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Location and Educational Signals

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Location and educational signals

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Abstract

Place shapes the educational attainment of children, yet the underlying reasons remain poorly understood. In this paper, I investigate the role of spatial differences in educational signals received by students. Using Dutch administrative data combined with high-stakes national exam scores, I show that students receive less ambitious track recommendations in rural areas conditional on ability. The spatial difference is comparable to the impact of having a university-educated parent and explains around half of the spatial difference in academic track enrollment. Key mechanisms are spillovers from high SES peers and stronger beliefs in the importance of education among urban teachers.

Key words: Spatial Inequality; Educational attainment; Teacher Bias; Human Capital

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1 Introduction

The place of residence during childhood forms a key determinant of educational attainment and labor market outcomes in many settings.[1] Yet, the mechanisms through which location shapes educational decisions and outcomes remain poorly understood. Places that are more or less beneficial for childhood development usually differ on many potentially relevant dimensions and data on intermediate outcomes throughout childhood typically remains unobserved. As a result, it has been challenging to study the factors that underlie the spatial differences in educational attainment and to design effective policy interventions to tackle the spatial inequality of opportunity.

One possible explanation is that students receive different signals regarding their academic potential depending on location. A large body of literature shows that the lower levels of educational attainment of various underrepresented groups — such as minorities (Papageorge, Gershenson and Kang, 2020), immigrants (Carlana, Ferrara and Pinotti, 2022), low-caste households (Hanna and Linden, 2012), low-SES households (Falk, Kosse and Pinger, 2020), and girls in mathematics (Carlana, 2019) — can in part be explained by the weaker educational signals received by children in these groups. Hoxby and Avery (2012) suggest that a similar process may play out on the spatial level, for instance due to a lack of experience among study counselors outside of metropolitan areas in advising high-performing students. However, it has been difficult to study spatial differences in educational ability signals provided to students, given that they are rarely documented in a consistent manner across geographic areas and an objective benchmark to verify them against is typically lacking.

In this paper, I leverage a unique setting in the Netherlands to study the spatial difference in educational ability signals provided to students. At the end of primary school, students have to select into one of three secondary school tracks which differ in academic content, length, and access to tertiary education. To assist with the decision-making, students are provided with a track recommenda-

[1] See for instance Chetty, Hendren and Katz (2016), Chetty and Hendren (2018), Chyn (2018), Chyn and Katz (2021), Nakamura, Sigurdsson and Steinsson (2022), Kawano et al. (2024), and Chyn, Collinson and Sandler (2025).

tion by the primary school teaching staff. Students participate during the same period in participate in the high-stakes national primary school exit exam which measures learning outcomes across three domains and which can be used as an objective benchmark to compare the teacher recommendations against.[2]

I start by showing that substantial variation exists in track enrollment across space. The likelihood that children enroll in the academic high school track varies between 10% and 40% depending on the childhood municipality of residence. The urban-rural gradient is particularly salient since children in larger cities are nearly twice as likely to enroll in the academic track compared to students in rural locations. While part can be explained by spatial selection, most of the spatial variation in track academic enrollment persists when controlling for household SES and national exam scores, highlighting that children of similar backgrounds and ability levels make different educational choices depending on location.

To investigate the role of educational signals, I use data on teacher recommendations, primary school exit exam scores, and school choices for the children who completed primary school between 2006 and 2014. I link the educational data to the wider administrative data which provides detailed information on a range of household characteristics including parental education, earnings, and migration background. This yields a baseline sample of 829.343 children whom we can consistently track throughout childhood. Since the urban-rural gradient is such a salient feature of the spatial heterogeneity in educational outcomes, I focus on the density of the childhood place of residence as the key place characteristic throughout the paper.

The analyses reveal substantial differences in the educational signals received by students across space. In the preferred specification using the full sample, a one log-point (or 0.87 s.d.) increase in childhood population density increases the probability of receiving an academic track recommendation by 1.7 percentage points (or 6%). This average estimate masks substantial heterogeneity, with estimates that are three times larger for students on the margin of admission to the aca-

[2]The primary school exit exam is centrally graded without teacher involvement and assesses language ability (vocabulary, spelling, and comprehensive reading), mathematics, and logical reasoning based on 200 multiple-choice questions.

demic track according to their exit exam score. The spatial differences in teacher recommendations are smaller for low and very high-ability students, although they remain visible and statistically significant even among the small subset of students who achieve the maximum score on the primary school exit exam.

Quantitatively, these spatial differences in teacher recommendations are substantial compared to individual and household characteristics. Among students on the margin of admission to the academic track, living in Amsterdam instead of a place at the 25th percentile of the density distribution increases the likelihood of receiving an academic track recommendation by 9 percentage points (pp). In comparison, girls are 1 pp more likely to receive an academic track recommendation and there is no difference between children with and without a migration background. Having a university-educated parent increases the likelihood of receiving an academic track recommendation by 11 pp. Hence, the spatial differences are larger than some previously studied household characteristics and comparable in magnitude to the effect of having a university-educated parent.

Interestingly, the spatial difference in track recommendations is visible across all demographic groups, suggesting that favorable household characteristics cannot isolate children from an unfavorable location. Furthermore, while no difference in recommendations is visible between students with and without a migration background at the national level, a substantial difference exists at the local level. Children with a migration background are 9 - 16% less likely to receive an academic track recommendation conditional on childhood place of residence. The difference between the local and national level is due to the fact that families with a migration background tend to locate in large cities, with the benefits provided by a more favorable location exactly offsetting the bias against children with a migration background at the local level. As such, spatial heterogeneity matters when studying differences in educational signals between population groups, as long as the groups are not spread homogeneously across space.

A key concern is that students in rural areas may have worse learning outcomes on skill dimensions that are not covered by the primary school exit exam. I investigate this in two ways. First, I study the effect of place among children who moved in the period shortly before the recommendations were constructed, and for whom the majority of their education thus took place in a different location compared to the teacher assessments. I find similar estimates among this group of students, suggesting that the spatial differences are not driven by local learning conditions. Furthermore, conditional on the location at the time when teacher recommendations are constructed, the density of the previous residential history has no effect on recommendations. This again suggests that students do not acquire unobserved skills at different rates depending on location. Second, I use the fact that the exit exam measures student ability across different domains to assess whether urban and rural students accumulate skills at different rates depending on the observed learning outcome. I find no evidence that the spatial distribution of student ability depends on the skill domain, suggesting that it's unlikely that a different distribution of unobserved skills across space drives the differences in recommendations.

An important question is what explains the less ambitious educational signals in rural areas. I find no evidence that distance to schools, differences in primary school religious affiliation, or differences in the local returns to education drive the results. Controlling for these factors leaves the spatial differences in teacher recommendations virtually unaffected. In addition, I find little evidence that statistical discrimination due to uncertainty over student ability can explain the findings. Following a reform in 2014 that made the teacher recommendations legally binding, teachers were granted the ability to upgrade their recommendation if a student outperformed the recommendation on the primary school exit exam. However, despite the less ambitious initial recommendations, teachers in rural areas are also significantly less likely to improve the recommendations when presented with evidence that conflicted with the initial recommendation.

Instead, the more ambitious recommendations are in part explained by positive spillovers due to the clustering of high-SES peers in cities. Controlling for the share of university-educated parents at the school level reduces the spatial difference in teacher recommendations by around 40%, indicating that a substantial portion of the spillover effects occurs within schools. These spillovers may result from high-SES peers raising the educational aspirations of children in the classroom, similar to the findings of Cattan, Salvanes and Tominey (Forthcoming) in Norway, or through higher "demand" for academic track recommendations by highly educated parents that is subsequently internalized by teachers. There is little evidence that the clustering of high-SES peers in cities affects the exit exam scores, highlighting that the spillovers operate through better teacher recommendations rather than through improved learning outcomes.

Furthermore, I find evidence that urban teachers have stronger beliefs in the importance of education as expressed through educational decisions in private life. Despite having worse learning outcomes at the end of primary school and similar teacher recommendations compared to rural teachers, urban teachers are more likely to have enrolled in the academic high school track and registered at university. Moreover, when analyzing the track enrollment choices that teachers make regarding their children, I find that primary school teachers in urban areas are significantly more likely to enroll their children in the academic track conditional on ability and the track recommendations provided by their children's teachers. As such, teachers in urban areas make decisions in private life that are in line with stronger beliefs in the importance of educational investment.

Finally, I quantify the importance of teacher recommendations in explaining the spatial difference in academic track enrollment. Using variation in teacher recommendations at both the individual level and the school level, I find that around half of the observed urban-rural academic track enrollment gap can be explained by the spatial differences in teacher recommendations. As such, the less ambitious nature of the educational signals received by students in rural areas plays an important role in explaining the lower rates of academic track enrollment. Furthermore, the spatial differences in teacher recommendations risk further reinforcing existing spatial differences in educational attainment over time.

The findings of this paper contribute to three strands of literature. First, the paper contributes to the literature on the role of place in shaping educational attainment (Chetty, Hendren and Katz, 2016; Chyn, 2018; Chetty and Hendren, 2018; Chyn and Katz, 2021; Nakamura, Sigurdsson and Steinsson, 2022; Kawano et al., 2024;

Chyn, Collinson and Sandler, 2025). While this literature has been successful in showing that the childhood place of residence affects educational attainment, an important question is what mechanisms can explain the effect. In this paper, I highlight a novel mechanism through which location can affect human capital accumulation, namely through the educational ability signals that students receive from the local environment. Quantitatively, this channel explains half of the spatial variation in educational attainment in the Netherlands.

Second, the paper contributes to the literature on teacher biases and their role in shaping student outcomes. Previous studies show that teacher biases in recommendations and evaluations play an important role in explaining the lower educational outcomes of children from immigrant families (Botelho, Madeira and Rangel, 2015; Carlana, La Ferrara and Pinotti, 2022; Alesina et al., 2024), low SES-households (Falk, Kosse and Pinger, 2020), minority groups (Burgess and Greaves, 2013; Papageorge, Gershenson and Kang, 2020), lower castes (Hanna and Linden, 2012), and girls in the field of mathematics (Lavy and Sand, 2018; Carlana, 2019). This paper is the first to expand this literature to encompass the spatial domain and shows that similar differences in teacher recommendations exist depending on location. The effect of location is visible for all demographic groups, highlighting that the spatial differences in teacher recommendations extend beyond previously observed differences between demographic groups.

Third, the paper contributes to the literature on the multidimensional nature of teacher impact (Jackson, 2018; Petek and Pope, 2023). Petek and Pope (2023) show that teacher impact can operate through various domains including cognitive development and behavioral outcomes. In this paper, I highlight the importance of a different dimension: the recommendations and guidance provided to students. Students have similar national test scores conditional on SES in urban and rural areas, suggesting that teachers in rural areas do not generally provide lower educational quality. Instead, teachers in rural areas provide significantly less ambitious recommendations to students conditional on ability, which is an important mechanism to explain the lower levels of educational attainment among students in rural areas. The important role of the provision of guidance and recommendations also relates to the recent work by Mulhern (2023), who shows an important role for study counselors in shaping educational trajectories among high-school students in Massachusetts.

The remainder of the paper proceeds as follows. Section 2 provides an overview of the context and data. Section 3 discusses the methodology and section 4 presents the main results and various robustness tests. Section 5 examines potential mechanisms and discusses the implications. Section 6 quantifies the importance of the teacher recommendations in explaining the spatial differences in academic track enrollment. Finally, section 7 concludes.

2 Context and data

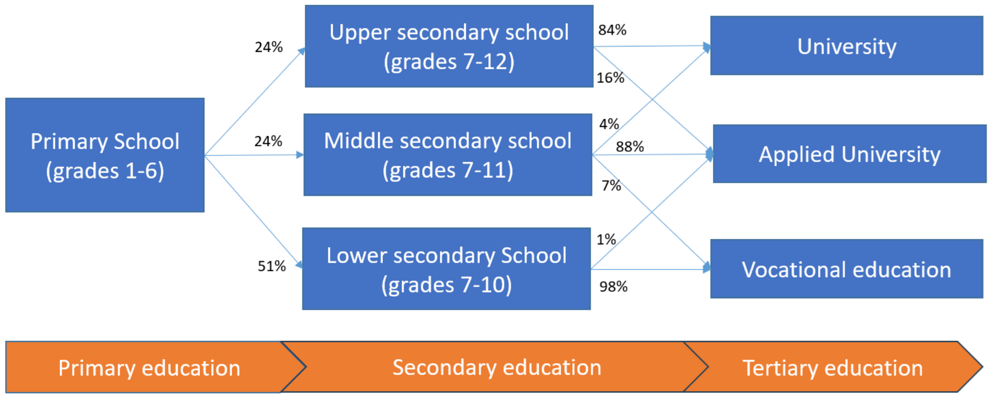
2.1 Educational system

The education system in the Netherlands consists of three stages as shown in Figure 1. Children enroll in primary school education at age 6 which lasts six years.[3] After completing primary school students select one of the three secondary school tracks, which differ in length, academic content, and access to tertiary education. Since the secondary school track is strongly linked to tertiary educational enrollment (see Figure 1), the choice for the secondary school track is an important decision that determines the educational pathway for the remainder of childhood. Students are free to apply to any secondary school track, but secondary schools decide which students to admit. Enrollment is free of charge for primary school and all secondary school tracks, whereas an annual enrollment fee of 2000 euros is charged for (applied) university and 1000 euros a year for vocational education.

Primary schools are not directly involved in the secondary school choice of students, but they do provide students with a recommendation to assist with the decision. The recommendation is provided by the primary school teachers based on their assessment of the appropriate level of secondary school track for the student. The primary schools decide which staff members are involved in constructing

[3] This section provides an overview of the educational system between 2006 - 2014 which is the main focus of this paper. The school system was reformed in 2014 as will be discussed later.

Figure 1: Overview of the Dutch education system



Note: Flows are based on the cohorts born in the Netherlands between 1994 - 2002. The flows are based on enrollment respectively three years after completing primary school and the highest level of completed secondary school. Lower secondary school is further divided into some subcategories which are not displayed here. Figure adapted from Van Maarseveen (2021).

the recommendations, with typically at least the school principal and teachers of the final two grades involved. The recommendation can be for a single secondary school track or can be a mixed recommendation if the teachers believe that more than one track might be suitable for the student. Table 1 shows the distribution of the secondary school track recommendations by teachers.

During the same period as primary schools construct the teacher recommenda-

Table 1: Secondary school track recommendations by teachers

School recommendation	% of students
Upper secondary school	14.36%
Upper secondary school/Middle secondary school	14.02%
Middle secondary school	15.09%
Middle secondary school/Lower secondary school	13.28%
Lower secondary school	41.74%
Upper secondary school/Middle secondary school/Lower secondary school	1.51%

Note: Distribution based on students born in the Netherlands between 1994 and 2002 who completed primary school between 2006 - 2014.

tions, students also participate in the primary school exit exam. The primary school exit exam is a national exam consisting of 200 multiple-choice questions in vocabulary, spelling, and reading comprehension (100 questions), mathematics (60 questions), and logical reasoning (40 questions). Schools can additionally opt into questions on world knowledge, consisting of natural sciences, geography, and history, which does not affect the exit exam score of students. Participation in the national exit exam is not mandatory for primary schools, although a large majority ($> 85\%$) of schools participate. The primary school exit exam is administered in February and is centrally graded, with the score translating into a recommendation for a secondary school track. The distribution of the primary school exit exam recommendations is shown in appendix A.

