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# Ability Composition in the Class and the School Performance of Immigrant Students*

Abstract

Using longitudinal data from the Italian National Institute for the Evaluation of the Education System (INVALSI), this paper investigates whether the ability of classmates affects the educational attainment of immigrant students. We focus not only on the average quality of peers in the class, but we further investigate which part of the ability distribution of peers drives the effect, by assessing the role played by the extreme tails of the ability distribution. Our empirical strategy addresses students' endogenous sorting into classes by exploiting the within-student across-subjects variation in achievements and the simultaneity problem by using predetermined measures of peers' ability. We show that peers' ability matters. While native students are mostly influenced by the average quality of their peers, immigrant children are detrimentally affected by the fraction of very low achievers in the classroom. Our findings provide valuable guidance to policymakers concerning the allocation of students to classes in order to foster immigrant students' integration and learning.

JEL code: J15, I21
Keywords: Peer effects, immigrant students, education

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# 1 Introduction

During the last decades, many OECD countries, especially in Europe, have seen a sharp increase in the number of immigrants. In 2020 immigrants accounted for 10% of the total population in the European Union, up from 6.3% in 1990 and 8.2% in 2000 (UN Population Division). This surge triggered a large empirical literature in economics that investigated the effects of immigration on host countries, focusing in particular on the labour markets (e.g. Dustmann et al. (2013), Cohen-Goldner and Paserman (2011) and Card (2001)) and more recently on the educational systems. In particular, a number of studies investigated the impact of immigrant students on natives' school achievements (see Figlio and Özek (2019); Frattini and Meschi (2019); Ballatore et al. (2018); Feld and Zölitz (2017) Ohinata and Van Ours (2013) among others). In most European countries, such interest was motivated by the concern that immigrant students would harm the performance of native peers in the class. In fact, immigrant children generally tend to be disadvantaged students. Many come from lower socio-economic backgrounds, learn in a foreign language and enter unfamiliar institutions; thus, they typically exhibit large performance gaps.

In this paper, we challenge the existing approach of assessing the impact of immigrants on the educational outcomes of natives by focusing instead on how immigrant students are themselves affected by their class environment and by the achievement of their native and immigrant peers. This study builds on the burgeoning literature on peer effects in education by investigating how and to what extent the ability of native and immigrant classmates affects their immigrant peers' educational outcomes. In particular, we estimate the impact of the average quality of peers in the class and further investigate which part of the ability distribution of peers drives the effect, by assessing the role played by the extreme tails of the ability distribution. In other words, we ask whether is the average quality of peers that matters for immigrant students' achievement, or rather the presence in the class of very high-achieving and very low-achieving peers.

Our empirical analysis is based on administrative data collected by the Italian National Institute for the Evaluation of the Education System (INVALSI henceforth) on four cohorts of students who completed lower secondary education in the academic years 2015/16, 2016/17, 2017/18 and 2018/19. Because data have a longitudinal structure, it is possible to track students over time and observe their prior achievements at the end of primary school. This allows us to construct indicators of peer quality in lower secondary schools based on predetermined measures of ability that are not simultaneously determined by students' own achievements. Our identification strategy follows Lavy et al. (2012) and exploits the within-pupil variation in achievement across subjects, as a way to solve the non-random sorting of students across schools and classes, which may bias the estimation of peer effects.

Our study contributes to the existing literature along several dimensions. First, in contrast to the extant literature drawing attention to the potential negative effect of immigrants on native students' learning and behaviour, we focus on understanding the peer effects mechanisms that affect *immigrant* children's performance. Shifting the focus to immigrant children, we provide new insights into how class composition may help narrow the gap between immigrant and native children and thus improve immigrants' integration into their host countries' school system. We believe this is a particularly relevant issue considering that adequate education is key to socioeconomic success and to overcoming the disadvantages of immigrants in European societies. Providing a better school environment for immigrant children is an important social investment in the long-term. Lasting positive growth effects may in fact arise from skilled immigrants fostering innovation through enhanced diversity, entrepreneurship, or international investment and trade (Bonin (2017)). Moreover, government budgets may improve, as education usually generates positive net fiscal returns. In addition, improving the educational outcomes of immigrants may help reduce income inequality and make host countries' societies more inclusive. Targeted policies to foster the school attainment of immigrants are thus crucial to heap the potential for economic growth and social integration that comes with the challenges of immigration. Second, our identification strategy addresses

some of the most severe problems in peer effects identification, such as students' endogenous sorting and peers' ability measurement, by exploiting both the within-pupil variation across subjects and the longitudinal structure of the data that provides predetermined measures of peers' ability, which help to solve the reflection problem. [1] Third, differently from Lavy et al. (2012), we are able to define the peer group very precisely because our data provides *class* identifiers (rather than *school* identifiers). This unique feature allows us to draw a more accurate picture of students' interactions in comparison to studies carried out at a broader level (i.e. using peers' measures at the school level) that might fail to capture some relevant effect. As Carrell et al. (2009) point out, peer effects estimates can in fact vary greatly depending on the accuracy with which the set of relevant peers is identified.

Our results suggest the basic but important finding that peers' quality matters. We also show that immigrant and native children are affected differently by their peers. While immigrant children are detrimentally influenced by the fraction of lowest-performing peers in the class, native students are more strongly affected by the average quality of peers. Additionally, we find that peer effects are stronger within groups: natives exert a greater influence on native students and immigrant students on other immigrants. This evidence aligns with findings in the literature on racial peer effects, wherein the largest impacts observed are intra-racial and have little or no spillover into other racial groups (Fruehwirth (2013); Hoxby (2000)).

The remainder of this paper proceeds as follows. Section 2 reviews the relevant literature on peer effects in education, discusses the primary identification challenges and highlights our contribution to the existing literature. Section 3 provides the institutional background for our analysis, explaining the main characteristics of the Italian education system (section 3.1) and of the immigrant population at schools (section 3.2). Section 4 outlines the empirical analysis and discusses our identification strategy and possible threats to identification (section 4.1). Section 5 describes the data and provides some relevant descriptive statistics. Section 6

[1] As many studies in the peer effects literature, we do not aim to separately identify endogenous and exogenous peer effects (Manski (1993)).

presents results, while Section 7 discusses a number of robustness and sensitivity checks. Finally, Section 8 concludes with a discussion of the potential policy implications of this research.

## 2 Literature review

The importance of peer effects in educational outcomes has drawn considerable attention in the literature. The intuition motivating this stream of research is that peers matter in determining students' performance and behaviour. Students with higher incoming ability may in fact improve their classmates' performance, for example, by motivating them (through competition) to work harder or by enabling their teachers to teach at a higher level. By the same token, low-ability or disruptive students may harm their classmates' educational attainment by occupying more of the teacher's attention. Overall, the empirical literature tends to substantiate the claim that students generally benefit from proximity to better-performing peers around (see Sacerdote (2011) for a review), but this effect is likely to be heterogeneous. High-performing students benefit from other high-achievers, while students with lower achievements benefit from peers who are performing slightly better than them (see, for example, Lavy et al. (2011); Imberman et al. (2012); Burke and Sass (2013)). However, high-performing peers do not always have a positive influence on their peers. They may decrease their classmates' self-confidence, thereby worsening their performance. A recent and growing stream of literature has analysed the role of relative comparison in the educational context and confirmed the existence of rank effects motivated by the impact of peers on self-esteem, conscientiousness and expectations (see, for example, Elsner and Isphording (2017); Murphy and Weinhardt (2020); Bertoni and Nisticò (2023); Pagani et al. (2021)).

Empirically, the identification of both the size and nature of peer effects entails a number of difficulties (Angrist (2014), Manski (1993)). The two primary challenges for the identifi-

cation of peer effects derive from the endogenous selection of students into a specific group (non-random sorting) and the simultaneous determination of the outcomes of students belonging to the same group (simultaneity).

The former problem relates to the fact that students are not randomly allocated to schools and classes. They self-select into schools and classrooms on the basis of their observable and unobservable characteristics. In the context of this study, for instance, immigrant children tend to have a lower socioeconomic background, and less access to information about the characteristics of local schools and are therefore more likely to be clustered in lower-quality schools than their native counterparts.

