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The influence of regional school infrastructure and labor market conditions on the transition process to secondary schooling in Germany

Abstract

After the systematic disadvantage of educational opportunities for children from rural areas in comparison to children from urban areas was a central research topic in the 1960s and 1970s, the role of regional disparities for educational opportunities at the transition to secondary level of the education system in Germany is now only irregularly discussed. There is still a relative lack of educational infrastructure in rural areas and regional labor market structures have hardly been considered as possible further determinants of regional educational disparities. Moreover, in the few current studies, important individual factors such as competencies, grades, school recommendations and educational aspirations could not be taken into account or they refer to individual regions. This paper picks up the question and tries to overcome these restrictions via combining data from the National Educational Panel Study Starting Cohort 3 (NEPS SC3) and regional information at the individual level. Once enriched with information on regional infrastructure, this data set not only contains necessary information on educational decisions, but also on important control variables at the individual level as mentioned above. Using multiple imputation to deal with missing values, hierarchical logistic regressions allow for investigating the impact of regional infrastructure on the probability of attending a high school in the school year 2010/2011 in Germany. The results show that school infrastructures are still significant factors in school choice even when controlling for relevant individual factors. The analyses show that a higher proportion of high schools to all secondary schools in the county a student lives in increases the probability that a high school is chosen at the transition from elementary to secondary school. For regional labor market structures no effects are revealed in this study.

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Keywords
School choice; Regional infrastructure; Hierarchical binary logistic regression, Missing values

Der Einfluss regionaler Bildungsinfrastruktur und Arbeitsmarktbedingungen beim Übergangsprozess zu weiterführenden Schulen in Deutschland

Zusammenfassung
Nachdem die Bildungsbenachteiligung von Kinder aus ländlichen Gebieten im Vergleich zu Kindern aus städtischen in den 1960er und 1970er Jahren noch ein zentrales Forschungsthema war, wird die Rolle regionaler Disparitäten in Bezug auf Bildungschancen am Übergang zur Sekundarstufe des Bildungssystems in Deutschland zwischenzeitlich nur mehr unregelmäßig diskutiert. Dabei ist nach wie vor ein relativer Mangel an Bildungsinfrastruktur in ländlichen Gebieten zu verzeichnen. Zudem wurden regionale Arbeitsmarktstrukturen als mögliche weitere Determinanten von regionalen Bildungsdisparitäten bislang noch kaum in Betracht gezogen. Auch konnten in den wenigen, aktuellen Studien wichtige individuelle Faktoren wie Kompetenzen, Noten, Schulempfehlungen und Bildungsaspirationen nicht berücksichtigt werden oder sie beziehen sich auf einzelne Regionen. Daher greift das vorliegende Papier die Frage nach regionalen Bildungsdisparitäten erneut auf und versucht, diese Restriktionen mit Daten der Startkohorte 3 (NEPS SC3) des Nationalen Bildungspanels zu überwinden. Nach der Anreicherung mit Informationen über die regionale Infrastruktur enthält dieser Datensatz nicht nur notwendige Informationen über Bildungsentscheidungen, sondern auch über die oben erwähnten Kontrollvariablen auf der individuellen Ebene. Hierarchische logistische Regressionen ermöglichen unter Rückgriff auf Multiple Imputation zwecks Handhabung fehlender Werte die Untersuchung des Einflusses der regionalen Infrastruktur auf die Wahrscheinlichkeit im Schuljahr 2010/2011 in Deutschland ein Gymnasium zu besuchen. Die Ergebnisse zeigen, dass regionale Schulinfrastrukturen weiterhin signifikante Faktoren bei der Schulwahl sind, selbst nach Kontrolle relevanter individueller Faktoren. Die Analysen zeigen, dass ein höherer Anteil der Gymnasien an allen weiterführenden Schulen des Kreises, in dem ein Schüler lebt, die Wahrscheinlichkeit erhöht, dass ein Gymnasium beim Übergang von der Grundschule zur weiterführenden Schule gewählt wird. Für regionale Arbeitsmarktstrukturen können keine Effekte festgestellt werden.

Schlagworte
Schulwahl; Regionale Infrastruktur; Mehrebenenanalyse; Imputation

1. Introduction

Peisert (1967) coined the metaphor of the catholic working class girl in rural areas. It refers to the four especially disadvantaged groups regarding educational opportunities in the 1960ies in Germany. This metaphor was, and is still present in current educational research, since sex (e.g. Stanat, Bergmann, & Tarazow, 2016) as well as social background (e.g. Henz & Maas, 1995; Shavit & Blossfeld, 1993; Georg, 2006; Becker & Lauterbach, 2016; Schindler, 2015, 2017; Buchholz & Pratter, 2017; Blossfeld, Blossfeld, & Blossfeld, 2019) are either central objects of investigation or serve as default control variables. Next to sex and social background, research has addressed the effects of being affliated to a certain religion, but there are doubts that there ever was, and is an effect of religion per se if social origin is controlled for (Helbig & Schneider 2014).

However, the effects of regional origin and infrastructure on educational opportunities have not received the same level of attention. There are few studies (see review of literature) dealing with this question, most of which utilize indicators for urbanity, instead of measuring infrastructure directly. Sixt (2010, 2013) measures the educational offering based on the number of schools per county ("Kreise"). Furthermore, the regional perspective was widened not only to include educational opportunity structures, but also to encompass labor market conditions, which could also be relevant for educational decisions. The analyses are based on data for birth cohorts ranging from 1980 to 1996 in West Germany as provided by the GSOEP. Unfortunately with these data, relevant factors for educational decisions such as competencies, grades, school recommendations or educational aspirations cannot be controlled for. Also for labor market structures the operationalization of the appropriate context measurements is still an open question. Further, these former analyses refer to educational decisions between 1990 and 2006 and are hence not informative about developments in the school infrastructure over the last few years, such as for example the school closures related to decreasing numbers of students as discussed in Weishaupt (2006). After educational expansion and in times of overall increased educational aspirations (Gehrmann, 2019 p. 104) one could hence ask if regional infrastructures still play a role at all.

The fact that less attention has been set on regional disparities is astonishing since on the aggregate level school infrastructure as well as educational participation rates in Germany are often focused. According to the National Report on Education, the sizes of catchment areas in general have been increasing from metropolis to sparsely populated districts for all school tracks, see Tab. D1-7web Autorengruppe Bildungsberichterstattung (2016). For schools where pupils can pursue a high school degree ("Abitur"), the average catchment area varies from 9.5 sq. km for a metropolis, to 52.2 sq. km for urban counties, and 139.9 sq. km and 236.1 sq. km in rural counties with some agglomerations and sparsely populated counties respectively. The report also documents regional educational disparities between districts in terms of the proportion of students attending high schools in the seventh grade in the school year 2014/2015, with this figure varying between 74 and 12 percent (Autorengruppe Bildungsberichterstattung, 2016, p. 78). This evidence suggests that regional disparities prevail. The question is then whether they have an impact at the individual level of educational decisions.

In line with Sixt (2010, 2013) this paper addresses the question of the influence of regional infrastructure in Germany on educational decisions at the transition from elementary to secondary education. The paper tries to overcome some of the restrictions of the former studies and reassesses the results of former analyses. The transition itself has always been a sensible phase for later educational success (Blossfeld, 1988). Students typically enter secondary education after grade four in most federal states. The individual choice is between different tracks or types of school, where a rough categorization is based on the school types "Hauptschule", "Realschule", "Gesamtschule", "Schulen mit mehreren Bildungsgängen", and "Gymnasium". While in general "Hauptschule" and "Realschule" prepare for a vocational education, the "Gymnasium" can be seen as a kind of high or grammar school preparing for academic education and university. "Gesamtschule" or "Schulen mit mehreren Bildungsgängen" are kinds of comprehensive schools where students learn both vocational and academic skills, but only in some cases they provide a high school degree ("Hochschulreife"/"Abitur") that enables university entrance directly. Throughout secondary education, students can move upward or downward between school tracks. The "downward mobility" of students from the academically oriented school type to the lower or middle secondary school types and the comprehensive school type is, however, much higher than "upward mobility" (Baumert, Trautwein, & Artelt, 2003; Rösner, 2005; Hillmert & Jacob, 2005; Ditton, Elsäßer, Gölz, Stahn, & Wohlkinger, 2017; Zielonka, 2017).

