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**Working Paper**

# The costs of losing admission lotteries: The transition from primary to secondary school in Bremen

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## The Transition from Primary to Secondary School in Bremen

Thomas Gößl, Anna M. Makles, Kerstin Schneider,
and Kevin J. Zuchanek

BERGISCHE UNIVERSITÄT WUPPERTAL
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# The Costs of Losing Admission Lotteries

**The transition from primary to secondary school in Bremen**

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**Abstract**: We study the consequences of losing admission lotteries in a centralized secondary school choice system with early academic tracking. Using administrative student panel data from Bremen, Germany, we exploit random tie-breaking within priority groups under an immediate acceptance mechanism. Losing admission lotteries substantially changes students' educational environment: lottery losers travel farther to school, experience greater disruption of peer networks, and attend schools with less advantaged socioeconomic compositions and lower average academic performance. We also document selective negative effects on standardised test scores and school-leaving certificates. While students with a migration background are much more likely to experience a lottery loss because they enter competitive lottery pools more frequently, native German students tend to experience larger relative changes in their school environment and are more likely to mitigate these costs by opting out of the public system and enrolling in private schools.

**Key words:** two-sided matching; school choice; immediate acceptance; admission lotteries; non-compliance
**JEL Classification**: I24; I26; I28; C78

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## 1. Introduction

In Germany's tracked education system, students typically transition from primary to secondary school at the age of ten, after completing fourth grade. Families must choose both the type of secondary school and the specific school the child will attend. The presence of private schools alongside the public education sector further diversifies the set of available options and increases the complexity of these decisions. The allocation of students to schools is decentralized at the school level or organized at the municipal level. Because education policy in Germany falls under the jurisdiction of the federal states, the specific rules and mechanisms governing school admissions vary across states and student allocation remains central to the debate on how to improve both the quality and fairness of school admissions.

This paper utilizes the city state of Bremen to examine the consequences of the immediate acceptance mechanism.[1] Of particular interest are the short- and long-term costs faced by students who lose the tie-breaking lottery, as the outcomes of those students feature prominently in the public debate. Bremen, a city state in the northern part of Germany, has used an immediate acceptance mechanism to allocate students to public secondary schools since 2011. Under this system, parents may rank up to three schools. Each year, approximately 3,600 students transition from primary to secondary school, and, hence, the lottery affects a substantial number of students. Depending on the year, the percentage of students who are not assigned to their first-ranked school varies between 10 to 13%, while about 2.5 to 6% are not assigned to any of their three ranked schools. These outcomes frequently generate dissatisfaction, complaints, and public controversy. Some of this dissatisfaction reflects families' strong preferences for particular schools. However, complaints also arise because parents do not always understand why their child lost an admissions lottery or how the allocation mechanism produced the final outcome. Such concerns are well documented in both education policy debates and the academic literature. Nevertheless, matching mechanisms that use lotteries to resolve excess demand remain widely employed in school districts around the world, including Amsterdam, Barcelona, Boston, Chicago, London, and Shanghai. Their continued use reflects the view that centralized matching procedures can allocate scarce school places in an efficient and fair manner.

There is an extensive body of research in economics and education examining the impact of school assignment mechanisms on both academic and non-academic student outcomes (Cullen et al., 2006; Hastings et al., 2006; Hastings et al., 2012; Deming, 2014; Angrist et al., 2016; Bibler & Billings, 2020; Ketel et al., 2023). However, there is no clear consensus on whether losing an admission lottery affects students' educational trajectories or leads to other significant costs. This study contributes to the debate by analysing the short and long-term consequences of losing one or multiple admission lotteries

[1] This study is supported by the *Senatorin für Kinder und Bildung der Freien Hansestadt Bremen, Institut für Qualitätsentwicklung im Land Bremen* (IQHB). The authors would like to express their sincere gratitude to Dr. Susanne Kollmann and Lutz Jasker for providing access to the data, the long-term cooperation, and their helpful comments. All errors are ours.

in a heterogeneous school environment. We use detailed longitudinal administrative data that allow us to make three contributions:

First, we examine eleven consecutive years without any changes to the school assignment process. The resulting sample comprises almost 14,000 students who participated in admission lotteries. The long observation period strengthens the robustness of our analysis and reduces concerns that the results are driven by temporary fluctuations in school demand. Moreover, since the risk of losing a lottery applies to different types of schools, our analysis covers the entire student population rather than a specific school track. At the same time, we argue that while the admission lottery itself is random, it is not random who enters the lottery pool. Hence some of the observed effects are driven by the heterogeneity in student backgrounds and their different levels of understanding regarding strategy incentives of the applied matching mechanism. Second, in contrast to previous studies, our data enables us to follow students both in the public and in the private school sector. This allows us to assess whether enrolment in a private school serves as a strategy for mitigating the costs of losing a lottery. We can also assess whether students remain in their initially assigned schools or subsequently move to one of their preferred schools. Third, in addition to non-academic outcomes, our dataset permits the analysis of academic outcomes – both short- and long-term. This perspective is particularly relevant in the German context given the early timing of secondary school transitions at the age of ten since students will be exposed to the consequences of their initial school assignment for many years. These contributions are possible due to detailed information in the administrative data, including standardised test scores, birthdate, gender, country of birth, language spoken at home, attended school and class, school type, school choice, special educational needs, eligibility for welfare benefits and school leaving certificates. The richness and longitudinal structure of these data therefore enable a comprehensive analysis of the consequences of losing admission lotteries.

Comparing lottery winners to lottery losers, we find that losing the admission lottery results in a variety of adverse effects, e.g. commuting distance, peer continuity and characteristics of assigned schools. Not being assigned to the first-ranked school, results in an increase in the commuting distance of 390 meters or 17%, compared to the control mean; not being assigned to either the second- or third-ranked school increase the commuting distance by up to 28%. Moreover, not being assigned to the first-choice school results in a loss of approximately two peers from primary school. Other costs relate to the social composition of the schools: students who lose the first-round lottery are assigned to schools with a higher share of students eligible for welfare benefits (8.5 percentage points (p.p.)) and a higher share of migrant students (8.3 p.p.). Moreover, the students also attend a school with a worse expected final GPA and a lower average socioeconomic status of the school. To analyse the effects on academic outcomes, we investigate students' standardised test scores in grade 8 (three years after the transition from primary to secondary school) and, for possible long-term effects, the final school-leaving certificates (five to eight years later). It turns out that there is no systematic effect of losing the admission

lottery on standardised test scores in grade 8. We also find no general adverse effect on long-term outcomes; lottery losers are overall not less likely to graduate with a certain school-leaving certificate. However, looking beyond these average effects reveals heterogeneous effects on both standardised test scores, specifically in language skills, and school-leaving certificates across specific outcomes and groups of students.

There is more evidence for heterogeneous effects, because entering the lottery is not random. Some groups of families understand the applied mechanism better than others[2] or are more penalized if their strategy fails. For example, migrant students are more likely to enter the lottery pool and compete for highly oversubscribed schools, whereas native German students tend to incur larger costs (in terms of effect size) due to strong preferences for more homogeneous school environments. Our results show that migrant students are 65% more likely to face costs associated with losing admission lotteries. Finally, we observe that some of the students who lose the lottery do not comply with the assignment. Foremost native German students, who lose the lottery, enrol in a non-assigned school in later years or attend a private school with a more homogeneous school environment.

## 2. Student Matching in the Federal State of Bremen

Each federal state in Germany is responsible for its education policy. The federal state of Bremen consists of two cities: the city of Bremen (hereafter: Bremen) with a population of 577,026 and Bremerhaven with a population of 119,357 (as of 2024). In Bremen, compulsory education starts at the age of six. Around the age of ten, students switch from primary to secondary school, and parents can choose their children's secondary school. The secondary school is the school that children typically attend until they finish schooling. The secondary school system in Bremen, unlike in many other German federal states, tracks children only into two types of schools: the academic track school (*Gymnasium*) and the comprehensive track school (*Oberschule*). As of 2021, there are eight academic schools, 34 comprehensive schools and ten private schools that offer a secondary school program. Both public school types are publicly funded and managed, and no fees are charged. Although there are differences between the two types of public secondary schools, students can obtain the same school-leaving certificates from both school types. Students may also opt-out to a private school or to leave Bremen's school system to receive education in the neighbouring federal state.[3]

[2] Kapor et al. (2020) show that only around 10% of parents understand the priority system, 20% the ranking penalty, while only around 5% state that the applied immediate acceptance mechanism is difficult to understand. Zuchanek (2025) shows in Bremen that students with migration background did not consistently have the same access to information about the assignment mechanism.

[3] Appendix A provides further information on the two different school types and the admission.

The Bremen Ministry of Children and Education (hereafter: school board) adopted an immediate acceptance mechanism with multiple tie-breaking based on a variation of the Boston mechanism, described in Abdulkadiroğlu and Sönmez (2003). When opting for public secondary schools, parents submit an application, ranking at most three schools (rank order list, hereafter: ROL). Once all applications have been submitted, applicants are assigned to the school they have ranked first, provided the number of applications does not exceed the number of seats. However, if the number of applicants is greater than the number of seats for that school, applicants are given priority depending on academic performance. In addition, for admission to comprehensive schools, it is also relevant whether the primary and the secondary school are affiliated (hereafter: affiliation). Each primary school has at least one affiliated comprehensive school, typically the schools that are closest to the primary school. Applicants with higher priority are accepted first, and if the school has no seat left afterwards, the remaining students are rejected. If there is excess demand within a priority group, a lottery is conducted within the priority group. The multiple tie-breaking rule is used, meaning that ties are broken within each priority group through the random lottery in every school independently (Ashlagi & Nikzad, 2020). In the next round, rejected applicants apply for the remaining seats in the second-ranked school. If there is excess demand, seats are again assigned according to the schools' priority lists and the lottery, as described above. However, if there are no remaining seats left, the third-ranked school is considered. The process is repeated in the third round. If students cannot be assigned to any of the schools on the ROL after the third round, parents will receive a notification from the school board. Following a counselling session, they will be offered another school place (hereafter: assigned school). The wait list for schools that have reached their full capacity remains active until the end of the winter term of the respective school year.

Parents also have the possibility to opt out of the city-regulated school assignment procedure, either by enrolling their child in a school outside the city state[4] or by choosing one of the private schools located in Bremen. Families may bypass the assignment procedure entirely and apply directly to a private school (not included in the sample), switch after receiving the assignment results, or transfer later during the child's secondary school career. Private schools follow a decentralized admission process, deciding on a case-by-case basis whether to admit students, for example, according to religious affiliation, suitability for specific pedagogical concepts, or certain performance requirements. For non-compliance of the admission lottery, Section 6.3 focuses on cases in which students switch schools after participating in the lottery. During the observation period, ten private schools offered secondary education tracks. Although some of these schools present themselves as academic track institutions,

[4] The city of Bremen is an enclave within the federal state of Lower Saxony.

students can generally obtain the same school-leaving certificates across all private schools. The schools are located throughout Bremen and charge average monthly tuition fees of about 340 EUR.[5]

## 3. Effects of Matching Assignments

When students switch from one educational stage to another, different versions of matching assignments are used by school boards worldwide. The assignments usually differ in terms of their mechanism (e.g., immediate or deferred acceptance), priority criteria for oversubscribed schools, the number of seats reserved for priority groups, or the maximum number of schools that can potentially be ranked on the submitted ROL. What they have in common is that once the school is oversubscribed, ties are broken by lottery. In Bremen, annually, about 89% of assignments are resolved in the first round on average. This is in line with results from other cities worldwide despite the existing variations in the immediate acceptance matching assignments (e.g., Calsamiglia & Guell, 2018; Terrier et al., 2021). Several papers investigate lottery outcomes, but whether admission lotteries cause adverse effects is unresolved.

Angrist et al. (2016) investigate admission lotteries in Boston's charter schools and find positive effects on educational performance for lottery winners. In contrast, Hastings et al. (2006) find no overall negative impact on reading abilities or math scores from losing the admission lottery. For other outcomes, such as increasing homework time and reducing grade retentions, the effects are minor. However, students whose parents have weaker preferences for academic quality face significant academic losses. For adverse effects in Charlotte-Mecklenburg County, Bibler & Billings (2020) examine residential relocations after switching from kindergarten to primary school and from primary to secondary school. They find that lottery losers are 6 p.p. more likely to opt-out of the public school system, and by doing so, parents are willing to pay a 9% to 11% housing premium to attend a school with higher mean test scores. In the same county, Deming (2014) tests the validity of school value-added models by exploiting the randomness of admission lotteries and concludes that they are good predictors for student's achievement. Hastings et al. (2012) find that the admission notification to the preferred school itself reduces absenteeism rates, particularly for boys, and test scores in general. Cullen et al. (2006) investigate the randomized lottery outcomes for high school admission within public schools in Chicago. They conclude that lottery winners take advantage of various dimensions, such as peer achievement or attainment levels. However, traditional academic outcomes, such as graduation rates, test scores, or school attendance, are not affected.

[5] Median tuition fees for the first child. Data from the 2023/24 and 2024/25 school years, based on private schools with publicly available tuition fees. Since tuition fees may vary across grade levels, we only considered entry-level grades for secondary school and only included private schools that offer secondary school tracks. While most families pay the regular tuition fees, in rare cases where economic hardship applies, families may apply for a fee reduction at some schools, although this remains an exception rather than the rule.

Closely related to our paper is Ketel et al. (2023), who analyse the consequences of losing an admission lottery for academic (university) track schools as a multidimensional treatment in Amsterdam. They find that lottery losers face disadvantages in terms of increased home-school distance, less favourable teacher and peer characteristics, and overall weaker school profiles. However, for academic outcomes and a range of other variables, some of which are collected via surveys, they find no additional significant effects. Unlike our study, Ketel et al. (2023) examine a deferred acceptance system with first multiple- and then single tie breaking over six years, in which truth-telling is a dominant strategy (Abdulkadiroğlu & Sönmez, 2003). In contrast, our study focuses on an immediate acceptance system with multiple tie-breaking over eleven consecutive years with no changes, where families rank up to three schools in a potentially strategic manner. Additionally, while Ketel et al. (2023) restrict their analysis to academic track schools, where capacity constraints are most severe, we include all students across both academic and comprehensive secondary schools in Bremen. This is relevant in the German context because families can put academic track as well as comprehensive schools on their ROL and students who lost the lottery can be assigned to either school types. This broader scope enables us to capture heterogeneity across the entire student population and, in particular, also the more disadvantaged student groups. It also offers a possible explanation for differences in findings, as students entering the academic track may be less vulnerable to disruptions in their educational pathways. In addition, we follow students throughout their primary and secondary school careers, including private schools. We interpret private school enrolment as a potential opt-out strategy after a lottery loss and quantify the consequences of such choices. This is particularly relevant in strategy-incentivising mechanisms, where some parents with the financial means for this outside option may be willing to take greater risks in their applications (Akbarpour et al., 2022). Finally, because the school tracking process in Bremen begins earlier, around age of ten, disruptions may have more meaningful and persistent effects, as students are exposed to these conditions in a sensitive phase of development and for a longer duration.

