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Original Article

Masked by the mean: immigrants in school and differential effects on student achievements

Solveig T. Borgen

Department of Sociology and Human Geography, University of Oslo, P.O. box 1096, Blindern 0317, Oslo, Norway
Corresponding author. Email: s.t.borgen@sosgeo.uio.no

Abstract

Immigrant inflows to Europe have changed student compositions in and across schools. Despite the strong intuition that peers matter for student outcomes, a comprehensive literature finds nil or moderate effects of immigrant peers. This study explores three reasons for this mismatch. First, it uses quantile regressions to reveal whether estimates on the average of the outcome mask differential effects across the outcome distribution. Second, it estimates the effect of attending schools with different immigrant shares, which is a composite of peer effects and the effects of school traits. Third, it compares the effects on teacher-assigned grades and objective standardized tests to explore whether the effects of immigrant share are influenced by teachers' grading practices. The results show that high achievers in schools with higher immigrant shares get better grades from their teachers, likely because they are assessed relative to peers with lower academic and socioeconomic levels. However, they show no sign of improved test scores. In contrast, low achievers obtain better test scores when having immigrant peers and this academic improvement is not explained by the general academic and socioeconomic level among peers. The findings demonstrate that effects on the mean outcome mask differential effects across outcome distributions.

Introduction

European countries have experienced a rapid increase in immigration flows, which have changed the composition of students in and across schools during the last decades (Brunello and De Paola, 2017). Yet, despite the strong intuition that peers influence student outcomes (Angrist, 2014), a comprehensive literature finds modest, if any, effects of immigrant peers on student outcomes, at least for natives (e.g., see the reviews by Van Ewijk and Sleegers (2010) and Brunello and De Paola (2017)). This study presents three possible reasons why earlier studies may fall short of identifying the consequences of attending schools with more immigrant peers.

First, modest immigrant peer effects could conceal that the presence of immigrant peers influences different students in disparate ways and that these effects level each other out. Having immigrant peers may, for instance, negatively affect a student's educational outcomes because, on average, the academic achievement levels of immigrants are lower (OECD, 2010; Sacerdote, 2011). However, if teachers lower their level of teaching to accommodate more immigrant students in school, this may aid the performance of low achievers while depriving high achievers of a level of teaching that allows them to excel (Lazear, 2001; Betts and Fairlie, 2003). Previous research typically uses linear regression models to estimate effects on the mean of the outcome, which may mask different effects for low- and high-achieving students.

Second, schools with a high share of immigrants may affect students apart from the immigrant peer effects (Raitano and Vona, 2010; Reardon and Owens, 2014; Borgen, 2021). Studies on school segregation have largely investigated the effects of being exposed to immigrant peers (i.e., immigrant peer effects), holding other school traits constant by using, for instance, school fixed effects (e.g., Hermansen and Birkelund, 2015), or by including controls for observed school traits (e.g., Jensen and Rasmussen, 2011). However, schools' immigrant share may influence students via both peer exposure and exposure to school characteristics that are associated with immigrant density, both of which are consequences of school segregation.

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Finally, obtaining good grades may be easier in schools with many immigrant peers. Since immigrants have lower academic achievements on average (OECD, 2010), more immigrant peers could make the best students appear better in the eyes of their teachers, regardless of their actual and objective academic achievements (Jonsson and Mood, 2008). Such 'teacher grading bias' could attenuate or conceal whether and how the share of immigrant peers affects students' learning.

This paper uses high-quality population-wide register data to study the effect of attending Norwegian lower secondary schools with different shares of immigrant students.[1] The paper contributes to the literature by addressing the three concerns presented above. First, I investigate whether the share of immigrant students affects low- and high-achieving students differently by supplementing traditional ordinary least squares (OLS) estimates with quantile regressions (Firpo, 2007). Quantile regressions allow me to look at effects at different parts of the outcome distribution. These types of heterogeneous effects are different from looking at the effects of various immigrant groups or effects on the mean for different groups (i.e., interaction variables). Second, I examine whether the effects of the immigrant share in schools work through exposure to immigrant peers or other school traits typical for schools with a high share of immigrant students. Value-added models (VAMs) are used to estimate the effect of immigrant share. These estimates are compared with the estimates from VAMs that control for the student body's academic and socioeconomic status (SES) composition and to VAMs that include school-fixed effects and thereby isolate the immigrant peer effects. Third, I investigate teacher grading effects by comparing the effects of the immigrant share on teacher-assigned grades with the effects on anonymously rated (objective) national test scores.

In the following, I present theoretical accounts of why and how attending schools with more immigrant students may affect academic outcomes. I then give a brief overview of previous research before I describe the Norwegian context and data. After that, I describe the methodological strategies and finally present and discuss the results.

Differential effects of attending schools with more immigrant peers

This study investigates whether attending schools with more immigrant peers has different effects on different students. First, the effects of the school's immigrant share may stem from exposure to immigrant peers. I apply a broad definition of peer effects that encompass all externalities of peers' characteristics and their actions, including effects that work through, for instance, changes in teaching or teachers' actions (Sacerdote, 2011). Additionally, the effects of attending schools with more immigrant peers could stem from school traits that correlate with the school's immigrant share (Reardon and Owens, 2014). In this section, I start by clarifying the distinction between the effects of peers and the effects of school traits, followed by a discussion of why attending schools with more immigrant peers may affect different students in disparate ways.

Effects of immigrant peers

There are reasons to expect both negative and positive spillover effects of traits that are typical for immigrant children. Compared to natives, immigrants have lower SES on average (Widmaier and Dumont, 2011) and, relatedly, lower academic achievements (OECD, 2010) (see also Table 1, which confirms these patterns in Norwegian register data). These characteristics could spill over on fellow students' achievements (Hoxby, 2000; Crowder and South, 2003). Furthermore, immigrants exhibit lower language proficiency on average (Espenshade and Fu, 1997; OECD, 2010) and show more behavioural issues (Hällsten, Szulkin, and Sarnecki, 2013), which may demand more attention from the teacher and thereby harm their peers' educational achievements (Lazear, 2001; Fletcher, 2010). Simultaneously, immigrants have been shown to have more positive attitudes towards school, spend more time doing homework, and have higher educational aspirations (Lauglo, 1999; OECD, 2010; Jonsson and Rudolphi, 2011; Friberg, 2019). This 'immigrant drive' could spill over on their peers and improve their academic motivation and achievements.

Moreover, whether and how peers' characteristics spill over on a student's achievements may depend on peers' characteristics *relative* to that student. While the normative model of peer effects suggests that having high-achieving peers is favourable for students' educational achievement (Goldsmith, 2011), social contrast theories imply more complex mechanisms. Students who compare themselves to relatively high-achieving peers may experience lower expectations and beliefs in their own academic competence (i.e., the small-frog-in-a-big-pond effect), while students who compare themselves to relatively low-achieving peers may experience the opposite (i.e., the big-frog-in-small-pond effect) (Davis, 1966; Jonsson and Mood, 2008; Crosnoe, 2009; Rosenqvist, 2018). Thus, to the degree that immigrant peers have lower academic achievements on average, more immigrant peers could boost students' academic motivation and thereby their achievements.