This article focuses in particular on the choice to attend high school ("Gymnasium") in comparison to other types of secondary schooling. High schools are much more spatially segregated than other non-academic school types, and the choice of a high school is the clearest expression of the educational desire for academic education. It opens up a direct path to tertiary education, and offers the most options for revising the path taken. The de-differentiation of the German secondary school system in recent years, due to demographic change (Bartl & Sackmann, 2014), tending towards a two-track system is also in line with a dichotomous view on the decision. Consequently, the corresponding regional infrastructure is operationalized as the proportion of high schools in a county in comparison to all other schools in the secondary school system. In addition, the paper at hand delves into the question of the influence that regional infrastructures related to labor market conditions exhibit on the decision for high school attendance. In doing so, the paper largely follows the analyses of Sixt (2010, 2013) and replicates these results in a broader sense on the basis of more adequate and recent data.

After the recapitulation of current research in section 2, section 3 provides theoretical considerations regarding the educational decision studied following the cost-return approach. Regional characteristics are defined as determining factors of relative costs and returns, rating different benefits of educational alternatives.

Section 4 gives an overview of the data used and section 5 provides a description of the statistical methods. Section 6 provides the empirical results, and the paper ends with a short conclusion and discussion of the results in section 7.

2. Review of literature

Baur (1972) provided an analysis addressing the effects of residence size on the educational decision to enter different types of secondary schooling. The transition rates calculated based on data from parent surveys in Baden-Württemberg in the years 1967, 1968, and 1969 differ according to the size of residential areas: the bigger the community, the higher the high school attendance rates. Based on the Mikrozensus data from 1972, Trommer-Krug (1980) compares the proportion of students in the age range between ten and fifteen in the different school tracks and uses as indicators for the regional infrastructure the length of the journey to school and the size of residence. Her results show, that in communities under 20,000 inhabitants, only 11 percent of the observed students attend high school, whilst this proportion reaches 20 percent in communities with more than 20,000 inhabitants. Henz and Maas (1995) study the differences regarding educational opportunities between rural and urban regions in Germany via multilevel regression models. Using data from the The German Life History Study on western German cohorts born between 1929 and 1961, their results point to an – although for younger cohorts diminished – still persistent negative effect of rural residence on the probability of attending high school when separating between sex and controlling for social origin. Taking a look at school offer and demand in Hamburg in 1973, Bartels (1975) analyses data from a parent questionnaire of grade four students. While the intention prevailed to send children to a certain school type ("Gesamtschule"), the children actually attended other types of schools. One reason was that the intended school type was too far away. Nowey (1983) has published similar results from a study in Bavaria combining official data from the Bavarian State Offce for Statistics and data from a second official source ("Strukturdatenbestand in der Fachdatenbank des Bayerischen Staatsministeriums für Landesentwicklung und Umweltfragen"). He concluded that the choice probability of a certain school decreases with the distance to that school.

Hansen (1993) has looked at the motivations of school choice for parents in Dortmund using a full census of all parents of grade four students at elementary schools in the school year 1986/1987. As the most important motives for selecting a school, more than half of the parents named "no long journeys" and "school nearby". In the group of parents who had not chosen a high school, the proportion of parents providing these answers was even higher. Only for the group of parents of future high school students the intended degree was a more important determinant of school choice than the physical distance to the school (Hansen, 1993, p. 142). This is in line with the results of Fickermann (1997) investigating the preferred school type of elementary school parents and the regional school structure in Thuringia in 1991/1992. He reported that the aspiration to attend a high school declined with the distance to the next high school: 46 percent of parents wanted their children to go to high school if there was a high school at their place of residence, 42 percent if the high school was up to five kilometers away. This proportion became much smaller if in order to attend a high school the children had to travel five to ten kilometers or even further, with 27 percent and 15 percent of parents respectively. Via path analysis, Fickermann (1997) confirms the development of regional disparities in terms of the density of schools as a determining factor of school choice. Even nowadays the distance to school seems to be a very important factor for school choice. This has been confirmed by Clausen (2006, 2008) using sample data of parents and students in grade four from Mannheim and Heidelberg. Riedel, Schneider, Schuchart, and Weishaupt (2010) investigating elementary school choice in Wuppertal highlight that schools nearby are chosen more often than those in line with the administrative school districts.

Sixt (2010, 2013) has investigated the correlation between the proportion of high schools to all secondary schools in a county and the probability to attend a high school via logistic multilevel regressions with data from the German Socio-Economic Panel (GSOEP) to obtain a better approximation for school infrastructure. The results show a significant and positive relationship between the proportion of high schools in a county and the probability of starting at high school for first-born children of the birth cohorts ranging from 1980 to 1996 in West Germany. Furthermore, the analysis focused on the interaction of regional and social origin and the question whether the regional infrastructure is more important for children with a less advantageous social background. The study documents an interaction effect but not as expected, as especially children with parents with an academic background profit from a higher proportion of high schools to all secondary schools in a county. As a possible explanation a so-called "Composition" effect was discussed, as the result could be influenced by the effect that families with higher amount of positive resources for education (measured by income, educational or occupational status) could be found in regions with a better (school) infrastructure more often. However, when interpreting the results of this study, one should take into consideration that the results could not be controlled for important individual variables, since e.g. competencies, grades, school recommendation or educational aspirations are not incorporated in the GSOEP data. As these variables are central for the selection of the school track (see theoretical considerations below) the results also could be biased. Sixt (2018) tries to overcome these restrictions by taking a closer look at decisions regarding high school attendance in the school year 2016/2017 via data from a regional project in Upper Franconia. She measures relevant individual information and uses physical distances to potential schools instead of aggregate measures regarding school offering available in administrative data. Furthermore, she controls for the region the families live in. These analyses reveal two central findings. First, in case distances are used in the multivariate logistic regression models, there is no difference between children living in rural and in urban areas in terms of the probability to attend a high school. Secondly, the further away the high school is from the place of residence, the less likely children attend high schools – independently of social origin. Unfortunately, these findings can be generalized for rather rural areas like Upper Franconia only, and it remains an open question if there is an effect of regional origin on educational opportunities at the national level.

In addition, the question remains whether there are any other regional structures that influence (individual) decisions at the transition to secondary education. Former studies have considered labor market indicators for the transition to vocational training and found some evidence for positive correlations (e.g. Bolder 1975, 1984; for a more current study, see Hillmert, Hartung, & Weßling, 2017). Sixt (2010, 2013) transfers this question to the transition from elementary to secondary school and argues in terms of a more or less long-term estimation of the benefits parents expect of a certain school track respectively school certificate. Staying in school for a longer time can be a strategy to avoid youth unemployment in a rather weak labor market. Reaching a high school certificate could also enhance the chances of getting an apprenticeship. In a strong labor market with a demand for differentiated qualified employees, the chances to get a job with another educational certificate than a high school degree are even higher, so that the benefits of alternative school tracks should increase. But, with regard to the results, the unemployment rate and the number of highly qualified persons at the level of "Raumordnungsregionen" show no effects. In her discussion, Sixt (2010, 2013) refers to the uncertainty whether the available operationalization of regional labor markets in terms of "Raumordnungsregionen" is the relevant one, as parents may have in mind an individually defined labor market context without correspondence to administrative borders.

Summarizing the literature discussed here, the effect of regional infrastructure on school choice seems to have decreased over time. However, the importance of the regional school offering for educational decisions has not disappeared, and the distance to school is one important factor determining parents' choice of school for their children. The studies mentioned so far typically work with indicators (size of residence, classification rural/urban area) for the reachability of schools and show that there is a gap between rural and urban areas regarding educational opportunities at the transition to secondary school, at least until the year 1990. Recent studies working with more direct measures for the offer or the reachability of schools are rare, while those of Sixt (2010, 2013) have other restrictions. This article is therefore concerned about the relevance of residence and region for educational success in Germany nowadays. We try to overcome the restrictions discussed above and ask again if the regional school offer and labor market conditions influence the educational decision of parents at the transition from elementary to secondary school.

3. Theoretical considerations

The theoretical considerations on the effects of regional infrastructure on educational decisions in the papers Sixt (2010, 2013) and in the paper at hand are based on a cost-benefit approach. Such approaches, especially those taking a sociological perspective on Rational Choice Theory (RCT), are currently – despite all criticism (Simon, 1993) – predominantly used as an explanatory approach, especially when it comes to educational inequality (Stocké, 2012). At the core of the sociological RCT, as found in Boudon (1974), Erikson and Jonsson (1996), Breen and Goldthorpe (1997) or Esser (1999), is the assumption that actors in decision-making situations weigh up the (subjectively expected) utilities of the possible alternatives against each other and then decide on those with the highest utility.

