

Spillovers in Fields of Study: Siblings, Cousins, and Neighbors*

Stanislav Avdeev, Nadine Ketel,
Hessel Oosterbeek, Bas van der Klaauw

Abstract

We use admission lotteries for higher education studies in the Netherlands to investigate whether someone's field of study influences the study choices of their younger peers. We find that younger siblings and cousins are strongly affected. Also younger neighbors are affected but to a smaller extent. These findings indicate that a substantial part of the correlations in study choices between family members can be attributed to spillover effects and are not due to shared environments. Our findings concur with those of recent studies based on admission thresholds, which find sibling spillovers on college or college-major choices. This indicates that the results from previous studies can be extrapolated to students away from admission thresholds, and from siblings to cousins and neighbors.

Keywords: Major choice; Higher education; Peer effects; Admission lotteries.

JEL Codes: I23, I24, J10

*This version: February 2024. Avdeev: University of Amsterdam (stnavdeev@gmail.com); Ketel: VU University Amsterdam (n.ketel@vu.nl); Oosterbeek: University of Amsterdam (h.oosterbeek@uva.nl); Van der Klaauw: VU University Amsterdam (b.vander.klaauw@vu.nl). We gratefully acknowledge valuable comments from conference and seminar participants in Amsterdam, Belgrade, Catanzaro, Copenhagen, Leuven, Oslo, and Prague. Ketel acknowledges financial support from a Veni-grant from the Dutch Science Foundation (NWO). Oosterbeek received support from the Research Council of Norway Toppforsk grant no. 275906. The non-public micro data used in this paper are available via remote access to the Microdata services of Statistics Netherlands (project agreement 7930).

1 Introduction

Choosing a field of study is among the most consequential choices that young people make. It is important for their prospects in the labor market (Kirkeboen et al., 2016; Ketel et al., 2016, 2019; Bleemer and Mehta, 2022), in the marriage market (Artmann et al., 2021; Kirkeboen et al., 2022), and for their health (Leuven et al., 2013). Yet, little is known about the factors that determine field of study (or major) choices. This is exemplified by the conclusion in Wiswall and Zafar (2015) who state that “even with our rich data on beliefs across a variety of pecuniary and non-pecuniary aspects of majors, major-choices in our data are still largely the result of heterogeneity in major specific and unobserved “tastes”.”¹ Information about the factors that determine field of study choices is an important input for policies that aim to influence these choices.

Positive correlations between study choices of family members and of neighbors suggest that network spillovers play a role for study choices (Raaum et al., 2003; Hällsten, 2014; Goodman et al., 2015; Van der Vleuten et al., 2020). Separating such spillovers from the mere correlation due to a shared environment is, however, challenging. A handful of recent studies have made progress by analyzing higher-education choices of the younger siblings and younger neighbors of applicants who were close to an admission threshold (Altmejd et al., 2021; Aguirrea and Matta, 2021) or a loan eligibility threshold (Barrios-Fernández, 2022) in regression discontinuity designs.² Specifically, Altmejd et al. (2021) study sibling

¹Wiswall and Zafar (2015) conduct a survey experiment in which they provide information about major-specific characteristics to study the determinants of college major choice.

²There is also work on spillovers in study choices in secondary education. Older siblings influence their younger siblings’ preferred high school in Mexico (Dustan, 2018), take up of advanced math and science courses in Denmark (Joensen and Nielsen, 2018), secondary education specialization in the Netherlands (Van der Vleuten et al., 2020), take up of high school Advanced Placement exam in the US (Gurantz et al., 2020), and high school major in Sweden (Dahl et al., 2024). Some papers look at sibling spillovers on achievement (Oettinger, 2000; Qureshi, 2018a,b; Nicoletti and Rabe, 2019; De Gendre, 2022; Karbownik and Özek, 2021; Zang et al., 2023; Figlio et al., 2023; Goldstein, 2023). Two Swedish studies find strong parent spillovers on children’s high school major (Dahl et al., 2024) and university field of study (Altmejd, 2023). There is some evidence of positive neighbor spillovers on secondary school enrollment in Mexico (Bobonis and Finan, 2009; Lalive and Cattaneo, 2009) and Chile (Matta and Orellana, 2022). Neighbors also influence early and secondary education performance in France (Goux and Maurin, 2007) and the US (List et al., 2023). Goulas et al. (2022) find that a higher share of female neighbors increases enrollment in an academic university and female enrollment in a STEM field.

spillovers in college and major choices in Chile, Croatia, Sweden, and the US. The authors use admission thresholds to compare younger siblings' study choices whose older siblings were just above or below the thresholds. They find that younger siblings follow their older siblings to the same college or to the same college-major combination. Similarly, [Aguirrea and Matta \(2021\)](#) exploit admission thresholds generated by Chile's centralized higher education system and find strong sibling spillover effects on university enrollment. [Barrios-Fernández \(2022\)](#) exploits variation due to student loans eligibility in Chile. He finds that neighbors are more likely to attend and complete a university if their closest neighbor becomes eligible for a student loan.³