To deal with this endogenous sorting of students across schools, previous studies adopt various empirical strategies. One method is to rely on some form of exogenous variation in student assignment to schools or classrooms. Duflo et al. (2011), for example, exploit the variation in peer composition generated by actual randomization, while Angrist and Lang (2004) rely on the substantial increase in the number of disadvantaged black or other minority students in the schools in Boston's rich suburbs as a result of the Metropolitan Council for Educational Opportunity's (Metco) desegregation program. Similarly, Gould et al. (2009) rely on the variation in the number of immigrant students induced by the exogenous immigration waves to Israel in the early 1990s, while Ballatore et al. (2018) use the exogenous variation in the number of natives and immigrants generated by the compulsory cap of 25 students per class in Italian primary schools. Figlio et al. (2021) exploit the variation in test scores of siblings who experience different cumulative exposures to school-cohort-specific peers' characteristics, holding the heterogeneity in family life-cycle fixed. Another common method to deal with endogenous sorting of students across schools is to use school fixed effects models to control for the unavoidable self-selection into schools and exploit the idiosyncratic within-school variation in peer characteristics across adjacent cohorts (Hoxby (2000); Ammermueller and Pischke (2009); Lavy et al. (2011), Tonello (2016), Gibbons and Telhaj (2016)) or across different classes (Frattini and Meschi (2019); Ohinata and Van Ours

(2013); Contini (2013)).

Even if controlling for school fixed effect accounts for most unobserved heterogeneity, sorting of students within schools across classes, or over cohorts, could potentially still be non-random. In this case, the estimation of peer effects would be biased. Lavy et al. (2012) improve on this strategy by using within-pupil regressions and exploiting the variation in achievements across three compulsory subjects tested.

The second empirical challenge in the estimation of peer effects lies in the fact that individual and peers' achievements are simultaneously determined and therefore causal inference is only possible if the peer group's predetermined ability measures are available. Some papers overcome this problem by measuring peer quality by fixed (and therefore predetermined) students' characteristics, such as the socio-economic background (see for example Hoxby (2000) and Ammermueller and Pischke (2009)). However, as underlined by Hoxby and Weingarth (2005) students' background attributes have little or no effect on students' outcomes once peers' achievements are properly controlled for. When longitudinal data are available, it is possible to use past achievements to measure peer ability. For example, Lavy et al. (2012) define the ability of 8th-grade peers using their predetermined 5th-grade test score. Taking advantage of the compulsory transition between primary and lower secondary school leading to substantial peers' reshuffling, these measures are conceivably exogenous to 8th-grade outcomes (see also Lavy et al. (2011), Gibbons and Telhaj (2016) that use a similar strategy).

In terms of findings, the existing literature tends to conclude that peer effects, even when statistically significant, are rather small: most studies find that a one standard deviation increase in average peers' quality raises outcomes by less than 10 percent of a standard deviation (see Lavy et al. (2011)). More recent studies have further shown that the effect of peers is not constant but largest when peers are students either at the very bottom or at the very top of the academic ability distribution. For example, Lavy et al. (2011) find that a high fraction of low-achieving students lowers classmates' educational outcomes with the effect operating by diverting teachers' attention to struggling students and raising the level

of violence and disruption within the class. Similarly, Lavy et al. (2012) provide evidence that a large fraction of very low-achieving peers lowers the educational performance of the other schoolmates. Fruehwirth (2013) shows that high-achieving students benefit the most from high-achieving peers. Similarly, Gibbons and Telhaj (2016) find that test scores of low-achieving students in the U.K. are harmed by the presence of high-achieving students, while upper-middle achieving students benefit from the presence of high-achieving students. Feld and Zölitz (2017) show that while students benefit from better peers on average, low-achieving students are negatively affected by high-achieving peers. Overall, recent papers provide evidence of non-linearities in peer effects and suggest that different students react differently to the ability of their peers. In this study, we investigate whether the performance of immigrants is affected by the ability of their peers and whether these effects are non-linear and concentrated in the tails of the ability distribution.

Our paper contributes to the existing literature in three important and distinct ways. First, it focuses on the effect of peers' ability on the school performance of immigrant students. While there is extensive literature analyzing the impact of immigrants and ethnic minorities concentration in the class on native students, little is known on the impact of migrants and ethnic minorities on themselves (Schneeweis (2015), Jensen and Rasmussen (2011) Ohinata and Van Ours (2013)). To the best of our knowledge, this is the first study on ability peer effects that specifically focuses on immigrant children's educational achievement. Despite the increasing number of immigrant students in all OECD countries' educational systems, there is scarce evidence on which policies to implement in order to foster their integration and learning [2]. In this paper, we contribute to the debate by showing how class composition impacts the educational achievement of immigrant students. Second, following Lavy et al. (2012), we adopt an identification strategy that addresses some of the most severe problems

[2]For other educational policies affecting the school performance of immigrant children, see, among others, Corazzini et al. (2021) on the impact of early childcare on immigrant children's cognitive outcomes and Carlana et al. (2022) on the impact of providing tutoring and career counselling to high-ability immigrant students.

in peer effects identification, such as students' endogenous sorting across school and classes and peers' ability measurement, by exploiting both the within-pupil variation across subjects and the longitudinal dimension of the data that provides predetermined measures of peers' ability. Third, differently from Lavy et al. (2012) we are able to define the peer group very precisely because our data provides *class* identifiers (rather than *school* identifiers). Finally, we further investigate whether peer effects stem from the average quality of class-mates or from the very bright and very poor achievers in the class.

# 3 Institutional background

## 3.1 The Italian education system

Education in Italy begins at age 6 and is compulsory until age 16. The school system is organized in two cycles. The first cycle comprises primary and lower secondary education. Primary education lasts for five years, while lower secondary education, the focus of our analysis, starts at age 11 and lasts for three years. When moving from primary to lower secondary school, students change schools and classes are reshuffled. Without having to pass any kind of examination, students enter lower secondary school with practically all new classmates. Once assigned to these classes, students remain with this set of peers from 6th grade until the end of 8th grade.

Each school's principal oversees the allocation of children to their classes. Formation criteria are established at the central level, and each school provides relevant information in official documents available online. Generally, these criteria establish that students should be equally distributed by ability, gender, and economic and social background. Table 1 reports the main guiding principles followed by school principals in the allocation of students to lower secondary school classes and confirms that the most relevant aspects in the class formation process are comparability across classes and heterogeneity within classes in the same school.

The Italian school system is mainly public and does not allow for students to be tracked by ability (Eurydice, 2013). Pupils with similar abilities or educational attainment cannot be grouped together for specific subjects, such as mathematics or science. In fact, children are assigned to the same class for all subjects and are taught by the same teachers. Class size ranges from a minimum of 18 students to a maximum of 27. The weekly class schedule is of 30 hours, with reading and math being the subjects occupying the most instruction hours. The academic disciplines, time of instruction, educational programs and their content are centrally defined by the Ministry of Education and therefore consistent across all Italian schools.

Table 1: Guiding principles followed by school principals in the allocation of students to classes

| **Criterion** | **Percentage** |
|---|---|
| Guarantee that classes are internally heterogeneous in terms of learning levels | 63.70 |
| Guarantee that classes are internally heterogeneous in terms of socio-demographic characteristics | 17.52 |
| Assign students to classes at random | 0.03 |
| Other criteria | 18.78 |

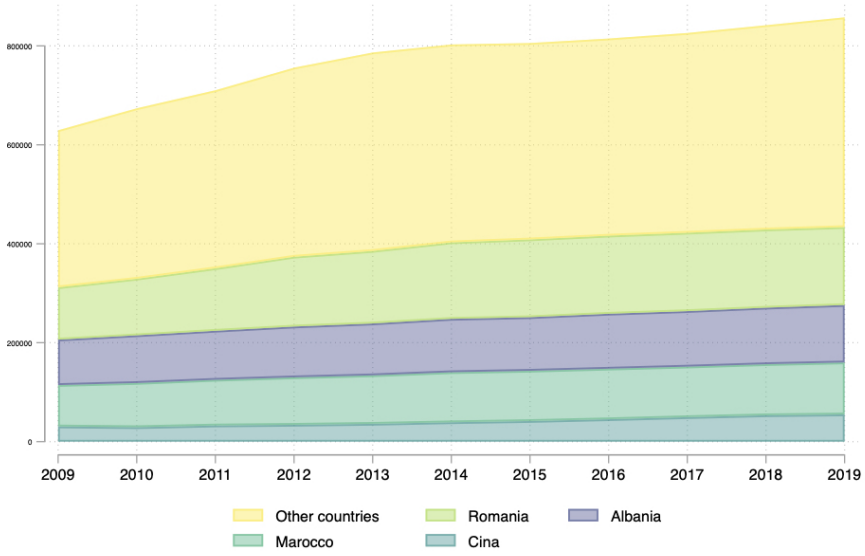
Notes: The table reports the guiding principles underlying the allocation of students to lower secondary school classes as reported by a nationally representative sample of school principals surveyed by INVALSI in the school year 2013/14.