The utility is on the one hand based on the (subjectively expected) costs of an alternative. This includes direct costs like financial costs, as well as opportunity costs that arise from lost earnings due to longer schooling instead of working on the labor market, but also expenditures in the form of time. Regional infrastructure plays an important role in determining costs. A worse or less dense offer of schools in a region leads to longer journeys to schools for individuals. This implies higher direct costs in the form of time and money spent on traveling to school. Also, higher opportunity costs arise if time must be spent on the journey to school instead for homework, hobbies, or friends. Furthermore, a longer journey to school can go along with physical or psychological stress, which needs to be taken into account as a cost factor as well.

To calculate the utility of a specific school choice, the costs of this alternative are balanced with its (subjectively expected) benefits. These can be decomposed into benefits conditional on successfully achieving the corresponding educational certificate, and the corresponding success probabilities. With a high school degree ("Abitur") it is argued that chances on the labor market, such as the chance of obtaining a job with a higher salary or with higher job security, are higher than with another degree. Thus regional labor market structures are possible determinants of the benefits of educational decisions, as these shape parental expectations regarding perceived benefits paying off the costs of education. Taking investment in education, e.g. the choice of a high school, as an investment in a child's competitivity regarding better jobs or job security, we would argue that the regional rate of unemployment has an impact on the kind of school track that is chosen at the end of primary education. We assume that the default choice favors a high school compared to other school tracks if there is a high rate of unemployment. Parents' logic would be to bestow upon a child an advantage against the competition when it comes to apprenticeships, and in the long run, good jobs, by ensuring them a high school degree. An alternative interpretation could be that longer periods spent at school push back the transition to the labor market and may protect a child against youth unemployment. We further assume that individual expectations are formed by the regional labor market structure, as the investment in higher education may be easier to amortize in labor markets that require highly qualified people. Accordingly, a relationship between the chosen educational alternative and the qualification profile that is typically demanded on the labor market can be expected. If there is a high proportion of jobs where higher education is requested, the expected benefits of attending high school increase. If there is a low proportion of highly-skilled jobs, the benefits and the utility of the high school track are reduced.

Last but not least, *subjective expectations* are depending on the individual context, where this context relates to individual factors like age, the assessment of abilities, and skills (see also primary effects of social origin, Boudon, 1974, pp. 29ff.). To access these factors, school grades and school recommendations (which can also be seen as formal restrictions in some federal states) are taken into account. Furthermore, family factors like income, occupation or level of parent education play an important role. For example, educational inequalities according to social origin are in part explained by different subjective expectations with regard to success probabilities associated with alternative educational tracks given the same level of performance. This leads to social selective educational decisions, as parents with higher education levels expect a higher probability of their children successfully finishing the chosen school track and have higher educational aspirations (secondary effects of social origin, Boudon, 1974, pp. 29ff.; see e.g. Relikowski, 2012; Gresch 2012). In addition, gender (see e.g. Schuchart 2010) as well as migration background (see e.g. Kristen & Dollmann, 2009) are seen as important individual factors that lead to different educational aspirations and therefore different educational decisions.

Summarizing the argumentation with regard to regional infrastructure, we expect that (a) the better the regional offer of a certain educational option is, the more likely this option will be chosen due to lower costs. As the benefits of choosing this school type should increase, we expect that (b) the worse the regional labor market is regarding job security, and (c) the more highly qualified the occupations offered in a regional labor market are, the more likely a high school will be chosen.

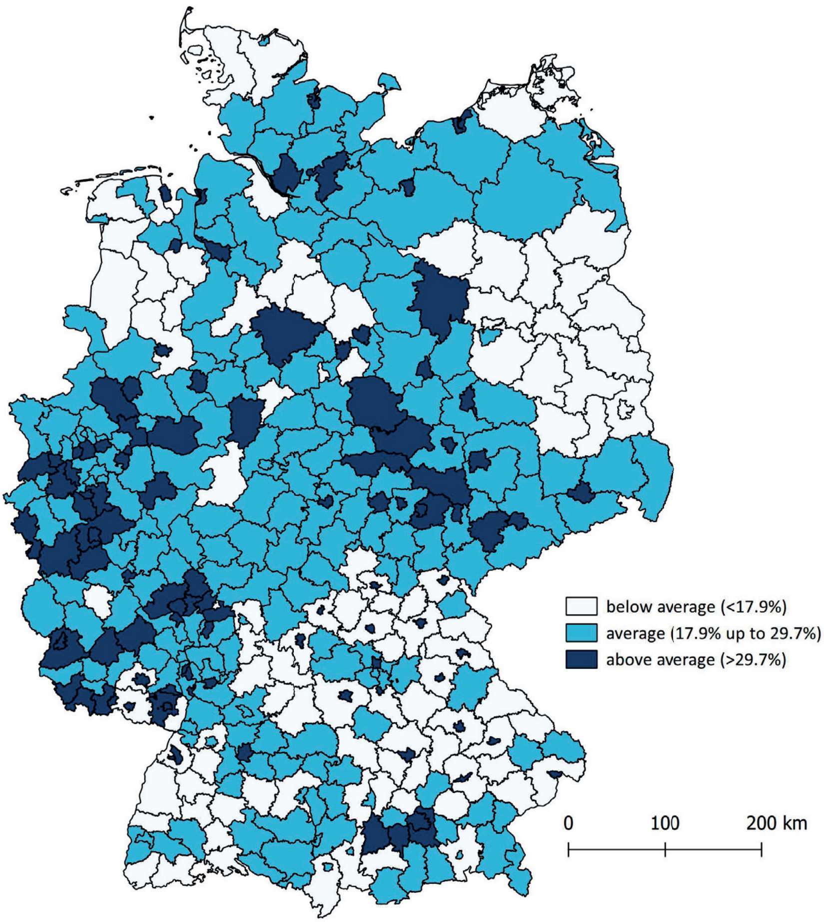
4. Description of data and sample characteristics

To test the formulated theses, individual and aggregated regional data providing information on individual educational decisions, as well as regional structures need to be considered. Data from the National Educational Panel Study: Starting Cohort Grade 5, doi: 10.5157/NEPS:SC3:6.0.1. (NEPS SC3) is used to assess individual and family characteristics, as well as educational decisions. From 2008 to 2013, NEPS data was collected as part of the Framework Program for the Promotion of Empirical Educational Research, funded by the German Federal Ministry of Education and Research (BMBF). As of 2014, NEPS is carried out by the Leibniz Institute for Educational Trajectories (LIfBi) at the University of Bamberg, in cooperation with a nationwide network (for a short overview see Blossfeld, von Maurice, & Schneider, 2011). It contains data for a sample of fifth-graders who opted at the end of the school year 2009/2010 for secondary school tracks (see below for information on the sampling approach). Hence, data on regional structures match to the time point of the decision whenever possible. The matching of regional data to NEPS SC3 is based on the municipality coding as of 31.12.2013, where there are 402 counties in Germany in 2013. Because of regional reforms, the number of counties varies from 2009 to 2013, especially due to reforms of the cutting of county regions in the eastern parts of Germany. In most cases, counties were simply pooled by the reforms, so that the corresponding structural information could be easily calculated for the new counties. In two cases the new borders do not fit with the old ones, so the structural information was adjusted proportional to population.

We use (analogous to Sixt 2010, 2013) the 4-stage *classification of counties* of the Federal Institute for Research on Building, Urban Affairs and Spatial Development (Bundesinstitut für Bau-, Stadt- und Raumforschung, BBSR). From the total of 402 German counties in 2009, 68 (16.9 percent) belong to metropolises (1, “Kreisfreie Großstädte”), 137 (34.1 percent) to urban counties (2, “Städtische Kreise”), 100 (24.9 percent) to rural counties with some agglomerations (3, “Ländliche Kreise mit Verdichtungsansätzen”), and 97 (24.1 percent) to rural counties with a sparse population (4, “Dünn besiedelte ländliche Kreise”). We use this indicator to establish a first impression of whether there is still a gap between rural and urban areas regarding high school attendance. To obtain a much closer measurement, we use information about the regional *school infrastructure* available from “Regionaldatenbank Deutschland”. It is a database which contains detailed offcial statistical data, e.g. information about the number of schools by type on the county level for several years. We generated the *proportion of high schools* (only “Gymnasien”, analogous to Sixt 2010, 2013) of a county in the school year 2009/2010 in relation to all other regular schools in the secondary school system (“Orientierungsstufe” + “Hauptschule” + “Schule mit mehreren Bildungsgängen” + “Realschule” + “Integrierte Gesamtschule” + “Waldorfschule”) to consider the relative offer of schools leading directly to university, and argue that the county level is the appropriate administrative area parents take into account when choosing a secondary school. The most appropriate measurement would be information about the physical distances from schools to parents’ houses. Such information would allow us to ignore the problem of the accurate definition of the relevant context, also known as the Modifiable-Area-Unit-Problem (MAUP), as discussed e.g. by Wu (2007). However, until such information is available, we can only use the data from the statistical offices, which are oriented towards administrative boundaries. With the exception of Lower Saxony, there is no regulation regarding school catchment areas, as it is the case with the “Schulsprengelprinzip” for elementary schools. Parents have the right to enroll their child at any secondary school in the respective federal state if the school has places available and the child meets the requirements for the respective type of school. However, using the federal state level as the context for measuring the considered school infrastructure maybe inadequate, as it can be assumed that the parents will always have a school in mind that can be reached by the child from their place of residence. As the level of communities is too small, the county level will be taken into account. Additionally, it is also worth considering that school planning is mostly based on this administrative area.