Although neither the school recommendation nor the primary exit exam score was binding in the period under study, secondary schools have historically relied on the primary school exit exam score as the key admission criteria (Statistics Netherlands, 2021). This changed when parliament enacted a new law in 2014 which made the teacher recommendation legally binding, since teachers believed that the emphasis on the primary school exit exam score created undue pressure for children to perform at one moment in time.[4] In the baseline analysis, I focus on the period between 2006 and 2014 when the teacher recommendation was not binding nor the leading admission criteria for secondary schools, since this is most representative of the type of recommendations that students receive in other settings. However, the results are similar in the post-reform period as will be shown in the robustness section.

Finally, since there was no prescribed process for the construction of the teacher recommendations in the period under study, the timing of the construction of the recommendation somewhat varies between schools. This raises the possibility that some primary schools may have used the exit exam scores when constructing the recommendations. While this cannot be excluded, it has to be noted that the results are very similar when estimated for the post-reform period when primary schools were legally obligated to construct and disseminate the recommendations well ahead of the primary school exit exam. Furthermore, to the degree that schools simply follow the exit exam scores in constructing recommendations, this would go against finding any spatial differences in recommendations conditional

[4]At the same time, the primary school exit exam became mandatory for all primary schools, but more than one test provider emerged and the exam was now conducted in April rather than February.

on exit exam scores.[5]

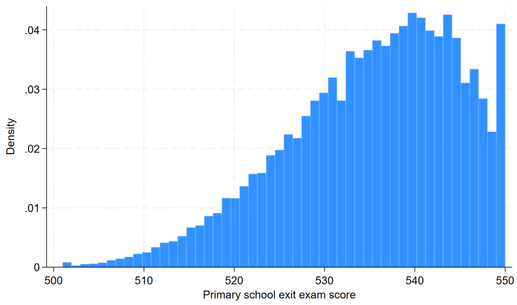
2.2 Data and descriptive statistics

The data on the primary school test scores, teacher recommendations, and secondary school enrollment decisions are obtained from Statistics Netherlands. The educational data has been connected to the general administrative databases from Statistics Netherlands, thus providing a wide range of household characteristics, including parental education, parental income, and migration background. I restrict the sample to those born in The Netherlands between 1994 and 2002 for whom both the primary school exit exam score and the primary school recommendation are observed in the period 2006 - 2014. This results in a baseline sample of 829.343 individuals. Appendix B provides more details on the sample construction and descriptive statistics.

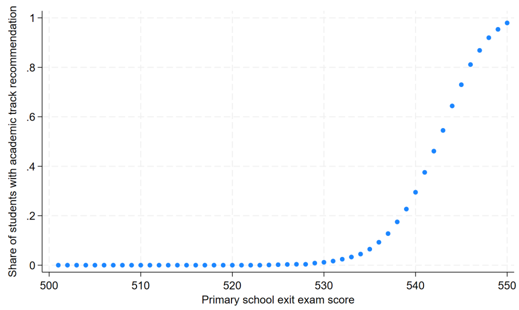
The primary school exit exam scores and teacher recommendations show a clear correlation but are not perfect substitutes. Figure 2 shows the density distribution of the primary school exit exam (left panel), as well as the share of students that received an academic track recommendation from their teachers by the exit exam score (right panel). Students below the 50$^{\text{th}}$ percentile on the exit exam (score < 535) rarely receive a teacher recommendation for the academic track, meaning that the exit exam score and teacher recommendations are in agreement for these students. Similarly, the overwhelming majority of students who score above the 90$^{\text{th}}$ percentile (score > 547) receive an academic track recommendation from teachers. The teacher recommendations are mixed for students around the margin of admission to the academic track according to the exit exam (scores between 540 - 544), with 30% to 70% of these students receiving a teacher recommendation for the academic track.

[5]Furthermore, I investigate discontinuities in teacher recommendations around the exit exam threshold of 545, which translates into a recommendation for the academic test according to the test. I find no jump in the likelihood of receiving an academic track recommendations from teachers around the threshold, using either the discrete exit exam scores or the more fine-grained correct number of answers on the 200 questions which translate into the final scores (see appendix B.5). As such, teachers are not simply following the suggested track based on the test score when constructing their own recommendations.

Figure 2: Exit exam scores and teacher recommendations



(a) Density distribution of the primary school exit exam.



(b) Academic track recommendations (%) from teachers by exit exam score

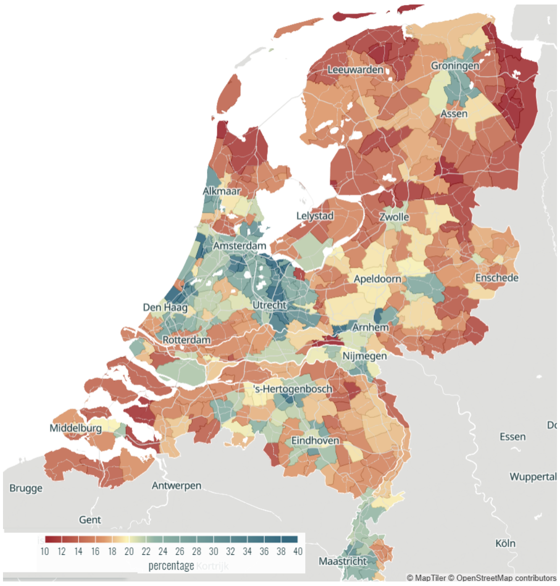
Note: Statistics based on those born between 1994 - 2002 and whom completed primary school between 2006 - 2014. The x-axis shows the score on the primary school exit exam, the y-axis the density distribution of the test score (left panel) and the percentage of students receiving an academic track recommendation from their teachers (right panel).

2.2.1 Spatial differences in educational attainment

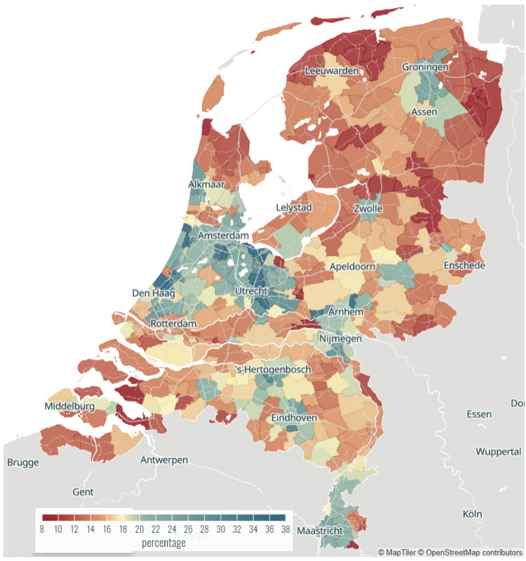
To get an impression of spatial differences in educational attainment, Figure 3 shows the likelihood of academic track enrollment (left) and university attendance (right) across space. As can be seen, there are substantial spatial differences in the likelihood that children enroll in the academic high school track and university. The urban-rural divide is particularly noticeable, with children in the denser populated parts of the Netherlands being significantly more likely to attend university compared to rural students.

Quantitatively, the urban-rural difference in academic track enrollment is substantial. Appendix Figure B.3 shows the relationship between population density and academic track enrollment for the baseline sample. The academic track enrollment - log density relationship is fairly linear with differences by density visible throughout the observed density distribution. Around 30% of students in the large cities enroll in the academic track against just over 15% in the most rural areas. While some of this difference can be explained by spatial selection, most of the academic track enrollment gap persists even when controlling for observed learning outcomes as shown in appendix Table B.4. As such, students with similar abilities make different educational choices depending on their location.

Figure 3: Spatial differences in academic track enrollment and university attendance



(a) Academic track enrollment by municipality



(b) University attendance by municipality

Source: Kansenkaart.nl. Track enrollment is measured at age 16, university enrollment is based on whether children have attended university by age 21. The municipality of residence in both cases is based on where children lived at age 15.

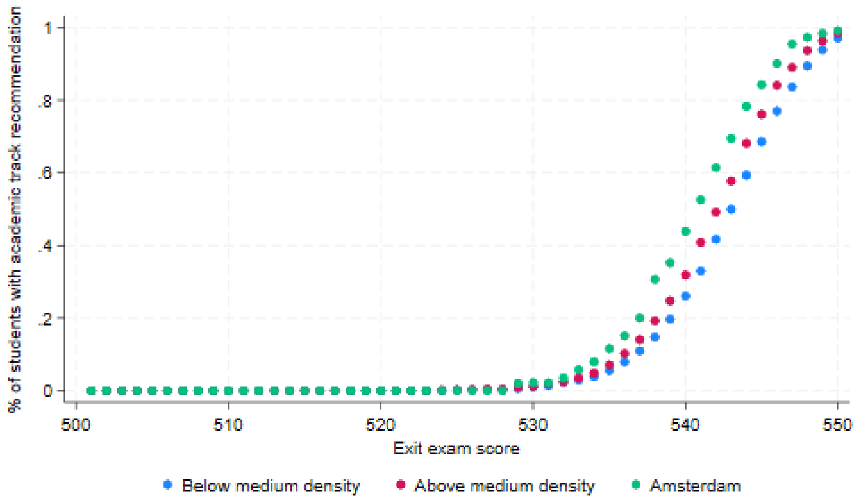
2.2.2 Spatial differences in teacher recommendations

To get a sense of the role that teacher recommendations may play in explaining the spatial differences in academic track enrollment, Figure 4 shows the percentage of students who received an academic track recommendation by the primary school exit exam score. The sample is split based on whether children reside in an area that is above or below the median density. As can be seen from Figure 4, low-performing students rarely receive an academic track recommendation regardless of their location. This changes for students who are at the margin of the academic track admittance according to the exit exam (around 540 - 544), where students in above-median density areas are around 10 percentage points more likely to receive an academic track recommendation compared to students in below median density areas. Children in the largest cities such as Amsterdam are another 10 pp more likely to receive an academic track recommendation. This difference remains visible throughout the distribution, only to narrow for the brightest of students.

The spatial differences are larger still and persist throughout the top of the distribution when studying whether students received a recommendation exclusively for the academic track as shown in appendix Figure C.1.

The spatial differences in teacher recommendations are substantial in magnitude,

Figure 4: Urban-rural gap in academic track recommendations



Note: Figure displays the share of students receiving an academic track recommendation for rural students (in blue) and urban students (in red). The sample is split evenly by the median population density of the place of residence. Amsterdam included in green for comparison.

even compared to individual characteristics. Appendix Table B.3 shows the difference in the probability of receiving an academic track recommendation conditional on test scores by gender, migration background, and parental education. Among the children on the margin of admission to the academic track, girls are 1 pp more likely to receive an academic track recommendation. No difference is visible for children with and without a migration background, whereas children with a university-educated parent are 11 pp more likely to receive an academic track recommendation. In contrast, living in a place 1 log point denser is associated with a 5.4pp increase in the likelihood of an academic track recommendation. Conditional on the test score, the difference in the likelihood of receiving an academic track recommendation between children at the 90th and 25th percentile of the density distribution is similar in magnitude to the effect of having a university-educated parent, and almost ten times larger than the observed difference in teacher academic track recommendations by gender.

3 Methodology

Since the urban-rural gradient is such a key feature of the spatial differences in educational attainment, I focus throughout the analyses on the differences in educational signals received by students in urban and rural areas conditional on learning outcomes and background. The detailed data on the exam scores and family characteristics allow me to flexibly control for many of the relevant characteristics that may differ between students in urban and rural environments. The baseline model used in the estimations is shown in equation 1.

$$\begin{aligned}\text{Teacher recommendation}_i &= \alpha + \beta_1 * \text{individual characteristics}_i + \\ \beta_2 * \text{household characteristics}_i &+ \beta_3 * \text{cognitive ability}_i + \beta_4 * \text{urbanization}_i \\ &+ \epsilon_i \quad (1)\end{aligned}$$

The individual characteristics include gender, birth cohort, and birth order within the household. As household characteristics, I include migration background, parental education, parental income, and the age of the oldest parent at birth. Migration background is measured as the country of birth of the parents.[6] Parental education consists of 19 possible levels for each parent which I flexibly interact to create 361 parental education combinations. One of the 19 possible levels is that no educational attainment is registered for the parents in the administrative data. In practice, these parents are likely to be low-educated since the coverage of the educational registers has historically been poor for those with low levels of educational attainment. The results are robust to the exclusion of this group as will be shown in the main tables.

Parental income is constructed following Chetty and Hendren (2018) and is defined as the log average income of both parents over a 5 year period. I use the income of the parents when children are between ages 10 - 14 since this is observed for all cohorts in the baseline sample. Finally, I include separate dummies for children whose parents have negative income or top-censored income in any year or have

[6]This is based on the country of birth of the mother, with the exception of cases where the mother was born in The Netherlands and the father was born abroad, in which case the country of birth of the father is used.

missing parental income for more than five parent-income years. These jointly account for 0.6% of the observations. Table B.2 in the appendix shows the summary statistics.

Regarding the controls for cognitive ability, I include separate dummies for each possible examination year interacted with the test score. A small number of students repeat the final year of primary school. In those cases, I use the first available test score to avoid endogeneity in grade repetition.

The last step is to classify how urban or rural each childhood location is. The lowest spatial aggregation unit on which place of residence is available is zip code, of which there are 3,980 with an average size of 11 km^2. I follow De La Roca and Puga (2017) and use the log of the number of people living within a 10km radius of the zip code centroid as density measure. Each student is assigned the density of the zip code of residence at the start of the final year of primary school. To improve the comparison between time periods and avoid potential endogeneity of population flows during the sample period, I use the density based on the population distribution in 2005, the last year before the study period. The distribution of the density measure and a density map are shown in appendix B.3.[7]

Equation 1 is similar to many other studies in the teacher bias literature and relies on the observed exam scores to correct for differences in learning outcomes between students (Burgess and Greaves, 2013; Lavy and Sand, 2018; Falk, Kosse and Pinger, 2020; Carlana, La Ferrara and Pinotti, 2022). Nonetheless, some factors that affect teacher recommendations and that may differ between urban and rural areas, such as non-cognitive skills, remain unobserved. The potential of such unobserved differences to drive differences in the teacher recommendations is discussed in section 4.3, which uses both movers as well as the multi-dimensional nature of the skill measures in the exit exam to show that spatial differences in unobserved ability are unlikely to drive the results.

[7]Note that the specification in equation (1) imposes a log-linear relationship between population density and educational outcomes and teacher recommendations. This seems well supported in this context as highlighted by appendix Figures B.3 and B.4.