This paper expands the evidence on spillovers in field of study choices by leveraging variation caused by admission lotteries to higher education studies in the Netherlands. During the period from 1987 to 1999, admission to oversubscribed fields of study was determined by the results from centralized admission lotteries. Fields of study in the health sector that ran admission lotteries are medicine, veterinary medicine, dentistry, occupational therapy, and biology. Other fields of study that ran admission lotteries are business, international business, and tourism. Due to the admission lotteries, some applicants to these fields of study were admitted while other, equally qualified, applicants were rejected. A large share of the rejected applicants ended up in another field of study. The rich administrative data from Statistics Netherlands allow us to link information from lottery participants to the study choices of their younger siblings as well as to those of their younger cousins and their younger neighbors. We can therefore analyze spillovers of fields of study on three different types of younger peers in one framework.

Our main finding is that there are strong spillovers of the fields of study of the lottery participants on the fields of study choices of their younger peers. Relative to a baseline (control complier mean) of 2.9%, the younger siblings of lottery participants who enrolled in the lottery field of study because they won the first lottery are 5.7 percentage points more likely to enroll in that same field of study. For younger cousins this effect is 2.2 percentage points (relative to a baseline of

³There are some papers studying correlations of cousins' GPA and years of education in the US ([Jæger, 2012](#)) and in Sweden ([Hällsten, 2014](#); [Adermon et al., 2021](#); [Collado et al., 2022](#); [Hällsten and Kolk, 2023](#)), but no papers studying cousin spillovers on the field of study choices.

1.1%), and for younger neighbors it is 0.3 percentage points (relative to a baseline of 1%).

Sibling spillovers are larger when the lottery participant and the younger sibling are of the same sex, suggesting a role model effect. There is no such interaction effect for cousins or neighbors. Neighbor spillovers are larger when the age difference between the lottery participant and the younger neighbor is smaller. Sibling and cousin spillovers are larger in high-income families suggesting a role of parental resources.

Our finding of substantial spillovers in education choices concurs with the results of [Altmejd et al. \(2021\)](#) and [Aguirrea and Matta \(2021\)](#). This indicates that the results from these studies can be extrapolated to students away from admission thresholds, and from siblings to cousins and neighbors. Consistent with the extrapolation away from admission thresholds, we indeed find that spillovers do not vary with the older peer’s relative ability level.

The paper continues as follows. Section 2 describes the Dutch higher education system and its use of admission lotteries. Section 3 describes the data. Section 4 discusses details of the identification strategy. Section 5 presents and discusses the results. Section 6 summarizes and concludes.

2 Institutional background

Students in the Netherlands who completed the six-years university track in secondary school can enroll in any Dutch university or college.⁴ Unlike the situation in the US, students choose their field of study upon application. Most fields of study accept all applicants, while some fields of study put a cap (quota) on the number of admitted students. Until 1999, fields of study with a quota held nationwide centralized lotteries to admit students. After 1999, the centralized admission lotteries were gradually replaced by decentralized admission policies. The fields of study that held at least one admission lottery between 1988 (the first year for which we can use data) and 1999 are: medicine, veterinary medicine, dentistry, occupational therapy, biology, business, international business, and tourism.

⁴Colleges, which are also referred to as university of applied sciences, can also be attended by graduates from the five-years college track in secondary school.

The admission lotteries for these fields of study were centralized and applied to all universities or colleges that offer them and not to combinations of a specific university and field of study, e.g. there was a nationwide lottery for admission to study medicine, not a lottery to study medicine in, say, Rotterdam. Upon their application to a field of study (e.g. medicine), applicants reported preferences for up to three universities. After the admission lottery for the field of study, these preferences were taken into account to assign lottery winners to universities. A vast majority of 74% of the lottery winners were assigned to their top-ranked university. There have also been admission lotteries for some fields of study at specific universities or colleges. Because the losers of these institution \times field of study-lotteries could enroll in the same field of study elsewhere, we do not use these lotteries in our analyses.

Lotteries were introduced as a response to increasing numbers of applicants, which exceeded the capacities of the fields of study. The Ministry of Education determined these capacities. To strike a balance between merit and equality of opportunity, the lotteries gave students with a higher GPA on the nationwide final exams from secondary school higher chances to be admitted. GPA is expressed on a scale from 1 to 10, where 6.0 or above indicates a pass.⁵ Table 1 shows which GPA intervals are assigned to the different lottery categories, labeled A to F.⁶ The table also shows the admission probabilities and shares of applicants for each category averaged across different fields of study with a lottery and lottery years. Only 5% of the applicants are in the top two categories which have admission probabilities above 75%. All other applicants have (much) lower chances to win the lottery of the field of study of their choice.