## 3.2 Immigrant students in Italian schools

Immigration is a relatively recent phenomenon in Italy. Between 1990 and 2019, the number of immigrants (foreign-born) in Italy has increased from 780,000 to 5.2 million, meaning that the share of immigrants in the Italian population has risen from 1.4% to 8.7% over the last 30 years (Frattini and Vigezzi (2018) and www.demo.istat.it). The majority of immigrants in Italy come from low and middle-income countries and on average are characterized by a lower socio-economic background than natives (Carlana et al. (2022)). The rapid surge in immigration to Italy also implied rising shares of students with an immigrant background in the education system. In the school year 2018/19, immigrant students accounted for 10% of the student population in Italy. As shown in Figure 1, over the last decade, the number of immigrant students increased by 27,3%, from 673 thousand in 2009/10 to 857 thousand in 2018/19, with immigrant students from Romania being the most represented (18.4%)

followed by Albanian (13.5%), Moroccan (12.3%) and Chinese (6.4%).

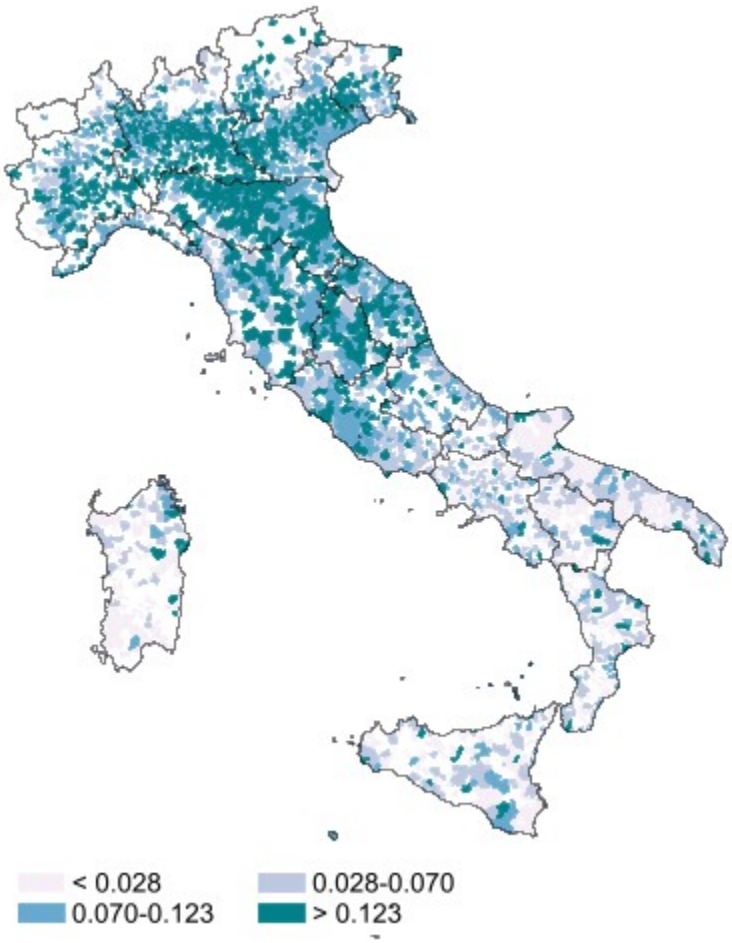
Figure 1: Number of foreign students in Italy by country of origin, 2009-2019




*Source: MIUR data.*

As reported in Figure 2, immigrants tend to concentrate in the Centre-North of the country (87%), with Lombardia and Emilia-Romagna regions hosting respectively 25,4% and 11,9% (Ministero Della Pubblica Istruzione, 2020). Given the described distribution of immigrant students in the Italian territory, we decided to not include in our analysis the South and the Islands where on average immigrants account for less than 3% of the student population. In section 7, we show that this choice does not alter the external validity of our empirical analysis.

Figure 2: Distribution of the share of grade 8 immigrant students in Italy, year 2018



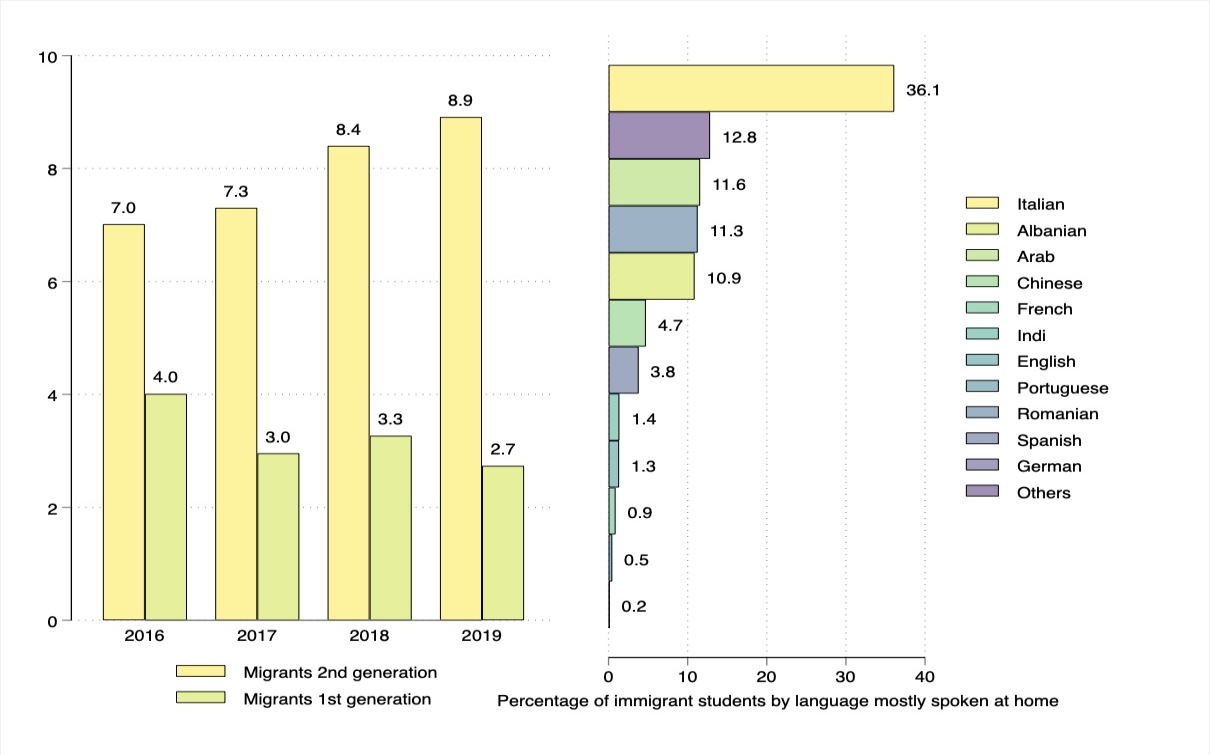

Note: The map shows the share of 8th grade immigrant students across Italian municipalities in 2018. Break points are quartile intervals in the share of migrants. Source: INVALSI data.