4 Results

4.1 Main results

Table 2 shows the effect of population density on the probability that a student receives an academic track recommendation obtained by estimating equation 1. The first column shows the general urban-rural gradient in recommendations conditional on exam score, whereas columns (2) and (3) add the various individual and family characteristics. As shown in the preferred specification in column (3), a one log-point increase in population density raises the likelihood of receiving an academic track recommendation from teachers by 1.7 percentage points. The inclusion of household characteristics somewhat reduces the estimates compared to column (1). This is mainly driven by the inclusion of parental education, which has previously been shown to affect teacher recommendations even conditional on test scores (Falk, Kosse and Pinger, 2020), with highly-educated parents being more likely to reside in urban areas.

One concern is that the results may be driven by the spatial selection of students,

Table 2: Effect of density on teacher recommendation for academic track

	(1)	(2)	(3)	(4)	(5)
Log density	0.0219***	0.0222***	0.0169***	0.0172***	0.0167***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
N	829.343	829.343	829.343	682.730	360.507
R^2	0.55	0.55	0.56	0.55	0.58
Exit exam score	Yes	Yes	Yes	Yes	Yes
Indv. Characteristics	No	Yes	Yes	Yes	Yes
Family Characteristics	No	No	Yes	Yes	Yes
Movers excluded	No	No	No	Yes	Yes

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: Table displays the density estimates obtained by estimating equation 1 including the various control variables described in section 2. Column (5) excludes all children where there is some uncertainty over the education of one of the parents as discussed in section 3. Standard errors are clustered on the municipality level.

with those who are most likely to attend the academic track relocating to an urban environment during the primary school years to improve access to education. To exclude this possibility, column (4) shows the estimates when excluding children who moved across municipalities at any point between ages 1 and 12, with similar results. Furthermore, column (5) shows the results when all children are removed with uncertainty over the educational attainment of either parent, with no effect on the estimates.[8]

The estimates in Table 2 are quite substantial in terms of magnitude. Children who live in a place that is one log-point denser are around 1.7 pp more likely to receive an academic track recommendation. Given that 28% of students receive an academic track recommendation, this implies an elasticity of academic track recommendations w.r.t. population density of 0.06. The differences are substantially larger still when instead focusing on the likelihood that students receive a recommendation exclusively for the academic track as shown in appendix C.1.

4.2 Heterogeneity

The estimates in Table 2 are based on all students within the relevant cohorts, including those who are very unlikely to receive an academic track recommendation given their learning outcomes in any location. This makes it probable that the effects differ throughout the ability distribution.

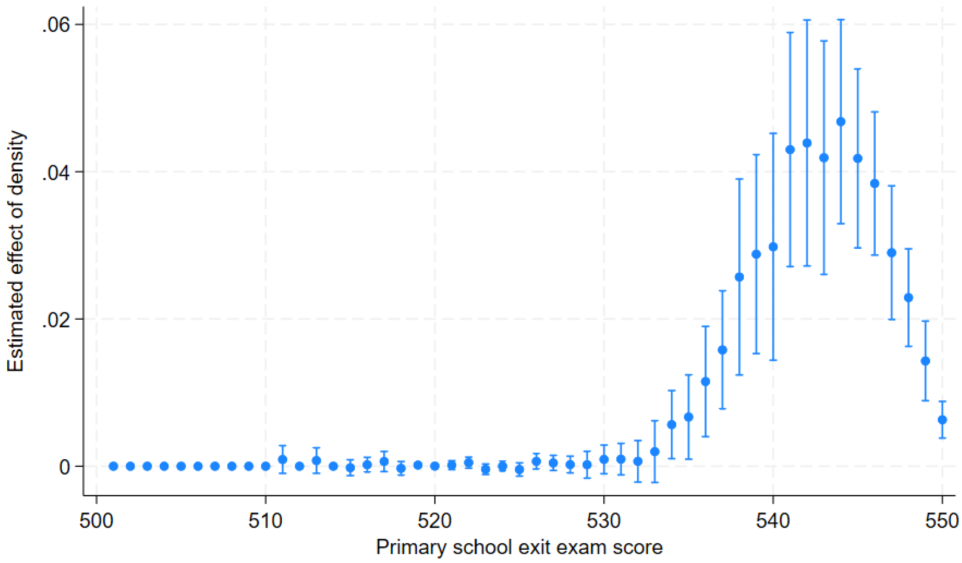
To investigate this, Figure 5 shows the estimates when separately estimating the effect of density for each exit exam score. The effect of location on teacher recommendations is the largest for students who are on the margin of admission to the academic track according to the exit exam. For this group, a one log-point increase in density is associated with a 4.0 - 4.5 pp increase in the likelihood of receiving an academic track recommendation. Given that around 30% - 70% of students in this range receive an academic track recommendation, these spatial differences in recommendations are substantial. The spatial differences in teacher recommendations are smaller for low-ability students and very high-ability students, suggesting that a favorable location is most important for students on the margin. Neverthe-

[8]The parental education is unknown for a group of parents as discussed in section 3 since administrative records have historically not recorded graduation and enrollment at the lower end of the educational distribution.

less, even among students with the maximum test score, which represents the top 4 percent in the national distribution, students in urban locations remain significantly more likely to receive an academic track recommendation.

The second question is whether a favorable location benefits all students equally

Figure 5: Effect of density on teacher recommendation by test score.



Note: Figure displays the density estimates obtained by estimating equation 1 separately by primary school exit exam score. The full set of individual and household controls are included in each regression.

or whether certain types of students are more sensitive to location in terms of their teacher recommendations. When comparing between groups, I restrict attention to students who scored at least 540 on the primary school exit exam (corresponding to the 60th percentile) to avoid including students with a very low baseline probability of receiving an academic track recommendation. Table 3 shows the effects of density on recommendations for boys and girls, children with and without a university-educated parent, and children with and without a migration background. The estimates for the various groups are similar and are not significantly different. This highlights that the results are not just driven by different spatial selection of groups, but that instead, the effects of location on teacher recommendations are visible within each demographic group. Furthermore, the estimates based on children with a university-educated parent imply that favorable household characteristics are not sufficient to isolate students from the negative effects of an unfavorable location.

Regarding the demographic groups, an additional implication presents itself. As

Table 3: Heterogeneity by observed characteristics

	Gender		Parental Education		Migration Background	
	Male	Female	High	Low	Yes	No
Log density	0.0337***	0.0342***	0.0317***	0.0356***	0.0324***	0.0402***
	(0.005)	(0.005)	(0.005)	(0.006)	(0.005)	(0.009)
N	149.980	141.568	139.546	151.545	251.455	40.394
R^2	0.23	0.23	0.22	0.23	0.23	0.24

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: Table displays the density estimates obtained by estimating equation 1 for various demographic groups. The parental education is defined as high if at least one of the parents graduated from university or applied university. Having a migration background is defined as having at least one parent born outside of The Netherlands. To improve comparability between the groups, children are only included if they scored at least 540 on the exit exam score. All regressions include the test score, individual controls, and household controls. Standard errors are clustered on the municipality level.

discussed in section 2.2.2 and highlighted in appendix Table B.3, there is no difference on the national level in teacher recommendations between children with and without a migration background conditional on test scores. However, this hides two opposing forces in which the higher likelihood that children with a migration background reside in an urban area and thus benefit from more generous teacher recommendations is exactly offset by the degree to which teachers provide lower track recommendations conditional on location.

Table 4 shows the effect of having a migration background on teacher recommendations conditional on location. Even though there is no difference visible in teacher recommendations received by children with and without a migration background on the national level, once I control for either population density or the municipality of residence, a substantial difference appears. Children with a migration background are 2.2 - 2.8 pp (7 - 9%) less likely to receive an academic track recommendation once geographic controls are included. This recommendation gap increases to 5.6 - 7.4 pp (12 - 16%) once we focus on children on the margin of admission to the academic track according to the exit exam score as shown in columns (4) - (6). As such, the results in Table 4 highlight the importance of taking into account location when studying differences in educational signals between SES groups, as long as the population groups are not spread homogeneously across space.

Table 4: Effect of migration background with varying geographic controls.

	All children			Marginal students		
	(1)	(2)	(3)	(4)	(5)	(6)
Migration background	-0.00202	-0.0215***	-0.0285***	-0.0126	-0.0561***	-0.0743***
	(0.005)	(0.003)	(0.005)	(0.0155)	(0.009)	(0.007)
N	829.343	829.343	829.343	168.358	168.358	168.358
R^2	0.55	0.55	0.56	0.06	0.07	0.11
Geographic controls	None	Density	FE	None	Density	FE
Full controls	Yes	Yes	Yes	Yes	Yes	Yes
Control mean	0.31	0.31	0.31	0.46	0.46	0.46

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: Table displays the density estimates obtained by regression the likelihood of receiving an academic track recommendation on exit exam score and migration background. Migration background is equal to one if at least one parent was not born in the Netherlands and zero otherwise. The first three columns include all children, the latter three columns focus on the children at the margin of admission to the academic track according to the exit exam (scores 540 - 544). Columns (1) & (4) include no geographic controls, columns (2) & (5) include population density, and columns (3) & (6) include a dummy variable for each of the 388 municipalities of residence. The control mean refers to the likelihood of receiving an academic track recommendation among students without a migration background. All regressions include the test score, individual controls, and household controls. Standard errors are clustered on the municipality level.

4.3 Robustness: unobserved heterogeneity

The estimates in the previous sections highlight that students receive less ambitious recommendations in rural settings conditional on observed learning outcomes. One question is whether students in urban and rural areas may differ on skill dimensions that are not measured by the test, but which are correctly identified by the teachers. This could for instance be the case if students in rural areas have worse non-cognitive skills conditional on observed learning outcomes, which can be observed by teachers but may not be fully reflected in the exit exam scores. While no data are collected on non-cognitive outcomes as part of the curriculum, I test whether such differences are likely to drive results in two ways.

First, I focus on children who moved in the period shortly before the primary school exit exam and teacher recommendations and who thus received the majority of their education in a different place than where the assessment took place. If the lower teacher assessments in rural areas reflect lower non-cognitive skill development among rural students, then we would not expect to find an immediate impact of the density in the new region of residence for students who freshly moved there conditional on the previous place of residency.

To investigate this, Table 5 shows the estimates when restricting the sample to children who moved across municipal boundaries in the calendar year before taking the standardized test and receiving the teacher recommendation.[9] The estimates are similar compared to the baseline estimates in Table 2, suggesting that the recommendations of students who move to a new place virtually instantly convert to that of the general population. This suggests the differences in teacher recommendation are unlikely to be due to differences in unobserved skills acquired by students in the local place of residence. Instead, students who move to higher-density regions are significantly more likely to receive a teacher recommendation for the academic track. Note that these evidence do not appear to be driven by the spatial selection of households based on the potential outcomes of children, since controlling for the exit exam score and household characteristics leaves the effect of density of the destination virtually unchanged.

We can take this analysis one step further and perform the reverse analysis. If students acquire non-cognitive abilities at lower rates in rural areas, then the density of the previous place of residence should affect the teacher recommendations among children who move toward the end of the primary school years. However,

[9]Both the teacher recommendations and standardized tests take place in the second half of the sixth year of primary school (typically around February). I restrict attention to children who moved between January - December of the preceding year which corresponds to the second half of the fifth year and the first half of the sixth year of primary school. These students received at the minimum 75% of the primary school instruction in their previous place of residence.

the results in table 6 show that conditional on test score and location at the time of the recommendations, the density of the previous place of residence has no effect on the teacher recommendations with a point estimate close to zero.

Taken together, the estimates in tables 5 and 6 suggest that it is the place of residence at the time of receiving the teacher's recommendation that matters, with little role for the place where students spent the majority of their childhood in affecting the recommendations. This suggests that differences in teacher recommendations are unlikely to be driven by differences in the acquisition of unobserved skills between urban and rural regions.

Second, I utilize the different learning domains covered by the primary school

Table 5: Mover sample - effect of density of the destination

	(1)	(2)	(3)	4)
Log density new location	0.0228***	0.0249***	0.0244***	0.0231***
	(0.009)	(0.007)	(0.006)	(0.007)
N	6.030	6.030	6.030	6.030
R^2	0.07	0.59	0.59	0.64
Municipality of origin FE	Yes	Yes	Yes	Yes
Exit exam score	No	Yes	Yes	Yes
Indv. Characteristics	No	No	Yes	Yes
Family Characteristics	No	No	No	Yes

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: Table displays the results for the sample of children who moved across municipalities in the calendar year prior to taking the test. The sample is restricted to children who moved across municipalities only once between ages 1 and 12 to ensure that the region of origin FE accurately captures the region in which children grew up. The results are similar if additionally a minimum moving distance is imposed. Standard errors are clustered on the municipality level.

exit exam to analyze whether urban and rural students have different distributions along the various observed skill dimensions. This can provide some insight into whether the inferred spatial distribution in student ability depends on the observed ability measures. The primary school exit exam consists of three manda-

Table 6: Mover sample - effect of density of the origin

	(1)	(2)	(3)	4)
Log density previous location	0.0212*	0.0012	0.0024	0.0003
	(0.009)	(0.007)	(0.007)	(0.007)
N	6.030	6.030	6.030	6.030
R^2	0.08	0.59	0.59	0.64
Municipality of residence FE	Yes	Yes	Yes	Yes
Exit exam score	No	Yes	Yes	Yes
Indv. Characteristics	No	No	Yes	Yes
Family Characteristics	No	No	No	Yes

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: Table displays the baseline results of table 2 for the sample of children who moved across municipalities in the calendar year prior to the test. The sample is restricted to children who moved across municipalities only once between ages 1 and 12 to ensure that the density of the previous location accurately captures the region in which children grew up. The results are similar if additionally a minimum moving distance is imposed. Standard errors are clustered on the municipality level.

tory parts which measure language ability, mathematics, and logical reasoning.[10] To investigate whether the skill distribution of urban and rural students depends on the skill domain, Table 7 shows the effect of density on the scores of the individual skill components conditional on the scores on the other dimensions. Some minor differences are visible, with students in urban regions performing better on the language section than would be expected based on their performance on the mathematics and logical reasoning parts. However, the differences are exceedingly small. A one log-point increase in population density raises the language ability conditional on the logical reasoning and math ability scores by 0.007 SD, suggesting that urban and rural students do not have very different ability distributions depending on the observed skill dimensions.

Finally, this is not a mechanical outcome. For comparison, the final row in column Table 7 performs the same analysis by gender instead of density. In this case, we see substantial differences between the predicted scores based on the other two

[10]Logical reasoning consists of 40 questions which tests the ability to correctly process and interpret information from tables, maps, and graphs.

skill measures and actual scores. For instance, girls perform on average around half a standard deviation worse on the mathematics section of the primary school exit exam compared to what would be expected based on their scores on the language and cognitive reasoning sections. However, no such differences are visible by density, highlighting that the inferred spatial ability distribution does not depend on the observed skill dimension.

