Location and educational signals: do students in rural locations receive less ambitious teacher recommendations?

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Abstract

Students in rural areas have worse outcomes across the globe compared to their urban peers, but the mechanisms behind this remain unclear. In this paper, I investigate whether students in rural areas receive less ambitious signals regarding their ability and educational prospects. Using data on teacher recommendations and national exam scores, I show that students in rural areas receive significantly less ambitious secondary school track recommendations conditional on observed ability. This difference is not explained by the spatial selection of households or unobserved heterogeneity in ability, is visible for all demographic groups, and is strongest for students on the margin of admission to the academic track. The spatial differences in recommendations are sizable, and comparable in magnitude to the well-established effects of household characteristics on teacher recommendations.

Key words: Teacher Bias, Spatial Inequality; Human Capital; Education

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1 Introduction

A large literature highlights the importance of childhood location for educational attainment and labor market outcomes.[1] One particularly salient feature is the urban-rural difference in educational attainment, with urban children outperforming their rural peers in virtually every country across the world. While some of this difference may reflect the spatial selection of households, recent studies show a clear causal link between childhood urban residency and educational attainment.[2] Concerns over urban-rural inequality and the perceived lack of opportunities in rural regions have also spilled over into the political debate, such as in the debates around Brexit. However, it remains unclear what factors prevent students in rural areas from enjoying the same opportunities as their urban peers, and hence what role public policy can play in equalizing the difference in opportunities.

One possibility is that students in rural environments receive less positive signals regarding their ability and educational prospects. Existing research has shown the importance of individual characteristics, such as minority status (Burgess and Greaves, 2013), caste (Hanna and Linden, 2012), gender (Carlana, 2019), parental education (Falk, Kosse and Pinger, 2020) and migration background (Carlana, La Ferrara and Pinotti, 2022) in shaping the assessments and recommendations provided to students, explaining the lower levels of educational attainment for these groups. Hoxby and Avery (2012) suggest that a similar process may well play out on the spatial level, as study counselors outside of metropolitan areas have less experience in providing recommendations to high-performing students. However, it has been difficult to assess whether students receive less ambitious recommendations in rural areas, given that recommendations are rarely observed and an objective benchmark to verify the recommendations against is typically lacking.

In this paper, I investigate whether students receive less ambitious signals regard-

[1] See for instance Chetty, Hendren and Katz (2016), Chetty and Hendren (2018) and Eckert and Kleineberg (2021) in the US, Deutscher (2020) in Australia or Alesina et al. (2021) in Africa.

[2] See for instance Gibbons and Silva (2008), van Maarseveen (2021) and Nakamura, Sigurdsson and Steinsson (2022) for evidence in developed countries, or Chiovelli et al. (2021), van Maarseveen (2022) and Schwank (2022) for evidence in developing countries. Furthermore, Adukia, Asher and Novosad (2020) show that educational attainment increases in rural India when the villages are connected by roads to nearby cities.

ing their ability and educational prospects in rural areas using a unique setting in the Netherlands. At the end of primary school, students select into one of the three secondary education tracks varying in academic content, duration, and access to tertiary education. To assists with decision-making, students are provided with a secondary school track recommendation by the primary school teaching staff. Students also participate in the national primary school exit exam during the same period, which measures learning outcomes in various subjects and can be used as an objective benchmark to compare the teacher recommendations against.[3] The teacher recommendations were not binding during the period under study, with secondary schools using the primary school exit exam score as the main admission criteria.[4]

The data on the primary school exit exam scores, teacher recommendations and school choices are obtained from Statistics Netherlands for the cohorts graduating between 2005 and 2014. This provides a baseline sample of 829.343 students. The educational data are linked to the Dutch administrative data, thus providing information on a wide range of household characteristics, including parental education, earnings, and migration background. Data is also available for the period after 2014, although a new law enacted by parliament made the teacher recommendations the legally binding admission criteria for secondary schools during this period.

The analyses show substantial differences in teacher recommendations between urban and rural environments conditional on cognitive ability and a wide range of household characteristics. In the preferred specification, a one log-point increase in population density increases the probability of receiving an academic track recommendation by 1.7 percentage points, from a mean of 28%. This average effect hides a substantial heterogeneity depending on ability. The differences in recommendations are strongest for students on the margin of admission to the academic high school track according to the primary school exit exam, with smaller differ-

[3]The primary school exit exam is graded centrally and assesses language ability (vocabulary, spelling, and comprehensive reading), mathematics, and logical reasoning.

[4]As a result of this practice, parliament changed the policy in 2014 and made the teacher recommendations binding, as politicians felt that the reliance on the standardized test put undue pressure on students to perform at a single moment in time.

ences for low and very high-ability students.

The effects of density on teacher recommendations are substantial compared to the effects of individual and household characteristics. Among the students on the margin of admission to the academic track according to the exit exam, students at the 90th percentile of the density distribution are around 9 pp more likely to receive an academic track recommendation compared to students at the 25th percentile of the density distribution. By comparison, girls are around 1 pp more likely to receive an academic track recommendation, children with a university-educated parent are around 11 pp more likely to receive an academic track recommendation, and no differences are visible between children with and without a migration background. Hence, the effect of location can be larger than some of the well-documented effects of individual and household characteristics on teacher assessments.

Furthermore, the difference in teacher recommendations between urban and rural locations is visible across the various demographic groups. The effects of a rural location on the recommendations are similar for children with and without a migration background, boys and girls, and for children with and without a university-educated parent. Hence, the difference in teacher recommendations between urban and rural communities cannot be explained by the spatial selection of various demographic groups affected by the teacher biases highlighted in the previous literature, but instead is visible across all demographic groups. Furthermore, the fact that the estimates are similar for children with and without a university-educated parent suggests that household characteristics favorable for education cannot compensate children for an unfavorable residential location.

One concern is that students in rural areas might be less capable on some of the skill dimensions not captured by the primary school exit exam. I control for this in two ways. First, to assess whether students in urban and rural locations have different distributions across the various skill dimensions that are included in the exam, using the fact that the primary school exit exam assesses student performance in four different domains (language, mathematics, logical reasoning, and world knowledge[5]). I do not find any evidence that students in urban and rural environments have substantially different distributions of skills along these four observed skill dimensions, which reduces concerns that the ability of students in urban and rural settings varies greatly across skill dimensions. Second, I use children who move in the period shortly before the recommendations are constructed to separate the teacher recommendations from local learning conditions. I find the same urban-rural gradient in recommendations for students who moved between municipalities shortly before the recommendations are constructed and for whom learning outcomes are thus less affected by local learning conditions. Furthermore, conditional on the municipality to which students migrated, the density of previous residential locations does not affect teacher recommendations, again suggesting that students do not acquire unobserved skills at different rates in urban and rural areas.

A second question is if the non-binding nature of the recommendations may have shaped the teacher recommendations and led them to incorporate various environmental constraints faced by rural students. To investigate this, I re-estimate the models for the post-2014 period, when the teacher recommendations became the legally binding admission criteria for secondary schools. The differences in recommendations between urban and rural locations are even larger in this period, suggesting that the non-binding nature is not affecting the results. Instead, during the post-reform period, the lower teacher recommendations in rural areas actively constrained the choice set of students, thus preventing high-ability students in rural environments from the possibility of enrolling in the academic track.

Finally, the question is what mechanisms drive the lower recommendations in rural environments. I do not find evidence that the selection of teachers differs between urban and rural environments, with similarly qualified teachers in both locations. Furthermore, the effects persist conditional on distance to schools, suggesting that the worse access to secondary schools in rural locations is not driving the results either. Instead, the concentration of highly-educated households in urban areas appears to be the main driver of the more ambitious teacher recommendations.

[5] Which is a combination of geography, history, and natural sciences.

