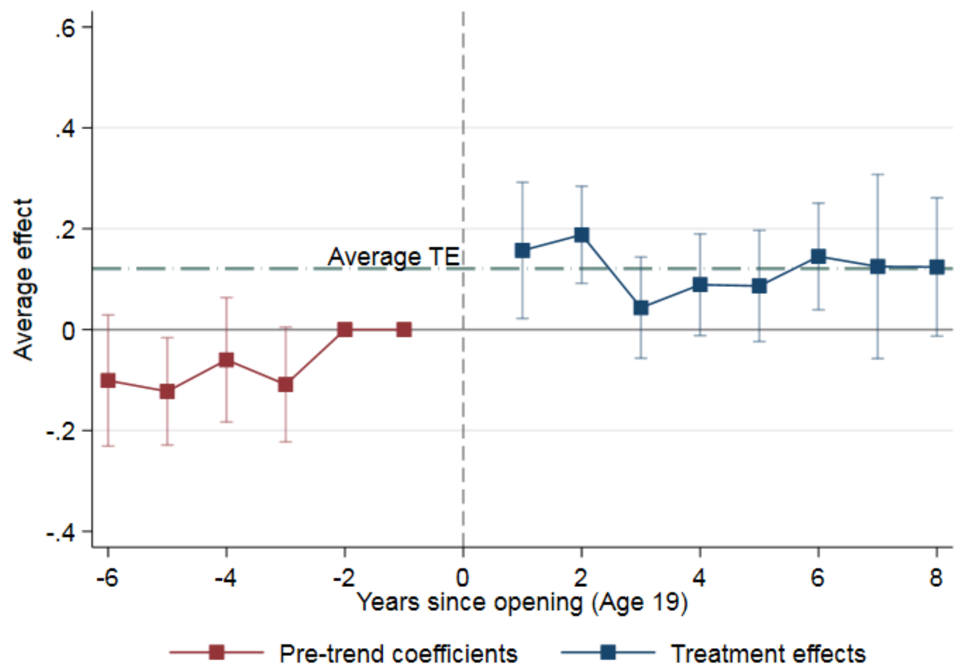
Figure 3: Gendered university education and mobility for 1940s cohorts



Notes: The graph shows the share with a university degree for men and women born in the 1940s by two types of districts, those with a local university within 20 km of when a person turned 19 and those where the next university was more than 40 km away. Four districts switched status for the relevant cohorts as they experienced the first openings—Düsseldorf (1965), Bochum (1966), Konstanz (1967), and Regensburg (1968). Differences are estimated by an Ordinary Least Squares (OLS) regression of university degree on gender, estimated separately for those from districts with with and without a local university. Standard errors are given in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Source: NEPS Network (2020). Cohorts born in West Germany in 1944-1949.

Figure 4: Event study: Probability to obtain a university degree



Notes: The graph shows yearly pre-trends (red) based on equation 6 and yearly post-reform treatment effects (blue) on university graduation for the entire sample according to the imputation by Borusyak et al. (2024) specified in equation 5. The treatment indicator at $t = 0$ captures whether a reform university is opened within 20 km of a person's hometown when they are 19. The control group is comprised of people from districts which had a pre-reform university within 20 km and those which never have a university within 20 km between 1945 and 1990. The dashed horizontal line depicts the average post-reform treatment effect. The estimates control for gender and family background (at least one parent with high school degree, siblings). The F-test on the joint significance of the pre-trend parameters gives an F-statistic of 1.76 with a p-value of 0.136.

Source: NEPS Network (2020). Cohorts born in 1944-1960 in treatment and control districts.

Table 1: Characteristics in 1960/61 of districts with and without university opening (NRW)

	(1) Old university	(2) University opening	(3) No university
Panel A: Population			
Population in 1000s	324.8	379.9	132.8
Popoulation / sq km	3311.3	2819.0	972.6
Women/men	1.1	1.2	1.1
Share population up to age 20	25.2	26.6	30.0
Share population older than 65	10.9	10.8	9.7
Birth surplus (per 1000)	4.9	4.5	8.7
Share migrants	24.1	25.3	23.1
Population growth 1950-1960 (%)	36.3	22.8	15.7
Panel B: Industry structure			
Area share for agriculture (%)	30.6	36.4	54.7
Cattle per 1000 capita	10	30	201
Chicken per 1000 capita	110	348	1281
Share working in manufacturing 1961 (%)	12.4	19.5	16.9
Panel C: Economic development			
GDP 1961 per 1000 capita (DM)	8854	7270	5634
GDP share manufacturing (%)	37.6	59.4	67.0
GDP share services (%)	62.4	39.1	32.0
GDP growth 1961-1970 (%)	110	96	97
Panel D: Communal finances			
Tax income per capita (DM)	185	185	129
Expenditure per capita (DM)	455	411	315
Building investment per capita (DM)	87	85	80
Share building investment of total expenditure	0.19	0.21	0.26
Panel E: Education			
Compulsory school students per teacher	42.88	44.92	43.30
High school students / inhabitants age 7-20	16.42	9.77	7.45
Panel F: Living conditions			
Flats per 1000 population	297	312	277
Hospital beds (acute) per 1000 population	135	95	63
Cars per 1000 population	106	89	80
Panel G: Politics			
Share voted CDU for district in 1961 (%)	52	42	48
Share voted SPD for district in 1961 (%)	33	45	36
SPD won the district election in 1961 (%)	25	70	41
Share voted CDU in state election 1962 (%)	53	41	50
Share voted SPD in state election 1962 (%)	37	49	39
Observations	4	10	81