Table 7: Urban-rural differences across observed skill dimensions

	Language	Math	Cognitive reasoning
Log density	0.0842**	0.0932*	-0.0844*
	(0.03)	(0.04)	(0.04)
Score on other skill dimensions	0.604***	1.021***	0.843***
	(0.001)	(0.002)	(0.002)
Comparison: Gender	4.659***	-7.463***	1.099***
	(0.001)	(0.002)	(0.002)
N	829.343	829.343	829.343
R^2	0.65	0.60	0.69
Mean	74.5	71.5	75.5
Standard Deviation	12	17	14

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: Each column regresses the outcome variable (Language/Math/Cognitive reasoning) on the individual characteristics, household characteristics and the average score of the two other dimensions (Language/Math/Cognitive reasoning). The scores on the individual categories have been rescaled to represent a 0 - 100 interval. The sample used is identical to the baseline sample. The row "Gender" in addition included a gender dummy with the estimate referring to the difference between girls relative to boys. Standard errors are clustered on the municipality level.

4.4 Robustness: post-reform period estimates

The estimates so far are all based on the period prior to the 2014/2015 school year when teacher recommendations were not legally binding. One concern is that teachers may be aware that their recommendations during the period of study did not necessarily constrain student choices, and may have felt free to factor in non-academic elements that students in rural areas face in attending the academic track, such as commuting distances or different local job opportunities. To investigate this, I utilize a reform that was introduced for the 2014/2015 school year which made the teacher recommendations a legally binding criteria for admission to secondary schools. Furthermore, teachers were now legally obligated to construct and disseminate the recommendations well in advance of students taking the national exit exam, which reduces concerns that teachers may have observed the standardized test scores when formulating their own recommendations.[11]

To investigate whether the reform affected teacher recommendations, Table 8 shows the estimates based on the first post-reform year. The effect of density on teacher recommendations is actually larger in the first post-reform year, suggesting that the non-binding nature of the recommendations is not driving the results. In the post-reform period, the less ambitious nature of teacher recommendations in rural areas now actively constrained the educational choices available to students since they could not attend the academic track unless it was included in the teacher recommendation. Hence, the non-binding nature of the teacher recommendations does not seem to play an important role in explaining the urban-rural differences. Appendix E.1 shows the results for the post-reform period up to the covid pandemic during which testing was suspended, with no evidence that the results have weakened in the years following the reform.

To show that the effects and spatial differences are not self-correcting over time, appendix table E.2 separately shows the results for the most recent 2023/2024 school year. The estimated effect of density remains significantly larger than the estimates for the pre-reform period and remain in line with the larger differences for the post-reform period shown in appendix Table E.1. As such, the spatial difference in teacher recommendations conditional on observed ability appears to have increased, rather than self-corrected, over the last 20 years.

Finally, a variety of new primary school exit exam providers emerged following

[11] I prefer to use the pre-reform period for the baseline results as students observe the teacher's recommendation in the post-reform period before taking the exit exam. Since students had the legal right to request schools to reconsider the teacher's recommendation in case their test score was significantly better than the teacher's recommendation, it provided an incentive to score (and prepare) particularly well for the test in certain cases. The fact that teacher recommendations became legally binding also means that the post-reform setting has less external validity since teacher and study counselor recommendations are typically not binding in most other settings.

Table 8: Effect of density on recommendations in the first post-reform year

	(1)	(2)	(3)	(4)	(5)
Log density	0.0292***	0.0290***	0.0216***	0.0230***	0.0218***
	(0.006)	(0.006)	(0.005)	(0.006)	(0.006)
N	115.033	115.033	115.033	95.509	57.930
R^2	0.54	0.54	0.56	0.55	0.57
Exit exam score	Yes	Yes	Yes	Yes	Yes
Indv. Characteristics	No	Yes	Yes	Yes	Yes
Family Characteristics	No	No	Yes	Yes	Yes
Movers excluded	No	No	No	Yes	Yes

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: Table displays the density estimates obtained by estimating equation 1 including the various control variables described in section 2 for the period 2014/2015. Column (5) excludes all children where there is some uncertainty over the education of one of the parents as discussed in section 3. Standard errors are clustered on the municipality level.

the reform. Although the CITO-group who provided the test in the baseline period remained the most popular primary school exit exam provider in the post-reform period, two new tests captured a substantial market share. To show that the results do not depend on the specific exit exam used to control for learning outcomes, Table E.3 in the appendix shows the estimations by exit exam provider. The urban-rural difference in teacher recommendations conditional on learning outcomes is similar across the three exit exams, highlighting that the results are not driven by any particular aspects of the primary school exit exam used in the preceding sections.

5 Mechanisms

An important question is what mechanisms can explain the less ambitious teacher recommendations provided to children in rural areas. In this section, I analyze six possible explanations: (1) the longer distances to schools in rural areas, (2) different types of primary schools in rural areas, (3) differences in local returns to education, (4) statistical discrimination, (5) within-school spillovers, and (6) differences in teacher quality and educational beliefs.

5.1 Distance to schools

One possibility to explain the lower recommendations is that secondary schools offering the academic track are less ubiquitous compared to schools offering the professional and vocational school tracks in rural areas. This suggests that students in rural regions on average face longer commuting distances. Even though this is not related to the academic performance of students, teachers may take such factors into account when deciding on their recommendations.

To investigate this possibility, I start by including controls for the distance to the nearest school that offers the academic track. The median distance to a school that offers the academic track is 2.5km, with the 90th percentile at 7.5km, reflecting the fact that distances to schools are relatively limited in this context. However, controlling for distance to schools leaves the density estimates virtually unaffected as shown in appendix Table C.2. Furthermore, the results in appendix Table C.3 show that the effects are similar even when restricting the sample to students who live in the same zip code as a secondary school offering the academic track, further suggesting that the findings are not driven by distance to schools.

5.2 Different primary school types

A second possibility is that the differences are a result of different types of primary schools operating in urban and rural regions. Most schools in the Dutch system are operated by private organizations with financing and conditions on the curriculum determined by the national government. A key differentiating characteristic of primary schools is their religious affiliation, with 34% of children attending a Roman-Catholic primary school, 30% attending a public primary school, and 24% attending a protestant primary school. The remaining 12% of students are spread across a variety of other categories. The share of religious schools is in practice higher in the countryside, which could affect the estimates if certain types of primary schools are structurally more or less likely to provide academic track recommendations.

To investigate this, appendix Table C.4 shows the estimates separately for Roman-Catholic primary schools, protestant primary schools, and public primary schools with a similar urban-rural gradient in the teacher recommendations within each school type. As such, the results do not reflect different types of primary schools in terms of religious affiliation that operate in urban and rural regions.

5.3 Differences in local returns to education

A third possibility is that teachers internalize the difference in returns to education across local labor markets and use this to guide students toward tracks. Research shows that the urban wage premium is higher for college-educated, which creates different returns to education depending on location (Davis and Dingel, 2019). The most relevant trade-off in this context is the return between having a university degree compared to an applied university degree, which corresponds to the decision of pursuing the academic or professional track in high school.

To construct returns to education at the local level, I use data on the annual tax returns for the full Dutch population. The returns to education are defined as the difference in annual earnings between those who have an academic degree and an applied university degree in the municipality of childhood residence. I focus on those between the ages 25 - 60 who earn at least the national minimum income to calculate the returns to education, with flexible controls for age and migration background. On average, university graduates earn about 26 logpoint more compared to applied university graduates. This somewhat depends on location, as university graduates in places at the 10th percentile of the density distribution earn 24.5 logpoints more than applied university graduates compared to 27.5 logpoints in the largest cities.

However, controlling for the local returns to education in practice has little effect on the main estimates. Controlling flexibly for the local returns to education in the place of residence, either in log points or in absolute amounts, has no detectable effect on the estimated effect of population density on teacher recommendations as shown in appendix Table C.5. As such, differences in the local returns to education do not appear to drive the differences in teacher recommendations between urban and rural locations.

5.4 Statistical discrimination

A fourth possibility is that the difference in teacher recommendations reflects statistical discrimination, with teachers in rural areas struggling to identify high-potential students given the relative scarcity. One way to investigate this possibility is to study the post-reform period. During this period, students first received the (legally binding) teacher recommendation and subsequently participated in the national primary school exit exam. When students performed substantially better on the exit exam than expected based on the teacher's recommendation, students had the right to request the school to revise its recommendation.
If it's the case that students receive lower recommendations due to statistical discrimination, then we would expect that updating occurs more frequently in rural regions when new (external) information arrives regarding the true ability of students. However, we see no evidence of this in practice. As shown previously, students are more likely to receive an academic track recommendation from teachers in urban areas. Furthermore, when investigating the effect of density on both the initial and final teacher recommendations, the effect of density is actually larger for the final recommendations as shown in Table 9. Thus, far from leveling the spatial playing field by providing new nationally comparable information, the arrival of this new information in practice increases the spatial differences in teacher recommendations.

The reason is that despite the significantly better initial recommendations in urban areas, teachers in urban areas are more likely to update their recommendations once new information arrives which contradicts their initial assessment. Table C.8 shows the effect of density on the likelihood of receiving a revised academic track recommendation among those who initially did not receive an academic track recommendation, but should qualify according to the exit exam score. Conditional on family characteristics and the primary school exit exam score, a one-log point increase in density raises the likelihood of receiving a revised academic track recommendation by 4.3pp. Figure C.4 shows the effect throughout

Table 9: Estimates of density on the initial and final recommendations

Teacher recommendation	Initial	Final
Log density	0.0278***	0.0293***
	(0.005)	(0.006)
N	530.486	530.486
R^2	0.56	0.58
Exit exam score	Yes	Yes
Indv. Characteristics	Yes	Yes
Family Characteristics	Yes	Yes

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: Table displays the density estimates obtained by estimating equation 1 including the various control variables described in section 2 for the period 2014 - 2019. Column (1) estimates the effect of density on the initial recommendations, released in February. Column (2) estimates the effect on the final recommendations, including revisions in response to better exit exam scores. Standard errors are clustered on the municipality level.

the density distribution, which reveals substantial non-linearities. In the largest cities, almost 30% of students receive an improved track recommendation following a better-than-expected exit exam performance, compared to fewer than 10% in rural areas. As such, it appears unlikely that statistical discrimination among teachers in rural areas explains the results.

5.5 Within school spillovers

A different possibility is that children in urban areas are more likely to benefit from positive spillovers due to higher SES peers. Since high-SES households are more likely to reside in cities, children in urban areas on average will have more advantaged peers. The spillovers may operate through a variety of channels, for instance if high-SES peers raise the aspiration levels in the classroom as shown by Cattan, Salvanes and Tominey (Forthcoming) in the context of Norway. Alternatively, the presence of highly educated parents may increase teacher recommendations by highlighting the importance of education to teachers, or simply through expected pressure if highly educated parents are more likely to "demand" that children receive an academic track recommendation.

To investigate this possibility, I examine the effect of having peers with university-educated parents within the school. In practice, there is substantial heterogeneity in the share of high-SES peers between primary schools. Schools at the 10th percentile of the distribution have 5.2% of children with at least one university-educated parent, whereas schools at the 90th percentile have 36.8% of children with at least one university-educated parent. To investigate the role of spillovers, I focus on the share of university-educated parents within the school. Table 10 shows the effect of controlling for parental composition at the school level. Controlling for the share of children with a university-educated parent within the school, either linearly or more flexibly, reduces the effect of density on teacher recommendations by 40%. This suggests that within-school spillovers due to higher-SES peers in cities may play an important role. The effect of controlling for the share of high SES students on the density gradient is similar for children from low and high SES backgrounds as shown in appendix Table C.6, suggesting that both groups benefit equally from the larger presence of high SES peers in cities.

The result appears to be primarily driven by the effect of high SES peers on teacher recommendations themselves. As discussed in more detail in the next section, children generally do not have better primary school exit exam scores conditional on SES background in urban environments. Controlling for the share of highly-educated parents within schools also leaves the density-test score gradient virtually unchanged as shown in appendix Table C.7, with a well-identified zero effect of population density on the primary school exit exam score. As such, the positive effects of the presence of high-SES peers in urban schools appear to mainly operate through higher teacher recommendations, rather than through better learning outcomes as measured by the exit exam score.

5.6 Differences in teacher quality and ambition

A final possibility is that the findings are driven by a different selection of teachers. Although the salaries for teachers are set through negotiations at the national level and large cities in particular report difficulties in attracting teaching staff, there

Table 10: Peer SES and the density gradient in teacher recommendations

	(1)	(2)	(3)
Log density	0.0186***	0.0108***	0.0109***
	(0.0064)	(0.0036)	(0.0037)
N	708.936	708.936	708.936
R^2	0.60	0.60	0.60
Exit exam score	Yes	Yes	Yes
Indv. & Family Characteristics	Yes	Yes	Yes
Share university educated parents	No	Linear	Flexible

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: Table displays the effect of estimating equation (1) on teacher academic track recommendations. Column (1) includes no school-level SES controls, column (2) includes a linear control for the share of parents that are university educated, column (3) includes a more flexible specification and adds a separate dummy for each 1 percentage point bin of highly-educated parents. The sample is restricted to primary schools that on average have between 12 and 90 students graduating per year between 2006 and 2014 to exclude very small and very large schools. Standard errors are clustered on the municipality level.

may nonetheless be a positive selection of teachers by ability into urban schools.[12] To investigate potential differences in teacher quality, I start by investigating whether teacher educational qualifications differ by density. Table 11 shows the results of regressing various indicators of educational outcomes among teachers on density. As can be seen from the first three columns, teachers in urban areas are not better qualified in terms of learning outcomes. Teachers in urban areas scored worse on the primary school exit exam, are not more likely to have received an academic track recommendation from their teachers, and do not have better grades upon high-school graduation if they attended the professional track that primary school teachers generally attend.

Furthermore, if teachers (or schools) in urban areas are generally of higher quality, then we would expect urban students to outperform rural students in terms of learning outcomes conditional on household characteristics. However, this is not

[12] See a report commissioned by the Ministry of Education regarding national teacher shortages. The share of unfilled positions in primary and secondary education is around twice as large in urban regions compared to rural areas. (Ecorys, 2020)

the case. Appendix Table C.9 shows that there is no effect of population density on average exit exam scores conditional on individual and household characteristics. Some differences are visible in the upper tails of the distribution. However, these differences are substantially smaller than the difference in the teacher recommendations, highlighting that differences in educational quality are unlikely to drive the differences in recommendations between urban and rural areas. Using the estimates from appendix Table C.9, it is possible to rule out that a one-log point increase in density increases the average test score by as much as 0.24 points, which is equivalent to 0.025 SD.[13]

Despite the evidence that teachers in urban areas are not necessarily better at improving student learning outcomes as measured by test scores, the evidence suggests that teachers in urban areas do have stronger beliefs in the importance of education. From the administrative data, we can study the educational choices of teachers. Despite having worse exit exam scores and similar recommendations compared to teachers in rural areas, teachers in urban areas are significantly more likely to have graduated from the academic high school track and subsequently to have completed a university degree as shown in columns 4 and 5 of Table 11. As such, urban teachers appear to have stronger beliefs in the importance of education as expressed through their educational choices. These differences are not driven by the spatial selection of teachers after graduation, as over 75% of primary school teachers work within 10km of their childhood place of residence, and the estimates are similar for those teachers as shown in appendix Table C.10.