Overall, one might expect both negative and positive spillover effects of immigrant peers. Such

Table 1 Variable descriptions and descriptive statistics

	Full sample					Natives	Immigrants		
	N	Mean	SD	Min	Max	Mean	Mean	Difference	Additional variable descriptions
Treatment									
Share of immigrant peers in 8th grade	299,603	0.094	0.119	0	0.984	0.079	0.236	−0.157*	Share of 8th grade school cohort peers who are born abroad or by foreign-born parents, excluding self.
Outcomes									
Grade point average	291,705	40.215	8.447	1.3	60	40.487	37.508	2.980*	Sum of teacher assigned final assessment grades and oral and written final exam grades assigned by external teachers.
Teacher assigned grades	290,024	3.703	1.009	1	6	3.742	3.309	0.433*	Mean of *Math grade* and *Norwegian grade*.
Math grade	288,088	3.556	1.217	1	6	3.590	3.216	0.374*	Teacher assigned final assessment grade in Math from 10th grade.
Norwegian grade	288,146	3.864	1.001	1	6	3.905	3.444	0.461*	Teacher assigned final assessment grade in written Norwegian, 10th grade.
National test scores	176,368	31.630	9.441	0	58	32.102	27.196	4.906*	Mean of n*ational test score in reading* and *national test score in Math*.
National test score in reading	169,441	29.310	8.521	0	47	29.752	25.064	4.688*	Anonymously rated, standardized national test score in Reading, 9th grade.
National test score in math	171,167	34.212	11.988	0	58	34.695	29.667	5.028*	Anonymously rated, standardized national test score in Math, 9th grade.
Individual characteristics									
8th-grade national test scores in Reading	281,536	26.505	8.587	0	48	27.029	21.143	5.886*	Anonymously rated, standardized national test score in Reading, 8th grade.
8th-grade national test scores in Math	286,131	33.189	13.268	0	76	33.716	27.911	5.805*	Anonymously rated, standardized national test score in Math, 8th grade.
Gender	299,961	0.488	n/a	0	1	0.488	0.489	−0.001	1 = female.
Number of siblings	299,815	2.002	1.276	0	18	1.948	2.520	−0.572*	Including half siblings.
Birth order	299,962	1.926	1.023	0	15	1.910	2.082	−0.172*	Within mother's children.
Residential relocation	299,963	0.152	n/a	0	1	0.140	0.275	−0.135*	1 = relocated during compulsory education.

Table 1. Continued

	Full sample				Natives	Immigrants		
	N	Mean	SD	Min	Max	Mean	Mean	Difference	Additional variable descriptions
Mother's age at birth	299,338	28.950	5.084	9	52	29.115	27.316	1.799*	Mother's age when giving birth to the individual.
Family structure	299,087	0.723	n/a	0	1	0.720	0.754	−0.034*	1 = lived in an intact or reconstituted family at age 16.
Immigrant background									
None	299,961	0.816	n/a	0	1	0.900	0.000	0.900*	Dummies for combinations of the individual's and its parents' native or immigrant origin.
Immigrant without Norwegian background	299,961	0.050	n/a	0	1	0.000	0.535	−0.535*	
Born in Norway by two foreign-born parents	299,961	0.044	n/a	0	1	0.000	0.465	−0.465*	
Born abroad with one Norwegian parent	299,961	0.008	n/a	0	1	0.009	0.000	0.009*	
Born in Norway with one foreign-born parent	299,961	0.071	n/a	0	1	0.078	0.000	0.078*	
Born abroad by Norwegian-born parents	299,961	0.011	n/a	0	1	0.013	0.000	0.013*	

Table 1. Continued

	Full sample					Natives	Immigrants		
	N	Mean	SD	Min	Max	Mean	Mean	Difference	Additional variable descriptions
Region of origin									
Norway	299,961	0.887	n/a	0	1	0.978	0.000	0.978*	Dummies for region of origin, based on registered country of birth. If born in Norway, the student inherits mother's country of birth (regardless of father's country of birth). If both the student and the mother are born in Norway, the student inherits the father's country of birth. Appendix H lists countries making up each region.
Western Europe and Northern America	299,961	0.019	n/a	0	1	0.010	0.115	−0.106*	
Eastern Europe	299,961	0.018	n/a	0	1	0.001	0.185	−0.184*	
Asia	299,961	0.025	n/a	0	1	0.006	0.207	−0.201*	
Middle East and Northern Africa	299,961	0.037	n/a	0	1	0.000	0.394	−0.393*	
Sub-Saharan Africa	299,961	0.008	n/a	0	1	0.001	0.071	−0.070*	
Latin America	299,961	0.006	n/a	0	1	0.003	0.028	−0.025*	
Parental characteristics									
Parental income	299,544	51.669	27.969	1	99	54.550	23.543	31.007*	The sum of parents' average annual earnings when the individual is 11–15 years of age, ranked in percentiles within the individual's birth cohort.
Parental receipt of social welfare	299,815	0.106	n/a	0	1	0.081	0.350	−0.269*	1 = the parents received total social welfare transfers above the monthly b.a. threshold in one or more years when the individual was 11–15 years of age.+
Parental education level									
Postsecondary, MA level or more	299,619	0.134	n/a	0	1	0.137	0.103	0.035*	Dummies for the highest education level attained by either parent when the individual is 16 years of age.
Postsecondary, BA level	299,619	0.354	n/a	0	1	0.367	0.226	0.141*	
Upper secondary	299,619	0.421	n/a	0	1	0.433	0.312	0.121*	
Basic compulsory or less	299,619	0.086	n/a	0	1	0.063	0.308	−0.245*	
Unknown	299,619	0.005	n/a	0	1	0.000	0.052	−0.051*	

Table 1. Continued

	Full sample					Natives	Immigrants		
	N	Mean	SD	Min	Max	Mean	Mean	Difference	Additional variable descriptions
Native peers' characteristics									
Average parental years of education	299,963	54.504	9.635	1	93.500	54.549	54.068	0.481*	Mean years of parental education among native peers, measured when peers are 16 years old.
Share with information on parental education	299,963	0.999	0.003	0.889	1	0.999	0.999	−0.000	Share of native peers with information on parental education.
Average parental income	299,963	12.971	0.886	7	18	12.974	12.933	0.042*	Mean parental income among native peers, based on peers' score on the variable*Parental income*.
Share with information on parental income	299,963	0.999	0.005	0.800	1	1.000	0.998	0.001*	Share of native peers with information on parental income.
Average 8th-grade national test scores	299934	0.042	0.273	−2.561	1.995	0.038	0.081	−0.042*	Mean standardized score on anonymously rated, standardized national test scores in Reading and Math, 8th grade among native peers.
Share with registered 8th-grade national test scores	299,937	0.983	0.033	0.083	1	0.984	0.978	0.006*	Share of native peers with information on anonymously rated national test scores in Reading and Math, 8th grade.
Lower secondary school counties									Dummies for 19 counties.
Lower secondary schools									Dummies for 976 schools, included only in selected analyses.
Graduation cohorts									Dummies for graduation cohorts 2010–2014.

Note: Fewer observations for national test scores from 9th grade reflect that these tests where implemented for the first time for the 2012 graduation cohort, and thus these test scores are available only for the 2012–2014 graduation cohorts.
+ The b.a. (basic amount) threshold indicates eligibility for benefits from the Norwegian Social Insurance Scheme such as unemployment benefits, disability benefits and the old-age pensions.
*$P < 0.01$ (two-tailed t-test of difference in means for natives and immigrants).

contradicting effects of peers may mitigate or even outweigh one another (Borgen, Borgen and Birkelund, 2022). Furthermore, as discussed in the next section, attending a school setting with a high share of immigrant students may affect students in more ways than through immigrant peer effects because these schools could be systematically different from other schools (Reardon and Owens, 2014).