The left panel of Figure 3 reports the share of first- and second-generation immigrant students in lower secondary schools, which are the focus of our paper. The figure confirms the rise of students with an immigrant background and reveals that second-generation migrants (children born in Italy to non-native parents) account for the majority of immigrant children in lower secondary schools. Despite we do not observe the country of origin of children in our sample, in the school years 2018 and 2019 students were asked to report the language mostly spoken at home.[3] The graph in the right panel of Figure 3 shows the percentage

[3]In all school years children are asked to report the language mostly spoken at home but only in the

of migrants by language mostly spoken at home. It emerges clearly that the language is a relevant source of heterogeneity: more than 60% of immigrant children speak at home a language that is different from Italian. This may explain the educational disadvantage of immigrant children that we will discuss in section 6.2.

Figure 3: Immigrant students in our sample




Note: Panel A shows the percentage of first- and second-generation migrants over time in lower secondary school. Panel B reports the percentage of immigrant students by language mostly spoken at home in the s.y. 2018 and 2019 (for the s.y. 2016 and 2017 the information is not available). Source: INVALSI data.

# 4 Empirical strategy and identification

The aim of our analysis is to estimate the impact of peer academic quality on students' test scores in 8th grade, at the end of lower secondary schools. The main challenge in estimating peer effects is the non-random sorting of students across schools and in some cases also between classes within schools (see also Angrist (2014)). Our identification strategy follows Lavy et al. (2012) and relies on within-pupil regressions that exploit the variation

school years 2018 and 2019 they are required to provide the specific language rather than simply reporting whether is a language different from Italian.

in attainments across two compulsory subjects tested at grades 8 and 5.[4] This strategy allow us to determine whether within-student variation in reading and math test scores is systematically associated with differences in peers' ability across subjects. In other words, this analytical framework examines whether a student's exposure to high- or low-achieving peers in a given subject translates to an improvement or a decline in his own performance in that subject. An advantage of this approach is that by including individual fixed effects we are able to control for a student's own unobservable average ability across the two subjects as well as for unmeasured family and class characteristics.

More specifically, following the notation in Angrist (2014), we estimate the following regression equation:

$$Y_{isct} = \alpha_i + \gamma_{st} + \beta_s xGender + \delta_1 P_{(i)sct} + \delta_2 P^h_{(i)sct} + \delta_3 P^l_{(i)sct} + \epsilon_{isct} \quad (1)$$

where the dependent variable $Y_{isct}$ measures 8th grade achievements of child $i$ in subjects $s$ in lower secondary school class $c$ in cohort $t$. Specifically, each child is tested on two compulsory subjects: reading and math. Our main variables of interest are $P_{(i)sct}$, $P^h_{(i)sct}$ , and $P^l_{(i)sct}$ that respectively capture the average ability in 5th grade in subjects $s$ of 8th-grade peers in class $c$, and the fraction of very high and very low ability peers in class $c$. In particular, we define high-ability and low-ability peers as students at the top and bottom 5 percent of the cohort-specific national distribution of 5th-grade INVALSI test scores. Crucially, all peer measures related to student $i$ are calculated leaving $i$ him or herself out of the calculation. Individual and subject-by-cohort fixed effects are captured respectively by $\alpha_i$ and $\gamma_{st}$. Further, we include subject-by-gender fixed effects, $\beta_s xGender$, to account for gender-specific differences across subjects that might potentially affect the sorting of students into lower secondary schools (Fryer Jr and Levitt (2010)). Finally, $\epsilon_{isct}$ is the error term. Standard errors are

[4]See also Lavy (2015) and Dee (2007) for similar strategies exploiting within-student across subjects variation.

clustered at the class level. The parameters of interest are $\delta_1$, $\delta_2$ and $\delta_3$ which respectively capture the effect of the average ability of 8th-grade peers and the impact of the fraction of high and low-achieving peers on students' outcomes.

All peers' ability measures are computed based on grade 5 test scores, which are predetermined and thus do not suffer from the reflection problems. This is especially true in our setting where children at the end of 5th grade make a compulsory transition between primary and lower secondary school, which implies a significant change to the class group composition. On average, in our data, 71% of 8th-grade students in the same class did not attend the same primary school, implying that they could not have mutually affected their 5th-grade test scores.

We exploit this high inter-school mobility to build separate measures of peer quality for new and old peers.[5] New peers are defined as peers who are in a student's 8th-grade class but were not in his/her 5th-grade class. Old peers are students who are together in the 8th grade and were in the same 5th-grade class as well. In our empirical analysis, we mainly focus on new peer quality measures, because they are certainly immune to the reflection problem. In fact, student $i$ 5th-grade test score is predetermined and thus not affected by 8th-grade new peers' outcomes. Differently from Lavy et al. (2012), we define peers at the class level. In Italy, peer group composition is constant throughout the lower secondary school period and most of the students' interactions happen within classes more than across classes (students are forced to spend time together and stay in the same classes together for the three years that they are in the lower secondary school). Finally, it is worth noting that our empirical approach imposes some restrictions on the types of peer effects that we can identify. First, peer effects are assumed to be the same for the two subjects. Second, the effect we are considering excludes potential spillovers across subjects. For instance, having high-achieving peers in math could affect students' reading test scores and vice versa. However, if this were the case, we would be bound to find no effects.

[5] Gibbons and Telhaj (2016) are the first ones to make this empirical distinction.

## 4.1 Threats to identification

Our empirical strategy exploits within-student variation in attainments across subjects and allows to control for students' own unobservable average ability across subjects and unmeasured individual and school or class characteristics. This approach should thus achieve a clean identification of peers' effects, under the main identifying assumption that peers' subject-specific ability is unrelated to unobserved determinants of individual students' subject-specific skills.

A first concern that may threaten this assumption is the subject-specific sorting of students across schools and classes. This could happen, for example, if a specific school or class specializes in math or language and attracts students based on their ability in those specific subjects. In this case, we would observe a correlation between individual variation in grade 5 test scores and within-student across-subject quality of peers. In the Italian context, this is unlikely because ability grouping is not permitted and educational programs are all set centrally by the Ministry of Education so that lower secondary schools are not allowed to tailor their educational offer or specialize in a specific subject. Further, following Lavy (2015) it is unlikely that schools that do not use the ability as an admission criterion are going to select students on subject-specific considerations. However, in order to exclude the possibility of subject-specific sorting, in Table 9 of Section 7, we perform a falsification test where we regress the ability of peers in grade 8 on students' own ability in grade 5. Reassuringly, the estimates reveal that there is no significant correlation between the within-student across-subjects variation in prior achievements and the variation in peers' ability across subjects. This evidence is also confirmed by the fact that when we augment our specification including students' own test scores at grade 5 (see Table 9), our coefficients of interest remain remarkably stable.

A second related concern is the non-random allocation of teachers to classes. This may

happen, for instance, if highly experienced teachers prefer to teach better classes: even if grouping students by ability is not feasible, a class that ends up being better in a specific subject may be allocated to a better teacher in that subject. Or, on the contrary, school principals may allocate the best teachers in a specific subject to classes where the students are particularly low-performing in that subject. In order to deal with this concern, we exploit detailed and novel data on teachers' characteristics provided by INVALSI for a nationally representative sample of schools and described in Section 7). Using this data, we perform a balancing check to show that teachers are actually randomly allocated to classes within schools (see Table 10, Section 7).

Finally, in Tables 11 and 12 we further check the robustness of our findings to alternative samples and estimation strategies leveraging variation within schools across adjacent cohorts and classes that are commonly used in the peer effect educational literature (see for example Ammermueller and Pischke (2009)). To conclude, in Table 13 we test the sensitivity of our results to changes in the thresholds used to define high(low)-achieving peers.

# 5 Data and descriptive statistics

Our analysis relies on administrative data collected by the INVALSI, the independent public agency in charge of evaluating the Italian school system and monitoring students' achievements in reading and math. The evaluation of students' attainments is carried out yearly at the conclusion of 2nd, 5th, 8th and 10th grade. All students in these grades are required to take part in the INVALSI assessment. The tests are administered on the same day, and the correction is made externally, following a predetermined marking scheme. This feature of the data makes students' performances wholly comparable across all Italian schools and classes. Testing comprises both multiple-choice and open-ended questions to assess students' key competencies in reading and math. In particular, the reading test evaluates mastery of grammar and reading comprehension, while the math test measures skills in problem-solving,

logic and interpretation of quantitative phenomena. All test scores are standardized to have a mean equal to 200 and a standard deviation equal to 40 for each subject and cohort.