## 4. Data

We use administrative individual-student level data, provided by the school board of Bremen. In particular, we use data on students participating in the transition from primary to secondary school between 2011 and 2021, covering all transition cohorts since the introduction of the centralized school matching procedure. The data contain information on students' characteristics, such as birth date, gender, eligibility for welfare benefits[6], first and second citizenship, country of birth, mother tongue,

[6] *Bremen-Pass (Bildungs- und Teilhabepaket)*: This pass is for low-income households and is intended to enable families to participate in social and cultural life.

language spoken at home, place of residence (city and building block), attended school and class, school type, special educational needs, and other variables.

To evaluate students' performance after the transition from primary to secondary school, we focus on the VERA-8 test, which is a nationwide standardized performance assessment in Germany (Schult, 2022). This standardised test is conducted in the third year following the transition to secondary school (grade 8). Linking the performance data to the individual-student level data is only possible for the years beginning in 2019; therefore, we can only use data on VERA-8 from 2019 to 2024, covering students who transitioned from primary to secondary school in $t-3$, i.e. in the years 2016 to 2021. We use the VERA-8 tests to assess student achievement in Mathematics and German.[7] In each subject, different test booklets are administered depending on the school type and performance level of the student. However, as these booklets are standardized, the data allows for comparisons across school types. For German, we differentiate between two skill domains: reading and spelling. Depending on the number of correctly answered questions, a level between 1 and 6 is assigned, with 6 representing the highest level.[8] For a long-term perspective on student performance, we further examine the types of leaving certificates attained by the first four cohorts (2011 to 2014). These include the university entrance certificate (*Abitur*) after seven to eight years after the transition to the secondary school; the intermediate certificate (*Mittlerer Schulabschluss*) after six years, which is awarded after completion of lower secondary education and qualifies students for vocational training or continued education in upper secondary tracks; and the basic certificate (*Einfache Berufsbildungsreife*) after five to six years, which represents the minimum school-leaving qualification and does not entitle students to progress to upper secondary education. Lastly, we investigate whether students leave schools without any school-leaving certificates.[9]

On the school level, we also have information on the average GPA of leaving certificates (central examinations). In Germany, the GPA of leaving certificates can vary from 1.0 (very good) to 4.0 (sufficient). A final grade of 5.0 is a failing grade. We observe variations in average GPAs across secondary schools, ranging from 1.97 to 3.38. Other school level data are the index of social composition (for primary [social index A] and secondary schools [social index B])[10] and the school's address. The school address can be used to compute the commuting distance of students. Since the student address is only known on the city block level, we calculate the home-school distance for all

[7] English test booklets (in Reading and Listening Comprehension) cannot be combined within or across years, since the scaling procedures and the number of booklets differ between cohorts. As a result, no consistent and comparable measure for English test scores over time can be constructed, which is why we exclude this subject from the analysis.

[8] Descriptive Statistics on the VERA-8 standardised test scores in Appendix B.

[9] According to International Standard Classification of Education (ISCED), *Abitur* is considered to be level 3 and *Mittlerer Schulabschluss* and *Einfache Berufsbildungsreife* are level 2.

[10] This is an index for needs-based/weighted school funding. The higher the index, the more additional funds. The index is ordinal and varies between 1 and 5. Social index A according to exit cohort of the primary school; Social index B according to the secondary school.

schools and for each student using the Euclidean distance between the centroid of the students' city block and the exact location of each school. Lastly, we have information on the capacity of each school for each cohort, calculated through the maximum number of students per class.

According to the school board rules, academic schools in Bremen may admit no more than 30 students per class, while comprehensive schools are limited to a maximum of 25 students per class. Given the upper bounds, excess demand for schools may arise. Figure 1 displays the number of first-ranked applications, the number of students on the waitlist (first-choice), and the total capacity across all academic schools and comprehensive schools that show excess demand throughout the entire observation period (17 out of 34 comprehensive schools). While the figure shows that a few schools consistently face excess demand, it also reveals non-monotonic year-to-year variation, indicating volatile demand without a clear upward or downward trend. This pattern suggests that parents base their application decisions on information from the previous year(s). Thus, a year of excess demand is often followed by a year of lower demand, possibly reflecting a reaction to rejections at oversubscribed schools in the preceding year(s). Given our eleven-year observation period, the analysis accounts for these fluctuations and does not primarily reflect the effects of exceptional years, such as those influenced by migration influxes, capacity changes, or unusually large or small birth cohorts. In the robustness checks in Section 7, we further explore year-to-year variation and examine whether the estimated effect occurs only in a specific year or extends across multiple years.

-- Figure 1 about here --

Students with special educational needs (8% of all students) are distributed prior to the general student matching assignment.[11] Students who do not submit a ROL (about 5% of all students per year) usually either immediately attend a private school, remain in primary school (grade retention is voluntary) or are assigned by the school board after the centralised admission procedure. These students cannot lose admission lotteries, because they do not participate in the regular student matching assignment and, hence, are excluded from our analysis. We also observe that annually around 40 students make use of the wait list and are ultimately admitted to their preferred, higher-ranked school despite initially losing the lottery for that school. These students are also excluded from the analysis, as their inclusion would bias the estimated costs.

Table 1 provides descriptive statistics for 39,350 students who handed in a ROL between 2011 and 2021. Column (1) Panel a) shows that around 49% are female and 32% are eligible for welfare

[11] Both school types reserve up to ten percent of places for so-called hardship cases. These may include i) children with physical disabilities, ii) children facing exceptionally severe family or social hardship, iii) or children with siblings already attending the same school if non-admission would cause family-related difficulties. According to the school board, hardship status is granted only in exceptional circumstances following an individual assessment.

benefits. Half of the students are migrants.[12] About 35% perform above a given threshold in mathematics and German at the end of primary school (hereafter: high-performing). Columns (2) to (4) present data for students participating in the first, second and third round of the lottery, respectively. While the share of high-performing students decreases, the share of welfare eligible students and migrant students increases in the second admission lottery. This trend continues when comparing the first and the third admission lottery.

-- Table 1 about here --

Panels b), c), and d) provide information on the social composition of secondary schools, including school characteristics, peer constellations, and the composition of the school entry cohort. Most of these variables, which constitute the main non-academic outcomes in our analysis, change substantially across lottery rounds. For example, the average share of students with a migration background at the assigned secondary school increases from about 43.2% (Column (2)) among students participating in the first-round lottery to approximately 56% among those participating in the third-round lottery (Column (4)). For the share of students eligible for welfare benefits, the corresponding figures increase from 26.7% to 43.5%. Similarly, students in the first-round lottery can expect to have around ten classmates who speak the same language at home, compared with only about one classmate in the third-round lottery. Comparable patterns emerge for former peers from primary school and the remaining indicators, suggesting that progressing to later lottery rounds is associated with increasingly adverse non-academic outcomes.

Panel e) shows the calculated distance to the different schools. Column (1) indicates that the average distance between students' homes and the closest comprehensive school is about 1 kilometre. The average distance to the closest academic school is 3 kilometres. The distance to the first-ranked school averages 2 kilometres. Columns (2) to (4) in Panel e) show that home-school distance increases from 2 kilometres (first-ranked school) to a maximum of 3 kilometres (assigned school).

Panel f) provides information on the assignment results.[13] On average, 88.7% of the students are assigned to the first-ranked school, while only 6.6% and 2.1% are assigned to the second- and third-ranked school, respectively. 2.7% do not get assigned to any of the ranked schools and are assigned by the school board after round three of the matching process. Having to participate in the admission lottery reduces the chance of being admitted to the first-ranked school to 77.4% and increases the likelihood of all other options accordingly (Column 1, Panel f)). In the third round of the lottery, the student has a chance of 88.0% to get the third-ranked school (Column 4, Panel f)).

[12] If one of the following criteria applies, we define the student as a migrant: a) has another or a second citizenship in addition to German citizenship, b) the place of birth is not Germany or c) mother tongue or the language spoken at home is not German.
[13] Further information: about 77% of students rank the maximum possible number of three schools on their ROL, as advised by the school board. Overall, 30% rank academic schools first, and around 26% of all students attend an academic school (comprehensive schools respectively).

Lastly, Panel g) gives information about lottery winners and losers. Out of the 39,350 students, 24,224 rank a safe school[14] as their first choice on the ROL and, thus, are not at risk of participating in any admission lottery. Another 1,334 students are excluded from the first admission lottery due to a low priority group, thus the remaining 13,792 students in Column 2 participate in the first round of the lottery. Of these, 3,122 students lose the lottery. After the first lottery round, most schools reach full capacity, which is why the number of students who are in the second and third round of the admission lottery is small. Column 3 in Panel g) shows the participants of the second admission lottery and Column 4 the third and last admission lottery. Only 275 students participate in the third and final admission lottery, while 1,064 are not admitted to any school on the ROL as their second- or third-ranked school have no more seats left after the prior round(s).

While the lottery itself is random (Appendix D, Table D2), access to the lottery might not. Some students are more likely to apply to oversubscribed schools and thus enter a lottery, while others are more inclined to choose safe schools and are therefore immediately accepted without facing the risk of the lottery. Possible explanations include strong preferences, a greater willingness to take risks or a lack of information about the assignment mechanism and its consequences. Table D1 in the Appendix presents the results of a t-test comparing students who end up in the lottery pool and those who do not and, therefore, do not participate in an admission lottery. Significant differences emerge, particularly with respect to preference for academic schools, performance and migration background. Academic schools tend to be more demanded and, thus, conduct lotteries more often. High-performing students enter in both school types the first priority group and, hence, they compete more often in admission lotteries compared to low-performing students, who are in the second priority group for comprehensive schools and in no priority group in academic schools. Students with migration background are overrepresented in the lottery pool, which might be explained by a lack of fully understanding the immediate acceptance mechanism in Bremen (Zuchanek, 2025). Consequently, the costs of the lottery differ not only in effect size, but also in frequency of entering the lottery pool between the native and the immigrant population (36.67% versus 34.10%).

## 5. Empirical Strategy

Utilizing lottery-induced randomization excludes the issue of endogenous sorting among students. Unlike the entrance into the lottery pool, lottery wins are random and independent from students' characteristics within their priority group, hence, students who win or lose in the admission lottery should be identical in both observable and unobservable characteristics. We analyze the observed

[14] A so-called ‚safe school' is a school, where admission probability equals one (de Haan et al., 2023). Hence, all students are assigned to this school in the first round of the matching assignment. Those schools do not experience excess demand. Note however, that the safe school status varies over time, depending on demand in a particular year.

differences in student outcomes between lottery winners and losers, and by doing so, we get a reliable estimate of the impact of losing the admission lottery.[15] In our model, we (1) compare being assigned to the first-ranked school with not being assigned to the first-ranked school, and then (2) being assigned to the $p^{th}$-ranked school with not being assigned $p^{th}$-ranked school, where $p$ is the preference ($p \in (2, 3)$) on the ROL or the assigned school $p > 3$. Thus, due to the nature of the immediate acceptance algorithm, $p$ denotes the rounds of the lottery. In round 1, students are allocated based on their first choice and in round 2 and 3 allocation is based on the second and third choice, respectively. Note, that the number of students who participate in each round decrease in the immediate acceptance algorithm because school places accepted in earlier rounds are final and are not reconsidered in subsequent rounds (see Table 1).

To assess the cost of losing the lottery, we first estimate the following linear model for the outcome variables $Y_{ist}$, for instance home-school distance, of student $i$ for whom school $s$ was the first preference on the ROL in *t*, where *t* denotes the admission lottery cohort (*t* = 2011, …, 2021):

$$Y_{ist} = \beta D_{ist} + \delta X'_{ist} + \lambda_t + \mu_s + \varepsilon_{ist} \quad (1)$$

Besides home-school distance, the outcome $Y_{ist}$ captures characteristics of the attended secondary school in comparison to the preferred secondary school, i.e. the share of migrant students, the share of students eligible for welfare benefits and the school's social index (social index B) as well as our measures of academic achievement.

$D_{ist}$ is a dummy variable defining the loss of the lottery. It equals one if student $i$ in cohort *t* is not assigned to her or his first-ranked school *s*, and zero otherwise. $X'_{ist}$ are individual characteristics, such as age, place of residence, gender, academic performance, migration background, eligibility for welfare benefits and attended primary school. We control for student characteristics, since the outcomes do not only depend on the lottery, but also on other variables, such as the place of residence and, therefore, proximity to certain schools and the demand for the first-ranked school. $\lambda_t$ are cohort fixed effects and $\mu_s$ are first-ranked school fixed effects. $\varepsilon_{ist}$ is the error term. While we use first-ranked school fixed effects to account for the magnitude of excess demand – and thus the probability of admission – we also discuss alternative specifications in Section 7.[16]

The validity of our empirical strategy depends on the randomness of the lottery, even though entering the lottery might not be random. Hence, we check for the randomness of the lottery draws

[15] Note that the probability of participating in a lottery is only conditioned on the demand for a particular school and the priority group of a random student.

[16] For example, if 101 high-performing students rank the same academic school – offering 100 seats – as their first choice, the probability of admission for each student is approximately 99.01%. In contrast, if 200 high-performing students compete for the same number of seats, the individual probability of admission drops to 50%.