Effects of other school characteristics

Immigrant students typically sort into more disadvantaged neighbourhoods and schools, which results in a correlation between certain school characteristics and the immigrant share. Moreover, the share of immigrant students might, over time, change the characteristics of the school.

Such school characteristics may include the teacher and teaching quality. On the one hand, high aspirations among immigrant students (Jonsson and Rudolphi, 2011) may be inspiring for teachers (Finley, 1984). On the other hand, teachers have been shown to prefer schools with native students (Bonesrønning, Falch and Strøm, 2005) and find it more rewarding to teach academically able students, who tend to have privileged backgrounds (Finley, 1984). Thus, teacher preferences and turnover may put students in schools with a high share of immigrant peers at greater risk of low-quality teaching (Karsten et al., 2006). Furthermore, teacher effectiveness is shown to be substantially lower in schools that serve poor and minority students (Peske and Haycock, 2006), and students in these schools may receive inferior schooling in terms of curriculum, time spent on curriculum, facilities, and information on their achievements (Gandara et al., 2003).

Additionally, schools with a high share of immigrant students may host native students who are systematically different from native students at other schools. Research has shown that the general student body in immigrant-dense schools tends to have systematically lower SES (e.g., Cebolla-Boado and Garrido Medina, 2011). The register data used in this study confirm a negative relationship between students' share of immigrant peers and their native peers' parental education and income.[2] Thus, we could expect that the immigrant share affects student outcomes through spillover effects from natives' SES as well as through the above-mentioned spillover effects from immigrants.

However, the school's immigrant share could also be related to school characteristics that are beneficial for students. For example, the performance gap between immigrants and natives in most OECD countries has spurred a range of policy initiatives, which provide extra resources and initiatives to schools with high shares of immigrants (OECD, 2010). Furthermore, it could generally be easier to get good grades in schools that typically have more immigrant students. As argued in the previous section, having immigrant peers with, on average, lower academic achievements could boost students' belief in their own academic competence. However, it could also make them *appear* better in the eyes of their teachers (Jonsson and Mood, 2008), which may lead to *less* harsh teacher assessments (Crosnoe, 2009). Such 'teacher grading bias' could make it easier to obtain good grades when the share of immigrants is high even without improving objective academic abilities (Cebolla-Boado and Garrido Medina, 2011).

Thus, the overall effects of attending schools with more immigrant students could be a composite of positive and negative effects of immigrant peers and school traits that are correlated with, or caused by, the immigrant share. Moreover, these contradicting mechanisms could play out in disparate ways for different students, as discussed below.

Differential effects of immigrant density

Differences and alterations in teaching could be one reason why the immigrant share might affect students differently. As mentioned above, schools with a high immigrant share are likely to receive extra resources targeted towards students with special needs (OECD, 2010). These targeted resources could make schools specialized in teaching low-achieving students in particular. Compensatory practices within these schools could further benefit low achievers (Downey and Condron, 2016). The individual teacher may give more attention to students who struggle academically (Loveless, Parkas and Duffett, 2008) and could lower the level of teaching in classes with a higher share of immigrant students to accommodate a lower achievement level on average (Cebolla-Boado and Garrido Medina, 2011; Hunt, 2017). Such specializations and alterations in the learning environment and teaching level would generally provide low achievers with teaching accustomed to their abilities while simultaneously depriving high achievers of teaching that allows them to excel further (Lazear, 2001; Betts and Fairlie, 2003). At the same time, providing extra resources to schools with a high share of immigrant students could exceed the resources required to accommodate students with special needs and thereby benefit their high-achieving peers as well (Hanushek, Kain and Rivkin, 2002; Fletcher, 2010).

A second reason for differential effects may be the above-mentioned teacher grading bias. As noted above, less harsh teacher assessment could make it easier to obtain good grades when the share of immigrant students is high (Crosnoe, 2009; Cebolla-Boado and Garrido Medina, 2011). Although this may imply that

teachers shift the entire grade distribution upwards, it might also affect students differently across the grade distribution. Studies show that teachers prefer to use the whole grade scale, but also that they avoid assigning the lowest grade (Prøitz and Borgen, 2010). The teacher grading bias likely has the strongest impact on the top of the grade distribution, where the room for teacher discretion is larger.

Lastly, the share of immigrants in school may affect students differently if students' resilience to unfavourable school settings differs. High-achieving students are more likely to have high-SES parents with the resources to compensate for school deficiencies (Bernardi, 2014). For instance, high-SES parents may compensate by providing the student with more instruction at home (Hunt, 2017). Since high achievers are more likely to have high-SES parents, these students may be more resilient to the above-mentioned negative spillover effects, adjustments in teaching level, and teacher quality. This implies that low achievers are more likely to be affected by school quality and fare relatively worse than high achievers in unfavourable school settings.

In summary, several mechanisms may produce effects of attending schools with more immigrant peers, and these mechanisms could play out differently for low- and high-achieving students. However, the existing literature almost exclusively estimates effects on the mean of the outcome, which may mask such differential effects.

Previous research

The literature on immigrant peer effects is mixed and includes studies that find negative effects (e.g., Szulkin and Jonsson, 2007; Gould, Lavy and Paserman, 2009; Contini, 2013; Veerman, van de Werfhorst and Dronkers, 2013; Schneeweis, 2015; Bossavie, 2017; Ballatore, Fort and Ichino, 2018; Fletcher et al., 2019), zero effects (e.g., Bifulco, Fletcher and Ross, 2011; Schwartz and Stiefel, 2011; Geay, McNally and Telhaj, 2013; Ohinata and Van Ours, 2013; Conger, 2015; Brandén, Birkelund and Szulkin, 2018), and even positive effects (e.g., Silveira et al., 2019). In the Norwegian setting, Hardoy and Schøne (2013) find negative immigrant peer effects in upper secondary school. However, these findings are disputed by Hardoy, Mastekaasa and Schøne (2018), who find no evidence of immigrant peer effects. Hermansen and Birkelund (2015) observe no immigrant peer effects on short-term educational outcomes in lower secondary schools and modest positive effects on long-term outcomes.

The above-mentioned studies estimate immigrant peer effects by keeping school characteristics from influencing the estimates. However, few researchers have attempted to estimate the joint effect of exposure to immigrant peers and school characteristics of schools with a high share of immigrants. One obvious reason is that many studies have primarily been interested in isolating immigrant peer effects. Another reason could be the challenge of overcoming selection bias, which studies on immigrant peer effects often handle in a simple and elegant way by keeping schools, and thus their characteristics, fixed (e.g., Conger, 2015; Hermansen and Birkelund, 2015; Hardoy, Mastekaasa and Schøne, 2018; Fletcher et al., 2019). However, even studies comparing students who attend different schools often control for school characteristics to isolate immigrant peer effects (e.g., Fekjær and Birkelund, 2007; Agirdag, Van Houtte and Van Avermaet, 2011; Jensen and Rasmussen, 2011).