Notes: The table shows mean pre-reform characteristics of districts in North Rhine-Westphalia (NRW) in 1960, where districts are divided into those with an pre-existing university (column (1)), with an opening (column (2)) and those which do not have a university until 1990 (column (3)).

Source: Data from NRW's Statistical Yearbooks for 1961 and 1962 (Statistisches Landesamt Nordrhein-Westfalen, 1961, 1962). The age structure is based on Klaudat (2018). Data for Panel C is taken from Statistische Landesämter (1973).

Table 2: Difference-in-differences results on the probability to have a university degree

	(1) Excludes family background	(2) Includes family background
Panel A: All		
τ	0.125***	0.121***
	(0.0267)	(0.0301)
N	4556	4490
Panel B: By gender		
τ men	0.0785**	0.0872**
	(0.0388)	(0.0389)
τ women	0.170***	0.153***
	(0.0340)	(0.0394)
Difference	0.091*	0.066
	(0.050)	(0.050)
N	4556	4490

Notes: The table presents estimates of τ from equation 5 following the imputation suggested by Borusyak et al. (2024). The outcome is a binary indicator of having a university degree. The treatment indicator equals 1 if a reform university is open within 20 km of a person's hometown when they are 19, and the analysis excludes those who turn 20 or 21 in the year of the opening. The control group is comprised of people from districts which had a pre-reform university within 20 km and those which never have a university within 20 km between 1945 and 1990. Column (1) presents estimates without covariates on the family background (at least one parent with high school degree, siblings) and column (2) includes these. Both columns include a female indicator, gender-specific yearly trends, and gender-specific treatment group fixed effects. Panel (A) pools the effect for men and women, while it is split up by gender in Panel (B). The bottom part of Panel (B) shows the gender difference in the treatment effects and associated standard errors based on a Wald test of equality of the estimates. Standard errors are given in parentheses, clustered on the place of birth level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Source: NEPS Network (2020). Cohorts born in 1944-1960 in treatment and control districts.

Table 3: Reach of a local university opening

	(1) Within district	(2) outside district, <20 km	(3) 20 km to <40 km
Panel A: All			
τ	0.171**	0.0494	-0.0293
	(0.0699)	(0.0566)	(0.0637)
N	1430	1426	1608
Panel B: By gender			
τ men	0.104	0.0267	-0.0955
	(0.0804)	(0.0794)	(0.0824)
τ women	0.246***	0.0740	0.0585
	(0.0691)	(0.0995)	(0.0649)
Difference	0.142**	0.047	0.154*
	(0.067)	(0.137)	(0.086)
N	1430	1426	1608

Notes: The table presents estimates of τ from equation 5 following the imputation suggested by Borusyak et al. (2024). The outcome is a binary indicator of having a university degree. The treatment indicator equals 1 if a reform university is open within a person's district of home (column (1)), outside the district but within 20 km (column (2)), or between 20 to 40 km (column (3)) when they are 19. The analysis excludes those turning 20 or 21 in the year a university opens within the respective distance. The control group is comprised of people from districts which never have a university within 50 km between 1945 and 1990. All columns include a female indicator, gender-specific yearly trends, gender-specific treatment group fixed effects, and family background characteristics (at least one parent with high school degree, siblings). Panel (A) pools the effect for men and women, while it is split up by gender in Panel (B). The bottom part of Panel (B) shows the gender difference in the treatment effects and associated standard errors based on a Wald test of equality of the estimates. Standard errors are given in parentheses, clustered on the place of birth level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Source: NEPS Network (2020). Cohorts born in 1944-1960 in treatment and control districts.