(Appendix D, Table D2) and conclude that the conditional mean independence assumption holds. Accordingly, $\beta$ measures the causal effect of not being assigned to the first-ranked school *s* on the ROL by losing the admission lottery. We restrict the sample to students who participate in at least one admission lottery, which excludes students whose first-ranked school is a safe school that does not reject any students.[17]

For $p \in (2,3)$ on the ROL and the assigned school $p > 3$, we follow the approach of Ketel et al. (2023) based on Abdulkadiroğlu et al. (2017) and categorize not being allocated to the first-ranked school into three groups: i) allocated to the second-ranked school, ii) allocated to the third-ranked school and iii) assigned to a school that is not on the ROL ($p > 3$). To compare equals with equals, we need to account for fixed effects of first-ranked schools (as in in Eq. (1)) and the probabilities of being allocated to the second- or third-ranked or to the assigned school. The probabilities of being assigned to these schools depend only on the priority group and the preference $p$, which in turn reflects the demand for that school. In line with Abdulkadiroğlu et al. (2017), we compute these probabilities (propensity scores) by executing the immediate acceptance mechanism with multiple tiebreaking as implemented in Bremen since 2011. To account for randomness introduced by the lottery, we run the simulation 1,000 times. Then, we average the assignment rates for the second- and third-ranked schools and due to the large number of draws, these average rates converge to the actual scores. With these propensity scores we can now properly compare equals with equals, meaning students with the same probabilities to lose the second- and/or third-ranked admission lottery, and attribute any differences in the outcome variables to the loss of the admission lotteries. Hence, the regression model is:

$$Y_{ipst} = \beta_2 R_{ist}^2 + \beta_3 R_{ist}^3 + \beta_{>3} R_{ist}^{>3} + f\left(\varphi_i^2, \varphi_i^3\right) + \delta X'_{ist} + \lambda_t + \mu_s + \varepsilon_{ipst} \qquad (2)$$

where $R_{ist}^p$ is 1 if student $i$ was assigned to the $p^{th}$-ranked school $s$ in year $t$ and zero otherwise, $\varphi_i^p$ represents the propensity score in the form of quantile dummies of student $i$ being assigned to the $p^{th}$-ranked school. Hence, $f\left(\varphi_i^2, \varphi_i^3\right)$ are four dummies for the quantiles of $\varphi_i^2$ interacted with four dummies for the quantiles of $\varphi_i^3$. At last, $\beta_p$ is the causal effect of being assigned to the $p^{th}$-ranked school instead of the first-ranked school.

A drawback of this method in our first-choice maximising intermediate acceptance setting is the smaller variation of matches resolved in the second and third round in contrast to the deferred acceptance mechanism as most matches are resolved prior to rounds 2 and 3.[18] However, on the quantile level, $\beta_p$ yields reliable estimates. In Figure 2, the distribution of the propensity score for ($p \in (1,2,3)$)

[17] With that we also exclude the very few cases of students that are not participating in any admission lottery. This can happen, when students only rank popular schools for which they are not in the first priority group and which schools have no capacity in the second round, e.g. a low-performing student ranks three popular academic schools or another student ranks only comprehensive schools which are not affiliated with the students' former primary school.

[18] See Abdulkadiroğlu et al. (2017) for formal proof that intermediate acceptance satisfies the equal treatment of equals property.

on the ROL is shown. The distribution of admission probabilities to the respective school on the ROL is depicted for all students that participate in any admission lottery. The bars above the x-axis represent students who are admitted to the respective school; the bars below represent those who are not admitted. The frequencies (y-axis) for the first-ranked schools are higher than for the second- and third-ranked schools due to the implemented intermediate acceptance method. For the second- and third-ranked schools, there are less students left and capacities are nearly exhausted. The vertical dotted lines depict the quantiles used in the main results of Eq. (2).

-- Figure 2 about here --

## 6. Results

### 6.1. Main Findings

The results in Table 2 show that losing the admission lottery affects students in a large set of outcomes, while for academic achievement, we find no overall effect. Table 2 Column (1) shows results based on Eq. (1) for the first-round lottery and Column (2)-(4) present results for being admitted to the second, third or no school on the ROL, according to Eq. (2).

-- Table 2 about here --

As expected, losing the lottery in the first-round results in a significant increase in the distance to the assigned school (Column 1), because families prefer schools nearby. Lottery losers are assigned to a school that is on average 392 meters further from their home, relative to the average distance in the control group of 2.2 kilometres, which translates into an increase in the commuting time. Losing the admission lottery in the first round also leads to a significantly different school composition (Panel b)). The social index B of secondary school increases by 0.235 units, there are more students eligible for welfare benefits (8.5 p.p.), and the share of migrant students is higher (8.3 p.p.). The expected GPA of the school-leaving certificate decreases by 0.063 when not attending the first-ranked school. Thus, the school attended has a lower academic standard than the first-ranked school.

To analyse effects of peer composition, we define different peer-related variables at two levels: First, potential peers at secondary school in Panel c). These variables include: (i) the number of students speaking the same language in the school, (ii) additionally including only students from the same class, and (iii) further restricted to students of the same sex. We observe between 1 and almost 9 less potential peers, depending on the definition. A similar conclusion holds for the second peer-related level: former peers from primary school (same class and same language spoken) in the entry cohort of the secondary school (in Panel d)). Losing the admission lottery leads students to start the secondary school with fewer peers from primary school (around 2 for both definitions).

To estimate the effect of losing the lottery on academic achievement in grade 8, three years after the transition to secondary school, we use standardized test results in German and mathematics. In Panel e), standardized test scores are estimated by subject and skill domain. Consistent with prior research (Hastings et al., 2006; Angrist et al., 2016; Ketel et al., 2023), the results suggest that admission lotteries do not have an overall negative effect on standardized test performance. In Panel f), we analyse long-term outcomes five to eight years after transitioning from primary to secondary school by looking at the acquired school leaving certificates. Note that this reduces the number of observations, because not all cohorts in the sample have graduated yet. We do not find any evidence that losing the admission lottery has a long-term effect in that respect. Losing the lottery does not decrease the likelihood to get a university entry, intermediate or basic school certificate, nor does the likelihood increase that students leave without a certificate.

The results for Eq. 2 in Columns (2)-(4) in Table 2 show the costs of being assigned to the second- or third-ranked or to a school that was not ranked by the parents. Most variables show that losing the lottery in round 1, 2 and 3 is associated with strictly increasing costs, while this is not the case for home-school distance. This might be explained by the multidimensionality of school choice, in particular, in a school system with different school types. However, the increase in home-school distance is with 637 meters largest when the student is assigned to a school by the school board. The same is true for the share of welfare benefit students (13.3 p.p.) and the share of migrant students (10.4 p.p.). In addition, students will have less peers from primary school in their class and less potential peers. The cost of losing in terms of overall academic standard is also strictly increasing. Not admitted to any of the ROL schools, decreases the average school GPA by 0.111 units.

For Eq. (2), the results for standardized test scores reveal no consistent evidence that lottery outcomes affect academic achievement. Most estimates are insignificant, and for mathematics we do not observe a significant effect in any specification. Within the German domain, however, the estimates display a more complex pattern. One possible explanation is that the three achievement domains differ in their responsiveness to changes in the school environment. Mathematics is a cumulative skill that depends heavily on previously acquired knowledge and individual cognitive ability and is therefore generally less sensitive to changes in peer composition or the social environment of the school. In contrast, language-related skills may be more closely linked to the surrounding learning environment. Reading comprehension is likely to benefit from daily language interactions, exposure to different peer groups, and communication within the classroom, whereas spelling relies more heavily on explicit instruction, orthographic training, and repeated practice. Since losing the admission lottery substantially changes the social composition of the assigned school, these language domains may respond differently to school reassignment.

### 6.2. Effect Heterogeneity

The main findings show that losing the lottery affects students in numerous ways but not necessarily students' academic achievement. In the next step, we investigate if specific groups of students face higher costs than others when losing the first admission lottery. Therefore, in Eq. (1), we differentiate groups by family income (eligible for welfare benefits or not), gender, country of origin, first-ranked school type (academic or comprehensive school) and students' performance (high-performing or not). The results show that losing the admission lottery affects some groups of students more than others. Table 3 shows the results by eligibility for welfare benefits for the first lottery round. Economically disadvantaged students are particularly affected regarding increased home-school distance and changes in peer networks (both former and potential peers), compared to students who are not eligible for welfare benefits. This is in line with previous findings that state that these students are more sensitive to distance (Ajayi, 2024) and also to peer networks (Burgess et al., 2015; Walters, 2018).

-- Table 3 about here --

The full set of results of the heterogeneity analysis of the first admission lottery are shown in Table C1 in the Appendix C.[19] There are no substantial differences between female and male students regarding the consequences of losing the lottery. Adverse effects for low-performing students mirror those of comprehensive school students, while high-performing students experience effects similar to academic school students. This pattern reflects the priority group system, where high-performing students typically target academic schools while low-performing students do not. Interestingly, we find that losing the admission lottery reduces the home–school distance for high-performing students and for those who ranked an academic school first, as they are often admitted to a closer school. This suggests that their initial preferences were for more competitive academic schools located further away.

For educational outcomes, we find little evidence of substantial heterogeneous effects. The null results for mathematics persist across all subgroups considered. While some effects emerge for German reading and spelling, these largely mirror the patterns observed in the main analysis and are only marginally significant at the 10% significance level. We also find some evidence that low-performing students are less likely to obtain a basic school-leaving certificate and that low-performing male students are less likely to obtain a university entrance certificate following the loss of the admission lottery.

More nuanced patterns emerge from the heterogeneity analysis by country of origin. Compared to the control group, native German students experience larger changes in school composition across nearly all outcomes, except for home-school distance. For example, losing the admission lottery is

[19] Due to the first-choice maximising immediate acceptance, second- and third-admission lottery observations get naturally more diminutive and more challenging to investigate. That is why we focus on Eq. (1) here. Results available upon request.

associated with an approximately 18% higher share of schoolmates with a migration background and a 29% higher share of schoolmates receiving welfare benefits. For students with a migration background, the corresponding increases are 15% and 21%, respectively. German students also tend to experience larger changes in social index scores and in peer network structures. These patterns likely reflect stronger preferences among native German families for a homogeneous school composition, which makes deviations from their first-ranked school choices more consequential for them. However, while German students tend to incur higher costs when losing the lottery (compared to the control mean), the probability of entering a lottery in the first place is disproportionately higher among students with migration background (Section 6.4).

### 6.3. Non-Compliance and Private Schools

Whether or not the adverse effects of admission lotteries are persistent also depends on compliance. Although switching schools in Bremen during secondary schooling is not common (e.g., around 85% of students participating in the admission lottery are observed in the same school in $t+2$)[20], we do observe enrolments in schools different from those assigned by the matching algorithm. This is not exclusive to Bremen but is observed in many other places with centralised admission procedures, e.g., Amsterdam (Ketel et al., 2023), Beijing (He, 2017), Chile (Arteaga, 2024), Denver (Abdulkadiroğlu et al., 2017), and New York City (Abdulkadiroğlu et al., 2015).

Figure 3 illustrates the number of (non-)compliant students from the year of assignment $t$ through $t+2$ for all participants in the first admission lottery in Bremen. The accompanying table below the figure presents both the number and share of students for each year ($t$, $t+1$, and $t+2$). As Figure 3 corresponds to outcomes in $t+2$, the figure visualizes the cumulative school transfers observed over time. A comparison across the three years reveals that already in grade 5, some students do not remain at the school they were initially assigned to.[21] These shares increase monotonically over time across all ranked options on the ROL, even among those who initially were admitted to their first-ranked school (almost 8% in $t+2$). Conversely, the share of students who were not initially assigned to their first-ranked school but are observed there in later years also increases steadily. The share of students transitioning to private schools also rises over time. This pattern is especially pronounced among students who were allocated to lower-ranked schools on the ROL and is highest among those who were assigned to a school outside their ROL by the school board (around 26%). Notably, students who were assigned by the school board are less likely to transition to a school listed on their ROL and more likely to attend a private school. From the figure and accompanying table, we conclude that while

[20] To increase the number of observations, we focus here on $t+2$. For results for $t$ and $t+1$, please refer to Appendix F.
[21] Note, these are not the students who were admitted to a preferred school via the wait list.

some students leave the initially assigned first-ranked school, the overall pattern suggests indeed a strong preference for the first-ranked school, and that despite strategic ranking behaviour. Additionally, the shift toward private schools across all groups indicates that private schools are an alternative, particularly for students who were placed at lower-ranked or non-preferred public schools.[22] However, unlike public schools, private schools in Bremen charge tuition fees, with average monthly costs amounting to approximately 340 EUR. Thus, attending a private school is not a feasible alternative for all student groups, for example, those eligible for social welfare benefits.

-- Figure 3 about here --

We further compare complying students to those who opt out and enrol in a private school after participating in the first admission lottery. As the immediate acceptance mechanism is first-choice maximising, the majority of matches are resolved in the first round and the number of observations is large, we focus on students who participate in the first-round admission lottery and either a) win or b) lose.

-- Table 4 about here --

For a causal effect of non-compliance, particularly enrolling in a private school, we implement propensity score matching approach based on key observable characteristics, including performance, age, gender, migration background, eligibility for welfare benefits and building block.[23] Specifically, each treated student (non-complier) is matched to a statistical twin from the control group (complier) using 1:1 nearest-neighbour matching without replacement. Matching is restricted to the common support region and applies a narrow caliper of 0.01 to ensure similarity. We assess balance quality using standardized mean differences before and after matching. This allows us to identify statistical twins among the compliers, who remained at their respective schools at $t + 2$, and those non-compliers who attend a private school after being assigned a seat by the lottery, both for winners and losers of the first admission lottery. As shown in Table 4, there are almost no differences in the matched sample in these observables between the group of identified statistical twins and the group of non-compliers who attend a private school.[24] This is true for lottery winners in (a) and lottery losers in (b). Hence, the results in Table 5 show the cost of attending a private school, after winning or losing the first round of the admission lottery.

[22] Around 15% of all non-complying students move to a different residential block, which may partly explain their non-compliance behaviour, as relocating is often associated with a change of school.

[23] This approach is different and independent of the propensity score matching with the iterations used in the empirical strategy for Eq. (2).

[24] Appendix F1 presents the table for the unmatched sample. There are significant differences between students who remain in public schools and those who switch to private schools in $t + 2$, e.g. the migration background as most migrant students do not switch to private schools. This highlights the necessity of searching for statistical twins to ensure the causal validity of the analysis.