This evidence regarding the stronger beliefs in the importance of educational investment among urban teachers is still somewhat indirect. To provide more direct evidence, I study the choices that primary school teachers make regarding the educational track enrollment of their children. Table 12 shows the effect of density on the academic track enrollment decisions among children of primary school teachers.[14] Teachers in urban areas are significantly more likely to enroll

[13]The same 0.025 SD limit applies when instead looking at the effect of density on the number of correct questions on the exit exam as shown in columns (3) and (4) of appendix Table C.9.

[14]I focus on those whose mother is a primary school teacher. While it's possible to also include fathers, the overwhelming majority (88%) of teachers in primary education are female. Furthermore, evidence suggests that mothers have a more prominent role in shaping the educational

Table 11: Relationship between density and teacher quality

	Exit exam score	Track recommendation	HS Grade	Academic track degree	University degree
Log density	-0.343**	0.00238	0.000	0.0186***	0.0298***
	(0.103)	(0.00751)	(0.009)	(0.005)	(0.005)
N	16.234	16.234	10.815	15.975	16.234
R^2	0.00	0.00	0.00	0.00	0.00
Mean	538.16	27.5%	6.60	11.3%	11%

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: Table displays the effect of density on teachers educational outcomes. Each observation represents one primary school teacher-year, with only teachers included who worked at least 50% of the time at their main affiliation and had a permanent contract in a given year. Teacher-school linkages are available for the period 2016 - 2022, which is the period also used for this table. Information on the primary school exit exam scores and teacher recommendations have only been available since 2006. This means that columns (1) and (2) are based on teachers employed in primary schools the period 2016 - 2022 but who graduated primary schools in the period after 2006, which is thus a relatively young sample reflecting entry into the profession. Columns (3) - (5) apply the same sample restrictions for consistency. Results are similar when using larger samples. For instance, we observe academic track and university completion for all teachers that graduated after 2005, with a similar urban-rural gradient in both outcomes for this larger sample. Standard errors are clustered on the municipality of residence.

their children in the academic track conditional on household characteristics and exit exam scores. Furthermore, this enrollment difference persists even conditional on the track recommendation that children received from their own teachers as shown in columns (3) and (4). Teachers in urban areas are significantly more likely to enroll their children in the academic track regardless of whether their children received an academic track recommendation or not. As such, teachers in urban areas not only provide more favorable recommendations to their students but also make more ambitious educational enrollment decisions regarding their own children.

While the evidence in this section is consistent with urban teachers having stronger beliefs in the importance of educational investment, it is hard to quantify the

outcomes of children (Rasmussen, Plug and Lundborg, 2024).

magnitude of this effect. The overwhelming majority of teachers do not obtain university degrees or have children in the age range during which we can observe educational choices, and we miss more fine-grained measures regarding the beliefs in education that cover the universe of teachers. As a result, it is difficult to construct a "revealed educational ambition" index for teachers at the school level. Thus, while the evidence suggests that urban teachers have stronger beliefs in the importance of educational investment as revealed through decisions in the personal domain, it is hard to pin down the exact magnitude of this mechanism in explaining the lower recommendations received by students in rural areas.

Table 12: Density and academic track enrollment among teachers' children

	(1)	(2)	(3)	(4)
Log density	0.0306***	0.0203***	0.00988**	0.0186***
	(0.005)	(0.003)	(0.005)	(0.003)
N	19.346	19.346	10.659	8687
R^2	0.47	0.50	0.24	0.29
Exit exam score	Yes	Yes	Yes	Yes
Indv. & Fam. Characteristics	No	Yes	Yes	Yes
Academic Track recommendation	-	-	No	Yes
Mean academic track enrollment	37.4%	37.4%	10.2%	70.8%

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: Table displays the effect of density on the probability of enrollment in the academic track. Sample restricted to children who graduated primary school between 2006 - 2014 and whose mother is observed working as a primary school teacher at any point between 2016 - 2022, which are the years covered by the teacher administrative data. Columns (1 - 2) include all children, column (3) only those without an academic track recommendation, and column (4) only those with an academic track recommendation. Academic track enrollment is based on enrollment in third grade, since enrollment statistics for the first two years of secondary school typically do not include track level. Standard errors are clustered on the municipality level.

5.7 Implications

Taken together, the findings suggest that the effect of density on teacher recommendations operates through the fact that cities feature the clustering of highly educated households, which leads to positive spillovers within schools. This is further reinforced by the fact that teachers in urban areas seem to attach more weight to educational investment, as evident in both their personal choices as well as the choices they make for their children.

The implications of the findings are an important point for discussion. On one hand, it is likely that the differences in teacher recommendations, particularly regarding the stronger beliefs in the importance of education, are partially a reflection of the environment in which they operate. Since the majority of primary school teachers work within 10 km of their childhood place of residence, this means that the less ambitious educational choices in their careers may reflect the general lower ambitions regarding educational attainment at the local level. As such, teachers could be considered just one example of the many potential actors from which children in rural areas receive less ambitious signals regarding their educational potential and opportunities.

At the same time, teachers are in a unique position to shape the educational trajectories of children. Teachers have the opportunity to provide a counterweight to the low educational expectations within a region or community and to provide a nationally consistent set of recommendations of possible educational pathways for students based on ability. Instead, teachers appear to internalize and reinforce the lower levels of educational investment in rural regions by providing less ambitious recommendations even for the brightest students in their region. This is particularly relevant since previous research shows that teaching staff recommendations and expectations have a strong causal effect on student outcomes (Carlana, 2019; Papageorge, Gershenson and Kang, 2020; Mulhern, 2023).

Finally, it is important to note that throughout the study, I define having received an academic track recommendation as being part of the option set presented to students by teachers. In practice, many teachers provide mixed recommendations to students as shown in Table 1. As such, the relevant margin in this study is not whether teachers unconditionally push students towards the academic track in urban and rural areas, which they may or may not desire to attend, but rather if it is included in the teacher recommendations as a potential trajectory at all. The difference in exclusive academic track recommendations between urban and rural areas is substantially larger and does not diminish along the observed ability distribution as shown in appendix C.1.

6 Quantifying the effects

The final question is how important the differences in teacher recommendations are in order to explain the observed spatial differences in academic track enrollment. One way to assess this is to compare the difference in academic track recommendations between urban and rural areas with the difference in academic track enrollment. Table 13 shows the effect of population density on academic track enrollment conditional on household characteristics and exit exam score. A one log point increase in density increases academic track enrollment by 1.65 pp. This is very similar to the baseline estimate of population density on teacher recommendations of 1.69 pp in Table 2. If we assume that students perfectly follow the teacher recommendations, then the difference in teacher recommendations fully explains the urban-rural academic track enrollment gap.

However, compliance with the non-binding teacher recommendations in practice will be imperfect and other factors may explain why rural students attend the academic track at lower rates. To investigate the degree to which teacher recommendations can explain the urban-rural enrollment gap, column (2) in table 13 controls for all possible combinations of exit exam score and teacher recommendations as part of the controls. In this case, the estimate compares the difference in academic track enrollment by density conditional on exit exam score and teacher recommendation. Controlling for teacher recommendations reduces the urban-rural enrollment gap by around 50%, highlighting that teacher recommendations may play an important role in explaining lower rates of academic track enrollment in rural regions.

One concern with this approach would be that teacher recommendations may be partially targeted toward student preferences. If teachers provide lower recommendations to students who signal that they do not intend to enroll in the academic track, and such students are more common in rural regions, then this approach may overestimate the importance of teacher recommendations.

Table 13: Teacher recommendations and the academic track enrollment gap

	(1)	(2)
Log density	0.0165***	0.00751***
	(0.0018)	(0.00095)
N	804.703	804.703
R^2	0.55	0.58
Exit exam score	Yes	Yes
Indv. & Family Characteristics	Yes	Yes
Teacher recommendations	No	Yes

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: Table displays the effect of estimating equation 1 on academic track enrollment. Academic track enrollment is measured 3 years after graduating from primary school. Around 3% of students are not observed as enrolled in any secondary school track, which likely reflects a combination of private school enrollment, enrollment in schools abroad, and enrollment in special needs schools. Standard errors are clustered on the municipality level.

A different approach is to use the fact that some schools generally seem to be more or less inclined to provide academic track recommendations to students beyond just the spatial dimension. In this case, we can estimate what happens to academic track enrollment if a student enrolls at a school that typically provides better track recommendations, conditional on exit exam scores, parental background, and the municipality of residence. Appendix D provides more detail on the estimation of the school-fixed effect in recommendations. As can be seen in appendix Table D.1, students who enroll at a school that is 1 pp more likely to provide an academic track recommendation based on other cohorts are 0.77 pp more likely to receive an academic track recommendation themselves (highlighting that the school-fixed effects do not just reflect statistical noise) and are 0.38 pp more likely to attend the academic track. This suggests that around half of the students who receive an academic track recommendation due to variations in teacher recommendation practices between schools within the same municipality end up following this recommendation.

As seen from the baseline estimates in Table 2, a one-log point increase in density is associated with a 1.7 pp increase in academic track recommendations. If we assume that also in this case half of the students follows the higher teacher recommendations, then we should expect the effect of density on academic track enrollment to decline by 0.85 pp once teacher recommendations are controlled for. This is similar to the actual reduction in the estimates observed in Table 13 when controlling for the recommendations. As such, using either the variation in teacher recommendations at the individual level as in Table 13, or using the variation in recommendations at the school level as outlined in appendix D, suggests that around half of the urban-rural gap in academic track enrollment can be explained by the less ambitious academic track recommendations provided by teachers in rural areas.

7 Conclusion and discussion

The findings of this paper show that large differences exist in the educational signals received by students depending on location. Using administrative data from the Netherlands, I show that the spatial variation in teacher recommendations is visible for all demographic groups, is not driven by the spatial selection of households, and is the strongest for students on the margin of admission to the academic track. The main drivers appear to be the clustering of highly educated households in cities which leads to positive spillovers on the recommendations for students, as well as the stronger beliefs in the importance of education among urban teachers. Quantitatively, around half of the spatial difference in academic track enrollment can be explained by the lower teacher recommendations in rural areas.

The findings of this paper have important implications for both research and policy. On the individual level, the paper shows evidence of a novel channel through which childhood location can affect educational choices. Previous studies have highlighted the impact of providing positive educational signals on educational investment among low-income households (Hoxby and Turner, 2015), low-SES households (Falk, Kosse and Pinger, 2020), girls in mathematics Carlana (2019), and immigrants (Carlana, La Ferrara and Pinotti, 2022). In this paper, I expand this literature to the spatial dimension and show that the less ambitious educational signals received by students in rural areas can explain a substantial part of the spatial variation in academic track enrollment.

The findings of this paper also have important consequences for regional inequality in the long run. Given the urban-rural divide in economic opportunities observed in many countries, the important role of educational attainment in driving regional economic growth (Gennaioli et al., 2013), and the finding that teacher recommendations and expectations have a causal effect on educational investment (Papageorge, Gershenson and Kang, 2020), the less ambitious teacher recommendations in rural areas may further exacerbate regional inequalities in the long run. This is particularly relevant as local economic fortunes matter beyond just the economic domain and has for instance been linked to political polarization.[15]

Finally, the paper has implications for the design of educational policies. Most of the attention regarding spatial variation in educational performance and school quality has been in the context of the US. This is partially due to the salience of local school financing structures studied for instance by Black (1999) and Biasi, Lafortune and Schönholzer (2025). In many European countries, including the Netherlands, the financing and governance of schools are organized at the state or national level, suggesting that local conditions should matter less for the opportunities provided to students. However, there are other mechanisms through which local conditions can affect schooling outcomes beyond just financing and standardized test scores. In this paper, I show the existence of such spatial variation in educational attainment and highlight one dimension that generates this variation: the differences in educational signals received by students in the form of teacher recommendations. At the same time, around half of the spatial variation in educational outcomes conditional on learning outcomes and household characteristics remains unexplained, which forms an important topic for future research.

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[15]Autor et al. (2020) for instance show the effect of declining regional economic fortunes on political polarization in the US, whereas Becker, Fetzer and Novy (2017) show that the Brexit vote support was concentrated in lower educated and 'left-behind' districts.

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Appendices

A Descriptive statistics on the recommendations from the test and teachers

The distribution of secondary school recommendations based on the primary school exit exam are shown in Table A.1. Recommendations for the lowest level of secondary school in practice are subdivided into three further sub-levels, but for the purpose of this study, I group these together since the focus is on admittance to the highest level of secondary school (the academic track). The exit exam scores are standardized within each year to correct for any potential differences in the item difficulty.

The secondary school track recommendations provided by the primary school

Table A.1: Primary school exit exam recommendations

Score on exit exam	School recommendation from test	% of students
545 - 550	Upper secondary school	19.05 %
537 - 544	Middle secondary school	31.86 %
500 - 536	Lower secondary school	49.09 %

Note: Distribution based on full distribution of students in the cohorts born between 1994 and 2002. The exit exam scores are standardized each year by the testing agency to adjust for minor differences in the difficulty of the test between years. The school recommendation from the exit exam follows directly from the score on the exit exam.

teachers are somewhat more complicated, since teachers can recommend multiple levels of secondary school in case they are uncertain about a student's ability or if they think a student is on the margin between two different levels. The distribution of the primary school recommendations for the baseline sample is shown in Table A.2. As can be seen, 14.36% of students receive a recommendation for the highest level of secondary school, with another 14.02% receiving a mixed recommendation of upper/middle secondary school. Finally, 1.51% of the students receive a highly mixed recommendation, with teachers describing all three levels of secondary school as potentially fitting.

Throughout the paper, I combine the first two recommendations (upper secondary

Table A.2: Secondary school track recommendations by teachers

School recommendation	% of students
Upper secondary school	14.36%
Upper secondary school/Middle secondary school	14.02%
Middle secondary school	15.09%
Middle secondary school/Lower secondary school	13.28%
Lower secondary school	41.74%
Upper secondary school/Middle secondary school/Lower secondary school	1.51%

Note: Distribution based on all students in the cohorts born between 1994 and 2002.

school and upper secondary school/middle secondary school) as having received an upper secondary school recommendation and treat this as the outcome of interest. A large share of the students receiving these recommendations subsequently enroll in an upper secondary school (85% of the students receiving a pure recommendation and 48% of the students receiving the mixed recommendation). I do not include cases in which students receive a recommendation for all three school types in the outcome of interest since this recommendation is highly targeted, and only 11% of the students receiving this recommendation subsequently enroll in the academic track. However, the results are similar when only focusing on the pure upper secondary school recommendations as furhter discussed in appendix C.1.