Figure 1 shows clear regional disparities on the county level for the proportions of high schools to all secondary schools in Germany 2009. The proportions range from 0.0 to 47.5 percent, with a median and mean (standard deviation) of 24.2 (8.5) percent. In order to describe the data, we classify the counties according to quartiles; counties with a proportion between 17.9 and 29.7 percent are described as counties with an average quantity of high schools, counties below 17.9 percent (lower quartile) are considered as under-average, whereas those with more than 29.7 percent (upper quartile) are considered as above average (see Table 1).

Figure 1: Proportion of high schools to all secondary schools per county in Germany 2009



Note. Source: Statistical offices of the Federation and the Länder, own illustration.

As shown by Table 1, the proportion of high schools to all secondary schools differs according to the classification of the county. The more urbanized a county is, the higher tends the proportion of high schools to be. The pairwise correlation amounts to -.409 with a corresponding *p* value below .001 when testing for zero correlation. Information about the regional labor market is taken from INKAR "Indikatoren und Karten zur Raum- und Stadtentwicklung", an online tool edited by the BBSR. To measure later competitiveness concerning jobs or job security, we take the unemployment rate at the county level in 2009, and to measure the offerings of highly skilled jobs in a county, we take the proportion of highly skilled employees in 2012. Unfortunately, there is no timely closer measurement available. On average (not depicted), the proportion of high schools to all secondary schools increases from 9.7 percent in 2012 to 10.2 percent in 2013; 10.6 percent in 2014 and 11.1 percent in 2015 respectively. This could lead to an overestimation of the effects that we will have to keep in mind when interpreting the results.

To overcome the problem that we do not know the individually relevant regional context for the labor market (see Sixt, 2010, 2013 and discussion above), we consider weighted versions of both indicators, where weighting is based on commuter flows labor at the county level as recorded in the statistics of the Federal Employment Agency and released by the Institute for Employment Research in 2018. The weighted labor market indicator for a county is thus given as $\tilde{x}_i = \sum_{j=1}^{N} P_{ji} / (\sum_{j=1}^{N} P_{ij})\, x_i$ with P_{ij} denoting the commuter flows from county i to j, and x_i the corresponding labor market indicator of county i. The weighted 2009 unemployment rates per county range from 3.2 to 17.3 percent, with a median of 6.9 and a mean (standard deviation) of 7.7 (3.4) percent, and the spatially weighted proportion of highly qualified employees 2012 ranges from 4.2 to 20.7 percent with a median of 8.8 and a mean (standard deviation) of 9.5 (2.9) percent. Note that the reported weighted indicators do not differ in a significant manner from the originals: the spatially unweighted unemployment rate of 2009 (not depicted) ranges from 2.2 to 17.8 percent, with a median of 6.7, and a mean (standard deviation) of 7.7 (3.4) percent, and the spatially unweighted proportion of highly qualified employees 2012 ranges from 4.0 to 29.7 percent, with a median of 8.5 and a mean (standard deviation) of 9.7 (4.4) percent.

As further shown by Table 1, the regional labor market indicators vary with regard to the classification of the county. Again, in order to describe the data, we classified the counties according to quartiles: counties with an unemployment rate between 4.9 and 9.9 percent are described as average, below 4.9 percent (lower quartile) are considered below average, and those counties with more than 9.9 percent (upper quartile) are above average. For the proportion of highly qualified employees, the lower quartile starts below 7.3 and the upper at 11.3 percent (see Table 1). While the unemployment rate reveals no clear pattern, the proportion of highly skilled employees is again positively correlated with urbanity. The pairwise correlation amounts to -.561 with a corresponding *p* value below .001 when testing for zero correlation.

Table 1: Regional structures by type of county

	type of county								total (n = 402)	
	metropolises (n = 68)		urban counties (n = 137)		rural counties with some agglomeration (n = 100)		rural counties with a sparse population (n = 97)			
proportion of high schools to all secondary schools (pwcorr: -.409; p < .001)										
minimum	15.3 %		5.9 %		0.0 %		5.9 %		0.0 %	
25 % percentile	26.4 %		19.8 %		16.7 %		14.3 %		17.9 %	
median	31.1 %		24.6 %		22.2 %		20.0 %		24.2 %	
M (*SD*)	31.1 %	(7.1)	25.0 %	(7.5)	22.1 %	(8.6)	20.2 %	(7.4)	24.2 %	(8.5)
75 % percentile	35.1 %		29.8 %		28.0 %		25.0 %		29.7 %	
maximum	47.5 %		45.5 %		47.1 %		38.5 %		47.5 %	
unemployment rate (pwcorr: -.015, not significant)										
minimum	3.8 %		4.0 %		3.2 %		3.2%		3.2 %	
25 % percentile	8.0 %		4.6 %		4.4 %		5.1 %		4.9 %	
median	9.5 %		5.8 %		6.3 %		7.9 %		6.9 %	
M (*SD*)	9.9 %	(2.8)	6.4 %	(2.5)	7.3 %	(3.5)	8.6 %	(4.0)	7.7 %	(3.4)
75 % percentile	12.2 %		7.6 %		10.2 %		11.6 %		9.9 %	
maximum	14.2 %		14.1 %		15.2 %		17.3 %		17.3 %	
proportion of highly qualified employee (pwcorr: -.5611; p < .001)										
minimum	7.5 %		5.8 %		4.5 %		4.2 %		4.2 %	
25 % percentile	11.1 %		7.2 %		6.3 %		5.6 %		7.3 %	
median	15.7 %		8.8 %		7.2 %		7.1 %		8.8 %	
M (*SD*)	15.5 %	(5.3)	9.7 %	(3.6)	7.9 %	(2.4)	7.4 %	(2.2)	9.5 %	(2.9)
75 % percentile	18.0 %		11.4 %		9.4 %		9.1 %		11.3 %	
maximum	20.7 %		18.9 %		13.7 %		12.9 %		20.7 %	

Notes. Source: BBSR, Regionaldatenbank Deutschland, INKAR, n = 402, own calculations. pwcorr denotes the pairwise correlation coefficient; *SD* denotes the standard deviation; p denotes the estimated p value; pwcorr for proportion high schools and unemployment rate is .2658 with a corresponding p value < .0001; pwcorr for proportion high schools/proportion of highly qualified employee is .4965 with corresponding p value < .0001; pwcorr for proportion of highly qualified employee and unemployment rate is .2080 with corresponding p value < .0001.

Unfortunately, we cannot measure some of the factors relevant for the educational decision before it has actually taken place, since the NEPS data collection starts after the transition to grade five. A potential way out could have been provided by NEPS Starting Cohort 2 data. However, after the transition to the secondary school track, the NEPS Starting Cohort 2 does not show sufficient heterogeneity to allow for disentangling the effects of regional infrastructure on the decision. But as the measurement in the NEPS SC3 is very early in grade five (November/December, with the school year starting in August/September), we assume that the measurements, especially with regard to competencies, are still comparable to the situation before the transition (grades refer to grade four and are surveyed retrospective in the parent and the student questionnaires). The NEPS data are the only data representative for Germany at the moment, offering diverse control characteristics like grades, competencies and information about social and migration background – and offer the possibility to add regional data.