An important feature of the admission lotteries is that lottery losers are allowed to participate in subsequent lotteries in later years. We address this feature by using the results of the first lottery in which someone participated as an instrumental variable for enrollment in the field of study with the lottery.⁷ [Leuven et al. \(2013\)](#) and [Ketel et al. \(2016\)](#) provide more detailed descriptions of the Dutch admission lotteries and educational system.

⁵Tuition fees are not used as instrument to reduce demand. Dutch universities are publicly funded and tuition fees are low and uniform across fields of study.

⁶Category “Other” refers to students who did not attend secondary school in the Netherlands and therefore did not participate in the final school exams, such as foreign students.

⁷It is not allowed to participate in multiple admission lotteries in the same year.

Table 1: Lottery categories

Category	GPA	Share	P(win)
A	$\text{GPA} \geq 8.5$	0.01	0.87
B	$8.0 \leq \text{GPA} < 8.5$	0.04	0.77
C	$7.5 \leq \text{GPA} < 8.0$	0.08	0.65
D	$7.0 \leq \text{GPA} < 7.5$	0.20	0.56
E	$6.5 \leq \text{GPA} < 7.0$	0.24	0.48
F	$\text{GPA} < 6.5$	0.32	0.43
Other	—	0.11	0.56

Notes: GPA is grade point average on the nationwide final exams in secondary school. Share is the share of applicants in each category. P(win) indicates the probability of being admitted in each category. Share and P(win) are averaged across different fields of study with a lottery and lottery years. The category “Other” refers to students who did not participate in the secondary school exams, such as foreign students. This category is excluded from the analysis.

3 Data

3.1 Data source and sample

We use administrative data from different registers available at Statistics Netherlands, which can be linked at the individual level, at the parent-child level, and at the neighborhood level. The person and household registers contain information on different demographic and education variables, i.e., age, sex, immigration background, neighborhood, university or college enrollment, and field of study. The register on admission lotteries contains information on all lottery participants, their lottery category, the year of participation, and the lottery results. We use first-time lottery participants between 1988 and 1999. We exclude applicants older than 21 when applying for the first time. Applicants from top category A are dropped because almost all of them are admitted. Finally, we exclude first-generation immigrants because it is often impossible to trace their cousins.

The units of the analysis in our study are sibling pairs, cousin pairs, and neighbor pairs. Siblings are individuals who have one or two parents in common. Cousins are individuals who have a common grandparent. Neighbors are individuals who live in the same neighborhood. We construct three samples.

To construct the samples of siblings and of cousins, we link lottery participants to their younger siblings and cousins using the registry of their (grand-)parents. We restrict the sample to lottery participants who have at least one sibling or cousin who is at least one year younger. If there are several older siblings or cousins participating in a lottery, we take the oldest older sibling or cousin to determine the treatment status of the younger ones. Results are almost identical when we use the youngest older sibling or cousin, or when we exclude families with more than one older sibling or cousin participating in a lottery. Our analyses are based on more than 33 thousand sibling pairs and on almost 80 thousand cousin pairs.

For the sample of neighbors, we link lottery participants to their neighbors using the most granular level of neighborhoods available in our data, the so-called “buurtcodes”. This information is available from 1995 onward. For the analyses of neighbor spillovers, we therefore only use lottery participants from 1995 onward. The average number of inhabitants per neighborhood is 1400. We exclude siblings and cousins from the sample of neighbors. To keep the analysis for neighbors similar to those for siblings and cousins, we restrict in our main analysis the sample to neighborhoods where only one person participated in a lottery. This leaves us with 48% of the lottery participants and 71% of the neighborhoods.⁸ We consider spillovers on neighbors who are between one and two years younger than the lottery participant.⁹ On average, there are 28 of such younger neighbors per neighborhood. Our analyses are based on more than 317 thousand pairs of neighbors.¹⁰

⁸In Subsection 5.4 we report results from a slightly more involved analysis that includes neighborhoods with multiple lottery participants. Results are very similar.

⁹The minimum age difference of one year is chosen to avoid reflection issues. The maximum age difference of two years is chosen to increase the likelihood that neighbors interact with each other.

¹⁰An alternative peer group could be students enrolled in the same secondary school. Information about secondary-school enrollment is unfortunately not available for the cohorts that participated in the admission lotteries. Using information from more recent cohorts, we find that 30% of the younger neighbors of students enrolling in studies that used to have a lottery, were enrolled in the same secondary school. Neighbor spillovers are therefore not synonymous for secondary-school spillovers.

3.2 Descriptive statistics

Panel A of Table 2 reports mean values of predetermined characteristics of lottery participants by the outcome of the first lottery. Around 55% of the lottery participants are female, 3% have a non-western background, and the average age at the first lottery is 18.8. Lottery participants have on average 2.5 younger siblings, 5.2 younger cousins and 27.6 younger neighbors. The average parental income of lottery participants is 73 thousand euro.