Once the number of university-educated individuals is controlled for, population density no longer affects recommendations, suggesting that the concentration of highly-educated households in cities leads to positive spillovers on other students. Interestingly enough, the spillovers of the well-educated population seem to operate largely outside of the schools, with similar effects of density regardless of the share of highly educated parents within the school. As such, the selection of highly-educated individuals into cities leads to a self-reinforcing cycle, whereby the spatial concentration of highly-educated households positively affects the educational attainment of the next generation.

The findings of this paper contribute to three strands of literature. First of all, the paper contributes to an emerging literature on the effects of childhood residency in urban and rural environments on educational attainment (Adukia, Asher and Novosad, 2020; Chiovelli et al., 2021; van Maarseveen, 2021; Schwank, 2022; Nakamura, Sigurdsson and Steinsson, 2022). While this literature has used a variety of contexts to study the effects of childhood urban exposure on educational attainment, it remains unclear what mechanisms can explain the positive effects of urban residency. This paper provides evidence of one mechanism, namely that students in rural environments receive less ambitious signals regarding their ability and educational potential. As such, the paper also contributes more generally to the literature on the geographic inequality of opportunity during childhood (Chetty, Hendren and Katz, 2016; Chetty and Hendren, 2018; Chyn and Katz, 2021) by highlighting a novel mechanism through which location can affect human capital accumulation.

Second, the paper contributes to the literature on teacher biases and their role in shaping student outcomes and educational careers. Previous studies have shown that teacher bias can explain the lower educational performance of children from immigrant families (Botelho, Madeira and Rangel, 2015; Carlana, La Ferrara and Pinotti, 2022), low SES-households (Falk, Kosse and Pinger, 2020), minority groups (Burgess and Greaves, 2013), 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 extend this literature to encompass the spatial dimension and shows a similar difference in teacher recommendations between urban and rural environments. Furthermore, the effects of location are visible for all demographic groups, suggesting that the spatial differences in teacher biases go beyond the previously established differences between demographic groups.

Finally, the paper contributes to a recent literature on the match quality between students and educational institutions. Most of the focus has been on assessing the degree of mismatch for various demographic groups within the educational system (Hoxby and Turner, 2013; Dillon and Smith, 2017, 2020; Dustmann, Puhani and Schönberg, 2017; Falk, Kosse and Pinger, 2020; Campbell et al., 2021). While some suggest that differences in teacher and study counselor recommendations may play a role in explaining the mismatch (Hoxby and Turner, 2013; Dillon and Smith, 2017; Campbell et al., 2021), empirical support has been scarce. This paper shows that teacher recommendations play an important role in the mismatch between students and educational institutions, and highlight that this mismatch also has an important spatial dimension. This finding can also explain the finding of Campbell et al. (2021) that school-fixed effects absorb a large share of the observed mismatch between students and educational institutions in the UK.

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 a variety of robustness tests. Finally, section 6 provides a discussion and concludes.

2 Context and data

2.1 Educational system

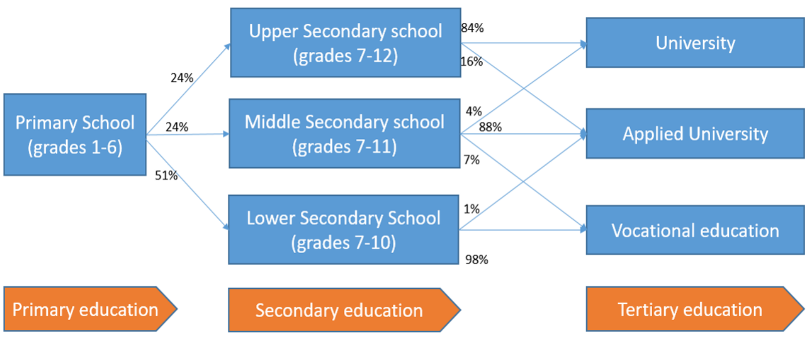
The Dutch education system consists of three stages as shown in figure 1.[6] All children enroll in primary school education at age 6, which lasts six years. After completing primary school, students select into one of the three secondary school tracks, which differ in length, difficulty and access to tertiary education. Since the secondary school track are strongly linked to tertiary educational enrollment (see

[6] This section provides an overview of the educational system between 2006 - 2014. The school system was reformed in 2014, as will be discussed later.

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 the secondary schools decide which students to admit. Enrollment is free in primary school and secondary schools, whereas an enrollment fee of 2000 euro a year is charged for university and applied university, and 1000 euro a year for vocational education.

Primary schools are not directly involved in the secondary school choice of stu-

Figure 1: Overview of the Dutch education system



Note: Flows are based on the cohort born in 1996. The flows are based on enrollment respectively three years after completing primary school and the highest level of completed secondary school. The lower secondary school is further divided into some subcategories, which are not displayed here. Figure taken from van Maarseveen (2021).

dents, but they provide students with a recommendation to assist with decision-making. 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 themselves decide which staff members are involved in constructing the recommendation, with typically at least the 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 recommendations, 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),

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 all students born between 1994 and 2001.

and logical reasoning (40 questions). Participation in the national exam is not mandatory for primary schools, although the 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 exit exam scores is shown in appendix A.

Although neither the school recommendation nor the primary exit exam score were binding in the period under study, secondary schools have historically relied on the primary school exit exam score as the main admission criteria (Statistics Netherlands, 2021). This changed when parliament enacted a law in 2014 to make the teacher recommendation legally binding, as many believed that the emphasis on the primary school exit exam score created undue pressure for children to perform at one moment in time.[7] In the baseline analysis, I focus on the period between 2005 and 2014 when the teacher recommendation was not binding nor the leading admission criteria for secondary schools, since this is more representative of the type of recommendations that students receive from teachers in other settings. However, the results are similar in the post-reform period as shown in the robustness tests.

Finally, since there was no prescribed process for the construction of the teacher recommendations in the period under analysis, the timing of the construction of the recommendation somewhat varies between schools. This raises the possibility that some primary schools may use the exit exam scores when constructing their

[7] At the same time, the 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.

own recommendations.[8] While this cannot be excluded, it has to be noted that the results are virtually identical when estimates for the post-reform period when primary schools were legally obligated to construct and disseminate their recommendations to students prior to the primary school exit exam. Furthermore, to the degree that schools simply follow the exit exam scores in constructing their recommendations, this would speak against finding any differences between urban and rural areas.

2.2 Data and descriptive statistics

The data on test scores, teacher recommendations, and enrollment decisions are obtained from Statistics Netherlands. The data is linked to the administrative databases from Statistics Netherlands, thus providing a wide range of background characteristics, including migration background, parental education, and parental income. I restrict the sample to those born in The Netherlands between 1994 and 2002 and for whom both the primary school exit exam score and the primary school recommendation are observed, which results in a baseline sample of 860.600 individuals. Appendix B provides some more detail on the sample construction and descriptive statistics.

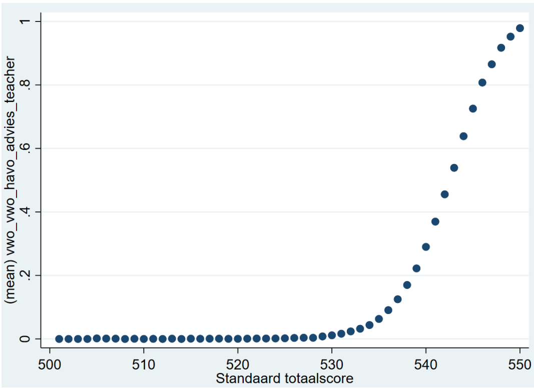
The primary school exit exam scores and the teacher recommendations show a clear correlation but are not perfect substitutes. Figure 3 below displays the share of students that received an academic track recommendation from the primary school teachers by the exit exam score. Students who score below the 50^{th} percentile on the exit exam (score <535) rarely receive a teacher recommendation for the academic track, meaning that the test score and teacher recommendations are in agreement for these students. Similarly, the overwhelming majority of students who score above the 90^{th} percentile (score >547) receive an academic track recommendation from the teachers. The teacher recommendations are relatively mixed for students around the margin of admission to the academic track according to the exit exam (score around 540 - 544), with 40 to 60% of the students receiving

[8] An evaluation in 2014 by the Ministry of Education found that around half of the schools constructed their recommendations in the period after participating in the primary school exit exam.