Cebolla-Boado and Garrido Medina (2011) consider school effects when investigating the impact of immigrant concentration on school results. They find negative effects that differences in school resources cannot explain. They also find indications that teachers alter their teaching strategy to aid low-achieving students. Investigating the Norwegian setting, Fekjær and Birkelund (2007) estimate the effects of the share of immigrant peers without adjusting for student sorting across schools. They find a small positive effect on the share of immigrant peers, but only after controlling for the school's academic composition.

One previous study and a master thesis have investigated differential immigrant peer effects using conditional quantile regressions, where the outcome distribution's quantiles are defined *conditional* on covariates (Marcato, 2016; Ohinata and Van Ours, 2016). Such estimates are valuable if one is interested in estimating immigrant peer effects on what is a high (low) quantile conditional on covariates. However, it is not a suitable approach when interested in the effect on low-achieving- versus high-achieving students because low-achieving students are more likely to have, for instance, lower SES (Killewald and Bearak, 2014). See Killewald and Bearak (2014), Wenz (2019), and Borgen, Haupt, and Wiborg (2021) for a discussion of the appropriate interpretation of results from different quantile regression approaches.

Overall, the theoretical expectations of how immigrant peers and other school traits typical for schools with more immigrant students affect student outcomes are complex and potentially contradicting. Moreover, the effects may vary depending on students' achievement level, which adds another layer of complexity to the theoretical expectations. Given the complexity of potential mechanisms and the contradicting findings of previous research, I refrain from stating clear hypotheses on the expected effects of immigrants in school.

The Norwegian setting

Norwegian school politics have been substantially influenced by social democratic ideas of equality and justice (Oftedal Telhaug, Mediås and Aasen, 2006). All children in Norway attend compulsory primary school (grades 1–7) without being graded or academically tracked. Admission to compulsory lower secondary school (grades 8–10) is based on local catchment areas rather than academic achievements. In lower secondary school, students obtain GPA, which they use to compete for admission to their preferred upper secondary school and program.

All schools offering compulsory education are publicly funded, and most of them are publicly owned and do not charge tuition fees. As of 2018, about 96 per cent of students gaining compulsory education attended public schools (Statistics Norway, 2018). Although a school reform in 2006 gave local schools more freedom to define subject content and teaching methods, the government prescribes centralized basic curricula (Oftedal Telhaug, Mediås and Aasen, 2006), which reduces differences between schools. Accordingly, most variation in student achievements occurs within schools and not between schools (OECD, 2019).

Given the modest contextual differences between schools and high rates of intergenerational socioeconomic mobility (Corak, 2013), the consequences of school segregation in Norway may be smaller than the corresponding effects in countries with more inequality. Nevertheless, schools with a high share of immigrants are likely to be systematically different from other schools in ways that affect student outcomes. On average, immigrants have poorer academic achievements and lower SES in terms of parental income and education compared with natives (see the descriptive statistics in Table 1). Simultaneously, immigrant students also show higher educational aspirations and spend more time on homework (Friberg, 2019).

Teachers in Norway seem to prefer teaching at schools with native students, and such teacher sorting may put students in schools with high shares of immigrant students at greater risk of low-quality teaching (Bonesrønning, Falch and Strøm, 2005). However, a range of policy measures may counter negative peer effects and the potential lower teacher quality. Among them are the provision of extra financial resources to schools with immigrants in need of language support, strategic plans to strengthen multicultural and inclusive teaching, supplementary education for bilingual teachers, and programs to involve, assist, and upskill immigrant parents (Hægeland, Raaum and Salvanes, 2005; OECD et al., 2010; OECD, 2010).

Data and variables

I use rich, population-wide administrative Norwegian data covering students who graduate from lower secondary school in the period 2010 to 2014. Unique personal identifiers make it possible to link information about an individual's education, schools, residential location, and immigration background. Furthermore, individuals can be linked to their parents and siblings, which provides information on family characteristics and parental SES.[3]

The treatment variable *share of immigrant peers* measures the individual's share of school cohort peers who are born abroad or in Norway by foreign-born parents (excluding the self) at time of lower secondary school enrolment. The treatment variable ranges from 0 to 1, where 1 indicates 100 per cent immigrant peers. The crude distinction between immigrants and natives fails to capture the diversity of the immigrant population, both regarding their geographical origin and other social traits. However, such a dichotomy allows for a suitable focus on the main argument of the study. Appendix A, nevertheless, provides results from analyses in which immigrant peers are defined as those born in a non-OECD country or Norway by parents born in non-OECD countries.[4]

Norwegian registers lack information on the assignment of students into classes within their school cohort. The average cohort size in the sample is 94.6 students, and most students are thus likely to experience considerably more proximity to peers within their class than to peers in other classes within the school cohort.[5] While measuring the treatment at the school cohort level instead of the class level does not bias the estimated effects of immigrant concentration, it will likely result in less precise estimates. An upside is, however, that measuring at the school cohort level instead of at the class level circumvents potential bias arising from the schools' non-random sorting of students and teachers into classes.

I use three main outcomes. *Grade point average* (*GPA*) is calculated from teacher-assigned final assessment grades (usually 14 grades) and oral and written final exam grades assigned by external teachers (usually two grades) and varies on a continuous scale from 1.3 to 60.[6] *Teacher-assigned grades* measure the individual's mean of 10th-grade teacher-assigned final assessment grades in two subjects; written Norwegian and Math. This outcome varies by 0.5 grades and takes 11 unique values from 1 to 6.[7] *National test scores* is the individual's mean score on anonymously rated and standardized national tests from the 9th grade in the two corresponding subjects, Reading and Math.[8] It varies on a continuous scale from 0 to 58 and is only available for the cohorts graduating between 2012 and 2014.[9] While *GPA* and *teacher-assigned grades*

are measured after students have been exposed to the treatment for three years, *national test scores* are measured after two years. All outcomes are standardized with a mean of 0 and a standard deviation of 1.

To control for confounding student characteristics, I use dummies for gender, family structure, residential relocation, lower secondary school county, immigrant category, and region of origin. I also include first- and second-order terms for mother's age when giving birth, number of siblings, and birth order.[10] National test scores from the 8th grade, which essentially are entry test scores, represent pre-treatment assessments of the student's objective academic skills that allow for VAMs (as discussed later). I include first- and second-order terms for the 8th-grade national test scores in Math and Reading. Additionally, I interact with each of the test scores with the lower secondary school county to rule out potential local variations in how tests are scored. Controls for parental characteristics include first- and second-order terms for parental income and dummies for parental receipt of social welfare and parental education level.

Analyses that adjust for academic and SES composition among peers include controls for native peers' average parental years of education, average parental income, and average 8th-grade national test scores, in addition to the share of native peers who have information on parental education, parental income, and 8th-grade national tests scores.[11] Table 1 describes the variables and gives descriptive statistics.

Methodological strategies

Students in schools with many immigrant peers are systematically different from other students in ways that may affect their educational outcomes, such as academic achievements and parental SES (Appendix Figure I1). If not taken into account, this selection may bias the estimated effect of the immigrant share.