We use all cases of NEPS SC3 for our analyses where students attend a regular secondary school in the school year 2010/2011 and have participated in the first NEPS wave. As in Berlin and Brandenburg the transition from elementary to secondary school takes place two years later than in the other federal states, students from these locations are excluded. In the end, we use a subsample of 4,880 from the total of 6,112 NEPS SC3 cases. As described in the introduction, our dependent variable is dichotomous: attending high school in grade five vs. not attending high school. As shown in Table 2, 46.9 percent of the children in our sample enter a high school. The sample of students has been established via a two stage sampling procedure based on an explicit stratification across school types and an implicit stratification across federal states and regional classification relating to the forerunner of the DegUrba "Abgrenzung ländlicher von städtischen Gebieten" classification (for details see Aßmann et al., 2011; Steinhauer et al., 2015; and Schnorr-Bäcker, 2014). Schools were sampled proportional to the number of classes per school at the first stage. As only two classes should be selected in case of three or more classes per school two classes were sampled at the second stage in order to aim at equal inclusion probabilities across schools and school types. All students in the sampled classes were asked to participate in the NEPS survey. Further, as the sampling is based on an implicit stratification across federal states and no effect of the regional classification on school participation prevails (see Steinhauer et al. 2015, Table 5), one school per county is included in the sample on average. Only for the independent cities and city states more than one school is included. Given this, no bias with regard to the distribution of types of regions is imposed on the sample and hence no effect on the regression analysis assessing the impact of regional factors on the individual educational decisions is expected. Due to the individual participation decision varying across schools, the observed sample quota of 46.9 percent for entering a high school is slightly higher than the quota of 44.0 percent reported for school year 2016/2017 (see Statistisches Bundesamt, 2018). To check for robustness, we have also run weighted regressions, see the section on statistical methods for details.

Table 2: Sample description – categorical variables

		observed sample		imputed samples	
		n	proportion	*M* of imputed samples	*SD* between imputations
high school attendance grade 5					
	no	2,592	0.531	-	-
	yes	2,288	0.469	-	-
	missing	0	-	-	
gender					
	female	2,360	0.484	-	-
	male	2,520	0.516	-	-
	missing	0	-	-	-
migration background					
	no	4,121	0.844	0.846	< 0.001
	yes	749	0.153	0.154	< 0.001
	missing	10	0.002	-	-
recommendation for high school					
	no	2,046	0.419	0.614	0.003
	yes	1,493	0.306	0.386	0.003
	missing	1,341	0.275	-	-
idealistic educational aspiration of children for "Abitur"					
	no	1,385	0.284	0.300	0.001
	yes	3,313	0.679	0.700	0.001
	missing	182	0.037	-	-
university degree (at least on parent ISCED 5B or higher)					
	no	1,470	0.301	0.476	0.005
	yes	1,813	0.372	0.524	0.005
	missing	1,597	0.327	-	-
occupational status according to EGP classification (3 categories)					
	service class: EGP I + II	906	0.186	0.281	0.003
	working class: EGP V–VII	978	0.200	0.416	0.005
	others: EGP III–IV	895	0.183	0.303	0.004
	missing	2,101	0.431	-	-
type of county					
	metropolises	653	0.134	0.200	0.001
	urban counties	1,587	0.325	0.450	0.001
	rural counties with some agglomeration	733	0.150	0.221	0.001
	rural counties with a sparse population	450	0.092	0.128	0.001
	missing	1,457	0.299	-	-

Notes. Source: NEPS SC3 (doi:10.5157/NEPS:SC3:6.0.1), own calculations. Due to rounding differences, deviations in the sum of the individual values are possible. *M* denotes the arithmetic sample mean and *SD* the sample standard deviation.

Table 3: Sample description – metric variables

		observed sample	imputed samples	
			M of imputed samples	*SD* between imputations
age in years and months	*n*	4,878		
	median	10.667	10.667	< 0.001
	M	10.722	10.722	< 0.001
	SD	0.523	0.523	0.001
	missing	2	-	-
reading comprehension (WLE)	*n*	4,867		
	median	-0.022	-0.022	< 0.001
	M	-0.008	-0.010	0.001
	SD	1.255	1.255	0.001
	missing	13	-	-
mathematical competence (WLE)	*n*	4,867		
	median	-0.010	-0.010	0.002
	M	0.001	0.001	0.001
	SD	1.167	1.167	0.001
	missing	13	-	-
grade in mathematics	*n*	4,753		
	median	2.000	2.000	< 0.001
	M	2.302	2.310	0.002
	SD	0.941	0.946	0.003
	missing	127	-	-
grade in German	*n*	4,740		
	median	2.000	2.000	< 0.001
	M	2.351	2.360	0.002
	SD	0.877	0.881	0.002
	missing	140	-	-
net equivalized income per month [€]	*n*	3,317		
	median	1428.571	1401.439	21.001
	M	1612.550	1574.155	28.054
	SD	1447.164	1378.932	97.396
	missing	1,563	-	-
proportion of high schools to all secondary schools	*n*	3,423		
	median	0.242	0.245	0.022
	M	0.241	0.243	0.021
	SD	7.310	7.448	0.012
	missing	1,457	-	-
regional unemployment rate	*n*	3,423		
	median	0.067	0.068	0.004
	M	0.072	0.072	0.006
	SD	2.569	2.604	0.006
	missing	1,457	-	-
proportion of highly qualified employees	*n*	3,423		
	median	0.092	0.093	0.009
	M	0.100	0.100	0.008
	SD	3.064	3.064	0.005
	missing	1,457	-	-

Notes. Source: NEPS SC3 (doi:10.5157/NEPS:SC3:6.0.1), own calculations. *M* denotes the arithmetic sample mean and *SD* the sample standard deviation.

Table 2 provides a further description of the categorical sample variables, whereas Table 3 refers to the metric sample variables. It is shown that most of our students are on average (standard deviation) 10.7 (0.5) years old, and nearly half of the sample is female (48.4 percent). Most of the students have no migration background (84.4 percent), meaning that they or their parents are not migrants. The average WLE-estimator (standard deviation) for reading comprehension amounts to -0.008 (1.255); for mathematical competence to 0.001 (1.167). The median grade in German, as well as Mathematics, is 2.0. Regarding the school recommendation, we find 30.6 percent with a positive recommendation for high school, while 67.9 percent of the children express a desire to obtain a high school degree (idealistic educational aspiration). Unfortunately, there is information missing from 29.9 percent of the parents, as parent participation was not coupled to student participation, see also below. Consequently, and together with item-non-response, 32.7 percent of information is missing with regard to the educational background of the family, as measured by the highest educational degree of the parents. 37.2 percent of the children in the sample have at least one parent with an ISCED-level of 5B or even higher. 18.6 percent of the families belong to EGP-Class *I* or *II*; 20.0 percent to EGP-Class *V-VII*, and 18.3 percent to EGP-Class *III* and *IV*, while information for 43.1 percent is missing. The monthly average net equivalised income, based on information for 68.0 percent of the families, is 1,612.55€, with the standard deviation of 1,447.16€ and the median at 1,428.57€. Regarding the regional origin, 13.4 percent of families live in a metropolis, 32.5 percent in urban counties, 15.0 percent in rural counties with some agglomerations, and 9.2 percent of the counties are classified with a sparsely population. The average (standard deviation) proportion of high schools to all secondary schools in the counties the students live in is 24.1 (7.3) percent (median 24.2), the unemployment rate 7.2 (2.6) percent (median 6.7), and the proportion of highly skilled employees 10.0 (3.1) percent (median 9.2). Again, due to the missing interview with the parents, we are missing information on residence addresses, and therefore the regional setting of 1,457 families, which makes up 29.9 percent of the sample. To handle missing values, we adapt a multiple imputation strategy, as described in the next section. As shown in the last two columns of Tables 2 and 3, the variation between the different imputed data sets is, however, only modest.

5. Statistical methods

To assess the effect of regional school infrastructure on individual educational decisions, we use binary logistic regressions accounting for the hierarchical regional structures with students nested within living regions and schools via random intercepts. Let y_{ij} denote the decision of an individual j in region i to join a high school, i.e. $y_{ij} \in \{0,1\}$ for all regions $i = 1, \ldots, N$ and $j = 1, \ldots, J_i$, where J_i denotes the number of individuals observed in living region i. Then the regression is implied by

$y_{ij} = I[X_{ij}\beta + W_i\gamma + \alpha_i + \epsilon_{ij} > 0]$ with $I[\cdot]$ denoting the indicator function, α_i denotes an unconditional independently and identically normally distributed regional effect with mean zero and variance σ_α^2, whereas ϵ_{ij} is identically and identically standard normally distributed (see Greene, 2004). We denote the set of regressors with variation at the individual and regional level including a constant as X_{ij}, and the regressor varying only at the regional level as W_i. Parameter estimation is directly accessible towards Maximum Likelihood using quadrature based integration (see Butler & Moffitt, 1982).