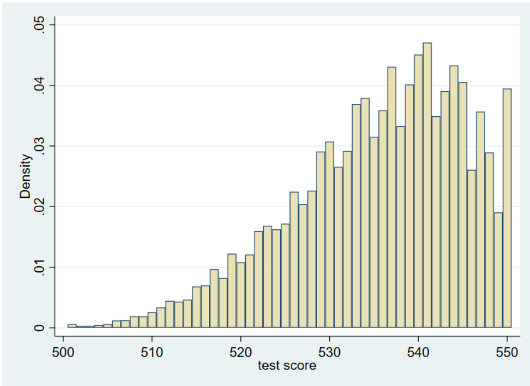
a recommendation for the academic track.

To get a first impression of the difference in teacher recommendations between

Figure 2: Teacher recommendations and exit exam scores



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



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

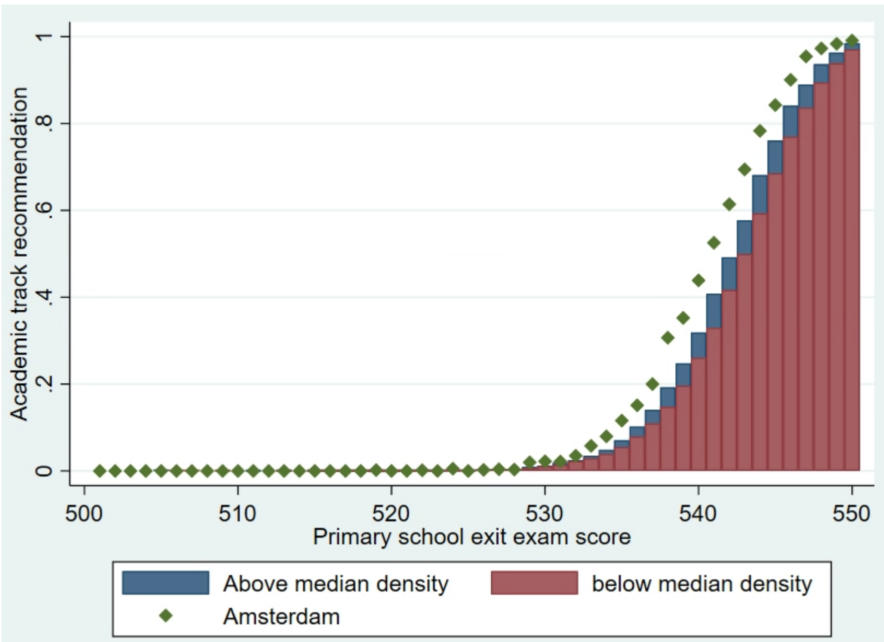
Figure 3: Academic track recommendations (%) from teachers by exit exam score

Note: Statistics based on those who completed primary school between 2005 and 2013. The x-axis shows the score on the primary school exit exam, the y-axis in the percentage of students receiving an academic track recommendation from their teachers (left panel) and the density distribution of the test score (right panel).

urban and rural areas, figure 4 shows the percentage of students who received an academic track recommendation by primary school exit exam score. The sample is split by the median density of the place of residence of the pupils. As can be seen from the figure, teachers rarely recommend low-performing students to attend upper secondary school in either urban or rural areas. 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 urban areas are almost 10 percentage points more likely to receive an academic track recommendation compared to students in rural areas. This difference remains visible throughout the rest of the distribution, only to narrow for the brightest of students. The differences are even larger when analyzing whether students received a recommendation exclusively for the academic track, as shown in figure C.2 in the appendix.

The spatial differences in teacher recommendations are substantial, even compared to individual characteristics. Table B.3 in the appendix shows the difference in teacher recommendations conditional on test scores between boys and girls, children with and without an immigration background, and children with and without a university-educated parent. Among the children on the margin of admission to the academic track, girls are 1.1pp more likely to receive an academic track recommendation, and children with a university-educated parent are 11pp more likely to receive an academic track recommendation. No differences are visible for children with and without a migration background. In contrast, living in a place 1 log point denser increases the likelihood of an academic track recommendation by 5.4pp for children on the margin of admission to the academic track. The difference in academic track recommendations between children at the 25th or 90th percentile of the density distribution is thus similar in magnitude to the effect of having a university-educated parent, and ten times larger than the observed difference between genders.

Figure 4: Urban-rural gap in academic track recommendations by test score



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

3 Methodology

The focus of this paper is on the difference in teacher recommendations received by students in urban and rural areas, conditional on learning outcomes and household characteristics. The highly detailed data on the exit exam scores and family characteristics allow me to flexibly control for many of the relevant differences between students in urban and rural environments. The baseline model used for estimations is provided in equation 1.

$$\text{Teacher recommendation}_i = \alpha_1 + \beta_1 * \text{individual characteristics}_i + \beta_2 * \text{household characteristics}_i + \beta_3 * \text{cognitive ability measure}_i + \beta_4 * \text{urbanization}_i + \epsilon_i \quad (1)$$

The individual characteristics consists of gender, birth cohort, and birth order within the household. For the household characteristics, I include migration background, parental education, parental income, and the age of the oldest parent at birth. The migration background is based on the country of birth of the parents.[9] The parental education consists of 18 possible levels for each parent, which I flexibly interact to create 324 parental education combinations. One of the 18 levels is that no educational attainment for the parent is registered 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 the lowest levels of educational attainment. However, the results are robust to the exclusion of this group. 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, as this is observed for all children in the baseline sample. Finally, I include separate dummies for children whose parents have a negative income, top-censored income, or miss parental income for more than five parent-income years, together accounting for 0.6% of the observations. Table B.2 in the appendix shows the summary statistics

[9] Which 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.

of the various control variables.

The next step is to classify how urban or rural the location of each student is. The lowest spatial dimension on which the place of residence is available is the zip code, of which there are 3980 in the Netherlands 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 centroid of the zip code as density measure. Each student is assigned the density of the zip code of residence at the start of their final year of primary school. The distribution of the density measure and a map with the density measure are both shown in appendix B.

Equation 1 follows the teacher bias literature and relies on the exam scores to correct for differences in learning outcomes between students (Burgess and Greaves, 2013; Alesina et al., 2018; Lavy and Sand, 2018; Falk, Kosse and Pinger, 2020; Carlana, La Ferrara and Pinotti, 2022). Nonetheless, some factors that might affect teacher recommendations and could differ between urban and rural areas, such as non-cognitive ability, remain unobserved. Section 4.3 discusses the potential of such differences to drive differences in teacher recommendations, using both the multi-dimensional skill measures contained in the exit exam as well as estimates based on movers to investigate whether unobserved skill differences are likely to drive the results.

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 as obtained from equation 1. The first column shows the overall differences conditional on exam score, similar to figure 4, where columns (2) and (3) include individual and family controls. As the preferred specification in column (3) shows, a one log-point increase in population density raises the likelihood of receiving an academic track recommendation by 1.7 percentage points (pp) from a mean of 28%, conditional on exit exam score and family characteristics. The inclusion of household characteristics somewhat reduces the estimates, which is mostly driven by the inclusion of the educational attainment of parents, which has previously been shown to affect teacher assessments and recommendations even conditional on test scores (Falk, Kosse and Pinger, 2020). Nonetheless, the estimate remains statistically significant and quantitatively similar when controlling for observed individual and household characteristics.