-- Table 5 about here --

For some variables, we see an average treatment effect on the treated (ATT) in Table 5 for first admission lottery winners (a) and losers (b).[25] Non-compliers commute between 1,000 and 1,220 additional meters to attend a private school, where they encounter a more homogeneous school composition with a substantial lower share of students eligible for welfare benefits (11 – 28 p.p.) and migration share (11 – 19 p.p.). In that respect, it is more profitable to attend a private school when losing the admission lottery in (b) as school composition becomes even more homogeneous in comparison to (a). For peer networks, in both (a) and (b), non-compliers encounter fewer potential peers, as private schools are generally smaller than public schools. The number of former classmates in the private school's entry cohort decreases, while the number of former schoolmates who speak the same language at home increases. These results are primarily driven by German speaking students attending a private school, as 77.5% of non-compliers who attend a private school are natives. While we do observe larger rates of students with the university entrance exam and less students with the intermediate certificate, we argue that opting out by enrolling in a private school is not a panacea and involves both time and monetary costs. Parents must pay a monthly tuition fee and their children must commute a longer distance to school. However, we assume that parents, who choose private schools for their children, prioritize a homogeneous school composition over commuting or monetary costs. This assumption is supported by the results in Section 6.2, which indicates that native German students have strong preferences for homogeneity in school composition and are more affected by losing the admission lottery in terms of effect size. But clearly, opting out is not generally feasible for all student groups, e.g., students eligible for welfare benefits, or is less frequently used by students with a migration background, who are disproportionately overrepresented in the lottery pool.[26]

### 6.4. Odds of Experiencing Costs of Lottery Losses

Combining the insights from this paper so far, we argue that the probability of being directly affected by a lottery loss can be expressed as the product of two terms: the probability of entering the lottery pool and the probability of losing the lottery conditional on pool entry. Formally,

$$\Pr(Loss) = \Pr(LP = 1) \times \Pr(L = 1 \mid LP = 1),$$

where $LP = 1$ denotes entry into the lottery pool by applying to an oversubscribed school, and $L = 1$ indicates losing the lottery once in the pool. It is important to emphasize that the lottery itself is random

[25] Social index A and B, standardised test scores and average GPA on school level are not available for private schools.

[26] Reasons why students with migration background are less likely to opt for private schooling after losing the admission lottery might be due to financial constraints, limited information about alternatives, and potential barriers related to application procedures or perceived social exclusion.

and unbiased: within a given priority group at a school, winners and losers are determined by chance alone. The formula therefore does not capture a bias in the lottery draws, but rather how often students are exposed to the risk of losing, that is, the likelihood that they will bear the costs of a lottery loss. For migrant students, this probability equals 0.1030 while for native German students it is 0.0625. The resulting odds ratio is given by

$$OR = \frac{\Pr(Loss \mid Migrant)}{\Pr(Loss \mid German)} = \frac{0.1030}{0.0625} = 1.65.$$

This implies that students with a migration background are about 65% more likely to experience a lottery loss than their native German peers and, hence, are more likely to incur the estimated costs. The higher odds are driven by systematic differences in school choice: migrant students apply more often to oversubscribed schools and are disproportionately represented in pools with tighter competition.

This approach shifts the focus from the causal effect of a lottery loss to the ex-ante odds of being in the lottery. In Bremen's immediate acceptance setting, language and information frictions plausibly amplify such exposure differences. Evidence shows that providing native-language assignment information shifts families toward more informed and selective choices, precisely the kinds of behavioural changes that govern who enters competitive lotteries in the first place (Zuchanek, 2025). From a policy perspective, this distinction is crucial: even when the lottery is fair, unequal exposure translates into unequal expected losses. Interventions that reduce information gaps, such as native-language materials that explain priority rules, tie-breaking lotteries, and the strategic incentives of the applied mechanism, can therefore lower group differences in exposure and, in turn, the odds of incurring lottery-related losses, without altering the randomness of the lottery itself.

## 7. Robustness Checks

The results presented are robust across various specification choices. As an alternative to Eq. (1), we replace first-ranked school fixed effects with (a) 50 dummies for every two-percentile of the propensity score for assignment to the first-ranked school and (b) the admission probability for the first-ranked school. We conclude that results are quite similar and remain significant and of similar size. For an alternative specification for Eq. (2), we use (c) deciles instead of quantiles. For (c), we conclude that although the interactions of $f\left(\varphi_i^2, \varphi_i^3\right)$ are sparsely populated – since most matches are resolved in the first round – the results are overall consistent with our main findings in Table 2.[27]

[27] Results for alternative specifications (a)-(c) upon request.

To further test the robustness of our results, we replace time fixed effects with interactions between the treatment variable (losing the admission lottery) and year dummies in Eq. (1). This specification allows us to assess whether the estimated effects are driven by a specific year or time period, thereby accounting for potential confounding factors or structural breaks. For all outcome variables, the interaction terms are jointly significant, indicating that treatment effects vary across years. This is not surprising, as fluctuation in demand (see Figure 1), capacity changes and composition of the cohort may vary over time. However, the year-specific coefficients fluctuate without a discernible temporal pattern. Many of them are statistically insignificant, and there is no indication that effects are concentrated in or triggered by a particular year or event. This supports the interpretation that the estimated treatment effects are not driven by single-year anomalies or a confounding factor and remain robust over the full observation period.[28]

Next, we extend our analysis and include voluntary VERA-8 assessments to increase statistical power and coverage across subjects. In Table 2, we omitted students who repeated a grade, were diagnosed with special educational needs – specifically dyscalculia or dyslexia – or who have lived in Germany for less than one year. In addition, schools decide whether their students take another test in a subject that is not the compulsory subject that year. Hence, including voluntary assessments also allows us to cover all three subjects tested each year, rather than being limited to a single compulsory test per cohort. In total, we increase the number of observations by 2,366 (around 55%) taken tests. However, participation in voluntary assessments is not random and may be correlated with unobserved school characteristics, potentially introducing selection bias. Table E1 in Appendix E presents the corresponding results. Overall, the findings closely resemble those reported in Table 2. Most estimates remain statistically insignificant. The only exceptions are German reading and German spelling, where the same lottery rounds as in the main analysis continue to exhibit statistically significant effects in the same direction, although the estimated effect sizes are somewhat smaller.

## 8. Conclusion

School choice mechanisms are intended to promote both efficiency and equity by allowing families to express preferences for schools and to prevent schools from selecting their preferred students in a decentralised manner. However, these systems often assume that families can navigate these complex procedures. Information asymmetries and other barriers can, however, distort choices and exacerbate inequalities in access to preferred secondary schools.

[28] Although this is the case, it is important to note that during the COVID-19 pandemic, many of the associated costs did not materialize, as classes were cancelled or held online. Therefore, for example, while students were technically assigned to schools with greater home-school distances, they were not practically affected by this in everyday life.

Using longitudinal student data from Bremen, a German city state, and its centralized secondary school assignment in an early tracking system, we exploit the causal variation introduced by random admission lotteries to study these dynamics. Lottery-induced randomization within priority groups provides a clear-cut solution to the problem of endogenous sorting while transitioning from primary to secondary school, as students who win or lose the lottery are comparable on both observable and unobservable characteristics. Our findings show that students who lose the admission lottery and are therefore not assigned to their first-ranked school bear higher non-academic costs – particularly in terms of social composition of the school and commuting time – than their peers who win the lottery. Regarding student performance, we find no systematic adverse effects on standardized test scores three years after the transition to secondary school, nor on school-leaving certificates awarded at the end of secondary education (five to eight years after transition). There are, however, some hints that students who lose the lottery have lower achievements in language skills.

In particular, we find that losing admission lotteries increases the home-school distance by approximately 392 to 637 meters, corresponding to more commuting time. Moreover, students who lose admission lotteries attend secondary schools with a different peer composition. Specifically, these schools have higher shares of students eligible for welfare benefits (an increase between 5.5 and 13.3 p.p.), a higher proportion of migrant students (6.4 to 10.4 p.p.) and lower social index scores and academic standards. Lottery losers are also assigned to schools with fewer former peers from primary school and fewer potential peers in fifth grade, based on language spoken at home and gender on school and class level. We also find evidence that specific groups of students are disproportionately affected by losing admission lotteries, especially students eligible for welfare benefits and native German students in terms of effect size. In response, mostly German students opt out of the public school system and enrol in private schools to access a more homogeneous school composition, accepting both tuition fees and longer commutes. In contrast, students who are eligible for welfare benefits are unlikely to opt out. Given the financial barriers associated with private schooling, opting for a private school to circumvent the consequences of losing the admission lottery does not appear to be a feasible or realistic alternative for them (Akbarpour et al., 2022). Moreover, students with a migration background are disproportionately represented in competitive lottery pools and, hence, lose the lotteries more often, but also rarely opt-out. Thus, although the effect size of costs upon losing is heterogeneous, migrant students face them more often because they are more frequently exposed to the lottery.

Our study contributes to the growing literature on admission lotteries and school assignment mechanisms. Existing evidence remains inconclusive regarding the consequences of losing an admission lottery. While some studies document no negative effects on academic or non-academic outcomes, others find little evidence of adverse consequences. Moreover, the mechanisms underlying these findings remain poorly understood (e.g., Hastings et al., 2006; Hastings et al., 2007; Bibler & Billings, 2020 & Ketel et al., 2023). We argue that our results are partly driven by the heterogeneity of

students and their different knowledge about the nature of the applied student matching algorithm, which – in our case - rewards strategic play. This implies that although the admission lottery is random by design, the likelihood of entering the lottery pool is not random.

Our results provide relevant insights for school choice policies and policymakers. When dealing with school enrolment, students and parents should not only consider future academic outcomes, but also social and commuting costs. After all, our analysis shows that social and commuting costs are indeed high while educational attainment is not adversely affected. However, parental frustration about not being assigned to the top-ranked school might be high as parents prefer schools with high-achieving and high socio-economically advantaged peers (Hastings & Weinstein, 2008; Burgess et al., 2015; Abdulkadiroğlu et al., 2020). Therefore, some parents decide to opt out and send their children to private schools for they are willing to pay higher commuting and monetary costs. More generally, our findings suggest that centralized school choice mechanisms can only achieve their intended goals of fairness and efficiency if families face comparable initial conditions when participating in the assignment process. In particular, equal access to clear and comprehensible information about the admission mechanism is essential. Otherwise, differences in information and understanding may translate into unequal exposure to admission lotteries, even when the lottery itself is random and unbiased.

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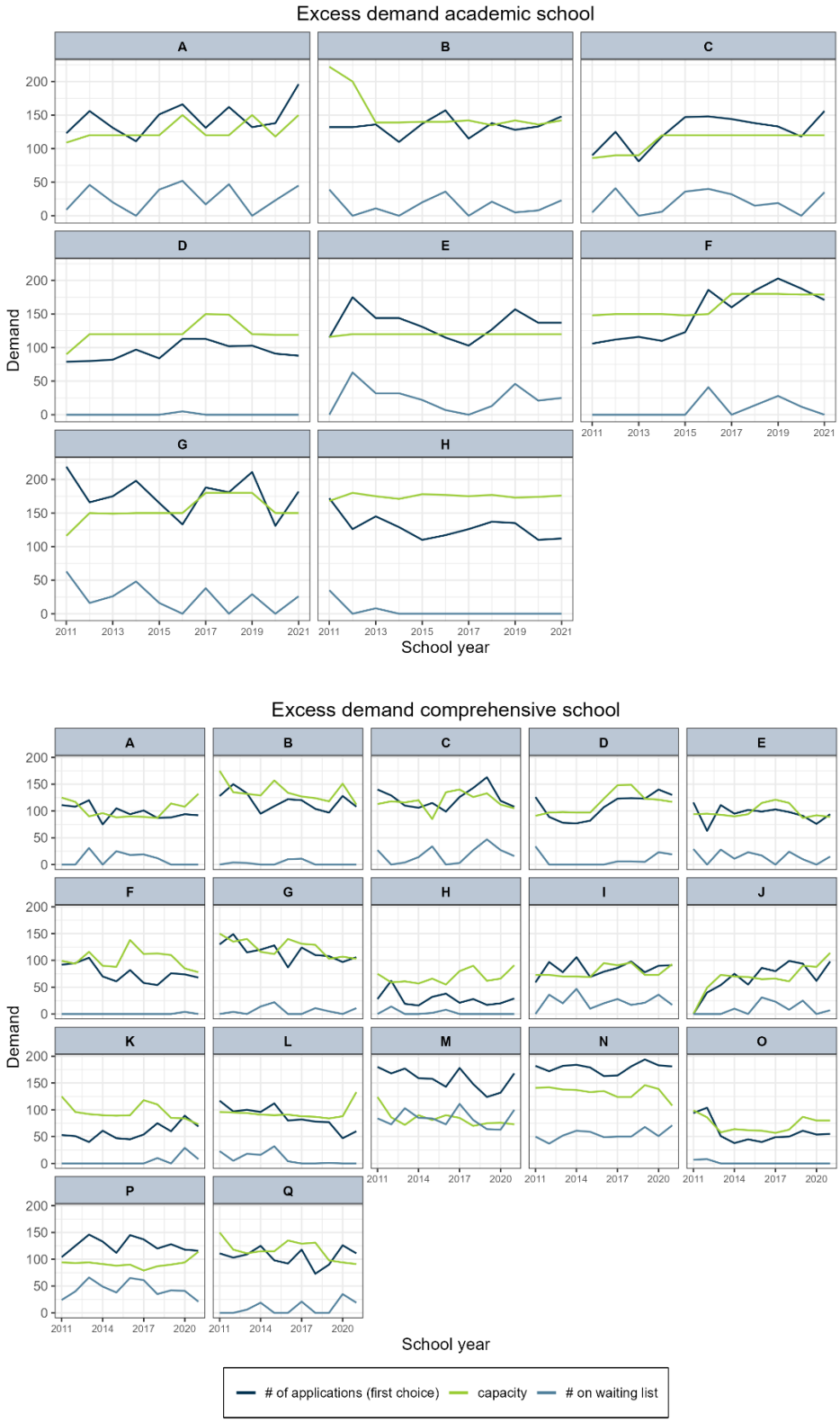
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**Figure 1** Demand, supply and waiting list