Table 4: Difference-in-differences results across educational distribution

	(1) Years of education	(2) High school	(3) Apprenticeship training	(4) Applied university	(5) Regular university	(6) Attended university
Panel A: All						
τ	0.383	0.0632	-0.109**	-0.0365	0.121***	0.132***
	(0.252)	(0.0467)	(0.0482)	(0.0296)	(0.0301)	(0.0316)
N	4448	4493	4490	4490	4490	4493
Panel B: By gender						
τ men	0.00613	0.0293	-0.0929	-0.0722*	0.0872**	0.0939**
	(0.331)	(0.0546)	(0.0620)	(0.0415)	(0.0389)	(0.0398)
τ women	0.739***	0.0957*	-0.124**	-0.00225	0.153***	0.168***
	(0.274)	(0.0515)	(0.0618)	(0.0355)	(0.0394)	(0.0431)
Difference	0.733**	0.066	-0.031	0.070	0.066	0.074
	(0.333)	(0.050)	(0.077)	(0.049)	(0.050)	(0.054)
N	4448	4493	4490	4490	4490	4493

Notes: The table presents estimates of τ from equation 5 following the imputation suggested by Borusyak et al. (2024). The treatment indicator equals 1 if a reform university is open within 20 km of a person's hometown when they are 19, and the analysis excludes those who turn 20 or 21 in the year of the opening. The control group is comprised of people from districts which had a pre-reform university within 20 km and those which never have a university within 20 km between 1945 and 1990. The columns compare estimates across different educational outcomes: years of education including apprenticeship training in column (1), probability to have a regular high school degree (*Abitur*, excluding *Fachabitur*) in column (2). Columns (3) to (5) look at a person's highest educational degree, i.e. apprenticeship training (column (3)), degree from an applied university (column (4)), and university degree in column (5) (same as in Table 2, column (2)). Column (6) looks at the likelihood to ever have attended university regardless of graduation. All columns include a female indicator, gender-specific yearly trends, gender-specific treatment group fixed effects, and family background characteristics (at least one parent with high school degree, siblings). Panel (A) pools the effect for men and women, while it is split up by gender in Panel (B). The bottom part of Panel (B) shows the gender difference in the treatment effects and associated standard errors based on a Wald test of equality of the estimates. Standard errors are given in parentheses, clustered on the place of birth level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Source: NEPS Network (2020). Cohorts born in 1944-1960 in treatment and control districts.

Table 5: Robustness to varying control group definition

	Baseline	Always uni within		Never uni within		
	(1)	(2)	(3)	(4)	(5)	(6)
		20 km	30 km	20 km	30 km	50 km
Panel A: All						
τ at age 20	0.121***	0.141***	0.143***	0.117***	0.128***	0.128***
	(0.0301)	(0.0341)	(0.0324)	(0.0326)	(0.0344)	(0.0462)
N	4490	2164	2538	3208	2483	1199
Panel B: By gender						
τ men	0.0872**	0.0997**	0.0983**	0.0870**	0.107**	0.0882
	(0.0389)	(0.0435)	(0.0416)	(0.0413)	(0.0447)	(0.0602)
τ women	0.153***	0.180***	0.186***	0.145***	0.148***	0.166***
	(0.0394)	(0.0423)	(0.0409)	(0.0419)	(0.0428)	(0.0537)
Difference	0.066	0.081	0.088*	0.058	0.041	0.078
	(0.050)	(0.052)	(0.051)	(0.052)	(0.054)	(0.067)
N	4490	2164	2538	3208	2483	1199

Notes: The table presents estimates of τ from equation 5 following the imputation suggested by Borusyak et al. (2024). The outcome is a binary indicator of having a university degree. The treatment indicator equals 1 if a reform university is open within 20 km of a person's hometown when they are 19, and the analysis excludes those who turn 20 or 21 in the year of the opening. The columns compare estimates across different control group definitions: Column (1) repeats the baseline from Table 2, column (2) where the control group is comprised of people from districts which had a pre-reform university within 20 km and those which never have a university within 20 km between 1945 and 1990. Columns (2) and (3) restrict the control group to districts which always had a university within 20 or 30 km, respectively. In columns (4)-(6) only districts which never had university within 20/30/50 km are used as the control group. All columns include a female indicator, gender-specific yearly trends, gender-specific treatment group fixed effects, and family background characteristics (at least one parent with high school degree, siblings). Panel (A) pools the effect for men and women, while it is split up by gender in Panel (B). The bottom part of Panel (B) shows the gender difference in the treatment effects and associated standard errors based on a Wald test of equality of the estimates. Standard errors are given in parentheses, clustered on the place of birth level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Source: NEPS Network (2020). Cohorts born in 1944-1960 in treatment and control districts where the definition varies by columns as explained in the table notes.