Panels B, C, and D of Table 2 report mean values of the characteristics of the younger peers of the lottery participants. Almost 50% of the younger peers are female and around 5% have a non-western background. The average age difference between older and younger siblings is 4.6 years, between older and younger cousins 9.2 years, and between older and younger neighbors 1.5 years.¹¹ 50% of all pairs are same-sex pairs.

The final column of Table 2 reports p -values obtained from regressing personal characteristics on an indicator for the older peer winning the first lottery, fixed effects for lottery field of study, lottery category and year of the first lottery participation, and interactions of these fixed effects. The p -values indicate that the samples of lottery winners and lottery losers themselves as well as the samples of their younger siblings, cousins and neighbors, are balanced.¹²

The lottery participants are divided over the different fields of study as follows: medicine 57.9%, veterinary medicine 9.4%, dentistry 4.8%, occupational therapy 3.8%, biology 1%, international business 17.7%, tourism 3.1%, and business 2.3%. While these percentages indicate that the larger share of applicants participated in the lottery for medicine or in a lottery in a health-related field, we find similar results when we exclude medicine or all health-related fields of study from the analysis (see Subsection 5.4).

¹¹This last number is due to the sample restriction of younger neighbors being between one and two years younger.

¹²Note that the table reports raw means while the p -values condition on fixed effects for lottery field of study, lottery category and year of the first lottery participation, and interactions of these fixed effects. This explains why some of the p -values are relatively low while the means for lottery winners and losers are virtually identical.

Table 2: Balancing table

	Lottery winners	Lottery losers	<i>p</i> -value
Panel A: Lottery participants			
Female	0.55	0.56	0.05
Non-western immigrant	0.03	0.03	0.58
Age at first application	18.84	18.88	0.36
Number of younger siblings	2.48	2.50	0.88
Number of younger cousins	5.24	5.24	0.54
Number of younger neighbors	27.79	27.49	0.49
Parental income	70,133	74,853	0.27
N	18,588	20,058	
Panel B: Younger siblings			
Female	0.49	0.48	0.25
Non-western immigrant	0.04	0.05	0.98
Age difference in years	4.63	4.58	0.64
Same sex pairs	0.49	0.49	0.81
Parental income	81,018	81,805	0.05
N	15,677	17,417	
Panel C: Younger cousins			
Female	0.49	0.49	0.37
Non-western immigrant	0.02	0.02	0.11
Age difference in years	9.22	9.23	0.48
Same sex pairs	0.50	0.50	0.92
Parental income	69,905	69,876	0.59
N	38,012	41,692	
Panel D: Younger neighbors			
Female	0.50	0.50	0.06
Non-western immigrant	0.08	0.08	0.05
Age difference in years	1.45	1.45	0.17
Same sex pairs	0.50	0.50	0.13
Parental income	55,647	56,734	0.20
N	131,260	185,957	

Notes: Since the lottery is weighted, the observed differences between lottery winners and losers in this table cannot be interpreted as causal. *p*-values obtained from regressing personal characteristics on an indicator for the older peer winning the first lottery, including fixed effects for lottery field of study, lottery category and year of the first lottery participation, and interactions of these fixed effects. All regressions use the normalized inverse of the propensity score as a weight.

4 Empirical approach

To estimate the effect of an older peer’s enrollment in the lottery field of study on the younger peer’s study choice, we use the following model:

$$Y_{ip} = \delta D_{ip} + X_i\beta + \mu_p + \varepsilon_{ip}, \quad (1)$$

where Y_{ip} is a dummy variable which equals one if the younger peer in pair i is enrolled in the field of study p for which the older peer participated in a lottery, and zero otherwise (including when the younger peer did not enroll in any higher education study). D_{ip} indicates whether the older peer in pair i is enrolled in the lottery field of study p . X_i is a vector of control variables including dummies for sex and non-western origin, and age of the older peer at the first lottery. These variables are included to increase precision. μ_p are fixed effects for lottery field of study, lottery category and year of the first lottery participation, and their double and triple interactions.¹³

Because not all lottery participants comply with the result of the first lottery in which they participate, estimation of equation (1) with OLS, may result in a biased estimate of δ .¹⁴ We therefore instrument D_{ip} with the result of the first lottery in which someone participated (Z_{ip}). We estimate a first-stage equation of the form:

$$D_{ip} = \alpha Z_{ip} + X_i\gamma + \lambda_p + \nu_{ip}, \quad (2)$$

where α indicates the compliance rate, i.e., the difference in enrollment rates between winners and losers of the first admission lottery in which they participated. Observations are weighted by the normalized inverse of the propensity score to win the lottery, such that estimates of δ can be interpreted as (local) average treatment effects (cf. [Śłoczyński et al., 2022](#)). We cluster standard errors at the level of the older peer as the treatment is assigned at this level (cf. [Abadie et al.,](#)

¹³Results are virtually identical when we only include fixed effects for lottery bins, i.e. field of study×lottery category×lottery year.