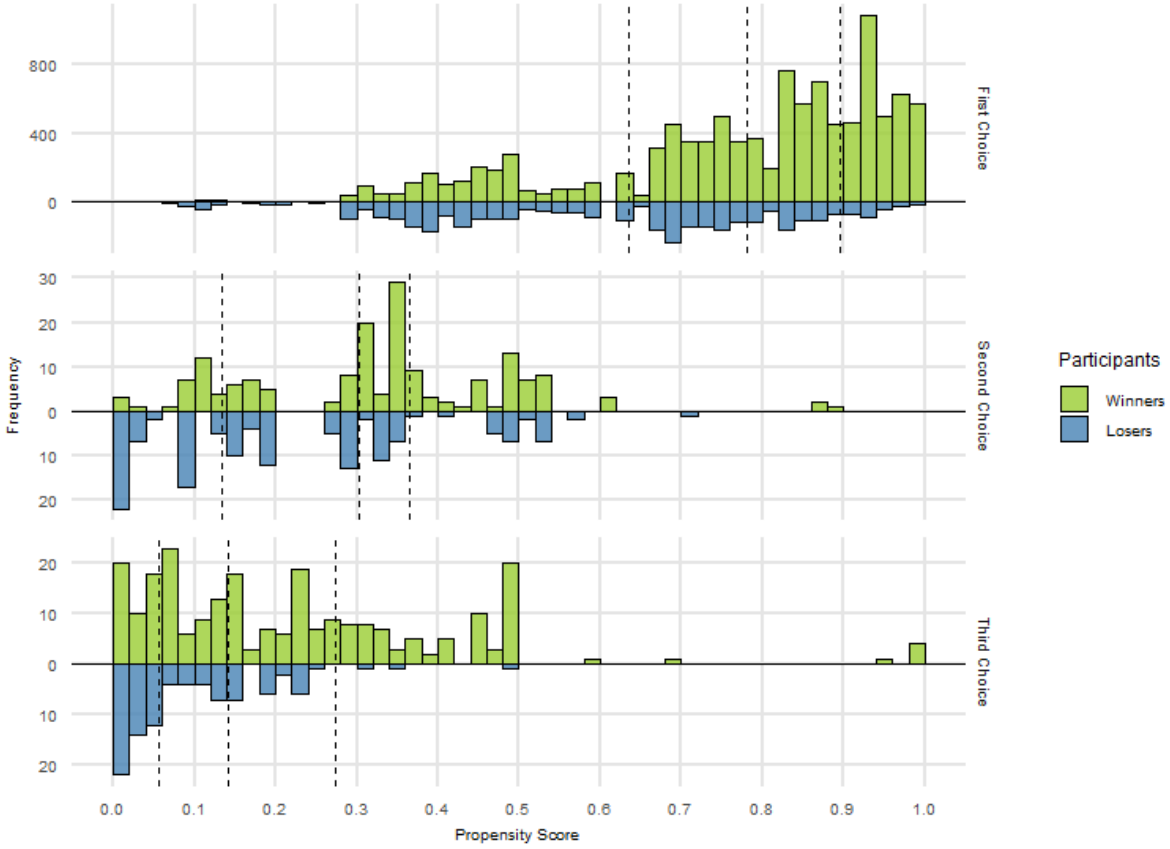

*Note: The figure shows the number of first-ranked applications, the number of students on the waitlist for the first choice and the capacity, which means 30 [25] students per established class minus pre-allocated students with special educational needs across all academic schools [all comprehensive schools with excess demand] over the whole observation period. 17 out of 34 comprehensive schools show excess demand in at least one year. Always 'safe' comprehensive schools are not shown here. We refrain from reporting at the school level using unique school identifiers or the school name.*

**Table 1** Descriptive Statistics

| | All participants (1) | 1st round of the lottery (2) | 2nd round of the lottery (3) | 3rd round of the lottery (4) |
|---|---|---|---|---|
| *a)* Student characteristics | | | | |
| Migrant | 0.501 | 0.515 | 0.713 | 0.662 |
| Female | 0.493 | 0.492 | 0.476 | 0.482 |
| High performance | 0.351 | 0.377 | 0.051 | 0.033 |
| Eligibility for welfare benefits | 0.317 | 0.312 | 0.433 | 0.371 |
| Age | 10.61 | 10.61 | 10.61 | 10.62 |
| *b)* School characteristics of secondary school | | | | |
| Social index B | 2.717 | 2.600 | 3.295 | 3.431 |
| Share of welfare benefit students | 0.338 | 0.267 | 0.424 | 0.435 |
| Share of migrant students | 0.462 | 0.432 | 0.551 | 0.560 |
| Average GPA (secondary school) | 2.451 | 2.394 | 2.461 | 2.504 |
| *c)* Potential peers in secondary school | | | | |
| Potential peers 1 (language) | 48.67 | 47.25 | 6.01 | 3.74 |
| Potential peers 2 (language, class) | 10.22 | 10.19 | 2.00 | 1.35 |
| Potential peers 3 (language, class, gender) | 5.62 | 5.62 | 1.50 | 1.15 |
| *d)* School entry cohort composition+ | | | | |
| Peers A (language) | 8.38 | 9.49 | 4.88 | 4.53 |
| Peers B (classmates) | 6.17 | 7.03 | 3.85 | 3.86 |
| Social index A | 2.848 | 2.908 | 3.693 | 3.342 |
| *e)* Average home-school distance (in meters) to | | | | |
| Closest comprehensive school | 1,007.46 | 952.79 | 798.22 | 904.36 |
| Closest academic school | 3,044.65 | 3,291.20 | 3,890.18 | 3,704.95 |
| 1st choice on ROL | 1,998.60 | 2,180.35 | - | - |
| 2nd choice on ROL | 2,533.00 | 2,538.22 | 2,580.85 | - |
| 3rd choice on ROL | 2,930.94 | 2,880.92 | 2,862.16 | 2,301.04 |
| Assigned school | 3,007.62 | 2,895.93 | 2,454.03 | 2,791.27 |
| Attending school | 2,000.95 | 2,261.32 | 2,577.30 | 2,373.50 |
| *f)* Assignment results | | | | |
| 1st choice on ROL | 0.887 | 0.774 | - | - |
| 2nd choice on ROL | 0.066 | 0.146 | 0.654 | - |
| 3rd choice on ROL | 0.021 | 0.039 | 0.213 | 0.880 |
| Assigned school | 0.027 | 0.042 | 0.134 | 0.120 |
| *g)* Lottery winners and losers | | | | |
| Winners | 24,224 | 10,670 | 166 | 242 |
| Losers | - | 3,122 | 88 | 33 |
| Observations | 39,350 | 13,792 | 254 | 275 |

*Note: The table presents descriptive statistics for those 39,350 students who participated in the student matching assignment between 2011 and 2021 in the city of Bremen. In Column (2) to (4), observations are reduced to students who participated in the respective lotteries. In the observation period, 1,334 students are excluded from the first admission lottery due to a low priority group, and 1,064 students have not been assigned to any school on the ROL. +School entry cohort composition is based on information of primary school exit cohort.*

**Figure 2** Admission Probability for Schools on the Rank-Order List




*Note: Each plot shows the distribution for the probability to be assigned to the school on the ROL (first, second, and third choice) for students who were assigned to that school (above the x-axis, green) or not (below, blue). Students with assignment probabilities equal to 0 or 1 are excluded. The vertical dotted lines depict the quantiles used in Eq. (2).*

**Table 2** Effects of Losing Admission Lotteries

| Outcome | Lottery winner Mean | Not admitted 1st ranked (1) | Admission 2nd ranked (2) | Admission 3rd ranked (3) | Not admitted to ROL (4) | N |
|---|---|---|---|---|---|---|
| *a)* Distance to secondary school | | | | | | |
| Home-school distance (in meters) | 2,254.74 [2,125.23] | 391.80*** (44.75) | 493.30*** (48.78) | 331.50*** (113.50) | 637.40*** (136.50) | 13,175 |
| *b)* School characteristics of secondary school | | | | | | |
| Social index B | 2.445 [1.280] | 0.235*** (0.023) | 0.078*** (0.026) | 0.420*** (0.052) | 0.464*** (0.069) | 13,175 |
| Share of welfare benefit students | 0.276 [0.178] | 0.085*** (0.003) | 0.055*** (0.004) | 0.127*** (0.007) | 0.133*** (0.009) | 13,175 |
| Share of migrant students | 0.416 [0.163] | 0.083*** (0.003) | 0.064*** (0.004) | 0.104*** (0.007) | 0.104*** (0.010) | 13,175 |
| Average GPA (secondary school) | 2.451 [0.181] | 0.063*** (0.003) | 0.043*** (0.004) | 0.071*** (0.008) | 0.111*** (0.011) | 11,878 |
| *c)* Potential peers in secondary school | | | | | | |
| Potential peers 1 (language) | 57.54 [44.93] | -8.76*** (0.674) | -5.50*** (0.793) | -12.32*** (1.566) | -13.91*** (1.593) | 13,175 |
| Potential peers 2 (language, class) | 12.20 [9.08] | -2.66*** (0.149) | -2.04*** (0.184) | -4.20*** (0.339) | -3.09*** (0.333) | 13,175 |
| Potential peers 3 (language, class, gender) | 6.63 [4.92] | -1.42*** (0.081) | -1.11*** (0.101) | -2.27*** (0.181) | -1.65*** (0.177) | 13,175 |
| *d)* School entry cohort composition+ | | | | | | |
| Peers A (language) | 8.06 [7.21] | -2.38*** (0.140) | -2.25*** (0.182) | -2.47*** (0.294) | -2.99*** (0.303) | 13,175 |
| Peers B (classmates) | 5.83 [3.94] | -1.83*** (0.081) | -1.77*** (0.102) | -2.01*** (0.182) | -2.02*** (0.183) | 13,175 |
| Social index A | 2.789 [1.302] | -0.025*** (0.010) | -0.029** (0.012) | 0.012 (0.021) | -0.012 (0.024) | 13,175 |
| *e)* Standardised test scores | | | | | | |
| Mathematics | 2.919 (0.046) | -0.401 (0.217) | 0.061 (0.237) | 0.328 (0.363) | -0.412 (0.460) | 1,530 |
| German (Reading) | 3.679 (0.052) | 0.231 (0.245) | 0.645** (0.278) | 0.329 (0.432) | 0.027 (0.480) | 1,383 |
| German (Spelling) | 3.878 (0.053) | -0.285 (0.307) | 0.071 (0.311) | 0.178 (0.441) | -0.627* (0.372) | 1,383 |
| *f)* Long-term outcome | | | | | | |
| University entrance certificate | 0.481 [0.500] | -0.021 (0.023) | 0.003 (0.029) | 0.034 (0.051) | -0.057 (0.053) | 4,898 |
| Intermediate certificate | 0.236 [0.425] | 0.023 (0.023) | 0.016 (0.030) | -0.027 (0.052) | 0.062 (0.052) | 4,898 |
| Basic certificate | 0.194 [0.388] | -0.030 (0.020) | -0.045* (0.028) | -0.019 (0.048) | -0.045 (0.044) | 4,898 |
| No school-leaving certificate | 0.079 [0.268] | 0.017 (0.012) | 0.016 (0.016) | 0.013 (0.025) | 0.022 (0.030) | 4,898 |

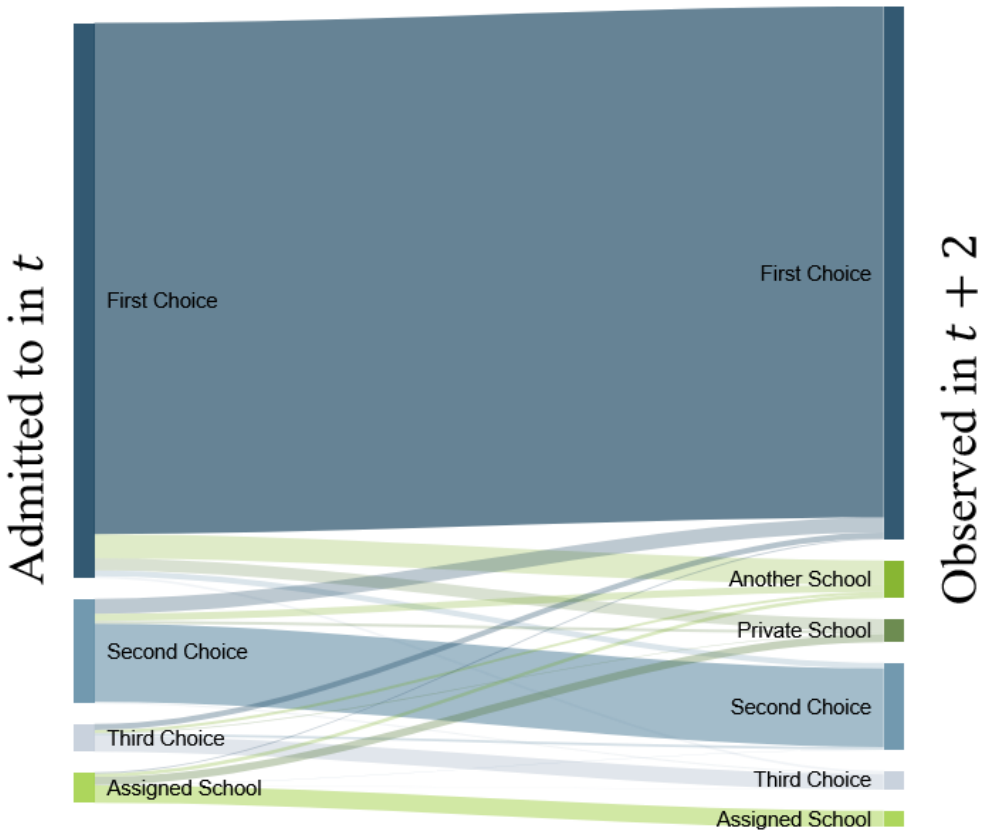
*Note: +School entry cohort composition is based on information of primary school exit cohort. Lottery winner mean: students who participate in the first admission lottery and win. Number of observations differs due to missing values: average GPA is not available for the first year of 2011, school-leaving certificates from 2011 to 2014, standardised test scores from 2016 to 2021 (only students for whom the VERA-8 standardised test was compulsory). Full set of covariates and fixed effects. Robust standard errors in parentheses (for VERA-8 clustered on secondary school class level). Standard deviations in brackets. * $p \leq 0.10$, ** $p \leq 0.05$, *** $p \leq 0.01$.*