Table 6: Robustness to estimator choice

	(1) BJS	(2) TWFE
Panel A: All		
τ	0.121***	
	(0.0301)	
Opening × post		0.110***
		(0.0382)
N	4490	4490
Panel B: By gender		
τ men	0.0872**	
	(0.0389)	
τ women	0.153***	
	(0.0394)	
Men: Opening × post		0.0818*
		(0.0428)
Women: Opening × post		0.138***
		(0.0466)
Difference	0.066	0.056
	(0.050)	(0.047)
N	4490	4490

Notes: The table presents estimates of τ from equation 5 following the imputation suggested by Borusyak et al. (2024) in column (1) (same as the baseline in Table 2, column (2)) and estimates of ρ from the TWFE specification in equation 7 in column (2). The outcome is a binary indicator of having a university degree. The treatment indicator equals 1 if a reform university is open within 20 km of a person's hometown when they are 19, and the analysis excludes those who turn 20 or 21 in the year of the opening. The control group is comprised of people from districts which had a pre-reform university within 20 km and those which never have a university within 20 km between 1945 and 1990. Both columns include a female indicator, gender-specific yearly trends, gender-specific treatment group fixed effects, and family background characteristics (at least one parent with high school degree, siblings). Panel (A) pools the effect for men and women, while it is split up by gender in Panel (B). The bottom part of Panel (B) shows the gender difference in the treatment effects and associated standard errors based on a Wald test of equality of the estimates. Standard errors are given in parentheses, clustered on the place of birth level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Source: NEPS Network (2020). Cohorts born in 1944-1960 in treatment and control districts.

Table 7: Results probing the common time trend assumption

	(1) Baseline	(2) Always-treaetd × year FE	(3) State × year FE	(4) Placebo
Panel A: All				
τ	0.121***	0.117***	0.0921**	-0.0367
	(0.0301)	(0.0311)	(0.0406)	(0.0579)
N	4490	4490	4476	3890
Panel B: By gender				
τ men	0.0872**	0.0845**	0.0600	-0.0570
	(0.0389)	(0.0396)	(0.0542)	(0.104)
τ women	0.153***	0.148***	0.122***	-0.0151
	(0.0394)	(0.0404)	(0.0452)	(0.0608)
Difference	0.066	0.064	0.062	0.042
	(0.050)	(0.050)	(0.058)	(0.120)
N	4490	4490	4476	3890

Notes: The table presents estimates of τ from equation 5 following the imputation suggested by Borusyak et al. (2024). The outcome is a binary indicator of having a university degree. The treatment indicator equals 1 if a reform university is open within 20 km of a person's hometown when they are 19, and the analysis excludes those who turn 20 or 21 in the year of the opening. The control group is comprised of people from districts which had a pre-reform university within 20 km and those which never have a university within 20 km between 1945 and 1990. Column (1) repeats the baseline from Table 2, column (2) while columns (2) and (3) allow for more flexible parametrisations of the yearly trend, i.e. by allowing specific year fixed effects for the always treated districts (column (2)) or for states (column (3)). Column (4) presents results on a placebo analysis which only includes individuals from treatment regions before their respective openings (and the entire control group) and where treatment is randomly shifted backwards 3-7 years. All columns include a female indicator, gender-specific yearly trends, gender-specific treatment group fixed effects, and family background characteristics (at least one parent with high school degree, siblings). Panel (A) pools the effect for men and women, while it is split up by gender in Panel (B). The bottom part of Panel (B) shows the gender difference in the treatment effects and associated standard errors based on a Wald test of equality of the estimates. Standard errors are given in parentheses, clustered on the place of birth level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Source: NEPS Network (2020). Cohorts born in 1944-1960 in treatment and control districts. In column (4) only individuals from treatment districts are included who were 22 and older in the year that a university opened.

Table 8: Compliers and treated students' location choice

	(1)	(2)
	Men	Women
	mean	mean
University degree	0.166	0.179
Distance to first university (km)	94.582	62.616
Attended local university	0.206	0.351
Share compliers	0.524	0.855
N	367	396

Notes: The table shows mean characteristics for men and women who turned 19 in districts which experienced an opening in or after the year of the opening. Note that the place of university is missing for around half of the observations, specifically for 44.3% of men and 47.9% of men. The share of compliers is computed as the gender-specific baseline estimate from Table 2, column (2) divided by the share of those with a university degree.

Source: NEPS Network (2020). Cohorts born in 1944-1960 in treatment who turned 19 in or after the year of the opening.