¹⁴Compliance is imperfect because not all winners enroll in the lottery field of study and because lottery losers often reapply and enroll in a subsequent year in the lottery field of study. While there were no restrictions on when lottery losers could reapply, a vast majority did so in the next year.

2023).

5 Results

We present the results in four parts. We start with the first-stage results. Next we present the main results of spillovers on younger peers. The third subsection presents our findings regarding heterogeneity of spillovers, which are informative about (the absence of) certain mechanisms. The final subsection discusses findings from various robustness analyses.

5.1 First-stage results

Table 3 shows the estimates of the effect of winning the first lottery on the probability to enroll in the lottery field of study. The table has two panels. Panel A reports results based on a sample of older peers where each older peer appears once, provided that they have at least one younger sibling, cousin or neighbor. Panel B reports results based on a sample of older peers where each older peer appears as often as they have younger siblings, cousins or neighbors. The results in Panel A are informative about the strength of the first-stage relationship. The results in Panel B are the relevant input for the IV regressions. It is reassuring that the results in the two panels are very similar.

The control means in Table 3 indicate that 42-47% of the applicants who lose their first admission lottery enroll in the lottery field of study. This occurs after winning an admission lottery in a later year. Winning the first lottery increases the probability to be enrolled in the lottery field of study by around 50 percentage points.¹⁵ Hence, winning the first lottery has a strong effect on the probability to be enrolled in the lottery field of study.

5.2 Main results

Panel A of Table 4 presents the main results of this paper. The first column presents reduced form (RF) and instrumental variable (IV) estimates of sibling spillovers, the second of cousin spillovers and the third of neighbor spillovers.

¹⁵The first-stage F -statistic is well above 104.7 in all models. These values ensure that

Table 3: First-stage estimates of winning the first lottery on enrollment in the lottery field of study

	Lottery participant enrolls in the lottery field of study		
	Sibling	Cousin	Neighbor
Panel A: Unique older peers			
Lottery participant wins	0.502*** (0.006)	0.506*** (0.006)	0.469*** (0.008)
Control mean	0.434	0.426	0.471
F-statistic	9,853.13	8,308.46	4,089.84
N	22,201	18,808	10,953
Panel B: Duplicated older peers			
Lottery participant wins	0.495*** (0.006)	0.507*** (0.007)	0.476*** (0.010)
Control mean	0.439	0.422	0.460
F-statistic	14,462.46	36,971.54	124,138.84
N	33,094	79,704	317,217

Notes: All regressions include controls for sex, non-western origin, age of the older peer at the first lottery, and fixed effects for lottery field of study, lottery category, year of the first lottery participation, and their interactions. Panel A includes a sample of older peers where each older peer appears once. Panel B includes a sample of older peers where each older peer appears as often as they have younger peers. Standard errors in Panel B are clustered at the older peer level (the lottery participant). *p<0.1; **p<0.05; ***p<0.01.

Table 4: Spillover effect of older peer's lottery result/enrollment in the lottery field of study on younger peer's study choice

	Younger peer enrolls in the lottery field of study		
	Sibling	Cousin	Neighbor
Panel A: Main results			
Older peer wins the first lottery (RF)	0.028*** (0.003)	0.011*** (0.001)	0.001*** (0.001)
Older peer enrolls (IV)	0.057*** (0.005)	0.022*** (0.002)	0.003*** (0.001)
Control complier mean	0.029	0.011	0.010
N	33,094	79,704	317,217
Panel B: Heterogeneity by lottery category			
Older peer enrolls	0.061*** (0.007)	0.026*** (0.003)	0.003** (0.001)
Older peer enrolls x 1 [Older peer's GPA < 6.5]	-0.008 (0.010)	-0.009** (0.005)	-0.001 (0.002)
N	33,094	79,704	317,217
Panel C: Heterogeneity by sex composition			
Older peer enrolls	0.050*** (0.007)	0.021*** (0.003)	0.003** (0.001)
Older peer enrolls x 1 [Same sex = 1]	0.020** (0.010)	0.001 (0.004)	-0.001 (0.002)
N	33,094	79,704	317,217
Panel D: Heterogeneity by age gap			
Older peer enrolls	0.059*** (0.006)	0.024*** (0.004)	0.003*** (0.001)
Older peer enrolls x 1 [Age gap > 5 (2)]	-0.007 (0.011)	-0.003 (0.004)	-0.003*** (0.001)
N	33,094	79,704	1,472,910
Panel E: Heterogeneity by parental income			
Older peer enrolls	0.041*** (0.005)	0.017*** (0.002)	0.001 (0.001)
Older peer enrolls x 1 [Parental income > median]	0.035*** (0.011)	0.012** (0.005)	0.003 (0.002)
N	32,995	79,484	316,141