B Sample construction and descriptive statistics

B.1 Sample construction

Table B.1 below shows the sample restrictions and their effect on the number of observations. As mentioned in section 2, I restrict the analysis to individuals born in The Netherlands between 1994 and 2002, which are 1.8 million individuals. I further restrict the sample to those individuals whose primary school exit exam score is available from Statistics Netherlands. The exit exam was not mandatory during this period, although around 85% of schools participated during this period, which means that we observe the test score for most students.[16]

[16]Note that the eventual drop in observations is larger than 15%. 45.000 student participated in the exit exam after 2014 and are thus excluded from the baseline sample. Furthermore,

The next step is to restrict the sample to those for whom the teacher recommendations are observed. The teacher recommendations have not been reported by schools to Statistics Netherlands for around 25% of the students, which is distributed evenly across years and primary school exit exam scores. Rural schools are somewhat more likely to choose not provide their recommendations to Statistics Netherlands. However, this selection is not related to student achievement as controlling for the primary school exit exam scores leaves the relationship between density and the likelihood of missing the recommendation completely unaffected. Hence, while we do not observe the teacher recommendations for all students and unobserved recommendations are somewhat more common in rural areas, the missing recommendations do not appear to be linked to student performance.
Finally, I impose some minor restrictions on the sample such as the condition that both parents are identified, that we can link the children to an address, that parents do not have more than eight children, and that both parents are adults at the time of birth. These restrictions do not result in any substantial losses in observations. The final sample consists of 829.343 individuals.

Table B.1: Sample selection

Restriction	No. of obs
Individuals born between 1994 - 2002 in the Netherlands	1,795,917
Both parents identified and fewer than 8 children	1,710,554
Observe a primary school exit exam score between 2006 - 2014	1,135,537
Observe teacher recommendations	851,355
Observe place of residence in the last year of primary school	830,555
Both parents adults at time of birth	829,343
Final Sample	829,343

B.2 Descriptive statistics for baseline sample

Table B.2 below shows the descriptive statistics of this core sample.

statistics Netherlands can only collect information on test scores if the schools agree that the information on their students can be shared with Statistics Netherlands, which means that some scores are unobserved. This changed following a reform in 2014 when the ministry of education started directly collecting the data on the test scores, since participating in an approved national primary school exit exam became a legal requirement for primary schools.

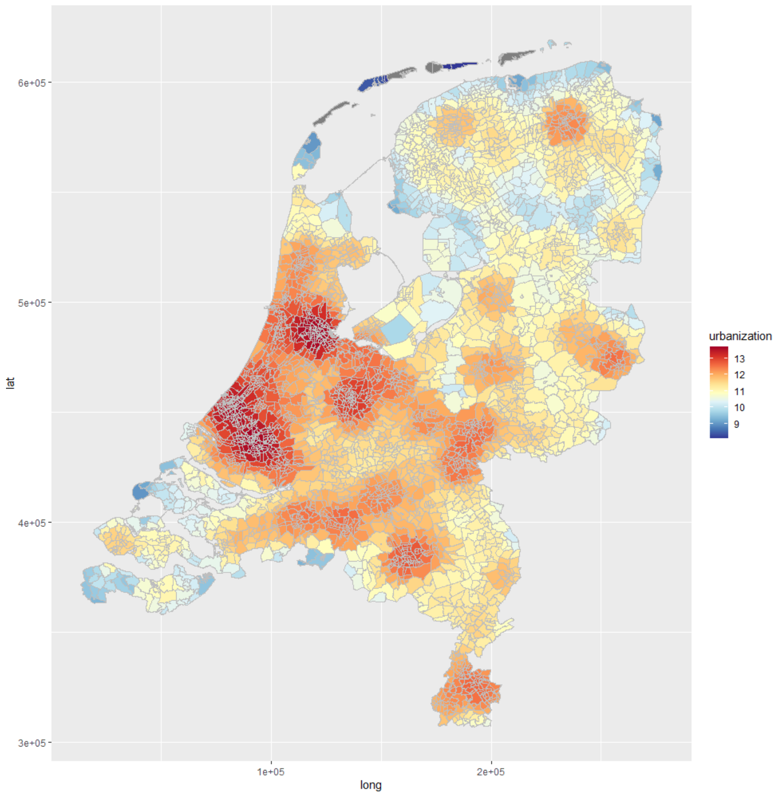
Table B.2: Descriptive statistics

Variable	N	Mean	St. Dev	p1	p99
Academic track recommendation					
From primary school teaching staff	829,343	0.284	0.453	0	1
From primary school exit exam	829,343	0.190	0.392	0	1
Individual characteristics					
Birth year	829,343	1997.914	2.54	1994	2002
Female	829,343	0.502	0.499	0	1
Birth order within household	829,343	1.775	0.971	1	5
Primary school exit exam score	829,343	535.454	9.629	510	550
Household characteristics					
Log population density	829,343	12.137	0.877	10.08	13.65
Migration background	829,343	0.197	0.397	0	1
Log parental income	829,343	10.450	0.939	8.70	11.85
Missing parental income	829,343	0.0017	0.0415	0	0
Censored parental income	829,343	0.0010	0.0327	0	0
Negative parental income	829,343	0.0022	0.0469	0	0
University educated parent	829,343	0.326	0.468	0	1
Parental education	829,343	121.656	114.534	1	336
Age oldest parent at birth	829,343	33.762	5.024	23	48

Note: Due to the confidential nature of the administrative data it is not possible to show minimum and maximum values. Hence the first and ninety-ninth percentiles are displayed instead. Regarding the academic track recommendations, the exit exam provides only a single recommendation, whereas teachers can provide a mixed track recommendation. This explains why more children have an academic track recommendation in case of the teacher recommendations. See appendix A for more details on the recommendations.

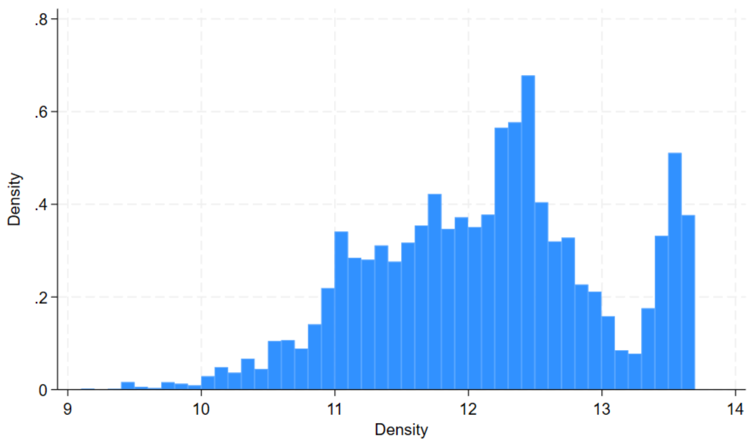
B.3 Density measure

Figure B.1: Map of density measure



Note: Density measure based on the log population within a 10 kilometer radius on the zip code of residence at age 11. Area's with extremely low density (< 8) are displayed in grey.

Figure B.2: Distribution of density measure



Note: Histogram of the density measure based on the log population within a 10 kilometer radius on the zip code of residence at the start of the final year of primary school.

Table B.3: Effects of density and household characteristics

Panel A: all children				
	(1)	(2)	(3)	4)
Log density	0.0219***			
	(0.00334)			
Female		0.00288***		
		(0.00070)		
Migration background			-0.00265	
			(0.00475)	
University educated Parent				0.0563***
				(0.00176)
N	829.343	829.343	829.343	829.343
R^2	0.55	0.55	0.55	0.55
Conditional on test score	Yes	Yes	Yes	Yes

Panel B: children on margin of admission to the academic track				
	(1)	(2)	(3)	4)
Log density	0.0542***			
	(0.00798)			
Female		0.0109***		
		(0.00245)		
Migration background			-0.0143	
			(0.0156)	
University educated Parent				0.108***
				(0.00402)
N	168.358	168.358	168.358	168.358
R^2	0.07	0.07	0.06	0.08
Conditional on test score	Yes	Yes	Yes	Yes

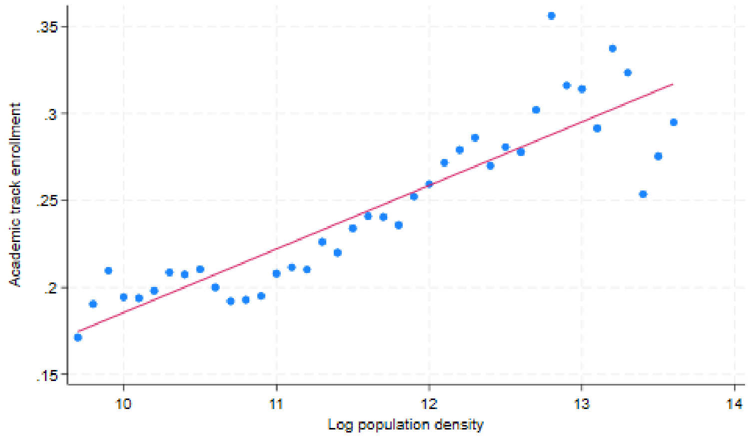
Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: Table displays the effect of density and three individual characteristics on teacher recommendations. Panel A shows the effects for all children, whereas panel B conditions on children having an exit exam score of 540 - 544. The controls for the test score are flexible, with a separate dummy included for each possible score. Migration background is defined as having at least one parent born outside of the Netherlands. A child is consider having a university educated parent if at least one parent obtained a university or applied university degree. Standard errors are clustered on the municipality level.

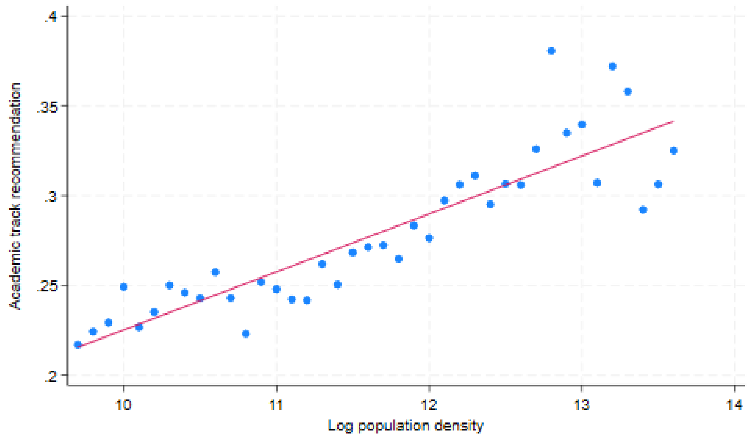
B.4 Descriptive statistics on urban-rural educational differences

Figure B.3: Relationship between density and academic track enrollment



Note: Figure displays the likelihood of attending academic track for the baseline sample by density. Population density is measured at the start of the final school year in line with the baseline density measure discussed in the main text. Bins with fewer than 500 observations are not displayed since they are fairly noisy.

Figure B.4: Relationship between density and academic track recommendations



Note: Figure displays the likelihood of receiving an academic track recommendation from teachers for the baseline sample by density. Population density is measured at the start of the final school year in line with the baseline density measure discussed in the main text. Bins with fewer than 500 observations are not displayed since they are fairly noisy.

Table B.4: Urban-rural academic track enrollment gap

	(1)	(2)
Log density	0.0377***	0.0275***
	(0.0064)	(0.0024)
N	804.703	804.703
R^2	0.01	0.50
Exit exam score controls	No	Yes

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: Table displays the effect of regressing academic track enrollment on density. Academic track enrollment is measured 3 years after graduating from primary school. Around 3% of students are not observed in any secondary school track, which likely reflects a combination of private school enrollment, enrollment in schools abroad and enrollment in special needs schools. Exit exam controls consists of a separate dummy each possible exit exam score by test year. Standard errors are clustered on the municipality level.

Table B.5: Urban-rural academic track enrollment gap in the post reform period

	(1)	(2)
Log density	0.0483***	0.0399***
	(0.0057)	(0.0047)
N	400.976	400.976
R^2	0.01	0.48
Exit exam score controls	No	Yes

Standard errors in parentheses

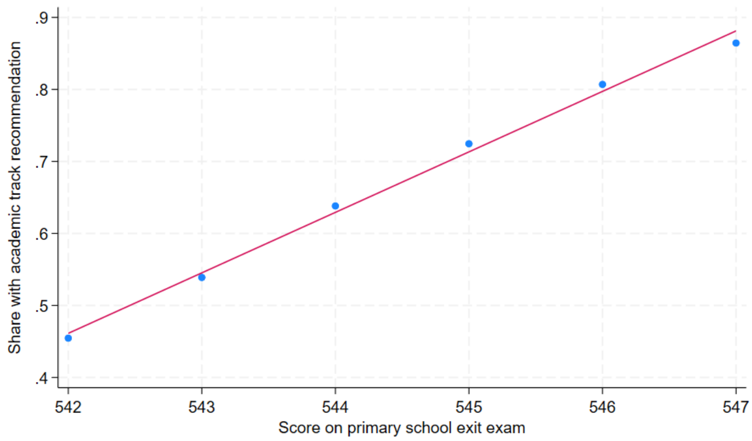
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: Table displays the effect of regressing academic track enrollment on density for the post reform period (i.e., the school years 2014/2015 - 2018/2019). Academic track enrollment is measured 3 years after graduating from primary school. Around 3% of students are not observed in any secondary school track, which likely reflects a combination of private school enrollment, enrollment in schools abroad, and enrollment in special needs schools which are unobserved. Exit exam controls consists of a separate dummy each possible exit exam score by test year. Standard errors are clustered on the municipality level.

B.5 Teacher recommendations around the academic track threshold

One concern is that teachers may observe the primary school exit exam when they construct their recommendations, and simply follow the recommendation of the test. To investigate if this is a concern, figure B.5 shows how the likelihood of an academic track recommendation develops around the threshold of 545, which would result in a recommendation for the academic track based on the exit exam score (see appendix A for more detail). There is no discrete jump of any kind visible in the teacher recommendations around the threshold of 545, suggesting that teachers are not simply following the recommendation of the primary school exit exam when constructing their recommendations. The same result holds when using the discontinuity based on the required number of correct questions required to get a score of 545 (not separately shown here).

Figure B.5: Relationship between academic track recommendations and exit exam scores around the threshold of the academic track



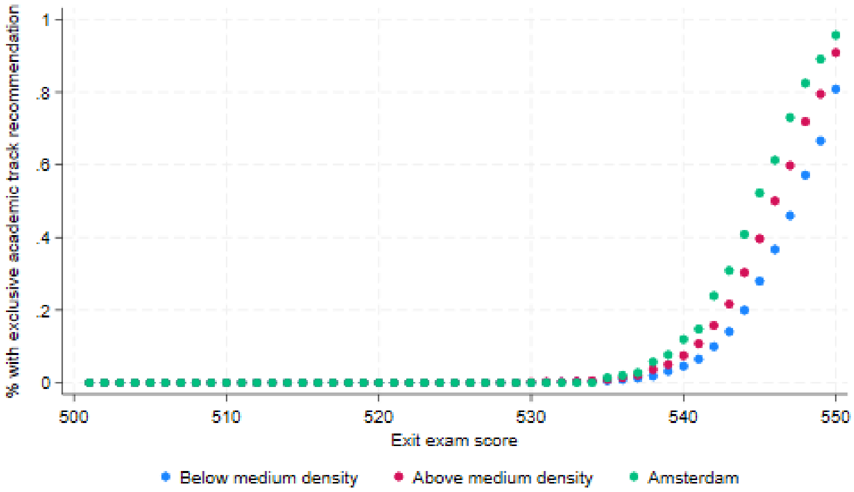
Note: Figure displays the likelihood of receiving an academic track recommendation from teachers for the baseline sample by the exit exam score for the scores around the threshold. The threshold for an academic track recommendation based on the test is 545 (see appendix A).