To handle the uncertainty within parameter estimation stemming from missing information, (see Table 2 and Table 3), we make use of multiple imputation via chained equations (MICE, see Rubin, 1976; van Buuren & Groothuis-Oudshoorn, 2011). Note that missing information in the regressor variables related to X_{ij} can be handled, as typically in MICE, via specification of a set of full conditional distribution models adapted to the scale of each variable and considering all other (completed) variables as conditioning factors. The information about in which region a child lives may be missing, as this information is surveyed within the parental interview and not all parents participated in the survey. As the region of schooling and the region of living relevant for the individual educational decision do not coincide per se, regional information cannot be matched to the individual level based on the known region of school. However, as each child is clustered within a school, we make use of the observed within school distribution of living regions to fill in the missing regional information on children's places of residence. Missing values are thereby imputed by drawing from the observed within school distribution of children's living regions via Bayesian Bootstrapping. Overall, we perform a total of M = 50 imputations, where for each imputation, we first impute the missing regional link information and then perform the imputation for missing individual specific values. Given M = 50 imputed data sets, we use combining rules for asymptotic normally distributed estimators in order to arrive at a correct assessment of estimation uncertainty, resulting in valid parameter inference. In order to assess relative fit of different (nested) model specifications, we refer to likelihood ratio tests and use the median pooling rule as suggested by Eekhout, van de Wiel, and Heymans (2017). We do so, as alternative combining rules for likelihood ratio test statistics currently discussed in the literature do not apply in the considered hierarchical context (see Chan & Meng, 2019). All computations have been conducted using R and Stata, where the R package MICE has been adapted to provide the multiple imputations, whereas the hierarchical binary logistic regressions have been conducted in Stata using the xtlogit and gllamm commands respectively. Combining rules to provide the final estimates are based on own R code. All codes for data handling and estimation are available from the authors upon request.

Note that we apply weighting within the considered hierarchical binary regression analysis only to check for the larger proportion of high school attendants (46.9) compared to the quota of 44.0 percent reported for school year 2016/2017 (see Statistisches Bundesamt, 2018). In contrast to a linear regression, where weights provide one way to account for heteroscedasticity, variance and mean parameter estimation are interrelated in binary regression analysis. Thus, no theoretical argument ensures that use of weights would help to discover the true regression relationship. The robustness is checked via assigning an individual weight factor of 0.820 to high school attendants and an individual weight of 1 to all others. These weight factors imply a weighted sample quota for high school attendance of 42.0 percent. Corresponding weighted regression estimates do not differ from unweighted regression analysis, see discussion of empirical results below.

6. Empirical results

The analysis of the individual decision to enter a high school is performed in two steps. The first step investigates the dependence between the degree of urbanization and high school attendance rates, as shown in Table 4. The results show higher attendance rates in urbanized counties (51.6 percent and 52.7 percent) compared to rural counties (38.9 percent and 33.0 percent). Looking at regional differences

Table 4: High school attendance and regional structures

	high school attendance grade 5 (school year 2009/2010)	
	yes	no
type of county		
metropolises	51.6 %	48.4 %
urban counties	52.7 %	47.3 %
rural counties with some agglomeration	38.9 %	61.1 %
rural counties with a sparse population	33.0 %	67.0 %
proportion of high schools to all secondary schools		
under average	45.6 %	54.4 %
average	46.1 %	53.9 %
above average	83.2 %	16.8 %
unemployment rate		
under average	48.2 %	51.9 %
average	51.0 %	49.0 %
above average	32.1 %	67.9 %
proportion of highly qualified employee		
under average	28.5 %	71.6 %
average	43.3 %	56.7 %
above average	51.2 %	48.8 %

Notes. Source: NEPS SC3 (doi:10.5157/NEPS:SC3:6.0.1), n = 4,880, imputed data, own calculations. Due to rounding differences, deviations in the sum of the individual values are possible.

in terms of fraction of high schools to all schools at the county level, we also find a strong relationship with attendance rates, as an above average supply is accompanied by higher attendance rates. The relationship between unemployment rates and school attendance rates is not in line with the expected ceteris paribus effect, thus pointing at general structural differences at the county level. The proportion of highly qualified employees is again in line with the expected effects with a higher fraction of highly qualified employees coinciding with a higher attendance rate for high school.

The second step of the analysis explicitly focusses on the individual level. Using hierarchical logistic regressions, we assess the effects of regional infrastructure on high school attendance. We consider five model specifications, denoted as I, IIa-c, III, IV and V. Model specification I considers no control variables at all, serving thus as the rudimentary benchmark specification allowing for nested model comparison, while specification II considers the regional infrastructure. Model specification IIa considers the type of county, whereas specification IIb considers the regional school offer, and specification IIc involves the regional labor market conditions. A joint consideration of the regional infrastructure variables is provided in model specification III. Model specification IV relates the individual background characteristics to the observed decision to enter a high school. V is the full model specification, involving all considered variables jointly. The corresponding estimates are provided in Table 5 with corresponding confidence intervals given in Table 6.

The results from model specification I highlight the regional clustering structure of the sample arising from the underlying sampling of schools. This implies a correlation of individuals at the county level of 0.72. Consequently, we would like to point out that our estimation results are expected to be more conservative compared to results that would arise from an individual sample not clustered within schools. Further, model specification I serves as a reference point to assess the joint significance of the considered explaining factors. We provide pairwise comparison of model specification I vs. IIa, I vs. IIb, I vs. IIc, I vs. III, I vs. IV, I vs. V, and IV vs. V. The results on the corresponding log likelihood values and likelihood ratio tests are given in Table 5. Overall, the comparison of model specification I with model specifications IIa, IIb, and IIc reveals that each set of regional factors is jointly significant in predicting the binary dependent variable. The same holds when considering all regional indicators jointly in model specification III. Comparing models I and IV indicates a strong increase in model fit arising from the set of individual control variables. However, the regional indicators add to this as indicated by the corresponding likelihood ratio test comparing model specifications IV and V with a median p value of .001. This confirms that the regional indicators are jointly significant predictors of the individual educational decision to enter a high school.

The effects of the regional infrastructure shown in model specifications IIa, IIb, IIc, and III are in line with the theoretical expectations. Regressing the individual decision on the type of county classification reveals that the probability of at-

Table 5: Multivariate models for the probability of high school attendance – parameter estimates, log-likelihood values, and *p* values

	I		IIa		IIb		IIc		III		IV		V	
	est. coef.	*p*	est. coef.	*p*	est. coef.	*p*	est. coef.	*p*	est. coef.	*p*	est. coef.	*p*	est. coef.	*p*
type of county (ref. metropolises)														
urban counties			-1.850	0.168					1.979	0.152			0.074	0.483
rural counties with some agglomeration			-5.066	0.015					-0.040	0.494			-1.493	0.250
rural counties with a sparse population			-6.713	0.002					-0.414	0.442			-1.711	0.251
proportion of high schools to all secondary schools					0.276	0.000			0.287	0.002			0.177	0.011
unemployment rate							0.326	0.091	-0.154	0.306			-0.237	0.159
proportion of highly qualified employee							0.460	0.005	0.067	0.385			-0.051	0.414
gender (ref: female)														
male											-0.113	0.270	-0.145	0.219
age in years and months											-0.524	0.007	-0.518	0.008
migration background (ref: no)														
yes											0.767	0.002	0.833	0.001
reading comprehension (WLE)											0.220	0.010	0.222	0.010
mathematical competence (WLE)											0.983	0.000	0.972	0.000
grade in mathematics											-0.438	0.001	-0.460	0.000
grade in German											-0.666	0.000	-0.660	0.000
recommendation for high school (ref: no)														
yes											2.072	0.000	2.074	0.000
idealistic educational aspiration of children for "Abitur" (ref: no)														
yes											3.674	0.000	3.742	0.000
university degree (at least on parent ISCED 5B or higher; ref: no)														
yes											0.470	0.029	0.454	0.037
net equivalized income per month [€]											0.136	0.096	0.131	0.102
occupational status according to EGP classification (3 categories; ref: service class: EGP *I + II*)														
working class: EGP *V–VII*											0.094	0.374	0.112	0.354
others: EGP *III–IV*											0.197	0.236	0.209	0.224
constant	-1.648	0.000	1.989	0.090	-7.630	0.000	-7.662	0.002	-7.825	0.030	3.350	0.083	1.904	0.328
variance parameter of random effect for living region	4.298	0.000	4.446	0.000	4.545	0.000	4.438	0.000	4.553	0.000	3.690	0.000	3.803	0.000
median log likelihood value (number of parameters)	-1,471.891 (2)		-1,460.373 (5)		-1,445.840 (3)		-1,457.197 (4)		-1,443.917 (8)		-751.123 (15)		-736.956 (21)	

Nested model comparison via likelihood ratio tests (median *p* /df / *SD*)

	median *p*	df	*SD*
I vs. IIa	2.632e-6	3	0.134
I vs. IIb	1.871e-14	1	4.688e-05
I vs. IIc	4.762e-08	2	0.050
I vs.III	2.361e-10	6	1.722e-05
I vs.IV	<1.00e-10	13	<1.00e-10
I vs.V	<1.00e-10	19	<1.00e-10
IV vs.V	0.001	6	0.010

Notes. Source: NEPS SC3 (doi:10.5157/NEPS:SC3:6.0.1), $n = 4{,}880$, imputed data, own calculations. Est. coef. denotes the parameter estimate based on multiple imputation; *p* denotes the estimated *p* value; df denotes the degree of freedom; *SD* denotes the standard deviation.