Notes: All regressions include controls for sex, non-western origin, age of the older peer at the first lottery, and fixed effects for lottery field of study, lottery category, year of the first lottery participation, and their interactions. All regressions use the normalized inverse of the propensity score as a weight. In Panel D, we include interactions with an indicator equal to 1 if the age difference is larger than 5 for siblings and cousins, and larger than 2 for neighbors. In Column (3) of Panel D, we include neighbors with at most a 10 years age gap. In Panel E, we include interactions with an indicator equal 1 if the parental income of older peers is above the sample median. Standard errors are clustered at the older peer level. *p<0.1; **p<0.05; ***p<0.01.

Turning first to sibling spillovers, we find that if an older sibling enrolls in the lottery field of study because they won the first lottery, a younger sibling’s probability to enroll in the same field of study increases by 5.7 percentage points. This is a substantial effect in comparison to the 2.9% enrollment rate of the younger siblings of losing compliers. This base rate of 2.9% is only slightly above the mean enrollment rate in the population of younger siblings of higher education students from the same cohorts.

Column (2) shows the results for spillovers on younger cousins. We find an increase of 2.2 percentage points on the probability that the younger cousin enrolls in the lottery field of study if the older cousin enrolled in it. This should be compared to a base rate (control complier mean) of 1.1%.

Column (3) presents the results for neighbor spillovers. There is a small but statistically significant effect of older neighbors’ enrollment in the lottery field of study on younger neighbors’ enrollment in the same field of study: 0.3 percentage points compared to a base rate of 1%.

The estimated spillover effects are larger for siblings than for cousins, and larger for cousins than for neighbors. When we multiply the respective estimates with the numbers of people exposed to them, the total spillover on siblings amounts to 0.141 ($=0.057 \times 2.48$), the total spillover on cousins equals 0.115 ($=0.022 \times 5.24$), and the total spillover on neighbors is 0.083 ($=0.003 \times 27.79$). Hence, the multiplier effect through siblings is about twice as large as the multiplier effect through neighbors. The multiplier effect through cousins is in between these two.

5.3 Heterogeneous spillovers

We now turn to heterogeneity in the spillover effects, which shed light on (the absence of) mechanisms underlying spillovers. We first examine whether spillovers differ by older peers’ prior ability, measured by their lottery category. This is informative about whether the spillovers vary with the relative rank of older peers in their program. Next, we examine whether spillovers are different for same-sex peers than for opposite-sex peers. This may be informative about role models as a driver of peer effects. Subsequently, we investigate whether spillovers vary

reported IV standard errors are valid for the 0.05 significance level (Lee et al., 2022).

with the age gap between the peers. Finally, we explore whether spillovers differ between families with above and below median income.

Lottery category. In Panel B of Table 4 we have interacted the treatment indicator with a dummy that equals one for lottery applicants from the lowest GPA-category on the secondary school exams ($\text{GPA} < 6.5$). The results indicate that we cannot reject that sibling and neighbor spillovers from lower-ranked applicants are the same as those from other applicants. Cousin spillovers from lower-ranked applicants are smaller but still substantial.

These findings are related to the difference in research designs in our study and the studies that leverage admission thresholds (Altmejd et al., 2021; Aguirrea and Matta, 2021). These studies estimate spillovers from marginally admitted students who are likely to belong to the weaker students in their program. Our results indicate that spillovers from such marginal students can be extrapolated to the entire ability distribution.

Sex composition. Panel C of Table 4 presents spillovers by the sex composition of pairs. The first column shows that the spillover between same-sex siblings is 2 percentage points larger than the 5 percentage points spillover between opposite-sex siblings. There are no such differences for cousins and neighbors. The result for siblings lends support for a role model mechanism, because older siblings can serve as role models for their younger siblings (Bandura, 1977; McHale et al., 2012) which is more likely for same-sex siblings than for opposite-sex siblings.

Age gap. Panel D of Table 4 presents results of spillovers that vary with the age gap between peers. For siblings and cousins we interact enrollment in the lottery field of study with a dummy for being more than 5 years apart, and for neighbors for being more than 2 years apart. For siblings and cousins the results reveal no variation of spillovers with the age gap. For neighbors, there is basically no spillover when the age gap exceeds two years. The results for siblings and cousins are at odds with an information mechanism, which predicts that spillovers are stronger when peers are closer because information is more up-to-date (Festinger, 1954; Whiteman et al., 2011). The result for neighbors is

consistent with the information channel. It might, however, also be the case that neighbors who are more than two years apart have little interaction.