C Additional results

C.1 Excluding mixed recommendations

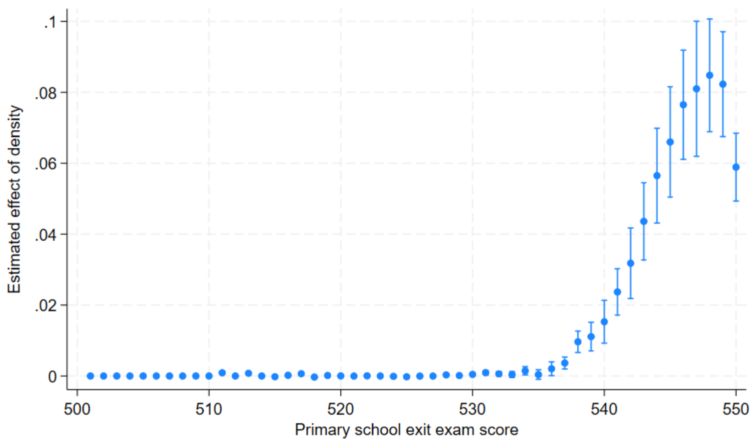
The baseline results are based on combining both the "pure" academic track recommendation and the mixed upper/middle secondary school recommendations shown in table 1. This section presents the results when analyzing whether a student exclusively received a recommendation for the academic track.

Figure C.1: Urban-rural gap in academic track recommendations by teachers



Note: Figure displays the share of students receiving an academic track recommendation for rural students (in blue) and urban students (in red). Dependent variable is whether a student received an exclusive upper secondary school recommendation (thus excluding the mixed upper/middle secondary school recommendations discussed in appendix A). The sample is split evenly by the median population density of the place of residence. Amsterdam included in green for comparison.

Figure C.2: Effect of density on exclusive academic track recommendations



Note: Figure displays the density estimates obtained by estimating equation 1 separately for each primary school exit exam score. Dependent variable is whether a student received an exclusive upper secondary school recommendation (thus no longer counting the mixed upper/middle secondary school recommendations as having received an academic track recommendation). The full set of individual and household controls are included in all regressions.

Table C.1: Effect of density on teacher recommendations exclusively for the academic track

	(1)	(2)	(3)	(4)	(5)
Log density	0.0261***	0.0264***	0.0220***	0.0221***	0.0229***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
N	829.343	829.343	829.343	682.730	360.507
R^2	0.47	0.47	0.48	0.47	0.50
Exit exam score	Yes	Yes	Yes	Yes	Yes
Indv. Characteristics	No	Yes	Yes	Yes	Yes
Family Characteristics	No	No	Yes	Yes	Yes
Movers excluded	No	No	No	Yes	Yes

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: Table displays the density estimates obtained by estimating equation 1 including the various control variables described in section 2. The outcome variable is whether the student received an unambiguous recommendation for the academic track, excluding all mixed recommendations. Column (5) excludes all children where there is some uncertainty over the education of one of the parents as discussed in section 3. Standard errors are clustered on the municipality level.

C.2 Controlling for distance to schools

To control for distance to schools, I calculate the distance from the home zip code at the start of the final year of primary school to the nearest secondary schools offering the academic track, with the school locations and track offerings included in the administrative data. The fourth column includes a linear distance measure (km to nearest schools), whereas the fifth column more flexibly controls for distance to schools in 1-kilometer bins. As can be seen from table C.2, the distance to schools offering the academic track are not driving the differences in teacher recommendations between urban and rural areas, with no significant difference in the estimated effects.

Table C.2: Estimations while controlling for distance to schools

	(1)	(2)	(3)	(4)	(5)
Log density	0.0233***	0.0235***	0.0169***	0.0159***	0.0165***
	(0.006)	(0.003)	(0.003)	(0.006)	(0.004)
N	829.343	829.343	829.343	829.343	829.343
R^2	0.55	0.55	0.56	0.56	0.56
Exit exam score	Yes	Yes	Yes	Yes	Yes
Indv. Characteristics	No	Yes	Yes	Yes	Yes
Family Characteristics	No	No	Yes	Yes	Yes
Linear distance controls	No	No	No	Yes	No
Dummy distance controls	No	No	No	No	Yes

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: Table displays the density estimates obtained by estimating equation 1 including the various control variables described in section 2. Column (4) controls for the distance to a school offering the academic track in km in a linear fashion, whereas column (5) flexibly controls for distance to schools in 1km bins. Standard errors are clustered on the municipality level.

Table C.3: Estimations for children living in same neighborhood as a secondary school offering the academic track

	(1)	(2)	(3)	(4)	(5)
Log density	0.0238***	0.0240***	0.0175***	0.0177***	0.0190***
	(0.006)	(0.006)	(0.005)	(0.005)	(0.004)
N	181.983	181.983	181.983	151.714	86.134
R^2	0.57	0.57	0.58	0.58	0.60
Exit exam score	Yes	Yes	Yes	Yes	Yes
Indv. Characteristics	No	Yes	Yes	Yes	Yes
Family Characteristics	No	No	Yes	Yes	Yes
Movers excluded	No	No	No	Yes	Yes

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: Table displays the density estimates obtained by estimating equation 1 including the various control variables described in section 2. Column (5) excludes all children where there is some uncertainty over the education of one of the parents as discussed in section 3. Sample restricted in all columns to children living in the same 4-digit zipcode (average size: 11km^2) as a secondary school offering the academic track. Standard errors are clustered on the municipality level.

C.3 Results by primary school type

The data on the post-reform period (2015 - 2019) also includes information on the religious affiliation of the primary school which children attend. This data is collected for all primary schools and available for the universe of children whom graduated primary school from 2015 onward. To investigate whether the urban-rural teacher recommendations are driven by different recommendation practices, with certain types of schools being more or less prevelant in urban areas, table C.4 below repeats the analyses for the three major school types. The first column present the results for Roman-catholic primary schools (34% of children), the second column for public primary schools (30% of students), and the third column for protestant primary schools (24% of children). The urban-rural differences are similar to the main estimate for the post-reform period shown in appendix table E.1 in all three cases, with fairly similar point estimates. As such, the results are not driven by different types of primary schools operating in urban and rural areas

Table C.4: Estimates by primary school type

	(1)	(2)	(3)
Log density	0.0254***	0.0298***	0.0241***
	(0.0028)	(0.0030)	(0.0026)
N	278.876	244.204	196.074
R^2	0.54	0.54	0.53
Exit exam score	Yes	Yes	Yes
Indv. Characteristics	Yes	Yes	Yes
Family Characteristics	Yes	Yes	Yes
Primary school type	Roman-Catholic	Public	Protestant

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: Table displays the density estimates obtained by estimating equation 1 including the various control variables described in section 2. Column (1) shows the estimate for Roman-Catholic primary schools, column (2) for public primary schools and column (3) for protestant primary schools. The period is based on the years 2014 - 2019. Controls are included for the score on the relevant exit exam. Similar results are obtained when restricting attention to schools that continued using the test provider that we also use in the pre-reform period, which continued to have a market share of more than 67% in this period. Standard errors are clustered on the municipality level.

C.4 Local returns to education

One possibility is that teachers provide worse recommendations in rural areas since the local returns to education are lower. To investigate this, I use the earnings data from the income taxes for all individuals between ages 25 - 60 between the years 2005 - 2014 who earn at least the national minimum wage in a given year. To increase precision of the estimates at the local level, I pool the years and estimate a single returns to education measure for each municipality.

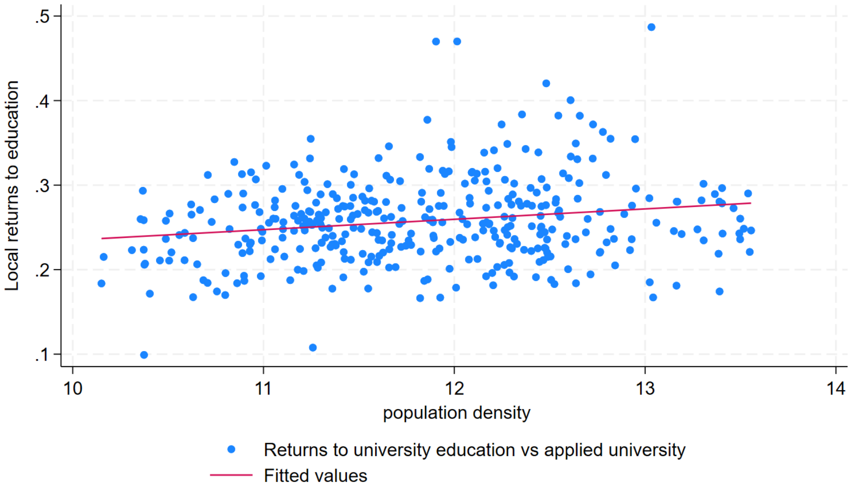
Since the labor composition somewhat differs between municipalities, and for instance age and migration background are both related with earnings as well as educational attainment, I flexibly include an interaction of country of origin $*$ age $*$ year as fixed effect. As such, the local returns to education estimate compare individuals within the same year, age, country of origin, and municipality.

Since the main decision for teachers is whether to recommend an academic track (with the professional track as the typical outside option for those for whom the academic track is considered), I focus on the local returns of having an academic university degree vs a professional applied university degree. Across all municipalities, university graduates on average earn 27.1 logpoints more compared to applied university graduates. Thus estimate ranges between 21 to 35 log-points among the municipalities at the 10th and 90th percentile.[17] Figure C.3 below shows the estimated returns to education for the 388 municipalities. While the local returns to education correlate with population density, as a one-log point increase in density increases local returns to education by 1.1 percent, most of the variation in returns to education exists across municipalities with similar population density.

To assess the impact of local returns to education on teacher recommendations, I flexibly control for the local returns to education and include separate dummies for each 1-percent bin. Table C.5 below shows the effect of controlling for the local returns to education. Controlling for the local returns to education does not materially affect the estimates as shown in column (2), and if anything, slightly increases the effect of density. The results is similar when controlling for returns to education in levels rather than in percentages as shown in column (3). As such, differences in local returns to education are not driving the main effects.

[17] One concern would be that these estimates pick up a lot of noise. In practice, since we use data on the full working-age population in each municipality over a 10 year period, the standard errors in the estimates are relatively small and vary between 0.5 - 1.0 logpoints. This means that most of the spread between the municipalities at the 10th and 90th percentile reflects differences in actual earnings between university and applied university graduates, rather than noise.

Figure C.3: Returns to education by municipality



Note: Figure displays the local returns to education at the municipality level, based on the difference in income between those with a university and applied university degree, corrected for differences in age, year, and migration background. See the accompanying text in appendix section C.4 for more detail on the underlying sample.

Table C.5: Effect of controlling local returns to education on baseline estimates

	(1)	(2)	(3)
Log density	0.0168***	0.0178***	0.0173***
	(0.0030)	(0.0026)	(0.0028)
N	829.343	829.343	829.343
R^2	0.56	0.56	0.56
Exit exam score	Yes	Yes	Yes
Indv. Characteristics	Yes	Yes	Yes
Family Characteristics	Yes	Yes	Yes
Local returns to education	No	In prct.	In levels

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: Table displays the density estimates obtained by estimating equation 1 including the various control variables described in section 2. Column (2) includes local returns to education defined as the difference in average earnings of university graduates vs applied university graduates on the municipality level, while controlled for age, year, and migration background. See text for more detail. Column (3) include the local returns to education in levels, with a separate bins for each 100 euros difference in average earnings. The average difference in earnings between people with a university and applied university degree is 1650 euro a month, with a 10 - 90 percent range at the local level of 1300 - 2100 euro. Standard errors are clustered on the municipality level.

C.5 Effects of school SES composition

Table C.6: Effect of school SES composition on teacher recommendations by SES group

University-educated parent?	No		Yes	
	(1)	(2)	(3)	(4)
Log density	0.0330***	0.0207***	0.0393***	0.0234***
	(0.0056)	(0.0052)	(0.0050)	(0.0051)
N	200.695	200.695	85.889	85.889
R^2	0.25	0.26	0.24	0.25
Exit exam score	Yes	Yes	Yes	Yes
Indv. & Family Characteristics	Yes	Yes	Yes	Yes
Controls for share of university educated parents	No	Yes	No	Yes

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: Table displays the effect of estimating equation (1) on teacher academic track recommendations. Columns (1 and 3) include no school-level SES controls, whereas columns (2 and 4) include a flexible specification that adds a separate dummy for each 1 percentage point bin of university educated parents in the school. The sample is restricted to primary schools that on average have between 12 and 90 students graduating per year between 2006 and 2014 to exclude very small and very large schools. Columns (1 - 2) show the effects for children with without a university-educated parent, whereas columns (3 - 4) show the effects for children with at least one university parent. Similar to table 3 in the main text, I restrict attention to children with a score of at least 540 to avoid including children with a very low probability of receiving an academic track recommendation. The 40% decline in coefficients remains the same in the unconditional regression, although the level is substantially lower for children from low-SES parents due to the difference in test score distribution between high- and low- SES parents. Standard errors are clustered on the school level.

Table C.7: School SES composition and test scores

	(1)	(2)	(3)
Log density	0.0110	-0.0594	-0.0398
	(0.0789)	(0.0732)	(0.0636)
N	708.936	708.936	708.936
R^2	0.60	0.60	0.60
Indv. & Family Characteristics	Yes	Yes	Yes
Share university educated parents controls	No	Linear	Flexible
Mean test score	535.75	535.75	535.75
SD test score	9.51	9.51	9.51

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: Table displays the effect of estimating equation 1 on primary school exit exam scores. Column (1) includes no school SES-controls, column (2) includes a linear control for the share of parents that are university educated, and column (3) includes a more flexible specification and adds a separate dummy for each 1 percentage point bin of highly-educated parents. The sample is restricted to schools that have between 12 to 90 students graduating per year between 2006 and 2014 to exclude both very small and very large primary schools. Standard errors are clustered on the municipality level.

C.6 Density and recommendation upgrading

Table C.8 investigates the relationship between population density and recommendation upgrading among those who initially did not receive an academic track recommendation from their teachers, but did have the primary school exit exam score that indicates suitability for the academic track. Children within this group had the legal right to request the school to reconsider its recommendation in the light of the exit exam score, although only 12% of this group in the end received an improved (legally binding) teacher recommendation. As shown in table C.8, this average of 12% hides substantial spatial heterogeneity. A one-log point increase in population density increases the likelihood of received a revised teacher recommendation by 4.3pp.