This analysis focuses on the four cohorts of students who completed the INVALSI test when they finished 8th grade in the school years from 2015/16 to 2018/19. The longitudinal structure of the data and the availability of class identifiers at each school stage allow us to relate each 8th-grade student to their 5th-grade test scores, as well as those of their peers. We exploit this feature of the data to compute predetermined measures of students' ability and peer quality for lower secondary school peers who either attended (i.e. *old peers*) or did not attend (i.e. *new peers*) the same primary school class.

INVALSI data also includes information on a number of demographic characteristics of children and their families including their gender, ethnicity, their parents' educational levels and working conditions and the index of Economic, Social and Cultural Status (ESCS).[6] We use this information to define students' immigrant status. A child is determined to be an immigrant if both parents are non-Italian citizens, regardless of their place of birth (in Italy, citizenship is acquired according to the *Ius Sanguinis* principle). Native children are those who have at least one parent with Italian citizenship.

Our sample is restricted to students attending a public school in the Northern and Central regions of Italy. Southern regions are excluded because most of the immigrants live in the North and Center (Frattini and Vigezzi (2018)), because Southern test scores are considered less reliable due to the higher incidence of cheating behaviours (Lucifora and Tonello (2015), Bertoni et al. (2013)) and because many classes in the South did not take part in the INVALSI test days in the 2014/15 school year due to a strike in the school sector. This means that 5th-grade test scores cannot be linked with 8th-grade test scores, a necessary

[6]The ESCS (Economic Social and Cultural status) index describes the socio-economic and cultural status of students' families. It is developed using the information provided by the students' and the schools' questionnaires regarding parents' educational level and working status, as well as the material possession of some specific goods including books, internet connections and a personal computer. The index is calculated using principal component analysis and by construction has mean zero and unitary variance.

condition for inclusion in this study sample.[7] The sample is further restricted to students with no missing observations on the variables used in the analysis. Our final sample includes 218,688 observations.

Table A4 in the Appendix lists and describes all variables included in our empirical analysis, while Table 2 presents key summary statistics (mean and standard deviation). Column (1) reports statistics for "regular" students, Column (2) for "top" students and Column (3) for "bottom" students. Regular students are defined as those with age 11 (i.e. grade 5) test scores in both reading and math above the 5th percentile and below the 95th percentile of the grade 5 test score distribution. Top and bottom students are the those who achieved above the 95th percentile and below the 5th percentile, respectively, in at least one of the two subjects tested at grade 5. By construction, regular students' 5th and 8th grade test scores are concentrated around 200, while those of pupils in the top and bottom 5 percent will respectively outperform or fall behind any other student. Concerning students' demographic characteristics, stark differences are apparent across the three groups. For instance, the lowest-performing students are the least likely to have highly educated and working parents. They are also more likely to have lower ESCS values and to have an immigrant background (in either the first- or second-generation). The opposite picture emerges for the highest-performing students, who generally have a higher ESCS, better-educated parents and are more likely to be native citizens.

[7] In Campania, Apulia and Sardinia, less than 75% of the classes took part in the INVALSI test. In Sicily it was less than 30%. For 8th-grade students, participation in the test was equal to 100% because the INVALSI test is part of the final exam that concludes the primary cycle of education and is a minimum requirement to enter upper secondary school. See INVALSI (2015) for additional details.

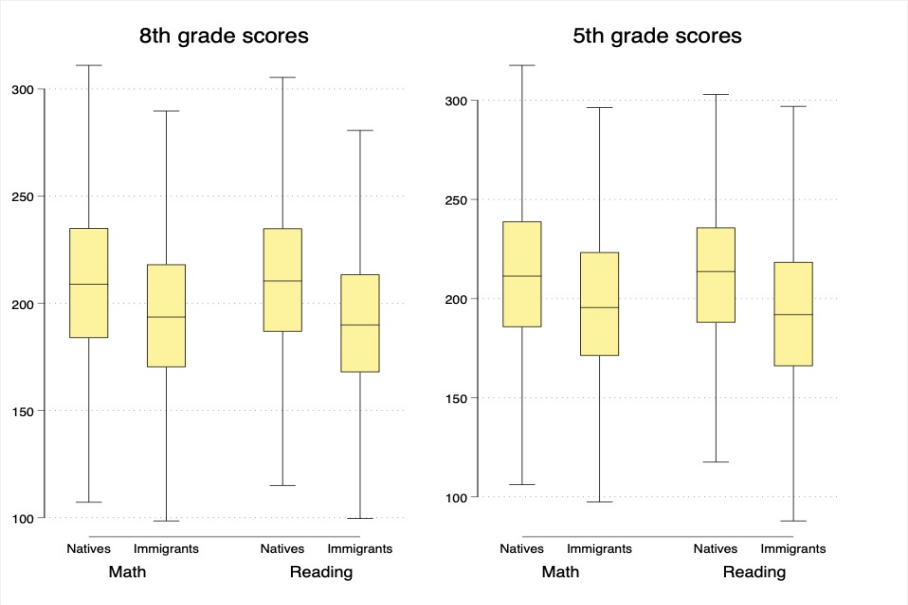
Table 2: Descriptive statistics

| | Immigrants | | | Natives | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | **Regular** | **Top** | **Bottom** | **Regular** | **Top** | **Bottom** |
| **Panel A: Test scores** | | | | | | |
| 8th grade reading test scores | 195.72 | 227.06 | 156.38 | 210.13 | 244.38 | 167.36 |
| | (31.85) | (38.32) | (28.77) | (32.46) | (34.71) | (28.17) |
| 5th grade reading test scores | 198.69 | 259.45 | 138.04 | 211.98 | 271.01 | 150.3 |
| | (29.47) | (37.96) | (27.84) | (29.46) | (33.21) | (28.52) |
| 8th grade math test scores | 199.59 | 239.7 | 166.44 | 209.74 | 251.02 | 167.48 |
| | (33.5) | (42.58) | (28.8) | (34.57) | (39.7) | (27.85) |
| 5th grade math test scores | 203.164 | 283.177 | 153.58 | 211.58 | 282.02 | 150.98 |
| | (30.62) | (34.63) | (28.63) | (30.79) | (34.65) | (26.94) |
| **Panel B: Demographic characteristics** | | | | | | |
| Female | 0.52 | 0.47 | 0.53 | 0.5 | 0.46 | 0.51 |
| | (0.5) | (0.5) | (0.5) | (0.5) | (0.5) | (0.5) |
| ESCS | -0.38 | -0.13 | -0.64 | 0.22 | 0.55 | -0.16 |
| | (0.83) | (0.87) | (0.81) | (0.88) | (0.87) | (0.87) |
| Immigrant first-generation | 0.27 | 0.26 | 0.37 | | | |
| | (0.2) | (0.44) | (0.48) | | | |
| Immigrant second-generation | 0.72 | 0.74 | 0.63 | | | |
| | (0.2) | (0.44) | (0.48) | | | |
| N | 87,616 | 4,310 | 17,446 | 742,469 | 76,482 | 51,234 |

Notes: The table shows the mean and standard deviation in parenthesis. Panel A displays students' educational outcomes, Panel B students' demographics. We restrict the sample to students that have INVALSI test scores not missing both in 5th and 8th grade. All test scores are standardized to have a mean equal to 200 and a standard deviation equal to 40 for each subject and cohort. For the definition of the variables see Table A4 in the Appendices.

To substantiate our claim on the existing educational gap between native and immigrant children, in Figure 4 we present 8th grade (left panel) and 5th grade (right panel) average students' test scores by immigrant status and subject. It stands out from the figure that immigrant students perform worse than natives in reading and math both in 5th and 8th grades.