Parental income. Panel E of Table 4 investigates differences in spillovers between families where parental income is above or below the median. While the sibling spillover is 4.1 percentage points for families with below median income, it is 7.6 percentage points for families with above median income. For cousins spillovers, the respective numbers are 1.7 percentage points and 2.9 percentage points. There are no differential neighbor spillovers by income. A possible mechanism that drives the differential spillovers by income for siblings and cousins is that the older peers from higher income families have made more informed choices than the older peers from lower income families. Alternatively, it may be that the older peers from higher income families enjoy studying more because they have to borrow less or do not need a side job to finance their studies.

5.4 Robustness

Table A1 in the appendix, presents results separately for all lottery fields of study except medicine, and for the three lottery fields of study that are not health-related (business, international business and tourism). The resulting estimates are a bit smaller and less precise than the main results but support to the same conclusions.

Table A2 in the appendix presents estimates of the effect of the older peer winning the first lottery on the probability of the younger peer to enroll in any higher education study. Only in the cousin sample there is some indication that the result of the first lottery has an extensive margin effect. This effect is, however, only significant at the 10%-level and small in comparison to the control complier mean of 0.654.

Table A3 in the appendix presents estimates of spillovers using different sample definitions for siblings, cousins, and neighbors. In the main analysis, we use the oldest older sibling to determine the treatment status of all younger siblings, and these are the baseline results in Column (1) of Panel A of Table A3. In Column (2), we use the youngest older sibling, and in Column (3) – we use only families with one older sibling participating in a lottery. Overall, the estimates

are virtually unchanged. We repeat this for cousins. In the main analysis, we use the oldest older cousin to determine the treatment status of younger ones, and these are baseline results in Column (1) of Panel B of Table A3. In Column (2), we use the youngest older cousin, and in Column (3) – we use only extended families with one older cousin participating in a lottery. The results are almost identical across different samples.

To keep the results for neighbors comparable to those of siblings and cousins, we restricted the neighbor sample in the main analysis to neighborhoods with one lottery participant. To also include neighborhoods with multiple lottery participants in the analysis, we need to take into account that in neighborhoods with multiple lottery participants the likelihood of exposure to lottery winners is larger. To do so we follow the approach of Abdulkadiroğlu et al. (2017), and specify the following model:

$$\begin{aligned} Y_{in} &= \delta D_{in} + p_{in} + \varepsilon_{in} \\ D_{in} &= \alpha Z_{in} + p_{in} + \nu_{in} \end{aligned}$$

where Y_{in} indicates whether the younger neighbor i is enrolled in the field of study for which at least one older neighbor participated in an admission lottery. D_{in} indicates whether there is at least one older neighbor in neighborhood n who enrolled in that field of study, Z_{in} indicates whether at least one older neighbor in neighborhood n won their first admission lottery. p_{in} is the assignment propensity score that at least one older neighbor in neighborhood n is a lottery winner. We include this score as a fixed effect. This extension of the model takes account of the fact that neighborhoods differ in the number of lottery participants and therefore in the probability of exposure to a lottery winner. We weight observations with the normalized inverse of the propensity score. Standard errors are clustered at the neighborhood level. Column (1) of Panel C of Table A3 presents the main results using only neighborhoods with one lottery participant, in Column (2) we use neighborhoods with multiple lottery participants with the propensity score strictly between 0 and 1, and in Column (3) - with the propensity score strictly between 0.1 and 0.9. The results are very similar.

6 Conclusion

Leveraging admission lotteries for higher education studies in the Netherlands, we find that the study choices of younger siblings and cousins are strongly affected by the field of study in which their older sibling or cousin enrolls. Also younger neighbors are affected but to a smaller extent. These findings indicate that a substantial part of the correlations in study choices between family members can be attributed to spillover effects and are not due to shared environments.

Our findings concur with those of recent studies based on admission thresholds, which find sibling spillovers on college and college-major choices. The similarity in results indicates that the results from these previous studies can be extrapolated to older peers away from the admission thresholds, and to a wider group of younger peers that includes cousins and neighbors. Moreover, while the previous studies find spillovers for college and college-major choices, our results demonstrate that even field of study choices are malleable.

Our results suggest that policies aimed at influencing young people's study choices, have multiplier effects, mainly through family networks. Our findings concerning differential effects by sex composition and family income should be taken into consideration when designing policies so that possible negative side effects regarding the diversity of the student body can be avoided.