Table 9: Commuting patterns of university students in the 1970s

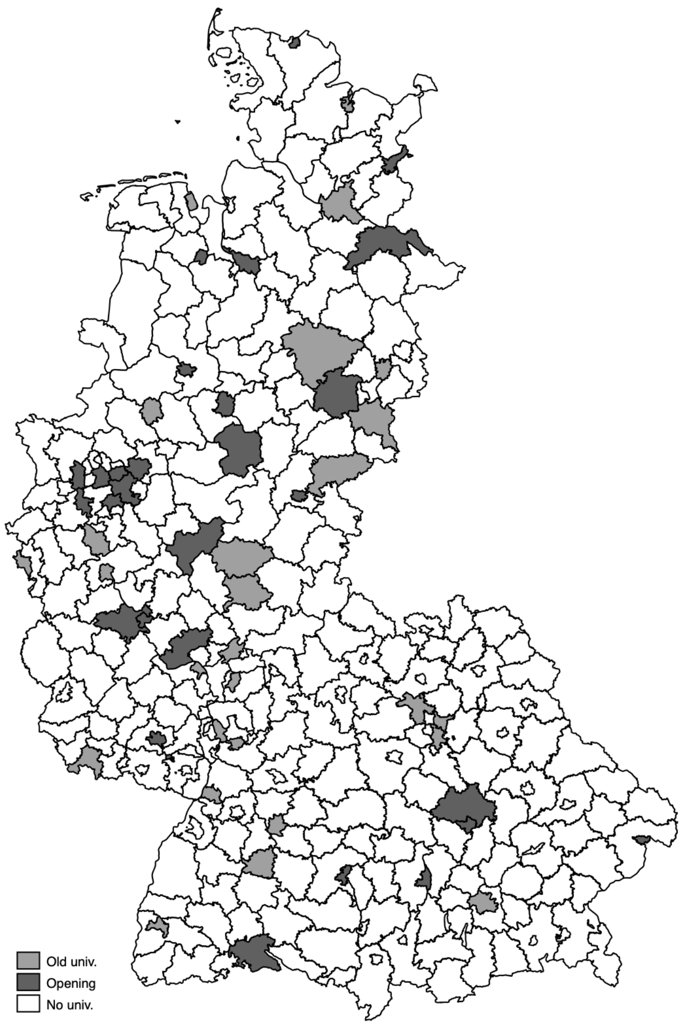
	Mobility survey 1976			Microcensus 1978	
	Men	Women		Men	Women
Panel A: Mode of transport (%)					
Public	30.04	44.69	Public	27.48	38.62
Individual	44.54	25.00	Individual	54.16	41.80
By foot	25.41	30.31	By foot	18.36	19.58
Panel B: Distance of commute					
Mean duration in min	31.1	31.0	*Time (%)*		
			<= 30 minutes	73.13	71.37
			< 1 hour	17.61	19.55
			>= 1 hour	9.26	9.08
Mean distance in km	15.2	12.6	*Distance (%)*		
			< 10 km	58.46	61.62
			>= 10 to < 25 km	22.65	20.81
			>= 15 to < 50 km	9.51	8.65
			>=50 km	9.38	8.92
Panel C: Student characteristics (%)					
Has driving licence	77.95	45.69	Living at home	33.25	30.91
Owns car or motorcylce	54.59	21.83			
N	6140	3088			
N commutes	1448	848	*N*	3392	2203

Notes: The table shows mean characteristics for commutes of university students in the 1970s based on a mobility survey conducted by the German Federal Ministry for Digital and Transport (BMDV) in 1976 (columns (1) and (2)) and the German Microcensus from 1978 (columns (3) and (4)) by gender.

Source: Columns (1) and (2) are based on the Continuous Survey on Behavior in Traffic 1976 (Bundesanstalt für Straßenwesen, Köln and Socialdata, Institut für Verkehrs- und Infrastrukturforschung, München, 1987). Columns (3) and (4) are based on 1978 German Microcensus (Forschungsdatenzentren der Statistischen Ämter des Bundes und der Länder, 2018).