Figure 4: Immigrant students' gap in 8th and 5th grade by subject

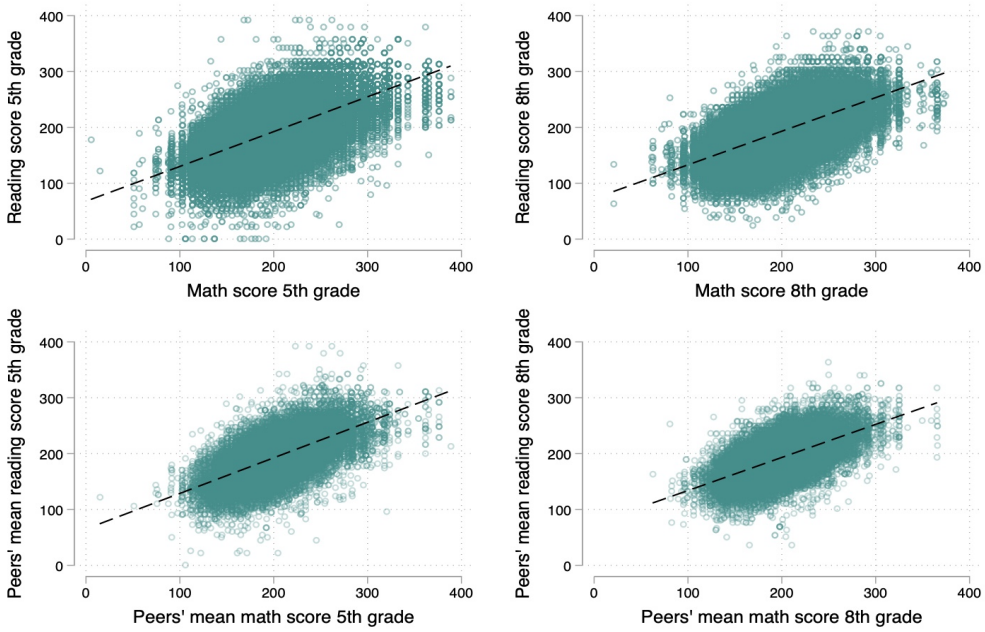



Note: The figure shows the boxplots of the standardized test scores by subject in 8th grade (left graph) and 5th grade (right graph) across immigrant and native students. The black line shows the median values, while the boxes represent the interquartile range. All test scores are standardized to have a mean equal to 200 and a standard deviation equal to 40 for each subject and cohort.

In this study, the identification of peer effects is based on the comparison of the same student's performance in two different subjects. Hence, identification is possible only if, for each student, there is enough variation across subjects in their own and in their peers' test scores. In the upper panel of Figure 5 we show the correlation between students' own test scores in reading and math in grade 5 and 8, while in the bottom panel we report the correlation between class average test scores in reading and math, measured in grades 5 and 8. The figure reveals that despite all correlations being high and positive, there is still substantial variation that we can exploit in our regressions. Similarly, Figure A1 in the Appendix reports the distribution of the difference in subjects' averages within classes

and confirms that there is a significant amount of within-pupil across-subject dispersion in average peers' 5th-grade test scores.

Figure 5: Correlations between students' own test scores and peer's test scores across subjects




Note: The top right (left) panel of the Figure shows the correlation between student's $i$ test score in math and reading in 5th (8th) grade. The bottom right (left) panel shows the correlation between peers' average test scores in math and reading in 5th (8th) grade. Dashed lines are the lines of best fit.

Table 3 reports means and standard deviations (overall, between- and within-students) of 5th and 8th-grade test scores and peers' quality measures, for immigrant (Panel A) and native (Panel B) students. Although, as expected, most of the variation in test scores is explained by the between-students variation, Table 3 shows that there is substantial within-student variation across subjects: this evidence confirms that test scores for the same student are not perfectly correlated across subjects and that there is enough variation we can leverage on. Similarly, there is some relevant variation also in the quality of peers across the two subjects. The latter holds for immigrants as well as for native students. The descriptive evidence in this section provides support for our identification strategy showing that there exists substantial within-student variation in test scores and peers' quality. This also supports our claim that immigrant students tend to be disadvantaged both in terms of educational achievements and

background characteristics.

Table 3: Within and between students' variation of test scores and peers' measures

| | Mean | Overall s.d. | Between s.d. | Within s.d. |
|---|---|---|---|---|
| **Panel A: Immigrant students** | | | | |
| 8th grade scores | 193.28 | 36.07 | 32.35 | 15.95 |
| 5th grade scores | 194.90 | 39.54 | 35.47 | 17.47 |
| Peers mean score (8th grade) | 206.49 | 29.88 | 29.11 | 6.72 |
| Fraction top 5% (8th grade) | 0.03 | 0.05 | 0.05 | 0.03 |
| Fraction bottom 5% (8th grade) | 0.03 | 0.05 | 0.04 | 0.03 |
| | | | | |
| N | 218,688 | | | |
| n | 109,344 | | | |
| T | 2 | | | |
| Attrition | 0.23 | | | |
| **Panel B: Native students** | | | | |
| 8th grade scores | 210.75 | 36.90 | 33.53 | 15.39 |
| 5th grade scores | 213.87 | 38.82 | 35.08 | 16.62 |
| Peers mean score (8th grade) | 208.42 | 31.13 | 30.42 | 6.60 |
| Fraction top 5% (8th grade) | 0.03 | 0.06 | 0.05 | 0.03 |
| Fraction bottom 5% (8th grade) | 0.03 | 0.05 | 0.04 | 0.03 |
| | | | | |
| N | 1,740,210 | | | |
| n | 870,105 | | | |
| T | 2 | | | |
| Attrition | 0.06 | | | |

Notes: The table shows means and overall, between- and within- standard deviations for 8th and 5th-grade test scores and peers' quality measures (peers mean score, fraction top and fraction bottom) for immigrant (Panel A) and native (Panel B) students. We restrict the sample to students that have INVALSI test scores not missing both in 5th and 8th grade. All test scores are standardized to have a mean equal to 200 and a standard deviation equal to 40 for each subject and cohort. The last row of Panel A and B reports the attrition rate, namely the share of students observed in grade 5 and missing in grade 8. For the definition of the variables see Table A4 in the Appendices.

# 6 Results

This section reports our results on the causal effect of peer quality on students' educational outcomes in 8th grade. Section 6.1 presents our baseline estimates, while Section 6.2 explores various dimensions of heterogeneity in the effect of peers' quality and discusses potential mechanisms at work. Section 6.3 further discusses our findings and compares the results for immigrant and native students.

## 6.1 Baseline estimates

Table 4 presents our results on the effect of peers' quality on immigrant students' test scores in grade 8th. Columns (1) and (3) report Ordinary Least Square (OLS) estimates while columns (2) and (4) report Within-Student (WS) estimates described in Section 4. Columns (1) and (2) present OLS and WS estimates of the effect of average peers' quality, while columns (3) and (4) report OLS and WS estimates of the impact of the percentage of bottom and top 5% peers. All specifications control for subject-by-cohort and subject-by-gender fixed effects. In OLS regressions, we also include cohort fixed effects and controls for students' demographic characteristics (gender, immigrant status, quarter of birth and the ESCS indicator measured in 5th grade). The outcome variables are reading and math test scores, standardised to have a mean of 200 and a standard deviation of 40 for each subject and cohort. Peer quality is predetermined and measured as the average of 5th-grade test scores of peers in grade 8th (mean score), as well as by the fraction of peers in each class that are below the 5th percentile (bottom) or above the 95th percentile (top) of the cohort-specific national distribution of 5th-grade test scores.

The OLS estimates in columns (1) and (3) of Table 4 indicate a positive and significant correlation between subject-specific peer quality and students' achievement. In particular, the coefficient of peers' mean scores is about 0.15, while the fraction of top students in the class is associated with an increase in test scores of about 9 points (which corresponds to about 22 percent of the overall standard deviation) and the fraction of bottom peers is associated with a reduction in test scores of about 30 points (which is about 75 percent of a standard deviation). Clearly, these estimates are biased by non-random sorting of students across schools: the positive association that we observe could be simply due to better students choosing better schools. When we address this issue, including student fixed effect in columns (2) and (4) and exploiting the random variation in peer quality across different subjects, the coefficients of peers' variables shrink substantially, as expected. In

particular, once we add student fixed effects, the coefficient of peers' mean score goes from 0.15 to 0.09 and the coefficients of the share of top and bottom peers diminish respectively to 4.4 and 10.8. This drop in the point estimates size indicates that the inclusion of student fixed effects is effective at controlling for within- and between-schools endogenous sorting, by eliminating unobserved students' and school characteristics. The direction of the implied bias suggests that there is a positive selection: students with higher unobserved ability are more likely to be assigned to schools (and classes within schools) with higher average peer quality. The reduction in the size of the estimated coefficients may be also due to the fact that WS estimates net-out spillovers across subjects. In the rest of the paper, we will focus only on our preferred and most stringent specification that includes student fixed effects.