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Appendix

Table A1: Spillover effects excluding medicine and excluding all health-related fields

	Younger peer enrolls in the lottery field of study		
	Sibling	Cousin	Neighbor
Panel A: All lottery fields of study			
Older peer enrolls	0.057*** (0.005)	0.022*** (0.002)	0.003*** (0.001)
Control complier mean	0.029	0.011	0.010
N	33,094	79,704	317,217
Panel B: Medicine excluded			
Older peer enrolls	0.031*** (0.005)	0.007*** (0.001)	0.001 (0.001)
Control complier mean	0.010	0.003	0.002
N	12,274	32,681	114,415
Panel C: All health-related fields excluded			
Older peer enrolls	0.045*** (0.006)	0.010*** (0.002)	0.004 (0.004)
Control complier mean	0.008	0.001	0.007
N	6,354	17,152	26,129

Notes: All regressions include controls for sex, non-western origin, age of the older peer at the first lottery, and fixed effects for lottery field of study, lottery category, year of the first lottery participation, and their interactions. All regressions use the normalized inverse of the propensity score as a weight. Standard errors are clustered at the older peer level. *p<0.1; **p<0.05; ***p<0.01.

Table A2: Spillover effect of older peer's lottery result on younger peer's enrollment in any higher education study

	Younger peer enrolls in any higher education study		
	Sibling	Cousin	Neighbor
Panel A: Main results			
Older peer wins the first lottery	0.004 (0.006)	0.010* (0.005)	0.000 (0.004)
Control complier mean	0.797	0.654	0.489
N	33,094	79,704	317,217
Panel B: Heterogeneity by lottery category			
Older peer wins the first lottery	0.004 (0.007)	0.011* (0.006)	0.007 (0.004)
Older peer wins x 1 [Older peer's GPA < 6.5]	0.002 (0.012)	-0.004 (0.011)	-0.019** (0.007)
N	33,094	79,704	317,217
Panel C: Heterogeneity by sex composition			
Older peer wins the first lottery	0.016** (0.007)	0.009 (0.006)	-0.003 (0.004)
Older peer wins x 1 [Same sex = 1]	-0.023** (0.010)	0.001 (0.007)	0.007* (0.004)
N	33,094	79,704	317,217
Panel D: Heterogeneity by age gap			
Older peer wins the first lottery	0.006 (0.006)	0.008 (0.008)	0.000 (0.004)
Older peer wins x 1 [Age gap > 5 (2)]	-0.008 (0.011)	0.001 (0.009)	0.005 (0.004)
N	33,094	79,704	1,472,910
Panel E: Heterogeneity by parental income			
Older peer wins the first lottery	0.010 (0.008)	0.013* (0.007)	-0.001 (0.005)
Older peer wins x 1 [Parental income > median]	-0.013 (0.011)	-0.001 (0.010)	0.001 (0.007)
N	32,995	79,484	316,141

Notes: All regressions include controls for sex, non-western origin, age of the older peer at the first lottery, and fixed effects for lottery field of study, lottery category, year of the first lottery participation, and their interactions. All regressions use the normalized inverse of the propensity score as a weight. In Panel D, for siblings and cousins we include interactions with an indicator equal 1 if the age difference is larger than 5, and for neighbors – larger than 2. In Column (3) of Panel D, we include neighbors with at most 10 years gap. In Panel E, we include interactions with an indicator equal 1 if the parental income of older peers is above the sample median. Standard errors are clustered at the older peer level. *p<0.1; **p<0.05; ***p<0.01.

Table A3: Robustness checks: different sample definitions

Panel A: Siblings	Oldest OS	Youngest OS	One OS
YS enrolls in the lottery	0.057***	0.057***	0.053***
field of study	(0.005)	(0.005)	(0.005)
YS enrolls in any	0.004	0.006	0.005
higher education study	(0.006)	(0.005)	(0.006)
N	33,094	33,094	31,990
Panel B: Cousins	Oldest OC	Youngest OC	One OC
YC enrolls in the lottery	0.022***	0.021***	0.021***
field of study	(0.002)	(0.002)	(0.002)
YC enrolls in any	0.010*	0.006	0.007
higher education study	(0.005)	(0.005)	(0.005)
N	79,704	79,704	70,798
Panel C: Neighbors	Youngest ON	At least one ON with $0 < p < 1$	At least one ON with $0.1 < p < 0.9$
YN enrolls in the lottery	0.003***	0.004***	0.004***
field of study	(0.001)	(0.002)	(0.001)
YN enrolls in any	0.000	-0.005	-0.004
higher education study	(0.004)	(0.004)	(0.004)
N	317,217	731,862	532,338

Notes: OS/YS - older/younger sibling, OC/OC - older/younger cousin, ON/YN - older/younger neighbor. All regressions use the normalized inverse of the propensity score as a weight. p is the propensity score measuring that at least one older neighbor is a lottery winner. In Panels A and B, standard errors are clustered at the older sibling/cousin level. In Column (1) of Panel C, standard errors are clustered at the older neighbor level, and in Columns (2) and (3) - at the neighborhood level. In all columns of Panels A and B and in Column (1) of Panel C, regressions include controls for sex, non-western origin, age of the older peer at the first lottery, and fixed effects for lottery field of study, lottery category, year of the first lottery participation, and their interactions. In Columns (2) and (3) of Panel C, regressions include the propensity score as a fixed effect. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.