Thus, I use information on a range of individual and parental characteristics to account for selection, including students' 8th-grade entry test scores. The test scores provide an objective pre-treatment assessment of students' academic achievements. Controlling for 8th-grade national test scores amounts to a VAM, which are widely used to separate the contributions of educational inputs on student achievements (Koedel, Mihaly and Rockoff, 2015). In this case, the VAM distinguishes the effect of the immigrant share in school from the effects of the initial academic achievement level of students who typically sort into schools with higher immigrant shares. There is a strong correlation between 8th-grade entry test scores and later academic achievements (9th-grade national test scores and 10th-grade teacher-assigned grades) (Supplementary Appendix J). This gives support to the assumption that student characteristics that affect academic achievements are already 'realized' in the pre-treatment achievements and that including these pre-treatment achievements as controls accounts for selection effects. I, nevertheless, also control for other observed individual and parental characteristics in the VAM. The VAM can be expressed as

$$Y_{isc} = \beta_0 + \beta_1 I_{isc} + \beta_2 X_{isc} + \delta_c + \varepsilon_{isc} \quad (1)$$

where i, s, and c indicate individual, school, and cohort, respectively. Y is the outcome of interest, and I presents the individual's proportion of immigrant peers in the school cohort (excluding the self). X is a vector of individual and parental characteristics, including national test scores from the 8th grade, δ denotes cohort fixed effects, and ε is an individual error term clustered on lower secondary school.

Isolating immigrant peer effects

The VAM presented by equation 1 captures the effect of the immigrant share, which includes immigrant peer effects *and* the effects of school characteristics that correlate with this share, such as teacher quality, teaching traditions, and resources. The model shown by equation 2 isolates immigrant peer effects by adding school-fixed effects to the VAM. Relying solely on variation within schools, the school-fixed effects model keeps time-invariant school characteristics from influencing the estimate and isolates the effects of immigrant peers and their characteristics (Hoxby, 2000)[12];

$$Y_{isc} = \beta_0 + \beta_1 I_{isc} + \beta_2 X_{isc} + \delta_c + \alpha_s + \varepsilon_{isc} \quad (2)$$

where αdenotes school-fixed effects.[13] To examine the role of academic and SES composition, the estimated β_1 from equations 1 and 2 are compared with β_1 from similar models where X also includes controls for academic and SES composition among peers.

Differential effects across the outcome distribution

I use unconditional quantile regressions (UQR) to examine whether the treatment effects of immigrant share in schools vary across the outcome distribution (Firpo, Fortin and Lemieux, 2009).[14] However, because of the ongoing debate on the correct interpretation of various quantile regression models (Wenz, 2019; Borgen, Haupt and Wiborg, 2021), I have also checked whether the generalized quantile regression model (Powell, 2020) provides the same results as the UQR model. In this case, the generalized quantile regression model provides similar point estimates to the UQR model (Supplementary Appendix L).

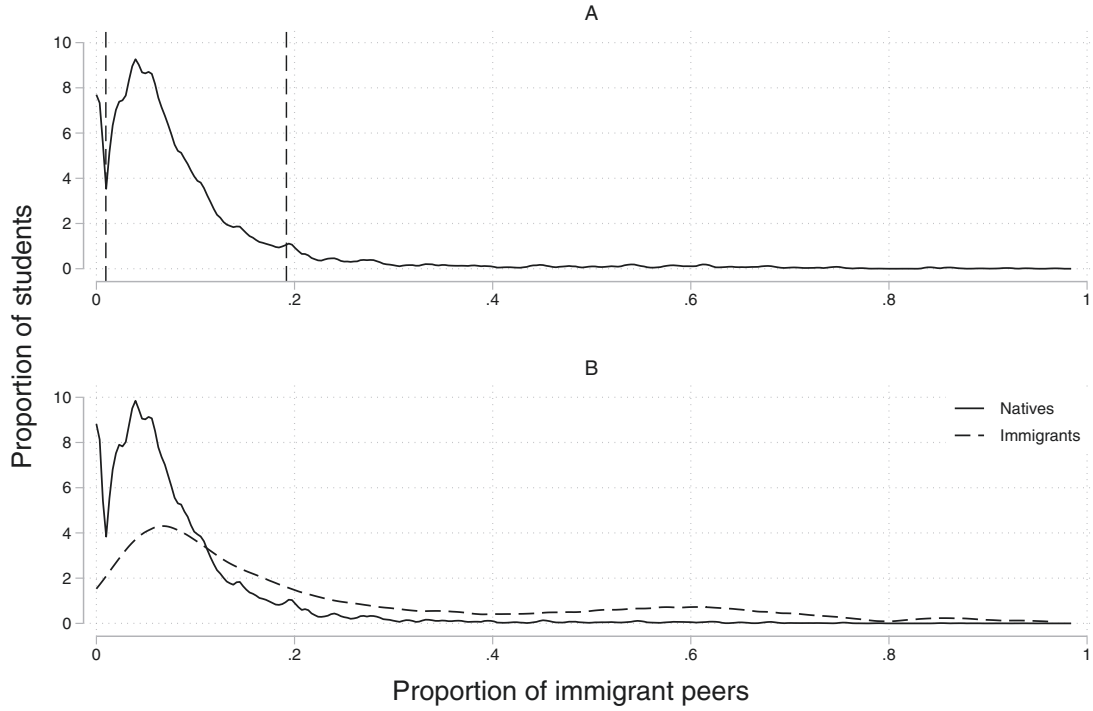

Figure 1 Proportion of students with different proportions of immigrant peers. (A) All students, marking the 10th and 90th quantiles of the distribution. (B) Separate distributions for natives and immigrants.

Results

Let me begin by showing some descriptive statistics. The maximum share of immigrants observed is as high as 98.4 per cent. However, as shown in Figure 1A, only about 10 per cent of students are exposed to more than 20 per cent immigrants. There is roughly a 20 percentage-points difference in the share of immigrants between the 10th and 90th quantile. I will interpret the results from the main analyses in terms of effects from a 20 percentage-point difference in immigrant share. Figure 1B shows that immigrant peers are unevenly distributed among natives and immigrant students in lower secondary school, indicating school segregation. On average, natives do better than immigrants on all three main outcomes, as shown in Figure 2.

Figure 3 shows the main results using both the VAMs (Panel A, C, and E) and the value-added school fixed effects models (Panels B, D, and F) for the outcome variables GPA (Panels A and B), teacher-assigned grades (Panels C and D), and national test scores (Panels E and F). I start by commenting on the results from models without controls for academic and SES composition among peers (blue, circle-shaped markers) and then compare these estimates to those adjusted for such peer composition (red, square-shaped markers).

The VAM in Panel A shows the estimated overall effects of the schools' immigrant share, capturing effects of both peers and correlated school characteristics. The OLS estimate at the top tells us that attending a school with more immigrant peers has a modest, positive effect on students' GPA, but this coefficient is not statistically significant at the 5 per cent level. However, the quantile regression estimates show tendencies of a negative effect on low-achieving students, which turns increasingly positive across the GPA distribution, and even significantly positive for the high achievers (quantiles 70, 80, and 90). For example, a 20 percentage-points increase in immigrant share raises students' GPA at the 90th quantile by (0.149 × 0.2) 3 per cent of a standard deviation. Overall, Panel A indicates that differential effects of attending schools with more immigrant peers are masked by estimates of the mean of the outcome. It also shows that the benefits of the immigrant share increase in line with students' achievement levels.