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 students who are most likely to attend the academic track relocating to an urban environment in the final years of primary school. To exclude this possibility, column (4) shows the estimates when excluding children who moved between municipalities between ages 1 and 12, with similar results. Furthermore, column (5) shows that the results also remain unchanged when all children are removed with uncertainty over the educational attainment of either parent.[10]

4.2 Heterogeneity

One question is whether urban residency affects all students equally or whether certain types of students drive the effect of residential location on teacher recom-

[10]The parental education is unknown for a group of parents as discussed in section 3, as in particular low educated parents are unlikely to have been captured by any of the historical records on educational attainment.

mendations. Table 3 shows the estimates separately by gender, parental education, and migration background. 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. The estimated effect of density on the teacher recommendations is very similar for children with and without a migration background, boys and girls, and children with and without a university-educated parent. The estimates for the various groups are not significantly different from each other. This highlights that the results are not just driven by the spatial selection of groups previously shown to be affected by biased teacher recommendations (such as immigrants and minorities), but that instead the negative effects of location on teacher recommendations are visible within each of the demographic groups. Furthermore, the estimates for children with university-educated parents imply that favorable household characteristics is not sufficient to isolate students from the negative effects of a remote location.

A second interesting dimension for heterogeneity is along the ability distribution. The baseline estimates in table 2 are based on all students, including those who would be very unlikely to receive an academic track recommendation in any location given their learning outcomes. To investigate this, figure 5 shows the effects of population density on the academic track recommendations estimated separately 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[11], with a one log-point increase in density being associated with a 4 percentage point increase in academic track recommendations. Given that around 40 to 60% of the students in this range receive an academic track recommendation, the effects are quite substantial. The differences are smaller for the low-ability students and high-ability students, suggesting that location has the strongest effect among marginal students. Nonetheless, even among students with the highest test score (representing the top 4 percentiles), an urban location still significantly increases the likelihood of receiving an academic track recommenda-

[11]Those with exit exam scores between 540 - 545, corresponding to the 65^{th} - 85^{th} percentile.

tion.

Table 3: Heterogeneity

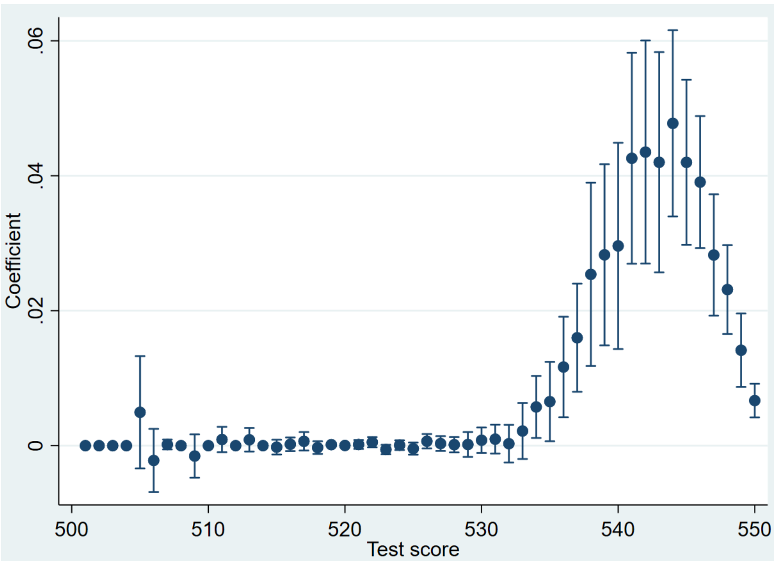
	Gender		Parental Education		Migration Background	
	Male	Female	High	Low	Yes	No
Log density	0.0337***	0.0342***	0.0317***	0.0356***	0.0324***	0.0402***
	(0.005)	(0.005)	(0.005)	(0.006)	(0.005)	(0.009)
N	149.980	141.568	139.546	151.545	251.455	40.394
R^2	0.23	0.23	0.22	0.23	0.23	0.24

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. Standard errors are clustered on the municipality level.

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.

4.3 Robustness: unobserved heterogeneity

The estimates above highlight that students receive less ambitious recommendations from teachers in rural settings conditional on observed learning outcomes. One question that arises is whether students in urban and rural areas may differ on some skill dimensions that are not captured by the test but correctly identified by the teachers. This might for instance be the case if rural students have significantly worse non-cognitive skills conditional on observed learning outcomes, which can be observed by the teacher but not by the test. While no data is collected on non-cognitive outcomes as part of the curriculum, we can test whether such differences are likely to drive the results in two ways.

First, we can use the various dimensions of the primary school exit exam to analyze whether urban and rural students have different distributions along the four observed skill dimensions. The primary school exit exam consists of three mandatory parts measuring language ability, mathematics, and logical reasoning.[12] Furthermore, a fourth set of questions measures students' "world knowledge", consisting of 80 questions on geography, history and, natural sciences. This fourth dimension was optional and was not used in the construction of the test scores.

To test whether urban and rural students have significantly different distributions across the observed skill dimensions, table 4 shows the effect of density on the scores of the individual skill components conditional on the test score on the other dimensions. Table 4 presents the results of the analysis, with some differences visible. For instance, students in urban regions on average have a higher score on the language questions than would be expected based on their performance on the mathematics and logical reasoning questions. However, the differences are quite small. A one log-point increase in population density raises the observed language ability by 0.007 standard deviations conditional on the logical reasoning and math ability scores, suggesting that urban and rural students do not have very different ability distributions among the observed dimensions.

A second way to investigate whether unobserved differences in learning outcomes

[12] The logical reasoning element consists of questions testing students their ability to use the correct information sources in the appropriate contexts and their ability to correctly process information from tables, maps and graphs.

Table 4: Urban-rural differences in skill dimensions

	Language	Math	Cognitive reasoning	World knowledge
Log density	0.0842**	0.0932*	-0.0844*	-0.474***
	(0.03)	(0.04)	(0.04)	(0.10)
Other skill dimensions	0.604***	1.021***	0.843***	0.758***
	(0.001)	(0.002)	(0.002)	(0.001)
	(0.001)	(0.002)	(0.002)	(0.001)
N	827.700	827.700	827.700	685.118
R^2	0.65	0.60	0.69	0.60
Mean	74.5	71.5	75.5	71.5
Standard Deviation	12	17	14	13

Standard errors in parentheses

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

Note: Each column regresses the outcome variable (Language/Math/Cognitive reasoning/World Knowledge) on the individual characteristics, household characteristics and a weighted average of the other mandatory dimensions (Language/Math/Cognitive reasoning). The sample used is identical to the baseline sample. Standard errors are clustered on the municipality level.

drive the results is to study children who moved in the period shortly before the primary school exit exam and teacher assessment, who thus received the majority of their education in a different municipality than where their assessment takes place. If the lower teacher assessments in rural areas purely reflect the lower non-cognitive skills of rural students, then we would not expect to find significant differences in recommendations for students who just freshly moved there, conditional on the previous region of residency.

To investigate this, table 5 shows the estimates when restricting the sample to children who moved between municipalities in the year before taking the standardized test and receiving the teacher recommendations.[13] The estimates are very similar to the baseline estimates and robust to the inclusion of various control variables. Given that a similar urban-rural gradient in teacher recommendations is visible for students who just moved to a new municipality and who obtained the majority

[13]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, corresponding to the second half of the fifth year and the first half of the sixth year.

of their education elsewhere, it suggests that the difference in teacher recommendation is not due to the different skills and abilities that students learned locally. Instead, students who move to higher-density regions are more likely to receive a teacher recommendation for the academic track conditional on their municipality of origin and exit exam results.[14]

Finally, 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 judgment of teachers among the group of movers. However, conditional on the current location and exit exam scores, the density of the previous place of residency has no effect on the teacher recommendations, as shown in table 6. Taken together, the findings of tables 5 and 6 show that only the location of students at the time of receiving the recommendation affects the teacher recommendations, with no role for the density of the place where students spend the majority of their childhood. This finding strongly argues against the possibility that the difference in teacher recommendations between urban and rural regions reflects a difference in the acquisition of unobserved skills.