**Table 3** Heterogenous Effects for Eligibility for Welfare Benefits

| Outcome<br>N | No eligibility for welfare benefits (8,960) | | | Eligibility for welfare benefits (4,215) | | |
|---|---|---|---|---|---|---|
| | Lottery winner mean | ATE | % change | Lottery winner mean | ATE | % change |
| *a)* Distance to secondary school | | | | | | |
| Home-school distance (in meters) | 2,340.35<br>[2,079.38] | 383.3***<br>(58.60) | 16.38 | 1,905.48<br>[2,041.70] | 433.6***<br>(82.81) | 22.76 |
| *b)* School characteristics of secondary school | | | | | | |
| Social index B | 2.169<br>[1.211] | 0.243***<br>(0.031) | 11.20 | 3.178<br>[1.177] | 0.196***<br>(0.039) | 6.17 |
| Share of welfare benefit students | 0.232<br>[0.167] | 0.080***<br>(0.004) | 34.48 | 0.391<br>[0.153] | 0.084***<br>(0.006) | 21.48 |
| Share of migrant students | 0.388<br>[0.156] | 0.074***<br>(0.004) | 19.07 | 0.492<br>[0.159] | 0.091***<br>(0.005) | 18.50 |
| Average GPA (secondary school) | 2.379<br>[0.181] | 0.060***<br>(0.005) | 2.52 | 2.450<br>[0.164] | 0.063***<br>(0.005) | 2.57 |
| *c)* Potential peers in secondary school | | | | | | |
| Potential peers 1 (language) | 67.63<br>[44.98] | -8.61***<br>(1.066) | 12.73 | 31.86<br>[33.04] | -9.28***<br>(0.995) | 23.13 |
| Potential peers 2 (language, class) | 14.14<br>[9.04] | -3.17***<br>(0.239) | 22.83 | 7.19<br>[6.92] | -2.11***<br>(0.216) | 29.32 |
| Potential peers 3 (language, class, gender) | 7.60<br>[4.96] | -1.64***<br>(0.131) | 21.61 | 4.15<br>[3.80] | -2.06***<br>(0.133) | 49.66 |
| *d)* School entry cohort composition+ | | | | | | |
| Peers A (language) | 8.85<br>[7.34] | -2.67***<br>(0.219) | 30.20 | 6.41<br>[6.65] | -2.37***<br>(0.214) | 37.02 |
| Peers B (classmates) | 5.71<br>[3.88] | -1.77***<br>(0.119) | 31.02 | 6.38<br>[4.05] | -2.06***<br>(0.133) | 32.30 |
| Social index A (exit cohort) | 2.453<br>[1.246] | -0.033**<br>(0.013) | 1.35 | 3.590<br>[1.075] | -0.015<br>(0.016) | - |
| *e)* Standardised test scores | | | | | | |
| Mathematics | 3.233<br>[0.053] | -0.161<br>(0.361) | - | 1.983<br>[0.067] | 0.106<br>(0.370) | - |
| German (Reading) | 4.001<br>[0.059] | 0.168<br>(0.473) | - | 2.781<br>[0.092] | 0.061<br>(0.460) | - |
| German (Spelling) | 4.198<br>[0.059] | -0.345<br>(0.581) | - | 2.935<br>[0.092] | -0.158<br>(0.361) | - |
| *f)* Long-term outcomes | | | | | | |
| University entrance certificate | 0.572<br>[0.495] | 0.015<br>(0.037) | - | 0.265<br>[0.442] | -0.046<br>(0.041) | - |
| Intermediate certificate | 0.211<br>[0.408] | -0.010<br>(0.035) | - | 0.294<br>[0.456] | 0.045<br>(0.047) | - |
| Basic certificate | 0.141<br>[0.348] | -0.036<br>(0.029) | - | 0.287<br>[0.453] | -0.015<br>(0.047) | - |
| No school-leaving certificate | 0.076<br>[0.264] | 0.031<br>(0.023) | - | 0.153<br>[0.360] | 0.016<br>(0.034) | - |

*Note: +School entry cohort composition is based on information of primary school exit cohort. Lottery winner mean: students who participate in the first admission lottery and win. Number of observations differs due to missing values. Full set of covariates and fixed effects. Robust standard errors in parentheses. Standard deviations in brackets. * $p \leq 0.10$, ** $p \leq 0.05$, *** $p \leq 0.01$.*

**Figure 3** Non-Compliance




| From | To | $t$ | | $t+1$ | | $t+2$ | |
|---|---|---|---|---|---|---|---|
| | | Obs. | Share (in %) | Obs. | Share (in %) | Obs. | Share (in %) |
| First Choice | First Choice | 10,212 | 95.76 | 9,890 | 93.69 | 9,604 | 92.05 |
| | Second Choice | 34 | 0.32 | 74 | 0.70 | 106 | 1.02 |
| | Third Choice | 5 | 0.05 | 19 | 0.18 | 41 | 0.39 |
| | Private School | 182 | 1.71 | 212 | 2.01 | 224 | 2.15 |
| | Another School | 231 | 2.17 | 361 | 3.42 | 458 | 4.39 |
| Second Choice | First Choice | 251 | 12.52 | 279 | 14.03 | 279 | 14.23 |
| | Second Choice | 1,616 | 80.64 | 1,524 | 76.66 | 1,473 | 75.15 |
| | Third Choice | 19 | 0.95 | 23 | 1.16 | 25 | 1.28 |
| | Private School | 43 | 2.15 | 48 | 2.41 | 48 | 2.45 |
| | Another School | 75 | 3.74 | 114 | 5.73 | 135 | 6.89 |
| Third Choice | First Choice | 96 | 18.01 | 106 | 20.11 | 109 | 21.17 |
| | Second Choice | 51 | 9.57 | 50 | 9.49 | 49 | 9.51 |
| | Third Choice | 334 | 62.66 | 309 | 58.63 | 289 | 56.12 |
| | Private School | 15 | 2.81 | 15 | 2.85 | 16 | 3.11 |
| | Another School | 37 | 6.94 | 47 | 8.92 | 52 | 10.10 |
| Assigned School | First Choice | 2 | 0.35 | 20 | 3.45 | 24 | 4.17 |
| | Second Choice | 3 | 0.53 | 3 | 0.52 | 6 | 1.04 |
| | Third Choice | 1 | 0.18 | 5 | 0.86 | 4 | 0.69 |
| | Private School | 134 | 23.76 | 152 | 26.21 | 148 | 25.69 |
| | Another School | 34 | 6.03 | 53 | 9.14 | 65 | 11.28 |
| | Assigned School | 390 | 69.15 | 347 | 59.83 | 329 | 57.12 |

*Interpretation: The Sankey diagram illustrates patterns of non-compliance when transitioning from primary to secondary school. On the left-hand side, students are shown according to the school they were initially admitted to in period* $(t)$*. On the right-hand side, students are shown according to the school they are actually observed attending two years later* $(t+2)$*. Note: 'Assigned School' refers to the school assigned by the school board when a student does not receive a placement at any school listed on their ROL. 'Another School' refers to a school that is neither on the ROL, nor the assigned school, nor a private school.*

**Table 4** Compliers and Non-Compliers Attending Private Schools

| Students Characteristics | Compliers mean | Non-Compliers mean | mean difference | p > \|t\| |
|---|---|---|---|---|
| (a) Winning first admission lottery | | | | |
| Age | 10.47 | 10.49 | 0.023 | 0.658 |
| Female | 0.448 | 0.439 | 0.009 | 0.849 |
| High performance | 0.709 | 0.717 | 0.009 | 0.835 |
| Migrant | 0.161 | 0.166 | 0.005 | 0.898 |
| Eligibility for welfare benefits | 0.040 | 0.040 | 0.000 | 1.000 |
| Building block | YES | YES | - | - |
| Propensity score for non-compliance | 0.038 | 0.038 | | |
| Std. dev. | 0.016 | 0.016 | | |
| N | 223 | 223 | | |
| (b) Losing first admission lottery | | | | |
| Age | 10.53 | 10.56 | 0.026 | 0.669 |
| Female | 0.613 | 0.516 | 0.097 | 0.086 |
| High performance | 0.555 | 0.555 | 0.000 | 1.000 |
| Migrant | 0.342 | 0.303 | 0.039 | 0.468 |
| Eligibility for welfare benefits | 0.045 | 0.045 | 0.000 | 1.000 |
| Building block | YES | YES | - | - |
| Propensity score | 0.308 | 0.352 | | |
| Std. dev. | 0.220 | 0.223 | | |
| N | 155 | 155 | | |

*Note: Columns for (a): Compliers, students that participate in the first admission lottery, win, and stay in the first-ranked school, at least two years after the matching assignment; non-compliers, students that participate in the first admission lottery and win but are observed in a private school two years after the matching assignment. Columns for (b): Compliers, students that participate in the first admission lottery, lose, and stay in the non-first-ranked school, at least two years after the matching assignment; non-compliers, students that participate in the first admission lottery and lose, but are observed in a private school two years after the matching assignment.*

**Table 5** Effects of attending private schools in t + 2, after participating in the first admission lottery

| Outcome | ATT in outcome when switching from public to private school | | | | | |
|---|---|---|---|---|---|---|
| | (a) Winning the first admission lottery | | | (b) Losing the first admission lottery | | |
| | Compliers mean | ATT | T-stat | Compliers mean | ATT | T-stat |
| *a)* Distance to secondary school | | | | | | |
| Home-school distance (in m) | 2,816.4 | 1,228.8*** | 3.97 | 2,345.5 | 1,057.9*** | 4.94 |
| | [2,293.6] | (309.18) | | [1,664.5] | (214.11) | |
| *b)* School characteristics of secondary school | | | | | | |
| Share of welfare benefit students | 0.175 | -0.117*** | -9.64 | 0.323 | -0.282*** | -16.00 |
| | [0.138] | (0.012) | | [0.198] | (0.018) | |
| Share of migrant students | 0.328 | -0.114*** | -9.78 | 0.447 | -0.191*** | -9.77 |
| | [0.112] | (0.012) | | [0.206] | (0.020) | |
| *c)* Potential peers in secondary school | | | | | | |
| Potential peers 1 | 86.01 | -24.24*** | -5.56 | 57.84 | -21.90*** | -5.73 |
| (Language) | [40.74] | (4.363) | | [38.89] | (3.822) | |
| Potential peers 2 | 18.39 | -11.44*** | -14.72 | 12.81 | -8.06*** | -11.16 |
| (Language, class) | [7.53] | (0.777) | | [7.70] | (0.723) | |
| Potential peers 3 | 9.50 | -5.44*** | -12.63 | 6.66 | -3.79*** | -9.72 |
| (language, class, gender) | [4.35] | (0.431) | | [4.11] | (0.390) | |
| *d)* School entry cohort composition+ | | | | | | |
| Peers 1 (language spoken at home) | 9.27 | 4.22*** | 3.86 | 7.68 | 8.40*** | 6.29 |
| | [7.65] | (1.094) | | [7.42] | (1.334) | |
| Peers 2 (classmates) | 5.54 | -3.77*** | -13.90 | 4.34 | -2.79*** | -10.42 |
| | [3.72] | (0.271) | | [3.09] | (0.268) | |
| *e)* Long-term outcomes | | | | | | |
| University entrance certificate | 0.616 | 0.027 | 0.34 | 0.481 | 0.296** | 2.32 |
| | [0.490] | (0.080) | | [0.509] | (0.127) | |
| Intermediate certificate | 0.192 | -0.068 | -1.13 | 0.370 | -0.222* | -1.89 |
| | [0.396] | (0.060) | | [0.492] | (0.118) | |
| Basic certificate | 0.164 | 0.041 | 0.64 | 0.037 | 0.000 | 0.00 |
| | [0.373] | (0.065) | | [0.192] | (0.052) | |
| No school-leaving certificate | 0.027 | 0.000 | 0.00 | 0.111 | -0.074 | -1.03 |
| | [0.164] | (0.027) | | [0.320] | (0.072) | |
| N | 223 | 223 | | 155 | 155 | |

*Note: +School entry cohort composition is based on information of primary school exit cohort. Columns for (a): Compliers, students that participate in the first admission lottery, win, and stay in the first-ranked school, at least two years after the matching assignment; non-compliers, students that participate in the first admission lottery and win but are observed in a private school two years after the matching assignment. Columns for (b): Compliers, students that participate in the first admission lottery, lose, and stay in the non-first-ranked school, at least two years after the matching assignment; non-compliers, students that participate in the first admission lottery and lose, but are observed in a private school two years after the matching assignment. ATT: average treatment effect on the treated, e.g. non-compliers effect due to the change to a private school. Standard errors in parentheses. Standard deviations in brackets.* $^{*}p \leq 0.10$, $^{**}p \leq 0.05$, $^{***}p \leq 0.01$.

**Appendix**

**Appendix A –Bremen's Secondary Schools**

In Bremen, there are unlike in other German federal states only two types of secondary schools: academic schools (*Gymnasium*) and comprehensive schools (*Oberschule*).[29] While there are differences between the school types, e.g. maximum class size (30 for schools and 25 for comprehensive schools), teaching structure and curriculum, students can obtain the same school-leaving certificates. The school-leaving certificate qualifying for university entrance is obtained after eight years in academic schools and nine years in comprehensive schools. In 2021, Bremen had eight academic and 34 comprehensive schools. In addition, there are ten private schools that offer a secondary school program.

The school types differ in their admission rules. For comprehensive schools, the first priority sorting depends on the affiliated primary school (schools close by) and an above-average academic performance of the student. For these students, one-third of a comprehensive school's capacity is reserved. The second priority group is defined solely by affiliation of the primary school. Hence, if a high-performing student from an affiliated primary school loses the lottery within the first priority group, the student will be considered again within the second priority group – but competes with low-performing students. This is the only case where students can be considered twice within a preference on the ROL. In case that seats remain unfilled, the remaining seats will be filled by lottery with students from non-affiliated primary schools. Wait list priority for comprehensive schools is 1) students from affiliated primary schools and 2) all other students. For academic schools, priority is only based on performance. Hence, after the first priority group, all other students will be admitted, if seats remain available. The wait list priorities differ: 1) performance, 2) siblings and 3) all other students. General admission rules/priorities:

a) Both school types reserve up to ten percent of places for so-called hardship cases. These may include i) children with physical disabilities, ii) children facing exceptionally severe family or social hardship, iii) or children with siblings already attending the same school if non-admission would cause family-related difficulties. According to the school board, hardship status is granted only in exceptional circumstances following an individual assessment.
b) Within each priority group, a lottery takes place if the number of applicants exceeds the number of available seats.
c) Applications submitted after the application deadline will be given lower priority.
d) If none of the schools on the ROL could be considered, parents will receive a mail from the school board. Following a counselling session, they will be offered another school place.
e) The wait list for the over demanded schools remains active until the end of the first term of the respective academic year.

[29] Freie Hansestadt Bremen – Die Senatorin für Kinder und Bildung (2025).