Supplementary Appendix O shows that the positive effect of the schools' immigrant share on high-achieving students' GPA is stronger for immigrant students. For example, a 20 percentage-points increase in the share of immigrant peers raises immigrants' GPA at the 90th quantile by (0.232 × 0.2) 4.6 per cent of a

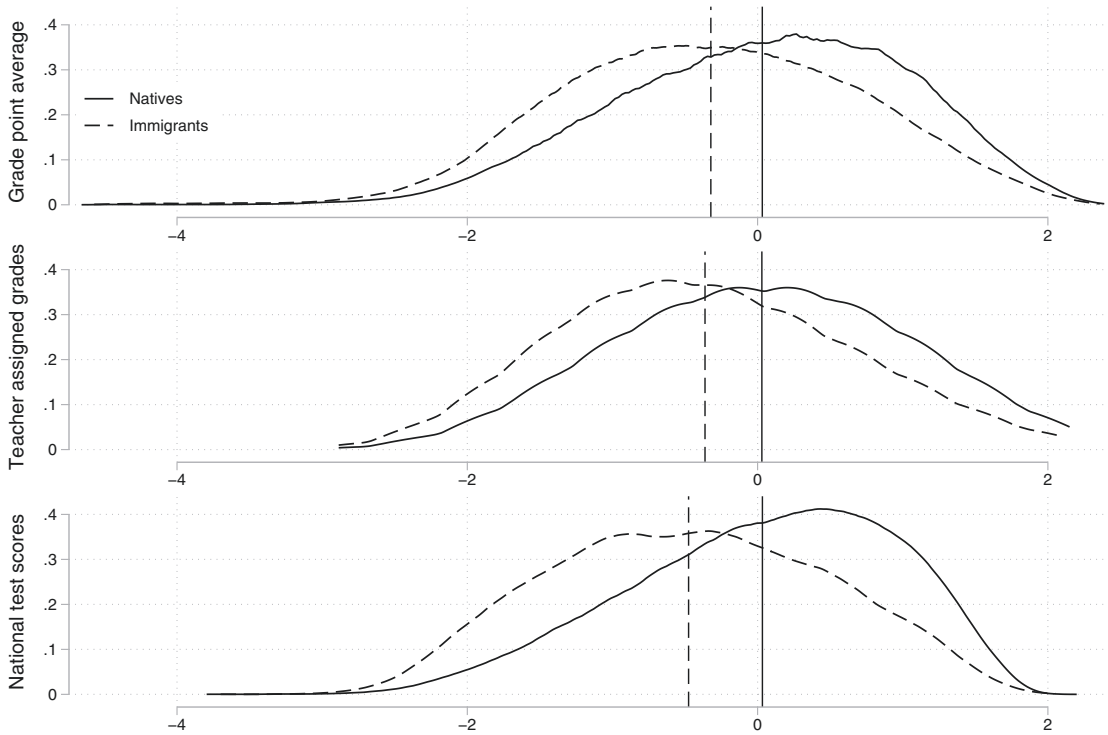

Figure 2 Distribution of the outcomes grade point average, teacher-assigned grades, and national test scores, separate for natives and immigrants.

standard deviation. However, the tendencies across the outcome distributions in all panels shown in Figure 3 are quite similar for natives and immigrants.

Two possible reasons why students increase their GPA from attending schools with higher shares of immigrant peers may be that they get better academic abilities and that it is easier for them to obtain good grades in these schools. One way to separate these mechanisms is to compare the effects on teacher-assigned grades to the effects on objective measurements of academic achievements (Panel C compared to Panel E). The effect on the mean of teacher-assigned grades is positive according to the OLS estimate in Panel C, and the effect seems to be increasingly positive across the outcome distribution (comparable to the effects on GPA shown in Panel A). Low achievers at the 10th quantile get (0.0757 × 0.2) 1.5 per cent of a standard deviation higher teacher-assigned grades from having 20 percentage-points more immigrant peers—an estimate that is borderline significant. For high achievers at the 90th quantile, the improvement is (0.17 × 0.2) 3.4 per cent of a standard deviation. Panel E shows a positive effect for low achievers when it comes to national test scores as well. Low achievers at the 10th quantile get (0.153 × 0.2) 3 per cent of a standard deviation higher scores from having 20 percentage-points more immigrant peers. The positive effects on both teacher-assigned grades and national test scores indicate that low achievers improve their academic skills from having immigrant peers. High achievers, on the other hand, show no significant improvement in national test scores despite their improvement in teacher-assigned grades. This indicates a teacher grading bias mechanism benefitting the most able students, in the sense that higher grades are assigned at the top of the grade distribution, despite no significant improvement at the top of the national test score distribution.

Differences between effects on teacher-assigned grades and objective test scores can only be interpreted as teacher grading bias if high (low) achievers in terms of school grades are high (low) achievers in terms of test scores. It is difficult to assess whether this assumption holds; while a strong correlation between the measures would be a convincing test, we should simultaneously expect the teacher grading bias, if it exists, to obscure this correlation. Nevertheless, a reasonably strong correlation is observed between the two measures (*Rho* = 0.77), and the overlap is larger at the top and bottom of the distributions (Supplementary Appendix P). Although some uncertainty remains, these results suggest that at an aggregated level, differences between effects on school grades and test scores are indicative of teacher grading bias.