4.4 Post-reform period: binding recommendations

A second concern is that teachers may be aware that the recommendations do not constrain students' choices during the period under analysis and thus feel free to factor in other factors that rural students face in attending the academic track, such as commuting distances or local job opportunities. Such "paternalistic" concerns by teachers are not necessarily unreasonable when the recommendations are not binding and thus do not restrict the choices available to students. To investigate this possibility, I use the reform introduced in the 2014/2015 school year which made the teacher recommendations legally binding. Furthermore, teachers were now legally obligated to construct and disseminate their recommendations

[14] One concern is that students may select into more and less urban regions based on their performance. However, controlling for the exam scores and household characteristics has little effect on the density estimates, suggesting that selection into urban and rural areas based on ability within this group of movers is limited.

Table 5: Restriction of sample to recent movers - effect of current region of residence

	(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. Standard errors are clustered on the municipality level.

Table 6: Restriction of sample to recent movers - effect of previous region of residence

	(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. Standard errors are clustered on the municipality level.

well in advance of students taking the standardized test, which also reduces concerns that teachers may rely on the standardized test scores when formulating their own recommendations.[15]

To see whether this affects the recommendations, table 7 shows the estimates for the school year 2014/2015. The difference in teacher recommendations is somewhat larger in the post-reform period compared to the pre-reform period, suggesting that the non-binding nature of the recommendations is not driving the estimates. Whereas in the period prior to 2014, teacher recommendations in rural areas could serve as a paternalistic guide to students without restricting their choices, the lower teacher recommendations in rural areas after 2014 actively constrained the educational choices available to students. Hence, the non-binding nature of the teacher recommendations does not seem to have played an important role in explaining the urban-rural differences. Appendix E shows the results for the period 2015 - 2019, with no evidence that the results have weakened in the years later after the reform.

5 Mechanisms

Finally, the question is what mechanisms can explain the lower recommendations provided in rural regions. In this section, I analyze three possibilities: the longer distances to schools in rural areas, different teacher selection, and the clustering of highly educated households in cities leading to local spillovers.

5.1 Distance to schools

One possibility to explain the lower recommendations of teachers is that schools offering the academic track are somewhat less ubiquitous compared to schools offering the middle and lower academic track, suggesting that rural students on

[15] I prefer the period prior to the school year 2014/2015 for the baseline results, since students observe the teacher recommendations before taking the exit exam in the post-reform period. As students had the legal right to request schools to reconsider their recommendation in the case that the test score was significantly better than the school recommendation, it provided an incentive to score (and prepare) particularly well in certain cases. The fact that teacher recommendations became binding also means that the post-reform setting has less external validity, as teacher and study counselor recommendations are typically not binding in most other countries.

Table 7: Estimation of the main results for the school year 2014/2015

	(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.

average have longer commuting distances in rural regions. Even though not related to the academic performance of students, teachers may take such factors into account when deciding on the recommendation. To investigate this possibility, I include controls for the distance to the nearest school offering the academic track for the students. The median distance to a school offering the academic track is 2.5km, with the 90th percentile at 7.5km, reflecting the fact that distances to schools are relatively limited in the Netherlands. However, controlling for distance to schools leaves the estimates virtually unaffected, as shown in the table C.5 in the appendix. Furthermore, table **??** in the appendix shows that the effects of density persist even when restricting the sample to students who live in a neighborhood where a secondary school offering the academic track is located, again suggesting that the effects are not driven by distance to schools.

5.2 Differences in teacher quality

A second possibility is that the results are driven by a different selection of teachers. Although the salaries for teachers are set on the national level and in particular large cities report difficulties in attracting teaching staff as a result[16], there may nonetheless be a positive selection of teachers into schools. As a first step, I analyze whether the teacher qualifications differ with density. Table 8 shows the results of regressing three indicators of teacher quality on density. As can be seen, there is no selection visible based on primary school exit exam scores or the likelihood that a teacher themselves received an academic track recommendation at the end of primary school. If anything, teachers in urban locations had slightly lower primary school exit exam scores compared to teachers in rural areas. Furthermore, around 20% of the primary teachers in the Netherlands has a university degree. However, there is again no clear relationship between density and teacher qualifications, suggesting that urban and rural teachers are not qualified to different degrees.

Table 8: Urban-rural differences in teacher quality

	Exit exam score	Teacher recommendation	University degree
Log density - previous location	-0.343**	0.00421	-0.00123
	(0.108)	(0.00751)	(0.00155)
N	12.816	12.816	423.481
R^2	0.00	0.00	0.00
Mean	538.3	27.5	19.5

Standard errors in parentheses

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

Note: Table displays the effect of density on three measures of teacher quality. Each observation represents one teacher-year, with only trachers included who worked at least 50% in their main affiliation. Teacher-school linkages have been available in the period 2016-2019, which is the period also used for this table. Information on the primary school exit exam score and teacher recommendations have only been available since 2006,. This means that columns (1) and (2) are based on teachers working in primary school education the period 2016 - 2019, but who only graduated primary schools themselves in the period after 2006. Standard errors are clustered on the municipality level.

[16]See for instance Ministry of Education (2020, p16) for an overview of the teacher shortages in primary education in the year 2017/2018. The number of unfilled positions is more than twice as large in the dense urban regions compared to the rural areas. https://open.overheid.nl/documenten/ronl-68ce3fee-b7f1-40fb-b84c-252c1fa929c3/pdf

5.3 Clustering of highly educated households in cities

A third possible explanation is that the clustering of highly educated households provides positive spillovers on the local community and the assessment of teachers. Such spillovers could occur through the labor market, by raising the local returns to education, or by increasing the beliefs in returns to education and the importance of education. Furthermore, the compositional effect may change teachers' default option when most children are expected to attend an academic track. This would be akin to the statistical discrimination mechanism that drives differences in teacher recommendations between various SES-groups, where teachers unsure of how to assess marginal students default towards the group average (Burgess and Greaves, 2013; Botelho, Madeira and Rangel, 2015).

To assess whether the clustering of highly educated households can explain the positive relationship between density and teacher recommendations, I first separate between the general population density and the density of highly educated individuals. Given that university education is less common among the older cohorts, I focus on the number of university-educated individuals between the ages 26 - 45. The correlation between the number of individuals and the number of university-educated individuals between ages 26-45 is naturally high at 0.97, although both urban and rural locations vary in the share of highly educated, thus enabling us to separate between the two measures. Table 9 below shows the effect of including population density and density of highly educated individuals simultaneously, with the positive effects being driven by the density of university-educated individuals. Conditional on the density of university educated, population density itself has no effect on the recommendations of teachers. This result holds both for children with and without a university-educated parent themselves, as table C.6 in the appendix shows.

The next question is whether the positive spillovers of highly educated households operate through the schools or outside of the schools. Table C.7 in the appendix shows the estimates when flexibly controlling for the share of highly educated parents within the school, with the majority of the effect remaining even when parental education within schools is controlled for. Furthermore, as table

Table 9: Effect of density of highly educated households

	(1)	(2)	(3)	(4)
Log population density	-0.0181***	-0.0172***	-0.00426	-0.00356
	(0.01)	(0.006)	(0.006)	(0.006)
Log university educated	0.0337***	0.0332***	0.0179***	0.0181***
	(0.009)	(0.005)	(0.005)	(0.005)
N	820.105	820.105	820.105	682.730
R^2	0.55	0.55	0.56	0.55
Exit exam score	Yes	Yes	Yes	Yes
Indv. Characteristics	No	Yes	Yes	Yes
Family Characteristics	No	No	Yes	Yes
Movers excluded	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 (5) excludes all children where there is some uncertainty over the education of one of the parents as discussed in section 3. Log population density is based on the log of individuals living within 10 km of the home location, whereas log university educated is based on the number of university educated between ages 25-25 living within 10km. Standard errors are clustered on the municipality level.

C.8 in the appendix shows, the positive effects of density are visible and similar even for schools within the bottom decile and top decile of the distribution of the parental education distribution. If the effects would operate purely through spillovers within schools, then we should expect little effect of density among schools with either very few or very many university-educated parents.