Figure C.4 further investigates this spatial heterogeneity and plots the likelihood that the recommendation is upgraded (y-axis) by population density (in 0.2 log point bins). The figure shows substantial heterogeneity, with children living in largest cities being well over three times as likely to receive an improved teacher recommendation for the academic track compared to children in rural areas.

Table C.8: Population density and likelihood of teacher recommendation revision.

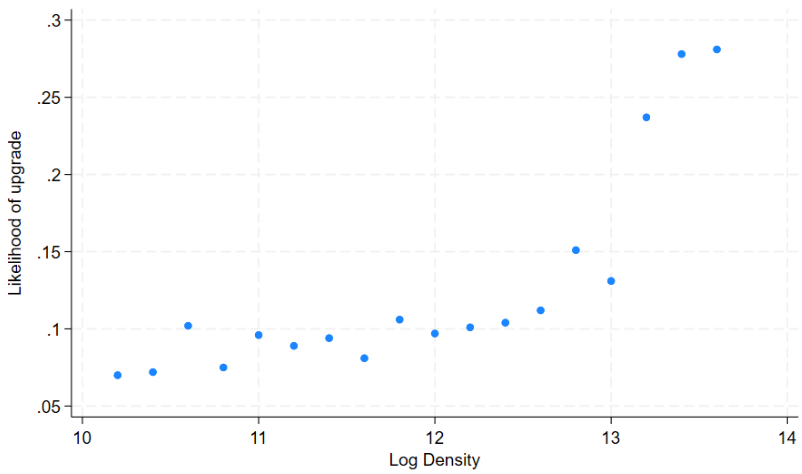
	(1)
Log density	0.0432***
	(0.0087)
N	55.977
R^2	0.09
Exit exam score	Yes
Indv. Characteristics	Yes
Family Characteristics	Yes

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: Table displays the density estimates obtained by estimating equation 1 including the various control variables described in section 2 on the likelihood of receiving an revised teacher recommendation for the academic track. The sample includes those who initially did not receive an academic track recommendation from the teachers, but did have an primary school exit exam score that suggested they should be in the academic track. Standard errors are clustered on the municipality level.

Figure C.4: Density and recommendation upgrading



Note: Figure based on children that received a primary school exit exam score that would indicate an academic track recommendation, but that did not initially receive an teacher academic track recommendation. The y-axis shows the share of students whom receive an revised teacher recommendation for the academic track, by density bins (x-axis). Individuals are group in bins based on the density of their place of residence, with a bin-width of 0.2. Bins with fewer than 500 observations are not displayed.

C.7 Differences in exit exam scores between urban and rural regions

Table C.9: Effect of density on exit exam scores

	Exit exam score		Correct answers		P(exam score $\geq$ 545)	
Log density	0.094	0.11	0.300	0.324	0.0128**	0.0069*
	(0.20)	(0.065)	(0.529)	(0.179)	(0.0046)	(0.0027)
N	829.343	829.343	829.343	829.343	829.343	829.343
R^2	0.00	0.20	0.01	0.21	0.00	0.10
Indv. Characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Family Characteristics	No	Yes	No	Yes	No	Yes
Mean outcome	535.45	535.45	146.47	146.47	19.1%	19.1%
SD outcome	9.62	9.62	26.93	26.93	0.39	0.39

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: Table displays the density estimates obtained by estimating equation 1 on the exit exam score itself. Columns (1 - 2) estimate the effect of density on the average test scores, columns (3 - 4) the effect of density on the number of correct answers on the 200 questions, and columns (5 - 6) estimate the effect of density on the likelihood of getting a score of at least 545 that corresponds to a recommendation for the academic track according to the primary school exit exam (see appendix A). Standard errors are clustered on the municipality level.

C.8 Differences in teacher characteristics - local teachers

Section 5.6 shows the differences in educational background between all teachers in urban and rural areas. One concern is that these differences may be driven by spatial selection. In practice, primary school teachers are not particularly mobile, with 76% of the primary school teachers living within 10km of their childhood municipality of residence as measured at the end of primary school. Table C.10 shows how the educational background of teachers and density hangs together for this set of teachers. The estimates are very similar compared to the full sample of teachers discussed in the main text, highlighting that the results in the main text are not driven by the spatial selection of teachers after completing their education.

Table C.10: Relationship between density and teacher quality - local teachers

	Exit exam score	Track recommendation	HS Grade	Academic track degree	University degree
Log density	-0.498**	-0.004	0.0097	0.0135***	0.0205***
	(0.116)	(0.00826)	(0.0104)	(0.0056)	(0.0055)
N	12.917	12.917	8.640	12.714	12.917
R^2	0.00	0.00	0.00	0.00	0.00
Mean	538.16	27.5%	6.60	11.3%	11%

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: Table displays the effect of density on teachers educational outcomes. Sample restricted to primary school teachers living within 10km of their childhood place of residence (76% of primary school teachers). Each observation represents one primary school teacher-year, with only teachers included who worked at least 50% of the time at their main affiliation and had a permanent contract in a given year. Teacher-school linkages are available for the period 2016 - 2022, which is the period also used for this table. Information on the primary school exit exam scores and teacher recommendations have only been available since 2006. This means that columns (1) and (2) are based on teachers employed in primary schools the period 2016 - 2022 but who graduated primary schools in the period after 2006, which is thus a relatively young sample reflecting entry into the profession. Columns (3) - (5) apply the same sample restrictions for consistency. Results are similar when using larger samples. For instance, I observe academic track and university completion for all teachers that graduated after 2005, with a similar urban-rural gradient in both outcomes for the larger sample. Standard errors are clustered on the municipality of residence.

D Do teacher recommendations matter?

An important question highlighted in section 6 is whether the teacher recommendations in this setting matter. As mentioned in the main text, the teacher recommendations were not nearly as important as the exit exam scores for high school track admissions during the 2006 - 2014 period and were mainly intended to guide students. To investigate whether the recommendations nonetheless affected student choices, I estimate the effect of enrolling in a primary school which is more generous with its recommendations conditional on student ability, municipality, and parental characteristics of the students. The primary school enrollment decision is made when a child is six years old and when parents may presumably still have limited information about the abilities of their child, as well as the policy of schools with respect to constructing the recommendations at age twelve.

To investigate the effect of attending a school which is more generous with its recommendations, I estimate the school-fixed effects from a regression on teacher recommendations. Equation 2 is estimated for all students and I calculate the average residual by primary school. When estimating equation 2, I exclude all students in the same graduation cohort and obtain the school-fixed effects from the students in the other school years. To avoid identifying off the same urban-rural gradient as in the main analyses, I include a municipality-fixed effect, so that the school-fixed estimates obtain from equation 2 reflect variation in teacher recommendation practices between schools in the same municipality.

$$\begin{aligned}\text{Teacher recommendation}_i = \alpha + \beta_1 * \text{individual characteristics}_i + \\ \beta_2 * \text{household characteristics}_i + \beta_3 * \text{cognitive ability measure}_i \\ + \beta_4 \text{municipality}_i + \epsilon_i \quad (2)\end{aligned}$$

One possibility is that all schools follow the same practices, in which case the school-fixed effects obtained from equation 2 purely resemble statistical noise. However, the school-fixed effect estimates are in practice quite informative. Students who attend a school where students in other cohorts are 1 pp more likely to receive an academic track recommendation are themselves 0.77 pp more likely to receive an academic track recommendation as shown table D.1. Furthermore, students who attend a primary school that provided better recommendations are 0.38 pp more likely to attend the academic track in third grade, 0.31 pp more likely to graduate from the academic track, and 0.28 pp more likely to enroll in university. The decline in estimates over the educational career are in line with general drop-out rates from the academic track and the diversion of students from the academic track to applied universities (see Figure 1), highlighting that these students were not misplaced.

While the analyses does not provide causal evidence of teacher recommendations on track enrollment, since schools that are more likely to offer academic track recommendations may also differ on other dimensions, it nonetheless provides strong suggestive evidence that the teacher recommendations affect student outcomes. In particularly the coefficients are quite informative. Conditional on family characteristics and the primary school exit exam score, a 0.77 pp increase in the likelihood of receiving an academic track recommendation leads to a 0.38 pp increase in the likelihood of academic track enrollment, which implies that students follow the teacher recommendations in about half of the cases. This is very close in line to the estimates based on individual variations in teacher estimates conditional on exit exam scores as discussed in section 6 of the main text.

Table D.1: Effect of attending a school which provides higher recommendations

	Academic Track recommendation	Enrolled in Academic Track third year	Graduated Academic Track	Enrolled in University
School-FE estimate	0.771***	0.383***	0.312***	0.284***
	(0.003)	(0.018)	(0.017)	(0.015)
N	453.181	453.181	453.181	453.181
R^2	0.58	0.53	0.49	0.42
Exit exam score	Yes	Yes	Yes	Yes
Indv. Characteristics	Yes	Yes	Yes	Yes
Family Characteristics	Yes	Yes	Yes	Yes

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: Table displays the effects of attending a school that is 1 pp more likely to provide students with an academic track recommendation than would be expected based on the exit exam scores and SES-composition. Secondary school enrollment and university enrollment are obtained from the educational registers. University enrollment is measured as being enrolled at university anytime between 7 and 9 year after completing primary school. I limit the sample to schools with not more than 90 students per cohort, since schools above this likely consist of multiple separate locations. In addition, the sample is limited to primary schools that have on average 20 or more students graduate per year between 2006 and 2014 to avoid too much noise in the school-fixed effect estimates. Including smaller schools scales all coefficients by approximately 0.7 as the school-fixed effect estimates are substantially noisier for the smaller schools. Crucially, the ratio of the effect on recommendations to enrollment (i.e., column (1) to (2)) remains unaffected when small schools are included. All standard errors are clustered on the municipality level.

E Post-reform period

E.1 Post-reform period estimates

As discussed in the main text, the Dutch educational system changed substantially in the 2014/2015 school year. In the post-reform period the teacher recommendations became legally binding, whereas the primary school exit exam score can now only be used by parents to request schools to revise their original recommendation. Furthermore, the teacher recommendations in the post-reform period are now constructed and communicated to students in February, whereas the primary school exit exam is not conducted until April. The reform also enabled various other testing agencies to develop their own primary school exit exam. The original test provider (CITO) remained the dominant test provider in the first post-reform school year of 2014/2015, while its market share gradually decreased in the years afterward.

For identification purposes, the post-reform period has the benefit that teachers are now guaranteed to not be able to observe students performance on the primary school exit exam prior to constructing the recommendations. The drawback is that students in the new situation are aware of the (binding) teacher recommendations months in advance of the test, which means that students who received a teacher recommendation which they felt was below their ability had a strong incentive to prepare well for the test, which provides the student with the legal right to request the school to revise its recommendation. At the same time, only 12% of students who scored better on the primary school exit exam compared to the teacher recommendation actually received an improved recommendation, as further discussed in appendix section C.6.

Table E.1 below shows the results when estimating the model for the post-reform period up to 2019, which was the last pre-covid year during which testing was suspended. I focus on the spatial differences in initial recommendations disseminated in February before students could request a revision of the recommendation. As can be seen, the results are somewhat larger compared to the baseline results reported in Table 2. As such, the main findings are not driven by the non-binding nature of the recommendations. Hence, the reform may have resulted in a stronger disadvantage for rural students in acquiring higher education, since they received comparatively even less ambitious teacher recommendations conditional on observed ability which were now also legally constraining student choices.

Table E.1: Estimation of the main results for the post-reform period (2015 - 2019)

	(1)	(2)	(3)	(4)	(5)
Log density	0.0366***	0.0363***	0.0267***	0.0276***	0.0278***
	(0.007)	(0.006)	(0.006)	(0.005)	(0.005)
N	413.862	413.862	413.862	346.648	221.430
R^2	0.55	0.55	0.56	0.56	0.57
Exit exam score	Yes	Yes	Yes	Yes	Yes
Indv. Characteristics	No	Yes	Yes	Yes	Yes
Family Characteristics	No	No	Yes	Yes	Yes
Movers excluded	No	No	No	Yes	Yes

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: Table displays the density estimates obtained by estimating equation 1 including the various control variables described in section 2 for the period 2014 - 2019. Column (5) excludes all children where there is some uncertainty over the education of one of the parents as discussed in section 3. Standard errors are clustered on the municipality level.

E.2 Estimates for most recent 2023/2024 school year

Finally, to highlight that that findings and results of this paper are not just a historical fact but remain highly relevant for today's practices, Table E.2 provides the estimates for the most recent 2023/2024 school year. Column (1) shows the estimates based on the exit exam by the CITO-group test provider who also developed the test used between 2006 - 2014, whereas column (2) shows the estimates based on all primary school exit exams. The estimates are similar compared to the findings for the 2014 - 2019 pre-covid period discussed above in appendix E.1 and remain significantly larger compared to the baseline findings for the period prior to 2014. As such, a substantial urban-rural difference in teacher recommendations conditional on academic ability remains visible today, and if anything, appears to have increased over time compared to the baseline period studied in this paper.

Table E.2: Estimates for the most recent 2023/2024 school year

	(1)	(2)
Log density	0.0273***	0.0262***
	(0.007)	(0.006)
N	64.413	148.677
R^2	0.55	0.54
Exit exam score	Yes	Yes
Indv. Characteristics	Yes	Yes
Family Characteristics	Yes	Yes
Test provider	CITO	All

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: Table displays the density estimates obtained by estimating equation 1 including the various control variables described in section 2 for the school year 2023/2024. Column (1) only includes children who performed the CITO exam which is the same test provider as in the baseline period bewteen 2006 - 2014, whereas column (2) also includes children who took a different exam.

E.3 Estimates by primary school exit exam provider

Furthermore, to highlight that the results also do not depend on the type of exit exam used as ability measure, table E.3 show the estimates in the post-reform period by the type of primary school exit exam. The estimates are quantitatively similar and statistically significant across all three test types, highlighting that the results are not driven by idiosyncrasies based on the test developed by CITO which was dominant prior to 2014 and remained the most common provider in the period 2014 - 2019.

Table E.3: Estimations by primary school exit exam provider

	(1)	(2)	(3)
Log density	0.0278***	0.0239***	0.0320***
	(0.007)	(0.006)	(0.006)
N	557.967	72.712	161.348
R^2	0.55	0.50	0.50
Exit exam score	Yes	Yes	Yes
Indv. Characteristics	Yes	Yes	Yes
Family Characteristics	Yes	Yes	Yes
Test provider	CITO	Route 8	IEP

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: Table displays the density estimates obtained by estimating equation 1 including the various control variables described in section 2 for the period 2014 - 2019. Column (1) only includes children who performed the CITO exam, column (2) children who took the "Route 8" exit exam, and column (3) children who took the IEP exit exam. All tests measured reading ability and mathematics, although the questions differed. Tests had to be approved as meeting the guidelines by the ministry of education to be used by schools as a test provider for the now mandatory primary school exit exam.