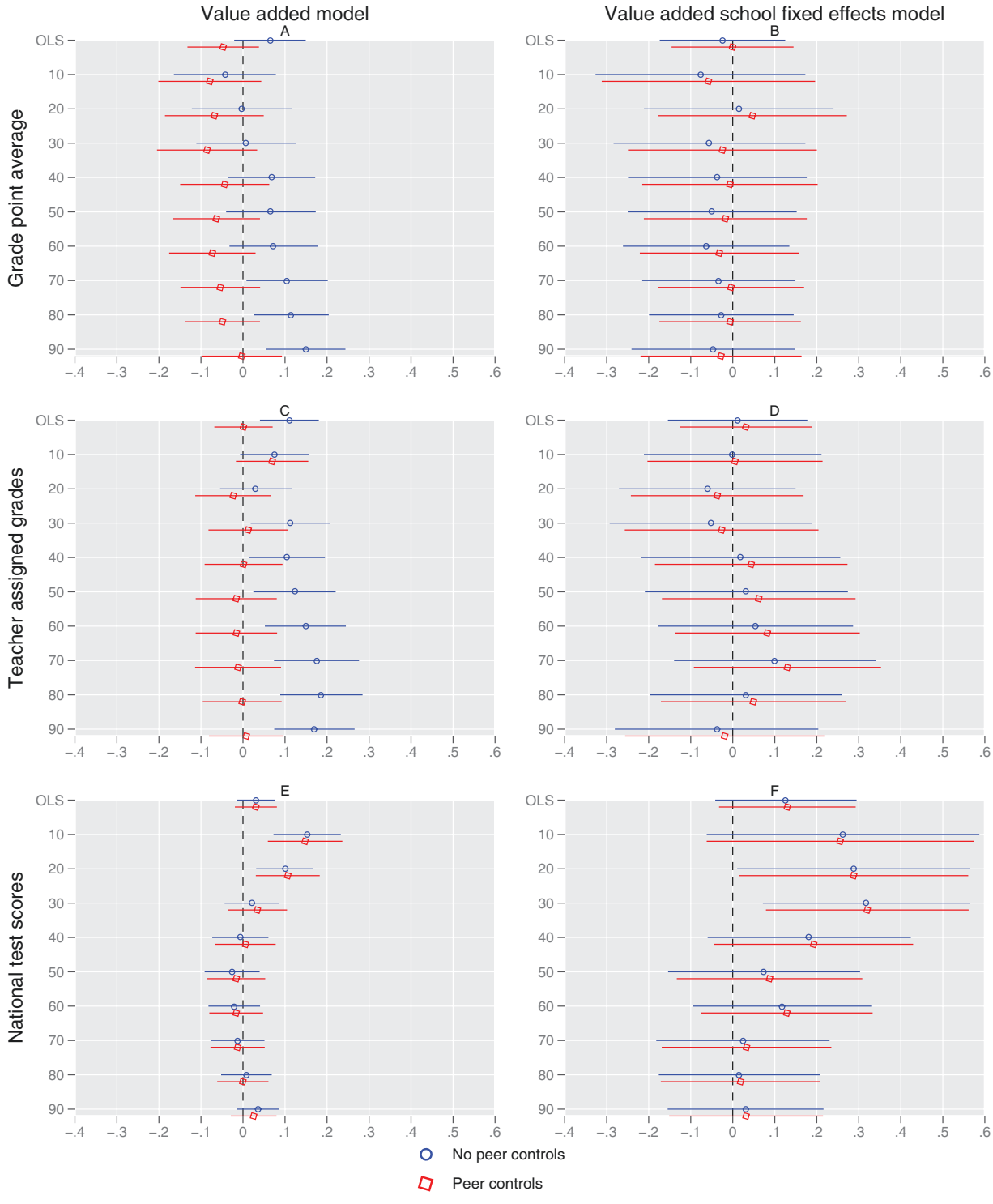

Figure 3 Effects of share of immigrant peers on grade point average, teacher-assigned grades, and national test scores, estimated using value-added models and value-added fixed effects models. Note: The top estimates (OLS) are from ordinary least square regression models, and the subsequent estimates (10-90) are from unconditional quantile regression models for quantiles 10 to 90 estimated by RIF-OLS using a Gaussian kernel function. The density curves used for the RIF-OLS models in Panels C and D are smoothed using

a bandwidth of 0.5. Appendix M shows the distribution of teacher-assigned grades with different degrees of oversmoothing, and demonstrates that the estimated effects are insensitive to oversmoothing. All models include dummies for 8th-grade cohort, gender, family structure, residential relocation, immigrant category, region of origin, school county, parents' social welfare, and parents' education, as well as first and second order terms for the number of siblings, birth order, mother's age at birth, parental income, 8th-grade national test scores in Reading and Math, and interactions between these scores and school counties. Models with peer controls include averages of native peers' parental years of education, parental income, and 8th-grade national test scores, as well as variables giving the share of native peers with information on parental education, income and 8th-grade national test scores. Sample size is for Panels A–B = 266,813, for Panels C–D = 265,762, and for Panels E–F = 161,251. Missing values are handled by listwise deletion. Confidence intervals (95 per cent confidence level) are from cluster-robust standard errors clustering on lower secondary school. See Appendix N for exact estimates and standard errors.

The red, square-shaped markers in Figure 3 show results from models that adjust for the academic and SES composition among peers. The student composition explains the positive effects of immigrant share on GPA (Panel A) and, for the most part, on teacher-assigned grades (Panel C). The positive effect on teacher-assigned grades for low-achievers is, however, robust to controls for the academic and SES composition. The estimates are only borderline significant but do not shift in a negative direction like at higher locations in the outcome distribution. Likewise, the positive effect of immigrant share on low achievers' national test scores is robust to adjusting for academic and SES composition (Panel E). Overall, this indicates that the potential teacher grading bias benefitting high achievers is driven by the academic and SES level among peers. Furthermore, it shows that low achievers' academic improvement from attending schools with more immigrant peers is not explained by the academic and SES composition among peers.

Isolating immigrant peer effects

The VAMs discussed above capture the effects of both peers and other school characteristics not kept constant by controls. By utilizing the within-school variation, the value-added school-fixed effects model removes the effects of stable school characteristics and thereby teases out immigrant peer effects. There are no immigrant peer effects on GPA, neither in the OLS model nor in the quantile regression models (Panel B in Figure 3). The same goes for teacher-assigned grades shown in Panel D. Not surprisingly, controlling for the academic and SES composition among peers does not alter the estimates to a substantial degree, as the native peer composition is unlikely to vary strongly with the within-school variation in immigrant share. However, note that including school-fixed effects results in considerably less precise estimates compared with the VAMs, as these models only exploit within-school variation (see Supplementary Appendix Q). This might imply that immigrant peer effects are too small to be identified in the current data by the value-added school-fixed effects model.

However, low achievers' improvement on anonymously rated national test remains when including school-fixed effects in the VAM (Panel E compared with Panel F). Notably, the effect on test scores at the 10th quantile is not statistically significant at conventional levels. However, the increase from having 20 percentage-points more immigrant peers is estimated to be (0.288 × 0.2) 5.8 and (0.232 × 0.2) 6.4 per cent of a standard deviation at the 20th and 30th quantile, respectively, and robust to controls for the academic and SES composition among peers. This suggests that immigrant peer effects are responsible for low achievers' improvement in national test scores.

Conclusions

The results from this study demonstrate that even though attending schools with a high share of immigrant peers does not influence students' average academic outcomes, such zero mean effects mask differential effects across the outcome distribution. The share of immigrant peers in Norwegian lower secondary schools has a positive but statistically insignificant influence on students' mean GPA, which is in accordance with previous research (Hermansen and Birkelund, 2015). However, quantile regressions show a negative but statistically insignificant influence on low achievers' GPA, and a positive influence on high achievers' GPA.

This suggests that attending schools with a higher share of immigrant peers improves grades for high-achieving students. However, the positive impact on high achievers' GPA is seemingly not caused by the immigrant share per se. Rather, it is explained by the general academic and SES composition of the student body in these schools. One explanation for these patterns could be that high achievers' motivation increases when surrounded by peers with relatively lower achievement levels (Davis, 1966). A competing explanation is that the lower achievement level among peers makes the best students *appear* comparatively better in the eyes of their teachers (Jonsson and Mood, 2008), which results in better grades. The results show that even though the best students get better grades from their teachers, there are no signs of improvement at the top of the national test score distribution. It seems that a 'teacher grading bias' makes it easier for the best students to get good grades in schools with higher shares of immigrant peers, and that this bias is likely

explained by the general academic and SES composition of the student body.

Other mechanisms seem to be at work for the low-achieving students. These students show improved national test scores by attending schools with higher shares of immigrant peers, which is not explained by the general academic and SES composition among peers. Additionally, analyses including school-fixed effects show that such benefits also result from variations in immigrant share within schools over time. Thus, the academic improvement of low achievers seems to stem from immigrant peer effects.

There are several potential explanations for these positive immigrant peer effects. One reason for the positive effect on low achievers could be that an immigrant drive spills over, especially on low achievers, and boosts their motivation and learning (Lauglo, 1999; OECD, 2010; Jonsson and Rudolphi, 2011). Another potential reason could be that teachers adjust the teaching level to accommodate low-achieving students when teaching in a classroom with more immigrants (Hunt, 2017). Lastly, it could be that schools with more immigrant students get extra resources that benefit the academic skills of low achievers and that the schools allocate such resources to classes with a high share of immigrants (Hægeland, Raaum and Salvanes, 2005; OECD et al., 2010; OECD, 2010). The high achievers seem resilient to the potential teaching adjustments that make low achievers improve their national test scores, as high achievers' national test scores remain unaffected. This could perhaps be attributed to higher parental involvement for high-achieving students if the teaching level is lowered to accommodate low achievers (Bernardi, 2014).