Taken together, the results suggest that while some of the effects of density may operate through the schools, the majority of the effect does not operate through the spillovers of parental education within schools. Hence, the clustering of highly-educated households in cities seems to generate its own dynamics, leading to positive spillovers on other children, both those with and without a university-educated parent themselves. This clustering of highly educated households combined with the positive effect on the education of the next generation thus seems to generate its own dynamics, leading to even higher educational investments in cities than would be expected based on the positive selection into cities. Conversely, a rural location depresses educational investment even among children who are qualified and seem to possess all the relevant abilities to pursue an academic career. These dynamics exacerbate the urban-rural differences in outcomes that would be expected purely on the spatial selection of households, and thus contribute to a lack of (educational) opportunities and advancement in rural areas.

6 Conclusion and discussion

The findings in this paper show that students in rural areas receive less ambitious secondary school track recommendations compared to their urban peers, conditional on household characteristics and learning outcomes. The difference in recommendations is visible for all subgroups, not driven by the spatial selection of households, and strongest for the students at the margin of admission to the academic track. The main driver of the difference appears to be the clustering of high-educated households in cities, leading to positive spillovers on the recommendations for other students. The exact nature of these spillovers remains unclear, but possible channels include higher returns to education, changes in norms or changes in role models and beliefs in the importance of education.

The findings have two important implications for research and policy. On the individual level, the paper provides evidence of a novel channel through which location can affect educational investment choices. Previous studies have highlighted the importance and positive effects of providing positive signals and encouragement in stimulating educational investment among low-income households (Hoxby and Turner, 2015), low-SES households (Falk, Kosse and Pinger, 2020) and immigrants (Carlana, La Ferrara and Pinotti, 2022). In this paper, I build on this literature and show that a lack of support and positive signals from teachers in rural areas can explain the lower levels of educational attainment of rural students. As such, the paper provides evidence of yet another way through which neighborhoods and residential locations during childhood affects opportunities and shapes economic outcomes.

Second, the findings of this paper have consequences for regional inequality in the long run. The positive selection of households into cities on cognitive ability

and education has been well documented in the literature (De La Roca and Puga, 2017; Bütikofer and Peri, 2021), as has the positive effect of urban residency on educational attainment (van Maarseveen, 2021; Chiovelli et al., 2021; Nakamura, Sigurdsson and Steinsson, 2022). In this paper, I provide evidence of how this selection of well-educated households into cities leads to its own dynamics, leading to more ambitious educational signals for children growing up in urban communities and subsequently higher levels of educational investment. The selection of households into urban and rural areas, combined with the own educational dynamics that this generates, risks exacerbating the regional inequality in educational attainment over time. This is particularly concerning since educational attainment is a main driver of economic development both on the regional (Gennaioli et al., 2013) and the national level (Hendricks and Schoellman, 2018).
Finally, it would be interesting to see if similar differences in teacher recommendations are visible in other countries. The urban-rural education gap is a truly global phenomenon, yet it's origins and consequences are still poorly understood. It would be interesting to examine how severe the spatial differences in teacher recommendations are in other contexts and whether they contribute to the spatial inequality in educational attainment also in other settings.

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Appendices

A Descriptive statistics on the test and school recommendations

Table A.1 shows the distribution of secondary school recommendations based on the primary school exit exam, as well as the exit exam scores corresponding to the recommendations. The lowest level of secondary school in practice is subdivided into three further sublevels, but for the purpose of this study, these are grouped together since the focus is on admittance to the highest level of secondary school (the academic track).

The secondary school recommendations provided by the primary schools are

Table A.1: Primary school exit exam recommendations

Score on exit exam	School recommendation from test	% of students
545 - 550	Upper secondary school	18.77 %
537 - 544	Middle secondary school	31.52 %
500 - 536	Lower secondary school	49.71%

Note: Distribution based on full distribution of students in the cohorts born between 1994 and 2001. 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.

somewhat more complicated, as primary schools 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 of two levels. Table A.2 below shows the distribution of the primary school recommendations for the baseline sample. 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 school and upper secondary school/middle secondary school) as having

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 2001.

received an upper secondary school recommendation and treat this as the outcome of interest. The majority of students receiving these recommendations are subsequently enrolled 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 the recommendation for all three school types in the outcome of interest since this recommendation is highly untargeted, and only 11% of the students receiving this recommendation subsequently enroll in an upper secondary school. Nonetheless, the results are similar when only focusing on the pure recommendation for an upper secondary school or when including the triple recommendation in the outcome of interest.

B Sample construction and descriptive statistics

Table B.1 below shows the sample restrictions and their effect on the number of observations. As mentioned in the main text, I restrict the analysis to those born in The Netherlands between 1994 and 2001, which are 1.8 million individuals. I further restrict the sample to those individuals who have their primary score exit exam available from Statistics Netherlands. The exit exam was not mandatory during this period, with around 15% of the schools not participating. In addition, Statistics Netherlands only receives information from the testing agency from schools that explicitly agreed to this information sharing, which not all schools have agreed to. However, earlier research (van Maarseveen, 2021) found no evidence of different selection between urban and rural schools in which schools make the test scores available.

The final step is to restrict the sample to those for whom the teacher recommendations are observed. The teacher recommendations have not been reported for around 25% of the students, which is spread similarly across years and primary school exit exam scores. Rural schools are somewhat more likely to not provide the recommendations to Statistics Netherlands. However, this selection is not related to student achievement, as controlling for the student exit exam scores leaves the relationship between density and the missing scores completely unaffected. Hence, even though we do not observe the teacher recommendations for all students and the missing recommendations are somewhat more common in rural areas, the missing recommendations do not appear to be linked to student performance. Further follow-up with Statistics Netherlands will be necessary to determine the reason for the missing recommendations.

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 have not more than eight children, and that both parents are adults at the time of birth. These restrictions do not cause any substantial losses in observations. The final sample consists of 860.600 individuals.

Table B.1: Sample selection

Restriction	No. of obs
Individuals born between 1994 - 2002 in Netherlands	1,794,473
Observed primary school exit exam score between 2005 - 2014	1,175,489
Observed teacher recommendation	851,355
Both parents identified	832.069
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

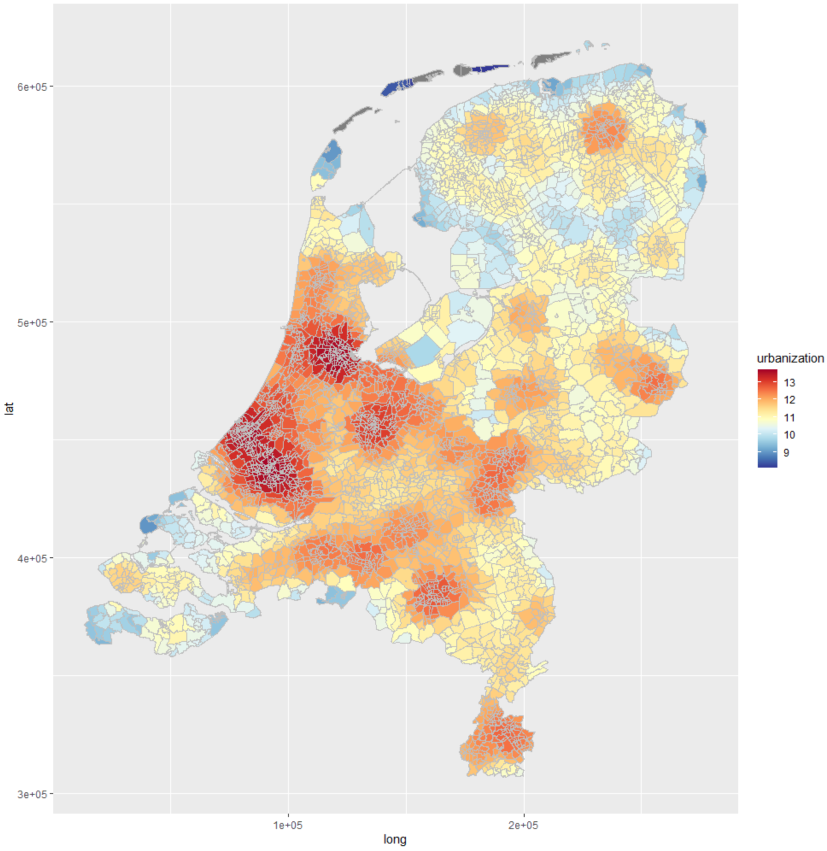
Table B.2 below shows the descriptive statistics of this core sample.