Table 6: Multivariate models for the probability of high school attendance – estimated confidence intervals

	I	IIa	IIb	IIc	III	IV	V
	95 % CI	95 % CI	95 % CI	95 % CI	95 % CI	95 % CI	95 % CI
type of county (ref. metropolises)							
urban counties		[-5.621;1.922]			[-1.799;5.756]		[-3.394;3.541]
rural counties with some agglomeration		[-9.655;-0.477]			[-5.035;4.955]		[-5.824;2.838]
rural counties with a sparse population		[-11.233;-2.193]			[-5.937;5.108]		[-6.709;3.287]
proportion of high schools to all secondary schools			[0.135;0.417]		[0.092;0.483]		[0.026;0.327]
unemployment rate				[-0.154;0.806]	[-0.750;0.442]		[-0.703;0.229]
proportion of highly qualified employee				[0.109;0.811]	[-0.378;0.512]		[-0.514;0.411]
gender (ref: female)							
male						[-0.475;0.249]	[-0.511;0.221]
age in years and months						[-0.943;-0.105]	[-0.941;-0.094]
migration background (ref: no)							
yes						[0.242;1.293]	[0.302;1.365]
reading comprehension (WLE)						[0.035;0.406]	[0.036;0.409]
mathematical competence (WLE)						[0.732;1.235]	[0.717;1.226]
grade in mathematics						[-0.700;-0.176]	[-0.723;-0.197]
grade in German						[-0.952;-0.381]	[-0.947;-0.373]
recommendation for high school (ref: no)							
yes						[1.641;2.502]	[1.642;2.505]
idealistic educational aspiration of children for "Abitur" (ref: no)							
yes						[2.966;4.382]	[3.023;4.461]
university degree (at least on parent ISCED 5B or higher; ref: no)							
yes						[-0.015;0.955]	[-0.044;0.951]
net equivalized income per month [€]						[-0.069;0.341]	[-0.071;0.333]
occupational status according to EGP classification (3 categories; ref: service class: EGP *I + II*)							
working class: EGP *V – VII*						[-0.482;0.671]	[-0.473;0.697]
others: EGP *III–IV*						[-0.339;0.733]	[-0.331;0.750]
constant	[-2.215;-1.082]	[-0.915;4.892]	[-11.378;-3.881]	[-12.942;-2.381]	[-15.957;0.307]	[-1.395;8.095]	[-6.776;10.584]
variance parameter of random effect for living region	[3.846; 4.751]	[3.947;4.944]	[4.083;5.007]	[3.933;4.944]	[4.070;5.035]	[3.255;4.124]	[3.341;4.266]

Notes. Source: NEPS SC3 (doi:10.5157/NEPS:SC3:6.0.1), n = 4,880, imputed data, own calculations. 95 % CI denotes the estimated 95 % confidence interval in terms of the 2.5 % and 97.5 % quantile.

tending a high school is significantly lower for rural counties. Also, as indicated by specification IIb, we find a positive influence of the proportion of high schools to all secondary schools in a county on the probability of attending a high school. With regard to regional labor market conditions, we find positive effects for both the regional unemployment rate and the share of highly qualified employees in the regional labor force. Bringing all regional infrastructure variables together in model specification III reveals that, given the substantial level of multicollinearity among the regional variables, only the regional school offer remains a significant determinant for the individual school decision.

When considering individual characteristics, the estimates for model specification IV are also in line with the theoretical expectations. Higher values in mathematical and reading competencies are associated with a higher probability of attending high school. Similar effects are documented for grades in mathematics and German, with worse grades reducing the probability of ending up in high school. We also find positive significant effects for educational aspiration and the school recommendation at the end of elementary schooling. Moreover, the effect of a migration background is in line with theoretical expectations and empirical results of other studies. As we control for the individual competence level, a migration background increases educational aspirations ceteris paribus, and thus the probability of attending high school. Positive significant effects are also found for the educational background of parents, where an university degree, as indicated by ISCED classification code 5b or higher, increases the probability of attending a high school. Furthermore, a higher household income is strongly associated with a higher probability of high school attendance. The documented effect for age reveals that fifth-graders at high schools are on average younger than fifth-graders not attending high schools. We interpret this age effect as being related to developmental tempo. Children who develop more slowly may either enter school later, stay longer at primary school, or may even change from higher school tracks to lower schools and repeat grades. Note that no significant difference between boys and girls is documented, and this also holds for occupational status as provided in terms of the EGP-class index.

The results from the full specification V reveal the robustness of the estimated effects obtained in specification III and IV respectively. This indicates that the regional school offer is still an important determinant of the individual educational decision regarding secondary schooling, even nowadays. Furthermore, it points at necessary extensions allowing to consider further operationalizations of the regional school offer more closely related to the costs implied by specific school choice, e.g. distance to schools. Note that we have checked the robustness of the documented regression relations via using individual weights in model specifications IV and V, see Tables 7 and 8 respectively. The corresponding results reveal no substantial difference compared to the unweighted regression analyses and thus confirm the still present effect of school infrastructure on the individual educational decision to enter a high school.

Table 7: Multivariate models for the probability of high school attendance – parameter estimates, log-likelihood values, and p-values for weighted regressions

	IV weighted		V weighted	
	est. coef.	*p*	est. coef.	*p*
type of county (ref. metropolises)				
urban counties			0.911	0.307
rural counties with some agglomeration			-0.196	0.465
rural counties with a sparse population			-0.202	0.465
proportion of high schools to all secondary schools			0.162	0.015
unemployment rate			-0.166	0.283
proportion of highly qualified employee			0.040	0.420
gender (ref: female)				
male	-0.189	0.169	-0.163	0.202
age in years and months	-0.496	0.011	-0.541	0.007
migration background (ref: no)				
yes	0.600	0.014	0.836	0.002
reading comprehension (WLE)	0.205	0.016	0.216	0.014
mathematical competence (WLE)	01.045	0.000	0.967	0.000
grade in mathematics	-0.388	0.002	-0.437	0.001
grade in German	-0.657	0.000	-0.658	0.000
recommendation for high school (ref: no)				
yes	2.056	0.000	2.128	0.000
idealistic educational aspiration of children for “Abitur” (ref: no)				
yes	3.551	0.000	3.675	0.000
university degree (at least on parent ISCED 5B or higher; ref: no)				
yes	0.518	0.014	0.507	0.019
net equivalized income per month [€]	0.117	0.097	0.114	0.120
occupational status according to EGP classification (3 categories; ref: service class: EGP *I* + *II*)				
working class: EGP *V–VII*	-0.153	0.283	-0.079	0.388
others: EGP *III–IV*	-0.187	0.236	-0.258	0.164
constant	3.395	0.068	-0.041	0.496
variance parameter of random effect for living region	4.722	0.000	5.097	0.000
median log likelihood value (number of parameters)	-706.365 (15)		-693.973 (21)	

Nested model comparison via likelihood ratio tests (median *p* /df / *SD*)	median *p*	df	*SD*
IV weighted vs. V weighted	0.001	6	0.251

Notes. Source: NEPS SC3 (doi:10.5157/NEPS:SC3:6.0.1), n = 4,880, imputed data, own calculations, effective sample size for weighted data is 4,469. Est. coef. denotes the parameter estimate based on multiple imputation; *p* denotes the estimated *p* value; df denotes the degree of freedom; *SD* denotes the standard deviation.