Table 4: Impact of peer quality on 8th grade outcomes of immigrant students. OLS and WS estimates.

| | (1) OLS | (2) WS | (3) OLS | (4) WS |
|---|---|---|---|---|
| Peers' mean score | 0.149*** | 0.092*** | | |
| a | (0.006) | (0.013) | | |
| Share of top 5% students | | | 9.905*** | 4.356** |
| | | | (1.357) | (1.879) |
| Share of bottom 5% students | | | -29.826*** | -10.806*** |
| | | | (1.322) | (2.180) |
| Observations | 217,338 | 218,688 | 217,338 | 218,688 |

Notes: The table reports the regressions' coefficients of the average peer quality (columns 1-2) and the fraction of top and bottom peers (columns 3-4) on immigrant students' 8th-grade standardized test scores. Columns (1) and (3) report OLS estimates. Columns (2) and (4) report within-student (WS) across-subjects estimates. The dependent variables are the INVALSI 8th-grade test scores in reading and math. All test scores are standardized to have a mean equal to 200 and a standard deviation equal to 40 for each subject and cohort. The fraction of top (bottom) peers is defined as the class share of students at the top (bottom) 5 percent of the cohort-specific national distribution of 5th-grade INVALSI test scores. All specifications include gender-by-subject fixed effects and cohort-by-subject fixed effects. Columns (1) and (3) additionally control for cohort fixed-effect, gender, immigrant status, quarters of birth and the ESCS index measured in 5th grade. Robust standard errors (adjusted for clustering at the class level) are in parenthesis, *** p<0.01, **<0.05, * p<0.1.

Results in Table 4 document that the quality of peers matters for immigrant students' performance. However, the peer measures in Table 4 are computed based on all classmates' abilities in grade 8. These estimates may suffer from reflection problems if some peers in grade 8 attended the same primary school as student $i$ (old peers). In this case, 5th-grade

test scores of student $i$ and those of her old peers would be simultaneously determined. Therefore, in Table 5, we construct peer quality measures separately for new peers and old peers and focus on the effect of *new peers* on students' achievements.

Table 5: Impact of new peers' quality on 8th-grade outcomes of immigrant students

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Peers' average score (new peers) | 0.005 | | -0.008 | 0.046*** | | 0.032** |
| | (0.011) | | (0.012) | (0.011) | | (0.013) |
| Share of top 5% students (new peers) | | 0.028 | 0.758 | | 3.653 | 0.624 |
| | | (2.303) | (2.61) | | (2.356) | (2.68) |
| Share of bottom 5% students (new peers) | | -6.936*** | -7.499*** | | -10.349*** | -8.012*** |
| | | (2.526) | (2.626) | | (2.685) | (2.748) |
| Control for old peers' quality | yes | yes | yes | no | no | no |
| Observations | 218,688 | 218,688 | 218,688 | 218,688 | 218,688 | 218,688 |

Notes: The table shows WS estimated coefficients of the average quality of new peers, the fraction of top and bottom new peers on students' 8th-grade standardized test scores. "New peers" refer to students in grade 8 in a given cohort that do not come from the same primary school. All test scores are standardized to have a mean equal to 200 and a standard deviation equal to 40 for each subject and cohort. The fraction of top (bottom) peers is defined as the class share of students at the top (bottom) 5 percent of the cohort-specific national distribution of 5th-grade INVALSI test scores. All specifications include student fixed effects, as well as gender-by-subject fixed effects and cohort-by-subject fixed effects. Columns (1)-(3) additionally control for the average quality of old peers. Robust standard errors (adjusted for clustering at the class level) are in parenthesis, *** p<0.01, **<0.05, * p<0.1.

In our main specifications, reported in columns (1), (2) and (3) of Table 5, we control for the average test scores of old peers, but as shown in columns (4)-(6) our estimates are not sensitive to the inclusion of this variable. Different columns include different peer quality measures as treatments. In columns (1) and (4) we include (new) peers' average ability only, in columns (2) and (5) we include only the fraction of new peers at the top and at the bottom 5 percent of the ability distribution, while in columns (3) and (6) we include all the three treatments together.

Estimates results reported in columns (1)-(3) of Table 5 indicate that, once we focus on new peers only, the positive impact of average peer quality completely disappears: the coefficients of mean score of new peers in columns (1) and (3) shrink in magnitude (compared to the results presented in Table 4) and turn not significant. Similarly, column (2) shows that the effect of the top 5% peers is positive but small and not statistically different from zero. Only

the effect of the bottom 5% peers remains sizable and significantly negative after focusing on new peers only. This result holds true also when we do not control for the quality of old peers (columns 4-6). In particular, the coefficient of 7.5 in column (3) implies that a 10 percent increase in the share of very low-achieving students in the class (which is like adding two bottom students in an average class of 20 students) reduces immigrant children's performance by 0.75 points, which corresponds to roughly 2 percent of a standard deviation (0.75/40=0.0185). The implied effect size is thus fairly small but in line with the findings of other studies. For example, Gibbons and Telhaj (2016) find that a one standard deviation increase in peer group prior achievement is associated with a 0.02 standard deviation increase in student achievement, while results in (Lavy et al., 2012) indicate that an increase in the class share of bottom peers from 0% to 20% (minimum and maximum values in their sample) would lead to a reduction in students' test scores of around 9% of a standard deviation. In general, specifications in Table 5 focusing on new peers detect smaller effects than those estimated when focusing on all peers, which suggests that looking at new peers helps overcome the residual reflection problem. Together, our results indicate that immigrant students are most affected by the quality of peers at the very bottom of the ability distribution. This finding is consistent with a "bad-apple"-type model of peer effects in which a small number of very weak students adversely affects the learning of all the others ((Lavy et al., 2012); Lazear (2001)) and is in line with previous papers documenting a detrimental impact of very low-achieving pupils (see Burke and Sass (2013); Lavy et al. (2011); Hoxby and Weingarth (2005)). Academically weak students may generate negative externalises: they are likely to require more of the teacher's attention at the expense of other pupils (see Auestad (2018)) and to distract both the teacher and students from productive tasks, lowering the quality of the instruction time in the class.

To further understand how the ability of peers shapes immigrant students' educational outcomes, in the next section we test for the presence of heterogeneous effects across several characteristics which will help identify possible channels at work.

## 6.2 Heterogeneous effects

In this section, we investigate whether the impact of class composition on students' achievements is heterogeneous along a number of relevant dimensions. In Table 6 we start by unpacking our results to allow peer effects to differ by gender, socio-economic background and initial level of ability. The first two columns of Table 6 show estimates by gender and indicate that there is no significant heterogeneity across this dimension. Both males and females are equally negatively affected by low-achieving students. We also find a weak indication that females benefit more than males from interactions with very bright peers: the coefficient of the share of top-achieving peers in the class is in fact positive for girls and negative for males, although they are both not statistically significantly different from zero. Columns (3) and (4) report the results by students' socio-economic status, as captured by the ESCS index. Students whose ESCS is above the median are defined as "high ESCS", while students with ESCS below the median are categorized as "low ESCS". We find that test scores of immigrant children coming from a more advantaged background are positively affected by the share of top-achieving peers in the class, with the effect of the share of bottom peers turning not significant. On the other hand, for low-ESCS immigrant students, the negative impact of the share of bottom peers persists. In columns (5) and (6) we explore whether peer effects differ by the initial level of ability, measured using students' predetermined test scores in grade 5. In particular, we define students to have a high (low) level of initial ability if the average 5th-grade test score across subjects is above (below) the median. For immigrants with high levels of initial ability, we find that peer quality has no effect on test scores, whereas the effect of peer quality for immigrant students with a low level of initial ability remains unchanged. Overall, results in Table 6 suggest that the detrimental effects of low-achieving peers uncovered in our baseline estimates for immigrant students (column 3 of Table 5) are driven primarily by most fragile students, namely children coming from a more disadvantaged background both in terms of resources and school readiness.