Appendix A. Further Figures and Tables

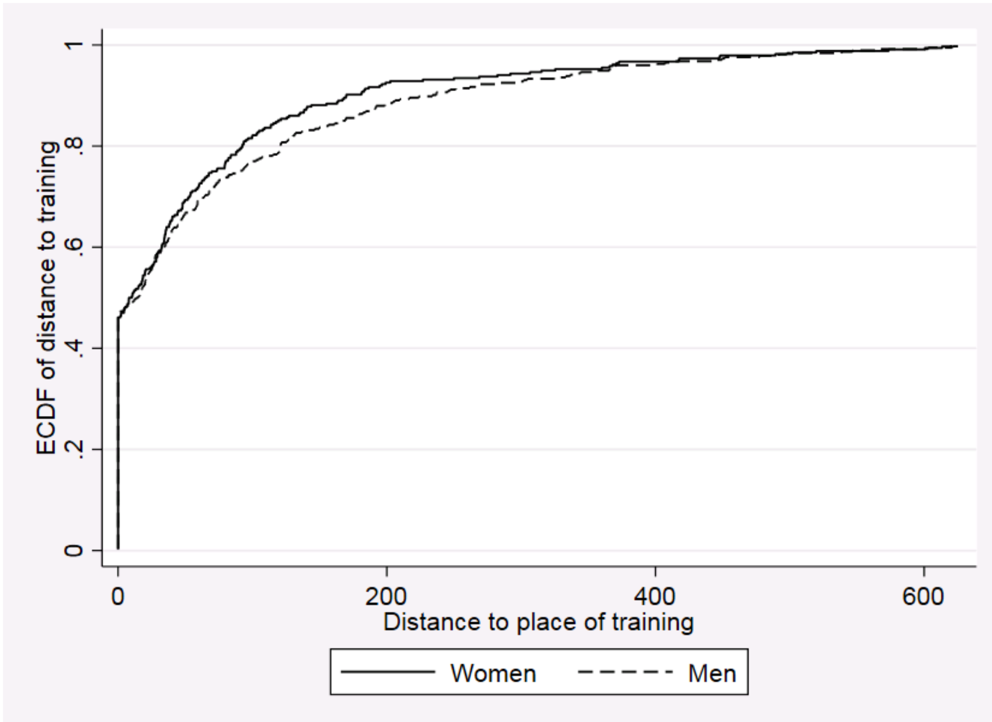
Figure A1: Map of university openings



Notes: The map shows West German districts, where districts do not have a university in the sample period (1945-1990). Light grey districts are those with a pre-existing university (opened 1949 by the latest). Dark grey districts experienced a reform opening between 1965 and 1990.

Source: University data based on the German Statistical Yearbooks 1952-1990 and augmented as described in section 3. Geographic information from a Shapefile for Germany in the administrative boundaries of 31 December 2001 obtained from GeoBasis-DE/BKG (2013).

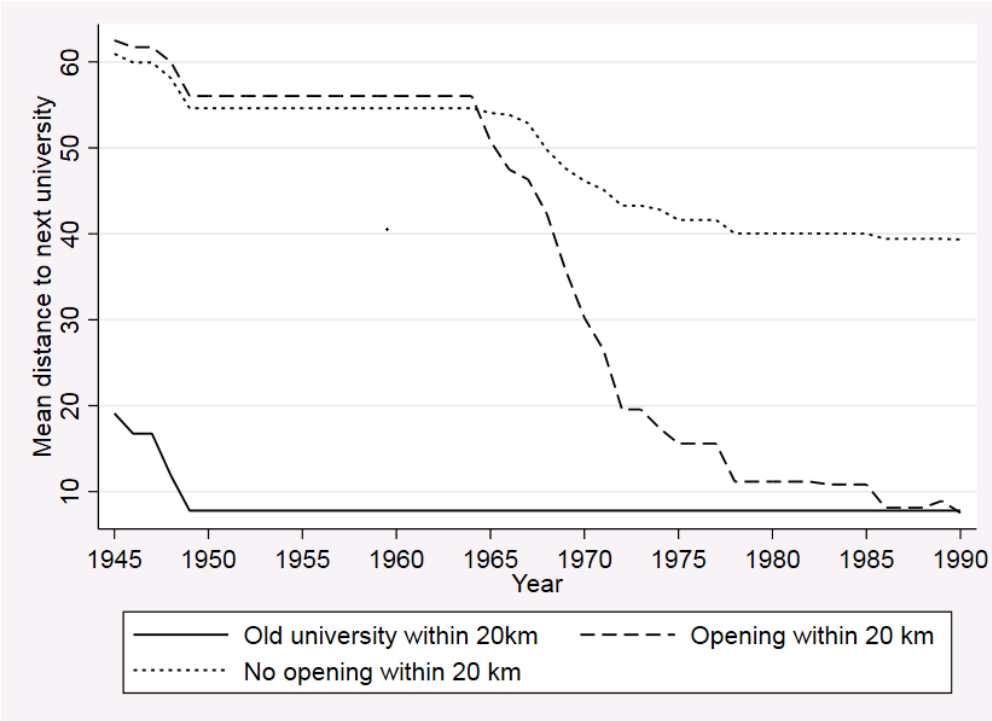
Figure A2: Mobility to vocational training before the reform



Notes: The figure shows empirical Cumulative Distribution Function (CDF) of the distance between the place of birth and the place of vocational training (first place of university, first place of apprenticeship training, or, if missing, place of first job) for pre-reform cohorts born 1944-1947 (aged 18 1962-1965). Distances are computed as differences between district centroids.

Source: NEPS Network (2020), cohorts born 1944-1947 in West Germany. Distance computation is based on a Shapefile for Germany in the administrative boundaries of 31 December 2001 obtained from GeoBasis-DE/BKG (2013). CDF computed using the package `distcomp` (Kaplan, 2019).