## Appendix B – Further Descriptive Statistics

**Table B1** Descriptive Statistics Standardised Test Scores

| | For students transitioning in: | | | | | |
|---|---|---|---|---|---|---|
| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
| *a)* Mathematics | | | | | | |
| Mean | 2.910 | 3.119 | 2.758 | 2.402 | 2.439 | 2.420 |
| | (0.079) | (0.028) | (0.060) | (0.055) | (0.025) | (0.061) |
| At academic school | - | 3.991 | 3.133 | 2.714 | 3.382 | - |
| | | (0.049) | (0.215) | (0.522) | (0.046) | |
| At comprehensive school | 2.910 | 2.715 | 2.747 | 2.397 | 2.052 | 2.420 |
| | (0.079) | (0.031) | (0.058) | (0.056) | (0.025) | (0.061 |
| Total No. Obs. | 312 | 2,687 | 516 | 470 | 2,756 | 333 |
| of which lottery participant | 159 | 927 | 146 | 222 | 812 | 229 |
| *b)* German (Reading) | | | | | | |
| Mean | 3.548 | 2.773 | 3.292 | 1.566 | 2.038 | 3.185 |
| | (0.069) | (0.074) | (0.037) | (0.037) | (0.071) | (0.033) |
| At academic school | - | 3.143 | 4.233 | - | - | 4.571 |
| | | (0.508) | (0.056) | | | (0.048) |
| At comprehensive school | 3.548 | 2.767 | 2.914 | 1.566 | 2.038 | 2.557 |
| | (0.069) | (0.075) | (0.043) | (0.037) | (0.071) | (0.034) |
| Total No. Obs. | 363 | 384 | 1,734 | 442 | 260 | 2,617 |
| of which lottery participant | 136 | 229 | 569 | 188 | 99 | 1,142 |
| *c)* German (Spelling) | | | | | | |
| Mean | 2.977 | 2.406 | 2.967 | 3.437 | 2.211 | 3.629 |
| | (0.052) | (0.058) | (0.031) | (0.076) | (0.055) | (0.034) |
| At academic school | - | 3.571 | 4.021 | - | - | 4.884 |
| | | (0.297) | (0.049) | | | (0.049) |
| At comprehensive school | 2.977 | 2.385 | 2.562 | 3.437 | 2.211 | 3.060 |
| | (0.052) | (0.058) | (0.032) | (0.076) | (0.055) | (0.038) |
| Total No. Obs. | 351 | 384 | 1,700 | 442 | 260 | 2,617 |
| of which lottery participant | 136 | 229 | 569 | 188 | 99 | 1,142 |

*Note: VERA-8 standardised test each year by subject and skill domain. The statistics include all available VERA assessments, both compulsory and voluntary. They also include students who did not participate in the compulsory assessment for their cohort due to exemptions or alternative testing arrangements (e.g., dyslexia, dyscalculia, or comparable special educational accommodations). Test is taken three years after transitioning from primary to secondary school. Compulsory Tests: English in 2019 and 2022, Mathematics in 2020 and 2023, German in 2021 and 2024. Standard errors in parentheses.*

## Appendix C – Heterogeneity

**Table C1** Heterogeneity for Equation (1)

| Outcome | (1) Sex | | | | (2) Country of origin | | | |
|---|---|---|---|---|---|---|---|---|
| | Male | | Female | | German | | Non-German | |
| N | (6,683) | | (6,492) | | (6,272) | | (6,903) | |
| | Lottery winner mean | ATE | Lottery winner mean | ATE | Lottery winner mean | ATE | Lottery winner mean | ATE |
| *a) Distance to secondary school* | | | | | | | | |
| Home-school distance (in meters) | 2,241.3 | 340.9*** (67.26) | 2,268.6 | 470.3*** (68.62) | 2,314.3 | 341.1*** (83.22) | 2,219.2 | 420.6*** (58.65) |
| *b) School characteristics of secondary school* | | | | | | | | |
| Social index B | 2.46 | 0.237*** (0.036) | 2.43 | 0.196*** (0.036) | 2.09 | 0.265*** (0.038) | 2.82 | 0.199*** (0.032) |
| Share of welfare benefit students | 0.28 | 0.069*** (0.005) | 0.27 | 0.072*** (0.005) | 0.23 | 0.067*** (0.006) | 0.33 | 0.072*** (0.005) |
| Share of migration students | 0.42 | 0.076*** (0.005) | 0.42 | 0.069*** (0.005) | 0.36 | 0.065*** (0.005) | 0.48 | 0.072*** (0.004) |
| Average GPA (secondary school) | 2.38 | 0.056*** (0.006) | 2.38 | 0.068*** (0.059) | 2.35 | 0.047*** (0.008) | 2.40 | 0.072*** (0.005) |
| *c) Potential peers in secondary school* | | | | | | | | |
| Potential peers 1 (language) | 56.72 | -11.05*** (1.089) | 58.39 | -11.06*** (1.058) | 82.55 | -16.69*** (1.284) | 41.05 | -8.14*** (0.867) |
| Potential peers 2 (language, class) | 12.07 | -2.91*** (0.233) | 12.24 | -3.22*** (0.235) | 17.23 | -5.44*** (0.296) | 6.88 | -1.83*** (0.179) |
| Potential peers 3 (language, class, gender) | 6.56 | -1.48*** (0.127) | 6.71 | -1.73*** (0.127) | 9.17 | -2.83*** (0.171) | 3.94 | -0.99*** (0.095) |
| *d) School entry cohort composition*[+] | | | | | | | | |
| Peers A (language) | 8.12 | -2.81*** (0.214) | 7.99 | -2.56*** (0.220) | 10.57 | -3.88*** (0.294) | 5.39 | -1.92*** (0.158) |
| Peers B (classmates) | 5.86 | -1.97*** (0.120) | 5.80 | -2.00*** (0.127) | 5.69 | -1.95*** (0.148) | 5.98 | -1.85*** (0.103) |
| Social index A (exit cohort) | 2.80 | -0.021 (0.015) | 2.75 | -0.031** (0.014) | 2.30 | -0.025 (0.017) | 3.27 | -0.023* (0.013) |
| *e) Standardised test scores* | | | | | | | | |
| Mathematics | 3.193 | -0.062 (0.435) | 2.662 | -0.078 (0.463) | 3.511 | -0.153 (0.557) | 2.352 | 0.228 (0.269) |
| German (Reading) | 3.515 | 0.531 (0.366) | 3.897 | -0.503 (0.491) | 4.445 | 1.519* (0.856) | 3.105 | 0.280 (0.324) |
| German (Spelling) | 3.740 | 0.387 (0.557) | 4.029 | -0.895* (0.455) | 4.500 | 0.824 (0.991) | 3.385 | -0.303 (0.356) |
| *f) Long-term outcomes* | | | | | | | | |
| University entrance certificate | 0.44 | -0.063* (0.038) | 0.52 | -0.002 (0.049) | 0.54 | 0.012 (0.044) | 0.40 | -0.022 (0.037) |
| Intermediate certificate | 0.25 | 0.057 (0.043) | 0.22 | 0.028 (0.046) | 0.22 | -0.018 (0.042) | 0.26 | 0.041 (0.038) |
| Basic certificate | 0.21 | -0.028 (0.042) | 0.16 | -0.025 (0.039) | 0.15 | -0.009 (0.035) | 0.24 | -0.045 (0.036) |
| No school-leaving certificate | 0.10 | -0.034 (0.031) | 0.10 | -0.002 (0.033) | 0.09 | 0.016 (0.029) | 0.10 | 0.026 (0.026) |

*Note: Continues on the next page.*

**Table C1** Heterogeneity for Equation (1), Continued

| Outcomes | (3) School Type (first choice) | | | | (4) Performance | | | |
|---|---|---|---|---|---|---|---|---|
| | Comprehensive school | | Academic school | | Low-performing | | High-performing | |
| N | (8,540) | | (4,635) | | (8,340) | | (4,835) | |
| | Lottery winner mean | ATE | Lottery winner mean | ATE | Lottery winner mean | ATE | Lottery winner mean | ATE |
| *a) Distance to secondary school* | | | | | | | | |
| Home-school distance (in meters) | 1,623.9 | 661.6*** (41.54) | 3,176.9 | -639.9*** (151.50) | 1,863.5 | 592.6*** (48.52) | 3,016.7 | -273.4* (144.2) |
| *b) School characteristics of secondary school* | | | | | | | | |
| Social index B | 3.05 | 0.086*** (0.025) | 1.56 | 0.575*** (0.064) | 3.24 | 0.142*** (0.026) | 1.56 | 0.393*** (0.068) |
| Share of welfare benefit students | 0.38 | 0.052*** (0.004) | 0.13 | 0.011*** (0.009) | 0.41 | 0.062*** (0.004) | 0.14 | 0.063*** (0.009) |
| Share of migration students | 0.47 | 0.070*** (0.003) | 0.34 | 0.050*** (0.009) | 0.51 | 0.070*** (0.003) | 0.32 | 0.044*** (0.009) |
| Average GPA (secondary school) | 2.50 | 0.036*** (0.003) | 2.22 | 0.189*** (0.013) | 2.50 | 0.045*** (0.003) | 2.25 | 0.120*** (0.014) |
| *c)* Potential peers in secondary school | | | | | | | | |
| Potential peers 1 (language) | 40.96 | -7.21*** (0.629) | 81.80 | -24.50*** (2.398) | 34.9 | -7.63*** (0.649) | 82.4 | -21.11*** (2.257) |
| Potential peers 2 (language, class) | 9.06 | -2.08*** (0.144) | 16.80 | -6.99*** (0.504) | 7.54 | -2.10*** (0.146) | 17.2 | -7.08*** (0.540) |
| Potential peers 3 (language, class, gender) | 5.03 | -1.10*** (0.078) | 8.98 | -3.66*** (0.276) | 4.26 | -1.12*** (0.078) | 9.16 | -3.70*** (0.304) |
| *d)* School entry cohort composition+ | | | | | | | | |
| Peers 1 (language) | 8.83 | -3.10*** (0.156) | 6.93 | -1.51*** (0.389) | 7.15 | -2.89*** (0.157) | 7.61 | -2.16*** (0.431) |
| Peers 2 (classmates) | 6.97 | -2.36*** (0.091) | 4.18 | -0.61*** (0.206) | 6.05 | -2.33*** (0.093) | 4.19 | -0.81*** (0.203) |
| Social index A (exit cohort) | 3.16 | -0.027** (0.011) | 2.21 | -0.029 (0.022) | 3.35 | -0.025** (0.012) | 2.14 | -0.016 (0.022) |
| *e)* Standardised test scores | | | | | | | | |
| Mathematics | 2.199 | -0.070 (0.261) | 4.205 | -0.224 (1.194) | 2.093 | -0.044 (0.263) | 4.149 | -0.208 (0.628) |
| German (Reading) | 2.523 | 0.295 (0.286) | 4.763 | 0.279 (1.937) | 2.539 | 0.320 (0.269) | 4.768 | 0.702 (0.865) |
| German (Spelling) | 2.614 | -0.176 (0.372) | 5.037 | -0.212 (1.204) | 2.603 | -0.005 (0.259) | 5.054 | 0.504 (0.686) |
| *f) Long-term outcomes* | | | | | | | | |
| University entrance certificate | 0.33 | -0.015 (0.029) | 0.74 | -0.027 (0.064) | 0.26 | 0.015 (0.029) | 0.80 | 0.003 (0.061) |
| Intermediate certificate | 0.32 | 0.024 (0.032) | 0.10 | 0.010 (0.047) | 0.34 | 0.029 (0.033) | 0.10 | -0.006 (0.035) |
| Basic certificate | 0.23 | -0.038 (0.028) | 0.10 | -0.028 (0.053) | 0.27 | -0.061** (0.030) | 0.05 | -0.033 (0.036) |
| No school-leaving certificate | 0.12 | 0.029 (0.022) | 0.06 | 0.045 (0.046) | 0.13 | 0.017 (0.023) | 0.05 | 0.035 (0.039) |

*Note: +School entry cohort composition is based on information of primary school exit cohort. Lottery winner mean: students who participate in the first admission lottery and win. Number of observations differs due to missing values. Full set of covariates and fixed effects. Robust standard errors in parentheses. * $p \leq 0.10$, ** $p \leq 0.05$, *** $p \leq 0.01$.*

## Appendix D – Lottery Participants and Randomness

**Table D1** T-Test Lottery Participants

| | Lottery Participant | | |
|---|---|---|---|
| | No | Yes | T-Test |
| Students Characteristics | | | Mean diff. |
| Age | 10.617 | 10.607 | 0.010 |
| | [0.570] | [0.570] | |
| Female | 0.493 | 0.491 | 0.002 |
| | [0.500] | [0.500] | |
| High performance | 0.338 | 0.374 | -0.035*** |
| | [0.473] | [0.484] | |
| Migrant | 0.489 | 0.517 | -0.028*** |
| | [0.500] | [0.500] | |
| Eligibility for welfare benefits | 0.320 | 0.312 | 0.008 |
| | [0.467] | [0.463] | |
| First choice academic school | 0.263 | 0.360 | -0.097*** |
| | [0.440] | [0.480] | |
| N | 25,427 | 13,923 | |

*Note: The table reports mean values for student characteristics by risk of lottery participation. T-tests compare the means of lottery participants and students who listed a safe school first or were excluded from the lottery due to a low priority group and, as a result, were assigned by the school board. Standard deviations in brackets.* $^{*}p \leq 0.10$, $^{**}p \leq 0.05$, $^{***}p \leq 0.01$.

**Table D2** Randomness Check for First Admission Lottery Win

| | Academic School | | Comprehensive School | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| | Performance | No-priority group | Performance + affiliation | Affiliation | No-priority group |
| Welfare Benefit (yes = 1) | -0.005 | -0.066 | 0.054 | 0.003 | -0.137 |
| | (0.030) | (0.112) | (0.097) | (0.015) | (0.151) |
| Migrant (yes = 1) | -0.001 | 0.082 | -0.082 | 0.034* | 0.038 |
| | (0.035) | (0.166) | (0.144) | (0.018) | (0.234) |
| Sex (female = 1) | -0.005 | 0.019 | -0.017 | -0.005 | -0.077 |
| | (0.015) | (0.091) | (0.048) | (0.012) | (0.111) |
| Age (in years) | -0.008 | 0.055 | -0.021 | 0.008 | -0.057 |
| | (0.014) | (0.098) | (0.048) | (0.011) | (0.108) |
| $R^2$ | 0.459 | 0.801 | 0.721 | 0.306 | 0.810 |
| *N* | 4,374 | 735 | 755 | 8,322 | 747 |

*Note: Dependent variable is first admission lottery win. Primary school, city block and year fixed effects are included. Lottery losers of (3) participate in (4) again, which is the only case, where students are considered twice (see Appendix A). Robust standard errors in parentheses.* $^{*}p \leq 0.10$, $^{**}p \leq 0.05$, $^{***}p \leq 0.01$.

We use a simple OLS method to check whether lottery outcomes are random. We analyse if characteristics like eligibility for welfare benefits, migration status, gender or age affect lottery outcomes. We use primary school, city block and year fixed effects. We also differentiate between priority groups and school types. We find no effects of different observables on lottery outcomes. Hence, we argue that in the city of Bremen, lottery-induced placement is random, and an exogenous sorting among students takes place.