Table 8: Multivariate models for the probability of high school attendance – estimated confidence intervals for weighted regressions

	IV weighted 95 % CI	V weighted 95 % CI
type of county (ref. metropolises)		
urban counties		[-2.629;4.452]
rural counties with some agglomeration		[-4.591;4.199]
rural counties with a sparse population		[-4.717;4.312]
proportion of high schools to all secondary schools		[0.015;0.309]
unemployment rate		[-0.733;0.401]
proportion of highly qualified employee		[-0.345;0.424]
gender (ref: female)		
male	[-0.575;0.197]	[-0.544;0.219]
age in years and months	[-0.920;-0.071]	[-0.973;-0.109]
migration background (ref: no)		
yes	[0.062;1.138]	[0.281;1.390]
reading comprehension (WLE)	[0.018;0.392]	[0.024;0.407]
mathematical competence (WLE)	[0.788;1.302]	[0.709;1.225]
grade in mathematics	[-0.648;-0.128]	[-0.702;-0.173]
grade in German	[-0.942;-0.372]	[-0.954;-0.362]
recommendation for high school (ref: no)		
yes	[1.632;2.480]	[1.652;2.604]
idealistic educational aspiration of children for "Abitur" (ref: no)		
yes	[2.828;4.275]	[2.945;4.406]
university degree (at least on parent ISCED 5B or higher; ref: no)		
yes	[0.053;0.983]	[0.029;0.985]
net equivalized income per month [€]	[-0.060;0.293]	[-0.076;0.304]
occupational status according to EGP classification (3 categories; ref: service class: EGP *I* + *II*)		
working class: EGP *V – VII*	[-0.676;0.370]	[-0.619;0.461]
others: EGP *III–IV*	[-0.698;0.324]	[-0.776;0.259]
constant	[-1.130;8.320]	[-8.850;8.769]
variance parameter of random effect for living region	[4.080;5.364]	[3.973;6.221]

Notes. Source: NEPS SC3 (doi:10.5157/NEPS:SC3:6.0.1), n = 4,880, imputed data, own calculations, effective sample size for weighted data is 4,469. 95 % CI denotes the estimated 95 % confidence interval in terms of the 2.5 % and 97.5 % quantile.

7. Conclusion

In this paper we analyze the role of regional disparities on educational opportunities. In empirical research this topic has been discussed irregularly in Germany since the 1960ies. The obtained results have shown that children from rural areas are systematically worse off compared to children in urban areas. An important factor explaining this disadvantage has been the relative lack of educational infrastructure in rural areas as especially Sixt (2010, 2013) has shown with analysis of the GSOEP regarding educational decisions in the years from 1990 to 2006. No effects are found for labor market structures. Unfortunately, there was no possibility to control some of the most relevant variables such as competencies or grades at the individual level in these former studies and especially for labor market structures the questions about the appropriate context measuring the effect is open. Hence, the paper at hand tries to replicate the results with more recent and comprehensive data provided by NEPS SC3, where the focus is set on the transition to secondary education in the school year 2010/2011.

First, the findings of this paper confirm that children from rural areas in Germany are disadvantaged in terms of educational opportunities. Operationalizing regional school infrastructure analogous to Sixt (2010, 2013) via the proportion of high schools to all secondary schools in a county, it is revealed that the rural effect can be explained by the school infrastructure and that the probability of a transition to high school is lower the lower the proportion of high schools in a county is. Although there is a conceptual difference in the sample definition (only first borns and birth cohorts from the western part of Germany are considered by Sixt, 2010, 2013) we can obtain the same results in this first step. Second, no significant effects can be found for labor market indicators given the operationalization of regional labor market conditions at hand. This operationalization differs from Sixt (2010, 2013) and should help to overcome the criticism that in administrative regions, i.e. "Raumordnungsregionen" are possibly not the relevant regional context when parents think about labor market benefits of different school tracks. But also the consideration of commuter flows does not lead to substantial effects. It remains still an open question whether this parental decision is not influenced by labor market structures at all or whether the assessment of the regional context of the regional labor market is still not adequate. Future research could re-examine these effects and consider alternative operationalizations, e.g. subjectively defined relevant labor markets without reference to administrative boarders. However, currently no appropriate database is available to address these issues. Third, the most interesting part of the results is whether the regional effect of the school infrastructure still persists when important control variables such as competencies, grades, school recommendations, and educational aspirations at the individual level are considered. Note that these were missing in the former studies using the GSOEP data. The analyses at hand with the NEPS SC3 reveal a persistent effect indicating that the regional school offer is a further important determinant of the individual educational decision regarding secondary schooling still today.

Even though the NEPS SC3 data are the most adequate data at the moment, some caveats and restrictions apply. First, the sample size and the two stage sampling procedure of NEPS SC3 causes the individual sample to be nested within schools, with typically no more than two schools in a county. Therefore, the informational content on variation at the regional level is systematically lower than it would be in an individual sample not nested at the school level. This may cause an underestimation of the effects of regional infrastructure indicators relative to an investigation carried out with an individual sample. A second limitation arises from surveying individual characteristics at the beginning of grade five, i.e. retrospective to the transition of interest. This may be crucial at least for measured educational aspirations, which need to be better measured in the years before the transition to allow for disentangling the infrastructure effect and the effect of high aspirations. Unfortunately, no data with prospectively measured controls are available yet which would allow for such an investigation of the transition processes to high schools. As addressed above, due to missing heterogeneity, NEPS SC2 does not provide a better data basis either. Furthermore, the database at hand is plagued by high fraction of missing information with regard to the county of residence of the students (see section 4) surveyed within the parental interviews.

A further issue, already discussed by Sixt (2010, 2013) relates to the fact that residential segregation cannot be controlled for. This means that we have no information on the spatial distribution of families with, and without, access to supportive educational resources in the counties. Possibly, families with access to supportive resources may live nearer to high schools than those with less. In this case, the presented result would not be an effect of infrastructure, but of residential segregation. To overcome this problem, it would be necessary to directly measure and operationalize distances to schools and control for the place of residence. Sixt (2018) provides a first study, albeit regionally limited to rather rural regions, and shows that after controlling for residential segregation, an effect of school infrastructure on educational decisions is still present. Furthermore, a closer look on smaller spatial contexts would be necessary as the school infrastructure as well as other infrastructure like public transport differs systematically between rural and urban areas and even worse between city districts (e.g. Hauf, 2007).

Despite these restrictions, evidence with regard to still existing regional inequalities in educational opportunities connected to regional disparities in school provision is strong. As the National Educational Report shows, the number of existing schools decreased, especially in rural areas, due to socio-demographic change (Autorengruppe Bildungsberichterstattung, 2016, p. 32), thus further contributing to regional educational inequality. Even if the trend towards declining birth rates, declining student numbers (Sekretariat der Ständigen Konferenz der Kultusminister der Länder in der Bundesrepublik Deutschland, 2018), and thus school closures (Weishaupt, 2006) seems to have come to an halt, the observation at hand is alarming as the structural inequalities observed in the 1960ies still prevail. Although education was, and is, still in the competence of the federal states, with the municipalities being responsible for school planning, regional disparities in educational offerings can be managed to a certain extent. It seems to be unrealistic to offer a two or three tracked school system so widespread that at an individual level the physical journeys to schools do not lead to systematically varying distances.

The equivalence of living conditions plays a prominent role in the current political debate, and is even enshrined in Article 72 of the Basic Law. This raises the question of other options for decoupling spatial access to educational institutions from access to educational opportunities. Therefore, regional opportunity structures like educational offerings should be more present in current political as well as scientific debate.

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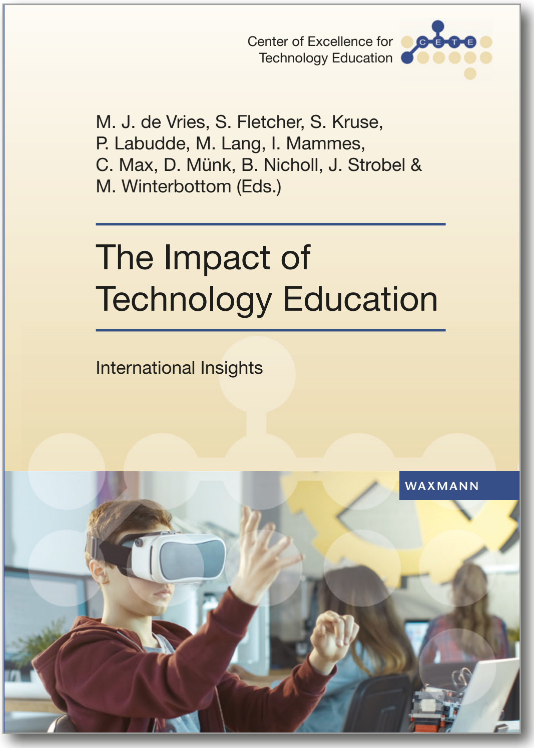

With contributions by

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The increasing use of technology in our lives requires not only the qualification of young professionals through vocational training in order to maintain innovation and technical and societal progress, but also a technical education "for everyone", to become a society with technology literacy. A lack of technology activities may not only result in a "technology illiteracy", thus making a responsible participation in social life more difficult, but also has an impact on identity development. Against this background, technology education is getting important and has an impact on various aspects of the personality, e.g. skills, knowledge and interest in technology, which initiate lifelong learning.

With the combination of articles, the editors of Technology Education Vol. III want to give an insight into international approaches of technology education and its impact. Nine authors, respectively teams of authors from various countries present their educational settings and the impact it has for the personality development in technology.

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