Figure A3: Distance to university by district type



Notes: The figure shows the mean distance to the next university for three types of districts: those with an old university within 20 km (opened 1949 by the latest, solid line), those which experience an opening within 20 km from 1965-1990 (dashed line), and those which never have university within 20 km between 1945 and 1990 (dotted line). The first and the last comprise the control group of the main analysis. Distances are computed as differences between district centroids.

Source: University data based on the German Statistical Yearbooks 1952-1990 and augmented as described in section 3. Distance computation is based on a Shapefile for Germany in the administrative boundaries of 31 December 2001 obtained from GeoBasis-DE/BKG (2013).

Table A1: Summary statistics

	(1) Male	(2) Female	(3) Always-treated districts	(4) Reform districts	(5) Never-treated districts
Panel A: Personal characteristics					
Female	0.00	1.00	0.48	0.52	0.49
Year of birth	1953.05	1953.54	1953.58	1953.33	1953.11
German nationality since birth	0.99	1.00	0.99	0.99	1.00
At least one parent with high school degree	0.15	0.18	0.25	0.17	0.12
Panel B: Educational outcomes					
High school dregree (Abitur)	0.27	0.23	0.30	0.25	0.23
Apprenticeship training	0.64	0.68	0.62	0.67	0.68
Highest degree from applied university (FH)	0.10	0.04	0.08	0.08	0.07
Highest degree from university	0.19	0.15	0.21	0.16	0.16
Panel C: Distance measures [in km]					
To next university at age 21	27.27	27.19	5.52	18.75	43.39
To first vocational training	55.05	50.17	45.10	47.72	59.23
To first attended university	110.24	98.96	79.75	108.61	123.08
N	2445	2390	1297	1178	2360

Notes: The table shows the mean value for key variables in my sample of people born between 1944 and 1960 in West Germany. Columns (1) and (2) split the sample by gender, whereas columns (3) to (5) splits it up by treatment group, i.e. those who were born in districts which always had university within 20 km from 1950 onwards (column (3)), those born in district which experienced an opening within 20 km between 1965 and 1990 (column (4)), and those born in districts where there was no university within 20 km until 1990 (column (5)).

Source: NEPS Network (2020). Cohorts born in 1944-1960 in West Germany.

Table A2: University districts and opening years

City	Opening year	City	Opening year
Aachen	before or in 1945	Regensburg	1968
Bonn	before or in 1945	Bielefeld	1969
Braunschweig	before or in 1945	Dortmund	1969
Clausthal	before or in 1945	Ulm	1969
Darmstadt	before or in 1945	Augsburg	1970
Erlangen	before or in 1945	Kaiserslautern	1970
Frankfurt	before or in 1945	Trier	1970
Freiburg	before or in 1945	Bremen	1971
Giessen	before or in 1945	Kassel	1971
Goettingen	before or in 1945	Bamberg	1972
Hamburg	before or in 1945	Duisburg	1972
Hannover	before or in 1945	Eichstaett	1972
Heidelberg	before or in 1945	Essen	1972
Hohenheim	before or in 1945	Luebeck	1972
Karlsruhe	before or in 1945	Paderborn	1972
Kiel	before or in 1945	Siegen	1972
Koeln	before or in 1945	Wuppertal	1972
Marburg	before or in 1945	Oldenburg	1974
Muenchen	before or in 1945	Osnabrueck	1974
Muenster	before or in 1945	Bayreuth	1975
Nuernberg	before or in 1945	Hildesheim	1978
Tuebingen	before or in 1945	Lueneburg	1978
Wuerzburg	before or in 1945	Passau	1978
Mainz	1946	Witten-Herdeke	1983
Mannheim	1946	Flensburg	1986
Saarbruecken	1948	Vallendar	1986
Wihlelmshaven	1949	Ingolstadt	1989
Duesseldorf	1965	Oestrich-Winkel	1989
Bochum	1966	Koblenz	1990
Konstanz	1967	Landau	1990

Notes: The table shows university districts (cities) and when I first treat a university as open for teaching.

Source: German Statistical Yearbooks 1952-1990 and augmented as described in section 3.

Appendix B. Further Higher Education Policies

In addition to the university openings, a new type of higher education institution was created: the university of applied sciences (*Fachhochschule*, I also refer to these as applied universities). The goal was to make higher education less elitist by allowing students to easily switch between more applied and more academic tracks. Entry qualifications for applied universities were lower than at regular uninversities and the curriculum was tailored towards high-skilled applied work on the labour market. Mostly, the foundation of applied universities meant upgrading existing institutions, such as schools of engineering (*Ingenieursschulen*) or other higher schools (*Höhere Fachschulen*) which provided training in subjects such as social work or business and economics. Given that applied universities were mostly transformations of existing institutions, I do not consider applied universities in the analysis.