## Appendix E – Standardised Test Scores

**Appendix E1** Compulsory and Voluntary Standardised Test Scores

| Outcome | Lottery winner Mean | Not admitted 1st ranked | Admission 2nd ranked | Admission 3rd ranked | Not admitted to ROL | N |
|---|---|---|---|---|---|---|
| Mathematics | 2.804 | 0.041 | -0.007 | 0.259 | -0.083 | 2,320 |
| | [0.357] | (0.134) | (0.153) | (0.208) | (0.230) | |
| German (Reading) | 3.316 | 0.184 | 0.332* | 0.171 | -0.123 | 2,171 |
| | [0.042] | (0.148) | (0.172) | (0.243) | (0.299) | |
| German (Spelling) | 3.641 | -0.213 | -0.100 | 0.062 | -0.549** | 2,171 |
| | [0.041] | (0.163) | (0.200) | (0.242) | (0.229) | |

*Note: VERA-8 standardised test (compulsory and voluntary). Lottery winner control mean: students who participate in the first admission lottery and win. Number of observations differs due to missing values. Full set of covariates and fixed effects. Clustered on secondary school class level. Robust standard errors in parentheses. Standard deviations in brackets.* $^{*}p \leq 0.10$, $^{**}p \leq 0.05$, $^{***}p \leq 0.01$.

## Appendix F – Non-compliance and Private Schools

**Table F1** Unmatched Sample: Compliers and non-compliers (opting for private schools in $t + 2$)

| Students Characteristics | Compliers mean | Non-Compliers mean | mean difference | p > \|t\| |
|---|---|---|---|---|
| (a) Winning first admission lottery | | | | |
| Age | 10.59 | 10.49 | 0.102 | 0.007 |
| Female | 0.496 | 0.439 | 0.057 | 0.094 |
| High performance | 0.444 | 0.717 | 0.274 | 0.000 |
| Migrant | 0.489 | 0.166 | 0.323 | 0.000 |
| Eligibility for welfare benefits | 0.282 | 0.040 | 0.241 | 0.000 |
| Building block | YES | YES | - | - |
| Propensity score for non-compliance | 0.022 | 0.038 | | |
| Std. dev. | 0.019 | 0.016 | | |
| N | 9.598 | 223 | | |
| (b) Losing first admission lottery | | | | |
| Age | 10.66 | 10.50 | 0.166 | 0.000 |
| Female | 0.481 | 0.511 | 0.030 | 0.435 |
| High performance | 0.081 | 0.637 | 0.556 | 0.000 |
| Migrant | 0.666 | 0.300 | 0.366 | 0.000 |
| Eligibility for welfare benefits | 0.480 | 0.042 | 0.438 | 0.000 |
| Building block | YES | YES | - | - |
| Propensity score | 0.070 | 0.352 | | |
| Std. dev. | 0.120 | 0.223 | | |
| N | 1.764 | 190 | | |

*Note: Columns for (a): Compliers, students that participate in the first admission lottery, win, and stay in the first-ranked school, at least two years after the matching assignment; non-compliers, students that participate in the first admission lottery and win but are observed in a private school two years after the matching assignment. Columns for (b): Compliers, students that participate in the first admission lottery, lose, and stay in the non-first-ranked school, at least two years after the matching assignment; non-compliers, students that participate in the first admission lottery and lose, but are observed in a private school two years after the matching assignment.*

**Table F2** Compliers and non-compliers (opting for private schools) in $t$ and $t+1$

| | | | | |
|---|---|---|---|---|
| | | $t$ | | |
| Students Characteristics | Compliers mean | Non-Compliers mean | mean difference | p > \|t\| |
| | (a) Winning first admission lottery | | | |
| Age | 10.43 | 10.46 | 0.027 | 0.631 |
| Female | 0.456 | 0.418 | 0.038 | 0.461 |
| High performance | 0.742 | 0.747 | 0.005 | 0.905 |
| Migrant | 0.176 | 0.176 | 0.000 | 1.000 |
| Eligibility for welfare benefits | 0.027 | 0.033 | 0.006 | 0.760 |
| Building block | YES | YES | - | - |
| Propensity score for non-compliance | 0.032 | 0.032 | | |
| Std. dev. | 0.015 | 0.015 | | |
| N | 182 | 182 | | |
| | (b) Losing first admission lottery | | | |
| Age | 10.48 | 10.58 | 0.106 | 0.077 |
| Female | 0.497 | 0.509 | 0.012 | 0.824 |
| High performance | 0.565 | 0.584 | 0.019 | 0.736 |
| Migrant | 0.311 | 0.348 | 0.037 | 0.478 |
| Eligibility for welfare benefits | 0.037 | 0.019 | 0.018 | 0.312 |
| Building block | YES | YES | - | - |
| Propensity score | 0.302 | 0.338 | | |
| Std. dev. | 0.210 | 0.210 | | |
| N | 161 | 161 | | |
| | | $t$+1 | | |
| Students Characteristics | Compliers mean | Non-Compliers mean | mean difference | p > \|t\| |
| | (c) Winning first admission lottery | | | |
| Age | 10.42 | 10.46 | 0.042 | 0.425 |
| Female | 0.458 | 0.425 | 0.033 | 0.495 |
| High performance | 0.726 | 0.731 | 0.005 | 0.913 |
| Migrant | 0.165 | 0.165 | 0.000 | 1.000 |
| Eligibility for welfare benefits | 0.028 | 0.033 | 0.005 | 0.779 |
| Building block | YES | YES | - | - |
| Propensity score for non-compliance | 0.037 | 0.037 | | |
| Std. dev. | 0.016 | 0.016 | | |
| N | 212 | 212 | | |
| | (d) Losing first admission lottery | | | |
| Age | 10.52 | 10.55 | 0.032 | 0.595 |
| Female | 0.545 | 0.500 | 0.045 | 0.429 |
| High performance | 0.532 | 0.551 | 0.019 | 0.734 |
| Migrant | 0.295 | 0.340 | 0.045 | 0.396 |
| Eligibility for welfare benefits | 0.032 | 0.051 | 0.019 | 0.397 |
| Building block | YES | YES | - | - |
| Propensity score | 0.305 | 0.349 | | |
| Std. dev. | 0.221 | 0.221 | | |
| N | 156 | 156 | | |

*Note: Columns for (a): Compliers, students that participate in the first admission lottery, win, and stay in the first-ranked school after the matching assignment; non-compliers, students that participate in the first admission lottery and win but are observed in a private school in the same year or one year after the matching assignment. Columns for (b): Compliers, students that participate in the first admission lottery, lose, and stay in the non-first-ranked school, after the matching assignment; non-compliers, students that participate in the first admission lottery and lose, but are observed in a private school in the same year or one year after the matching assignment.* $^{*}p \leq 0.10$, $^{**}p \leq 0.05$, $^{***}p \leq 0.01$.

**Table F3** Effects of attending private schools in $t$, after participating in the first admission lottery

| Outcome | ATT in outcome when switching from public to private school | | | | | |
|---|---|---|---|---|---|---|
| | (a) Winning the first admission lottery | | | (b) Losing the first admission lottery | | |
| | Compliers mean | ATT | T-stat | Compliers mean | ATT | T-stat |
| *a)* Distance to secondary school | | | | | | |
| Home-school distance (in m) | 2,882.4 | 769.2*** | 2.65 | 2,332.6 | 1,118.9*** | 5.02 |
| | [2,281.4] | (289.88) | | [1,692.62] | (223.10) | |
| *b)* School characteristics of secondary school | | | | | | |
| Share of welfare benefit students | 0.160 | -0.144*** | -13.77 | 0.327 | -0.304*** | -20.15 |
| | [0.129] | (0.010) | | [0.188] | (0.015) | |
| Share of migrant students | 0.316 | -0.143*** | -12.58 | 0.458 | -0.221*** | -12.10 |
| | [0.113] | (0.011) | | [0.204] | (0.018) | |
| *c)* Potential peers in secondary school | | | | | | |
| Potential peers 1 | 88.35 | -31.36*** | -6.43 | 59.08 | -22.93*** | -6.28 |
| (Language) | [41.25] | (4.877) | | [37.54] | (3.648) | |
| Potential peers 2 | 19.03 | -14.75*** | -19.63 | 12.85 | -8.33*** | -12.02 |
| (Language, class) | [7.42] | (0.751) | | [7.59] | (0.693) | |
| Potential peers 3 | 9.84 | -7.18*** | -17.59 | 6.68 | -3.90*** | -10.16 |
| (language, class, gender) | [4.19] | (0.408) | | [4.13] | (0.384) | |
| *d)* School entry cohort composition+ | | | | | | |
| Peers 1 (language spoken at home) | 8.00 | 6.40*** | 5.05 | 7.76 | 9.44*** | 7.19 |
| | [7.29] | (1.269) | | [7.53] | (1.313) | |
| Peers 2 (classmates) | 5.38 | -3.49*** | -7.93 | 4.31 | -2.79*** | -11.33 |
| | [3.76] | (0.306) | | [2.89] | (0.246) | |
| *e)* Long-term outcomes | | | | | | |
| University entrance certificate | 0.719 | 0.000 | 0.00 | 0.577 | 0.154 | 1.16 |
| | [0.453] | (0.080) | | [0.504] | (0.133) | |
| Intermediate certificate | 0.172 | -0.078 | -1.30 | 0.269 | -0.115 | -1.01 |
| | [0.380] | (0.060) | | [0.452] | (0.114) | |
| Basic certificate | 0.078 | 0.078 | 1.37 | 0.077 | -0.038 | -0.59 |
| | [0.270] | (0.057) | | [0.272] | (0.066) | |
| No school-leaving certificate | 0.031 | 0.000 | 0.00 | 0.077 | 0.000 | 0.00 |
| | [0.175] | (0.031) | | [0.272] | (0.075) | |
| N | 182 | 182 | | 161 | 161 | |

*Note: +School entry cohort composition is based on information of primary school exit cohort. Columns for (a): Compliers, students that participate in the first admission lottery, win, and stay in the first-ranked school in the same year of the matching assignment; non-compliers, students that participate in the first admission lottery and win but are observed in a private school in the same year of the matching assignment. Columns for (b): Compliers, students that participate in the first admission lottery, lose, and stay in the non-first-ranked school in the same year of the matching assignment; non-compliers, students that participate in the first admission lottery and lose, but are observed in a private school in the same year of the matching assignment ATT: average treatment effect on the treated, e.g. non-compliers effect due to the change to a private school. Social index A and B, standardised test scores and average GPA on school level are not available. Standard errors in parentheses. Standard deviations in brackets.* $^{*}p \leq 0.10$, $^{**}p \leq 0.05$, $^{***}p \leq 0.01$.

**Table F4** Effects of attending private schools in $t + 1$, after participating in the first admission lottery

| Outcome | ATT in outcome when switching from public to private school | | | | | |
|---|---|---|---|---|---|---|
| | (a) Winning the first admission lottery | | | (b) Losing the first admission lottery | | |
| | Compliers mean | ATT | T-stat | Compliers mean | ATT | T-stat |
| *a)* Distance to secondary school | | | | | | |
| Home-school distance (in m) | 2,902.0 | 968.4*** | 3.11 | 2,527.9 | 858.8*** | 3.70 |
| | [2,266.7] | (311.16) | | [1,822.8] | (232.32) | |
| *b)* School characteristics of secondary school | | | | | | |
| Share of welfare benefit students | 0.168 | -0.123*** | -10.23 | 0.322 | -0.284*** | -16.54 |
| | [0.136] | (0.012) | | [0.195] | (0.017) | |
| Share of migrant students | 0.324 | -0.124*** | -10.69 | 0.448 | -0.199*** | -10.39 |
| | [0.115] | (0.012) | | [0.210] | (0.019) | |
| *c)* Potential peers in secondary school | | | | | | |
| Potential peers 1 | 89.30 | -28.04*** | -6.19 | 58.72 | -23.03*** | -6.17 |
| (Language) | [40.88] | (4.529) | | [37.93] | (3.732) | |
| Potential peers 2 | 18.95 | -12.74*** | -16.42 | 12.76 | -8.12*** | -11.38 |
| (Language, class) | [7.42] | (0.776) | | [7.62] | (0.713) | |
| Potential peers 3 | 9.88 | -6.25*** | -14.48 | 6.77 | -3.87*** | -9.64 |
| (language, class, gender) | [4.36] | (0.431) | | [4.22] | (0.401) | |
| *d)* School entry cohort composition+ | | | | | | |
| Peers 1 (language spoken at home) | 9.02 | 5.43*** | 4.70 | 7.33 | 8.09*** | 6.03 |
| | [7.48] | (1.155) | | [7.45] | (1.341) | |
| Peers 2 (classmates) | 5.58 | -3.76*** | -13.73 | 4.15 | -2.64*** | -10.60 |
| | [3.65] | (0.274) | | [2.96] | (0.249) | |
| *e)* Long-term outcomes | | | | | | |
| University entrance certificate | 0.657 | 0.014 | 0.18 | 0.500 | 0.250** | 1.96 |
| | [0.478] | (0.080) | | [0.509] | (0.127) | |
| Intermediate certificate | 0.214 | -0.086 | -1.34 | 0.357 | -0.214* | -1.88 |
| | [0.413] | (0.064) | | [0.488] | (0.114) | |
| Basic certificate | 0.086 | 0.086 | 1.52 | 0.072 | -0.036 | -0.58 |
| | [0.282] | (0.057) | | [0.262] | (0.061) | |
| No school-leaving certificate | 0.043 | -0.014 | -0.45 | 0.071 | 0.000 | 0.00 |
| | [0.204] | (0.032) | | [0.262] | (0.070) | |
| N | 212 | 212 | | 156 | 156 | |

*Note: +School entry cohort composition is based on information of primary school exit cohort. Columns for (a): Compliers, students that participate in the first admission lottery, win, and stay in the first-ranked school at least one year after the matching assignment; non-compliers, students that participate in the first admission lottery and win but are observed in a private school one year after the matching assignment. Columns for (b): Compliers, students that participate in the first admission lottery, lose, and stay in the non-first-ranked school, at least one year after the matching assignment; non-compliers, students that participate in the first admission lottery and lose, but are observed in a private school one year after the matching assignment ATT: average treatment effect on the treated, e.g. non-compliers effect due to the change to a private school. Social index A and B, standardised test scores and average GPA on school level are not available. Standard errors in parentheses. Standard deviations in brackets.* $^{*}p \leq 0.10$, $^{**}p \leq 0.05$, $^{***}p \leq 0.01$.