Table B.2: Descriptive statistics

Variable	N	Mean	St. Dev	p1	p99
Academic track recommendation					
From primary school teaching staff	829,024	0.288	0.453	0	1
From primary school exit exam	829,024	0.190	0.392	0	1
Individual characteristics					
Birth year	829,024	1997.914	2.54	1994	2002
Female	829,024	0.502	0.499	0	1
Birth order within household	829,024	1.775	0.971	1	5
Primary school exit exam score	829,024	535.454	9.629	510	550
Household characteristics					
Log population density	829,024	12.137	0.877	10.08	13.65
Migration background	829,024	0.197	0.397	0	1
Migration background	829,024	0.197	0.397	0	1
Log parental income	829,024	10.450	0.939	8.70	11.85
Missing parental income	829,024	0.0017	0.0415	0	0
Censored parental income	829,024	0.0010	0.0327	0	0
Negative parental income	829,024	0.0022	0.0469	0	0
University educated parent	829,024	0.326	0.468	0	1
Parental education (detailed)	829,024	121.656	114.534	1	336
Age oldest parent at birth	829,024	33.762	5.024	23	48

Note: Due to the confidential nature of the data, it is not possible to show the minimum and maximum values. Hence the first percentile and ninety-ninth percentile 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 two recommendations.

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.

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

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

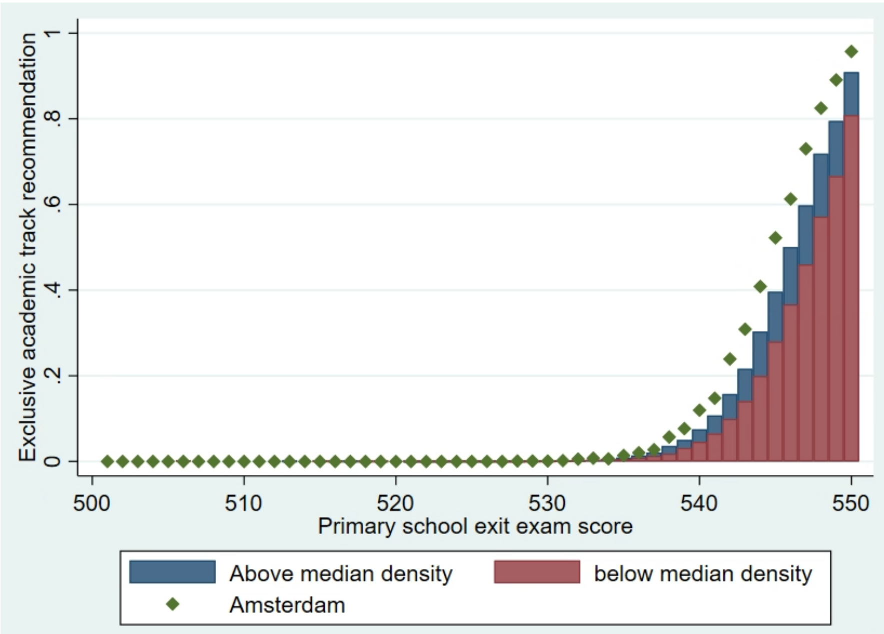
Note: Table displays the effect of density and three individual characteristics on teacher recommendations. Panel A shows the effects for all children, whereas panel B conditions on children having an exit exam score of 540 - 544. The controls for the test score are flexible, with a separate dummy included 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.

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.2: Urban-rural gap in academic track recommendations by teachers

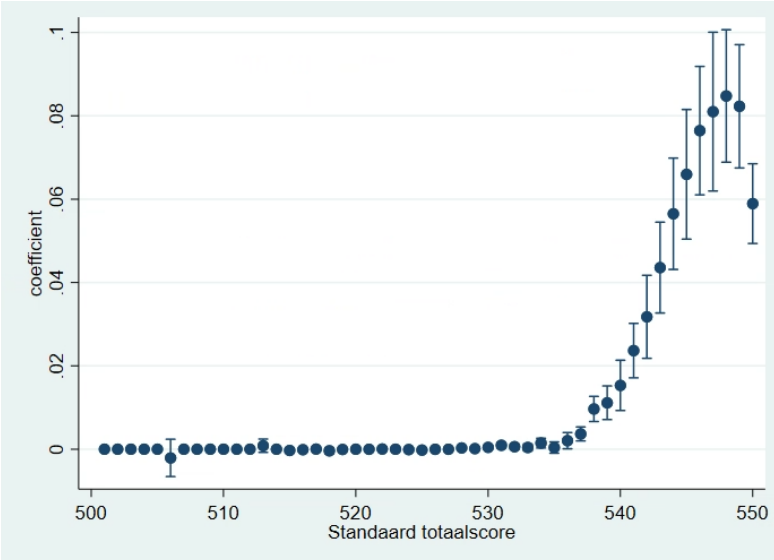


Note: Figure displays the share of students receiving an academic track recommendation for rural students (in red) and urban students (in blue). Dependent variable is whether a student received an exclusive upper secondary school recommendation (thus excluding the mixed upper/middle secondary school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

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.5, the

Figure C.3: Effect of density on academic track recommendations by test score



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 excluding the mixed upper/middle secondary school recommendations). The full set of individual and household controls are included in all regressions.

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.4: Estimations while controlling for distance to schools

	(1)	(2)	(3)	(4)	(5)
Log density	0.0233***	0.0235***	0.0174***	0.0171***	0.0170***
	(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 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.

Table C.5: Estimations for children in same neighborhood as an academic secondary school

	(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.2.1 Effect of clustering of highly-educated households

Table C.6: Estimates split by children without (col 1-2) and with (col 3-4) a university educated parent

	(1)	(2)	(3)	(4)
	No university	educated parent	university	educated parent
Log population density	-0.0134	-0.00596	-0.0128	-0.0128
	(0.005)	(0.005)	(0.008)	(0.008)
Log university educ. parents	0.0450***	0.0340***	0.0457***	0.0288***
	(0.004)	(0.004)	(0.007)	(0.006)
N	172.594	172.594	150.319	150.319
R^2	0.24	0.25	0.24	0.25
Exit exam score	Yes	Yes	Yes	Yes
Indv. Characteristics	No	Yes	No	Yes
Family Characteristics	No	Yes	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 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. Standard errors are clustered on the municipality level.

C.2.2 Within-school spillovers

One interesting question is to what degree the positive effects of highly-educated is due to spillovers within the schools, with parents in urban schools being more likely to be educated. To investigate to what degree the positive effects of urban residency can be explained by the spillovers from having classmates with university-educated parents, I investigate the effect of controlling for the share of children with a university-educated parent. Table C.7 shows the effects of controlling for parental education within schools. Column (2) shows the estimates when controlling for the share of children with a university-educated parent in a linear fashion and whereas column (3) instead includes a separate dummy for each 1-percent bin of university-educated parents. As can be seen from C.7, controlling for parental education somewhat reduces the effect of density, but the larger majority of the effect persists. This suggests that the positive spillovers of having more university-educated parents in school in cities is unlikely to drive the results. The importance of density persists even when we focus on schools with an extremely low share of university-educated parents ($< 15\%$) or schools with a very high share of university-educated parents ($> 53\%$), corresponding to the bottom and top deciles. The effect of density remains also clearly visible here, suggesting again that spillovers within schools due to the clustering of highly educated households is unlikely to explain the positive effect of density. Instead, the positive spillovers seem to operate on a higher spatial level than just the school.