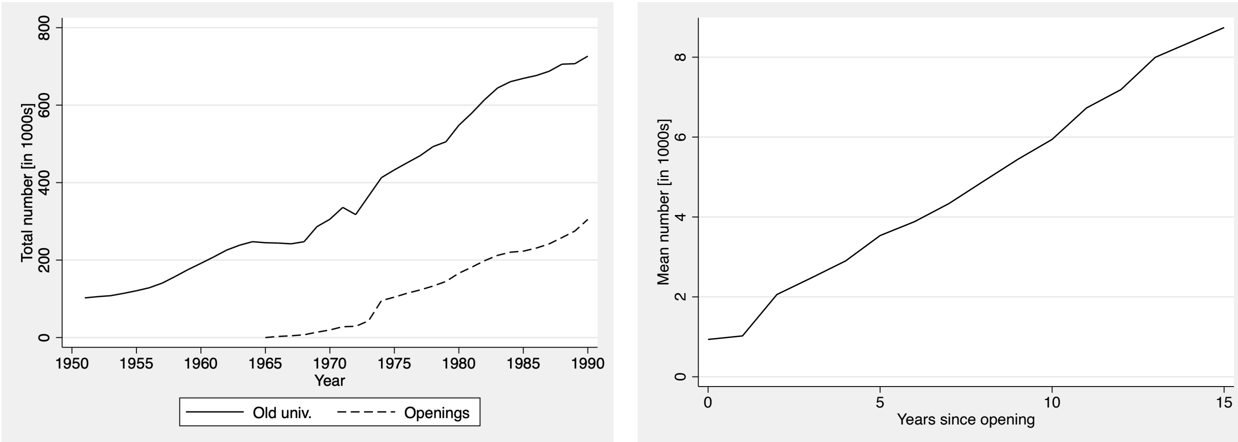
From the end of the 1960ies, a new idea came up which was the organisational combination of regular and applied university into the so-called comprehensive universities (*Gesamthochschule*). The idea was to allow for both applied and regular tracks at these institutions, so that students would be able to easily switch between tracks. While it was initially planned to transform all regular universities into comprehensive universities, this did not happen (Bartz, 2007), and in the end, the few newly founded comprehensive universities became regular universities instead. Therefore, I treat comprehensive universities like regular ones in my analysis.

In addition to opening new institutions, capacities of all universities were increased as can be seen from Figure B1. However, capacity considerations were little systematic. According to a government statement of 1973, state and federal governments started to devise a comprehensive and long-term plan for German universities only in 1970 (Bundesregierung, 1973). For this, studies predicting both the overall, regional and subject-specific demand (Heine et al., 1980) were used as a basis for further planning (Bundesregierung, 1973). Again, there was no clear formula which these reports follows, and in instead several approaches were used to derive capacities on the university level, as outlined in Griese (1970). The most widely used approaches in practice involved a formula which computed university places based on the number of courses, the number of participants per course and the number of courses a student needs to take. However, it is unclear what the real consequences these capacity considerations meant for university access. Capacity constraints were binding only in a range of subjects (mostly medical, dental medicine and veterinary medicine studies, as well as some other sciences, such as chemistry and pharmacy, and psychology (Bundesregierung, 1973)).[14] Therefore, increased capacities largely reflect increased demand rather than removing direct access barriers.

Lastly, the government introduced a generous student funding scheme in its Federal Training Assistance Act (*Bundesasbildungsförderungsgesetz, BAföG*) in 1971. Importantly, the law introduced a legal claim on training assistance and parental or spousal income was the only eligibility criterion, in contrast to previous scholarship-type funding options which were preliminary merit-based. The training assistance was the same for men and women,

[14]Note that this did not change by a ruling of the Federal Constitutional Law (*Bundesverfassungsgericht*) in 1972, which resulted in a centralised system for admission into programs with high demand (*Zentralstelle für die Vergabe von Studienplätzen, ZVS*). Constraints in the above-mentioned subjects remained binding, in particular for medical studies, pharmacy and psychology (for 1973, see Bundesregierung, 1973).

Figure B1: The importance of new universities



(a) Students in old and new universities

(b) New universities grew

Notes: Part (a) shows the number of students in old universities (solid line) and new universities (dashed line) between 1945 and 1990. Panel (b) shows the student number growth of new universities since their opening.

Source: University and student data taken from the German Statistical Yearbooks 1952-1990 and augmented as described in section 3.

and higher if a student had to cover rental expenditure. Therefore, the introduction of Federal Training Assistance cannot explain the heterogeneities I observe between regions and between men and women.