It is generally hard to reflect on the size of the estimated effects. While the effect sizes reported in this paper are small, like most peer effects on educational outcomes (Sacerdote, 2011), the effects may nevertheless be relevant when put into context. As an example, consider this paper's estimated effect of immigrant share on the 90th quantile of the GPA distribution. A 20 percentage-point increase in immigrant share increases the 90th quantile by about 3 per cent of a standard deviation. Since applicants to upper secondary school mainly compete for admission based on their GPA, even a slightly higher GPA could make students reach the cut-off for their preferred school and cause competing students to fall short of admission. Hence, even small effects may be of consequence for students' life chances. Further, back-of-the-envelope calculations show that an effect size of 3 per cent of a standard deviation equals about 12.5 and 8.2 per cent of the sample's raw native-immigrant gap (0.241) and raw girl-boy gap (0.367) at the 90th quantile, respectively. Thus, the estimated effects are sizable when viewed relative to differences that get substantial attention in the sociological literature.

An open question is whether the effects found in this study apply to other settings. The social-democratic ideas of equality that influence Norwegian school politics (Oftedal Telhaug, Mediås and Aasen, 2006) ensure modest quality differences between schools, as most schools are publicly owned and funded, do not charge tuition fees, and adhere to common curricula. Furthermore, we know that schools with a high share of immigrant peers receive extra resources (Hægeland, Raaum and Salvanes, 2005; OECD et al., 2010; OECD, 2010). The positive effects on low achievers' academic skills from attending schools with a higher share of immigrant peers could occur because the initial modest quality difference tips in favour of these schools when counting extra resources. Thus, we should not necessarily expect similar positive effects on academic achievements in settings with larger initial quality differences or less targeted resources. The indication of a teacher grading bias benefitting the most able students is, however, less likely to be a consequence of social democratic ideas influencing Norwegian school politics and deserves the attention of both researchers and educational policy-makers in other countries as well.

There are some limitations of this study worth mentioning. First, teacher-assigned grades are compared with national test scores to disentangle effects on students' learning from teachers' grading practices. However, national test scores are observed in 9th grade, while teacher-assigned grades are observed one year later, in 10th grade. The results show that attending schools with higher shares of immigrant peers affects high achievers' GPA and teacher-assigned grades but not their national test scores. This could reflect that the positive effect somehow kicks in during the 10th grade for these students. However, it seems unlikely that the duration of exposure explains the lack of effects for high achievers' national test scores since the analyses show positive and significant effects on these scores for low achievers.

Second, I assume that the academic skills measured by a national test score in Reading are comparable to the skills teachers evaluate when assigning a final assessment grade in Norwegian. On the one hand, teachers assign final grades solely based on performance and knowledge, and not effort, attitude, or participation (Prøitz, 2013), which should make teacher-assigned grades and national test scores comparable measures. On the other hand, according to the national curricula for 10th-grade Norwegian, the student should be competent in communication, language, literature, and culture, which is a more diverse skill set than that measured by the national test in Reading (Norwegian Directorate for Education and Training, 2013). A correlation of 0.65 between the two measurements indicates that students who fare well on national tests in Reading are highly likely to get

a high teacher-assigned grade in Norwegian, which somewhat mitigates this concern.

The last limitation is that immigrants are a heterogeneous group, and the effects of various immigrant groups may differ as well. Overall, the share of immigrants from non-OECD countries seems to have quite similar effects across the outcome distribution as the share of immigrants in general (see Supplementary Appendix A). The estimates differ in some models, but unfortunately, the large confidence intervals in some of these models make it difficult to draw strong conclusions. A promising avenue for further research could be to examine effects of specific immigrant groups in more detail.

Endnotes

1. The term 'immigrant' comprises those born abroad or in Norway by foreign-born parents.
2. The correlations between the share of immigrant peers and the average of native peers' parental income and education are −0.0363 and −0.0335, respectively.
3. Permissions to use register data were granted by the Norwegian Data Protection Agency, the National Research Ethical Committee, and the Data Protection Official in Norway. The data are stored on encrypted servers and are not to be shared.
4. In the analyses sample, immigrants with non-OECD origins are significantly disadvantaged in terms of academic outcomes, parental education, and parental income compared to immigrants with OECD origins.
5. Schools cohorts with fewer than ten students and schools that admit fewer than ten students on average each year are excluded, as small cohorts and small schools are likely to be specialized or serve students with special needs.
6. Students are normally drafted to one final written exam in Norwegian, Math, or English, and one oral exam. The GPA is the sum of all grades divided by the number of grades and then multiplied by 10. Students who obtain less than eight grades are registered with zero GPA on their school leaving certificate (1.23 per cent of the sample) regardless of how well they have performed. I exclude these outliers from the sample in the main analyses, as they affect the estimates disproportionally. The trends across the GPA distribution are similar with and without these outliers, but including students with zero GPA skews estimates for both high- and low-achieving students in a negative direction (Appendix B).
7. I use the mean of Math and written Norwegian grades since each of them takes only six unique values, and quantile regressions require more fine-grained outcomes. However, the treatment could have different effects on Math and Norwegian skills, and these effects could vary for students at different achievement levels. I conduct separate analyses on national test scores in Math and Reading, both of which are on a continuous scale, to assess the magnitude of this problem. Appendix C indicates that the share of immigrant peers affects reading skills more than math skills, but the effect trends across the outcome distributions are roughly similar.
8. The school may exempt students from national tests if the student has received a formal decision on eligibility for special needs education or special language education. Non-participation may bias the estimates if it varies systematically in line with students' share of immigrant peers. Appendix D shows that, conditional on controls, no significant relationship exists between a student's share of immigrant peers and the likelihood of participating in national tests.
9. Using the 2012–2014 graduation cohorts renders less precise and insignificant effects on GPA and teacher-assigned grades compared to the main analyses, but similar trends across the outcome distributions are nevertheless observed (Appendix E).
10. Appendix F shows that the results are similar when adding more detailed controls, including dummies for country of birth and dummies for each value of the mother's age when giving birth, number of siblings, and birth order.
11. The main analyses include controls for the average of native peer characteristics and not immigrant peer characteristics for three reasons. First, immigrant peers are more likely to have systematic missing values on parental income and education. Second, these controls capture the academic and SES composition at schools without controlling away relevant characteristics of immigrant peers. Third, such an approach is in accordance with Hermansen and Birkelund (2015), who also use Norwegian register data to investigate immigrant peer effects. Appendix G shows results from analyses including controls for immigrant peer characteristics and both native and immigrant peer characteristics.
12. Significant changes in school catchment areas are relatively rare, and I have no *a priori* reason to expect that these changes systematically bias the estimates in one direction or the other.
13. Appendix K shows that estimates are similar with and without controls for school cohort size.
14. I use the logic of the xtrifreg command developed by Borgen (2016) when adding school fixed effects since it is both burdensome and time-consuming to include high-dimensional fixed effects in the conventional rifreg command developed by Firpo, Fortin and Lemieux (2009).

Supplementary data

Supplementary data are available at *ESR* online.

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