Table C.7: Effects of density while controlling for share of highly educated parents

	(1)	(2)	(5)
Log density	0.208***	0.0171***	0.0157***
	(0.006)	(0.00159)	(0.00157)
N	706.142	706.142	706.142
R^2	0.56	0.56	0.56
Exit exam score	Yes	Yes	Yes
Indv. Characteristics	Yes	Yes	Yes
Family Characteristics	Yes	Yes	Yes
Share university educated parents - linear	No	Yes	No
Share university educated parents - flexible	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. The sample is restricted to schools that on average have between 12 and 90 students graduating each year between 2006 and 2014 to exclude very small and very large schools. Column (2) controls for the share of highly-educated parents in the school in a linear fashion, and column (3) controls for the share of highly-educated parents in the school by adding dummies for each 1-percent bin. Parental education is based on the students graduating between 2006 and 2014. Standard errors are clustered on the school level.

Table C.8: Estimates split by share of university educated parents in the school

	(1)	(2)	(3)	(4)
	Bottom decile		Top decile	
Log population density	0.0167***		0.0235***	
	(0.003)		(0.007)	
Log university educated		0.0137***		0.0188***
		(0.003)		(0.006)
N	70.886	70.886	70.886	70.886
R^2	0.51	0.51	0.56	0.56
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 density estimates obtained by estimating equation 1 including the various control variables described in section 2. The sample is restricted to schools that on average have between 12 and 90 students graduating each year between 2006 and 2014 to exclude very small and very large schools. Columns (1) and (2) show the results for the schools in the bottom decline of the distribution of the share of children with a university educated parent. Column (3) and (4) show the results when restricting the sample to the schools in the top decile of the share of children with a university educated parent. Parental education is based on the students graduating between 2006 and 2014. Standard errors are clustered on the school level.

D Do teacher recommendations matter?

One question is whether recommendations eventually matter in this setting. As mentioned in the main text, they 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 affect student choices, I investigate what the effect is of enrolling in a school that is more generous with its recommendations conditional on student abilities. The enrollment decision for primary school is made when a child is six years old, and presumably, parents have limited information about the abilities of their child, as well as the policy of schools with respect to writing the school recommendations at age 12.

To investigate the effect of attending a school that is more generous with its recommendations, I first estimate the school-fixed effects in a regression on the teacher recommendations. I estimate equation 2 for all students and calculate the average residual by primary school, which are then included in equation 1 and study a variety of subsequent educational outcomes. Table D.1 shows the results of this exercise.

$$\text{Teacher recommendation}_i = \alpha_1 + \beta_1 * \text{individual characteristics}_i + \\ \beta_2 * \text{household characteristics}_i + \beta_3 * \text{cognitive ability measure}_i + \epsilon_i \quad (2)$$

Children who attend a school that is 1 percentage point more likely to provide an academic track recommendation are by construction also more likely to receive an academic track recommendation themselves. However, the effects are not limited to just recommendations. Attending a school that is 1pp more likely to provide an academic track recommendation increases the likelihood of enrolling in the academic track by 0.45pp and to remain enrolled in the academic track in the final year by 0.37pp. Furthermore, it also increases the likelihood of attending university by 0.3pp. While this does not provide direct causal evidence, since schools that are more likely to offer academic track recommendations may also differ on other dimensions, it nonetheless provides suggestive evidence that the teacher track recommendations affect and shape student outcomes.

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

	Upper Track recommendation	Enrolled in Upper Track third year	Enrolled Upper Track sixth year	Enrolled in University
School-FE estimate	1.021***	0.453***	0.368***	0.311***
	(0.003)	(0.018)	(0.017)	(0.015)
N	829.343	829.343	829.343	829.343
R^2	0.58	0.53	0.48	0.40
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 1pp 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. Standard errors are clustered on the municipality level.

E Results for the 2014 - 2019 school years

As mentioned in section 4.4 the main text, the Dutch educational system changed in the school year 2014/2015. The teacher recommendations have become legally binding, whereas the primary school exit exam can now only be used by parents to request schools to revise their original recommendations. Post-reform, the teacher recommendations are constructed and communicated much earlier to students (typically in February), whereas the primary school exit exam is not taken until April. At the same time, the reform allowed various other testing agencies to construct their own primary school exit exam. The original test provider remained the dominant test provider in the school year 2014/2015, while its share gradually declined in the years afterward.[17]

For identification, the benefit of the period after 2014 is that teachers no longer observed students their performance on the primary school exit exam, which thus

[17] For this reason, I restrict attention to the first year post-reform. However, the results are very similar for the school years between 2015-2019 as shown below.

is truly an unknown benchmark. The drawback is that students in the new situation are aware of their teacher recommendations months in advance, which means that students who received a teacher recommendation that they felt is below their ability had a strong incentive to prepare well for the test, which would provide the possibility to request the school to revise its recommendation.

Table 7 below shows the results when model 1 is estimated for the year 2014/2015. The teacher recommendation used as outcome variable are the initial recommendations disseminated in February before students could request a revision of the recommendation in case the student performs better than expected on the exit exam. As can be seen, the results are quite similar, and if anything larger than the baseline results reported in table 2. Hence, the results are not driven by teachers using the test scores to construct their recommendations. Furthermore, the results imply that urban and rural teachers did not change their recommendations when their recommendations became legally binding, with a similar urban-rural gap in recommendations conditional on student ability visible in the post-reform year. Hence, it appears likely that the reform has resulted in a permanent disadvantage for rural students in acquiring higher education as they receive worse (binding) teacher recommendations conditional on revealed ability.

Table E.1: Estimation of the main results for all post-reform years (2014-2019)

	(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

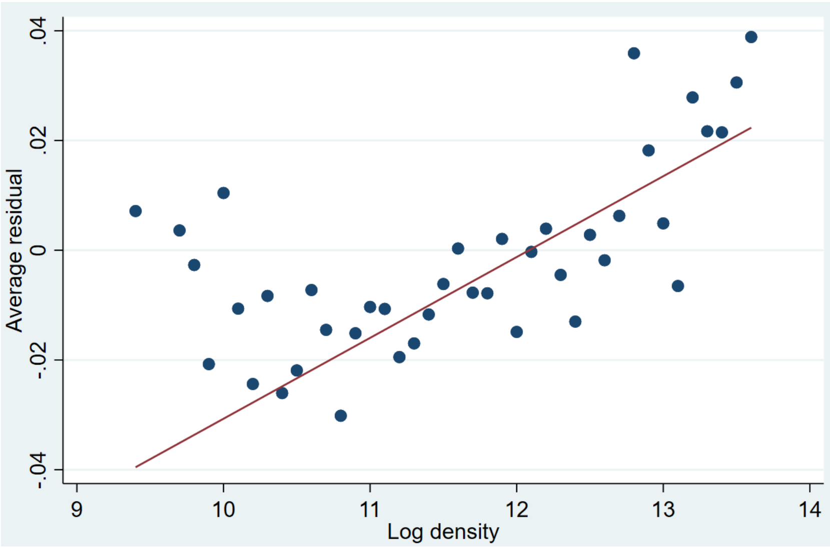
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

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.

F Log-linearity assumption

Equation 1 relies on the log-linearity assumption between the density and the teacher recommendations. This has previously been shown to be a good approximation for the relationship between density and academic track enrollment in the Dutch context (van Maarseveen, 2021). Nonetheless, if the log-linearity assumption misrepresents the actual relationship between teacher recommendations and density, then the estimates might be biased. To investigate this, figure F.1 below plots the average residuals of the baseline specification by density, which are obtained by estimating equation 1 without including the density measure. The log-linear functional form specification appears to be a reasonable approximation for the relationship observed between density and teacher recommendation in the data, with the exception of observations in the bottom 1% of the density distribution (below log density of 10), which perform somewhat better than would be expected based on the log-linear specification.

Figure F.1: Distribution of the density measure



Note: Density measure based on the log population within a 10 kilometer radius on the zip code of residence at the start of the final primary school year. The residuals are obtained by estimation equation 1 without the density measure, with the residuals averaged over 0.1 wide bins. The fitted regression is weighted by the number of observations. Bins with fewer than 500 observations not displayed as the estimates are fairly noisy.