Table 6: Impact of peer quality on 8th-grade outcomes of immigrant students. Heterogeneity by gender, socioeconomic background and initial ability

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | **Gender** | | **ESCS** | | **Initial ability** | |
| | Females | Males | High | Low | High | Low |
| Peers' average score (new peers) | -0.016 | 0.001 | -0.031 | -0.000 | -0.005 | -0.009 |
| | (0.017) | (0.017) | (0.024) | (0.014) | (0.022) | (0.015) |
| Share of top 5% (new peers) | 1.663 | -0.302 | 8.499* | -1.987 | -3.654 | 3.786 |
| | (3.529) | (3.597) | (4.919) | (2.974) | (4.209) | (3.177) |
| Share of bottom 5% (new peers) | -7.064** | -7.972** | -5.157 | -7.798*** | -1.793 | -9.475*** |
| | (3.470) | (3.513) | (4.752) | (3.022) | (4.633) | (3.023) |
| Observations | 113,774 | 104,914 | 53,936 | 163,402 | 69,024 | 149,664 |

Notes: The table reports WS estimates of the effect of the average quality of new peers, fraction of top and bottom new peers on students' 8th-grade standardized test scores by gender (male/female), socio-economic background (ESCS higher/lower than the median) and initial ability (average test score across subjects higher/lower than the median). The dependent variables are the INVALSI test scores in reading and math. All test scores are standardized to have a mean equal to 200 and a standard deviation equal to 40 for each subject and cohort. The fraction of top (bottom) peers is defined as the class share of students at the top (bottom) 5 percent of the cohort-specific national distribution of 5th-grade INVALSI test scores. All specifications include the average quality of old peers, gender-by-subject fixed effects and cohort-by-subject fixed effects. Robust standard errors (adjusted for clustering at the class level) are in parenthesis, *** p<0.01, **<0.05, * p<0.001.

We have so far explored the heterogeneity of peer effects along some of the dimensions most investigated in the existing literature. We now focus on some novel characteristics that better qualify the immigrant status of the students in our sample. Immigrant students are in fact a much more diverse than homogeneous population. Students with an immigrant background can differ widely in their country of origin, language traditions, and the length of time spent in the host country and these factors may impact the way peers influence their learning. In Table 7, we test if peer effects vary by 1) whether the immigrant student is foreign-born (1st generation) or born in Italy from foreign-born parents (2nd generation) (columns 1 and 2), 2) whether they usually speak Italian or another language at home (columns 3 and 4), 3) whether they have one or both parents with an immigrant background (columns 5 and 6).

We find no heterogeneous effects for first- versus second-generation immigrant children: both groups are adversely affected by high shares of very low-achieving peers and do not significantly benefit from higher-quality peers in the class. However, the negative effect of a high

Table 7: Impact of peer quality on 8th-grade outcomes of immigrant students. Heterogeneity by immigrant status, language spoken at home and parents' nationality

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | **Immigrant status** | | **Language spoken at home** | | **Parents' nationality** | |
| | *1st gen* | *2nd gen* | *Italian* | *Other language* | *Both foreign* | *One Italian* |
| New peers' average score | -0.002 | -0.010 | -0.010 | -0.010 | -0.007 | -0.031 |
| | (0.022) | (0.014) | (0.019) | (0.016) | (0.013) | (-0.056) |
| Share of top 5% (new peers) | -3.070 | 2.417 | 1.154 | 0.330 | 0.462 | 6.669 |
| | (4.662) | (2.985) | (3.823) | (3.45) | (2.674) | (10.833) |
| Share of bottom 5% (new peers) | -9.022** | -6.754** | -3.379 | -10.266*** | -7.643*** | -3.881 |
| | (4.363) | (3.135) | (3.844) | (3.355) | (2.685) | (11.613) |
| Observations | 63,360 | 155,328 | 82,546 | 127,898 | 208,846 | 9,842 |

Notes: The table reports WS estimates of the effect of the average quality of new peers, the fraction of top and bottom new peers on students' 8th-grade standardized test scores by immigrant status (1st/2nd generation) (column 1-2), language mostly spoken at home (column 3-4), and parents' nationality (column 5-6). The dependent variables are the INVALSI test scores in reading and math. All test scores are standardised to have a mean of 200 and a standard deviation of 40 for each subject and cohort. The fraction of top (bottom) peers is defined as the class share of students at the top (bottom) 5 percent of the cohort-specific national distribution of 5th-grade INVALSI test scores. All specifications include the average quality of old peers, gender-by-subject fixed effects and cohort-by-subject fixed effects. Robust standard errors (adjusted for clustering at the class level) are in parenthesis, *** p<0.01, **<0.05, * p<0.001.

share of low-performing kids seems to be more pronounced for immigrant students that do not use the Italian language at home (column 4) and that have both parents born abroad. Negative effects of being exposed to foreign language-speaking peers are also detected by Chuard et al. (2022) showing a reduction in the probability of attending an academic track for ethnic minorities exposed to a higher share of foreign language-speaking peers in the class, particularly if peers speak the same foreign language.

Overall, these results, reinforce our previous finding: a large fraction of "bad" peers in the class is detrimental to learning, especially for most fragile and less integrated immigrant children. We interpret this finding, considering that a higher proportion of low-achieving students in the class may result in a deterioration of teachers' pedagogical practices and in the relationships between teachers and students, and may increase the level of classroom disruptions (see for example Lavy et al. (2011)). Fragile immigrant students are especially

harmed in this situation because they are likely to be less able to cope with difficult learning environments.

### 6.3 Discussion

Overall, our estimates indicate that the school performance of immigrant students is harmed by the presence of high shares of very low-achieving peers in the class. In contrast, the average peers' quality and the fraction of very bright peers do not affect their educational outcomes. While our paper focuses on the school performance of immigrant students, in order to provide policy implications regarding class formation, it is important to consider the effect of peers' quality on native students as well. In this paragraph, we first replicate our baseline analysis in Table 5 on the sample of native students (see Table A1 in the Appendix) and we then investigate in Table 8 whether immigrant and native students have different reference groups (Fordham and Ogbu (1986)), by defining our peer measures separately for immigrant and native students. This distinction sheds light on potential differences in the influence exerted by immigrant and native students' academic quality on their peers. We use the same ability distribution for immigrant and native students when defining students in the top and bottom 5%. In Table A2 in the Appendix, as a sensitivity check, we show that our results hold if we use separate ability distributions for immigrant and native students [8]. Results in Table A1 show that native students are not negatively affected by the share of bottom peers, but they benefit from a higher average quality of peers in the class (see columns 1, 4, and 6). Moreover, Column (5) outlines that the fraction of bright peers positively impacts native students' achievement when the quality of old peers is not controlled for. However, this effect becomes statistically insignificant when all the treatments are analysed jointly in the same regression (column 6). Overall, these findings suggest that the quality of peers matters for both native and immigrant students, but they are affected in different

[8] This may be relevant considering that, as discussed in section 5, the distributions of test scores of immigrant and native children differ considerably: in the fraction of top peers there is an under-representation of immigrant children while they are more heavily concentrated in the lower tail of the ability distribution.

ways: immigrants are detrimentally influenced by the share of bottom peers at the extreme of the ability distribution, while natives are mostly affected by the average quality of peers in the class. This evidence may be explained by the fact that immigrant children, on average, start secondary school with lower initial test scores and would benefit more from teachers' time compared to natives, so they appear to be more sensitive to potentially disruptive low-achieving peers.

Estimates in Table 8 provide further evidence in line with those in previous tables, and they enrich our understanding of the contribution of immigrant and native children to the observed effects. Our results suggest that immigrant students are affected mainly by their immigrant peers. In particular, immigrant students benefit from the average ability of both immigrant and native students (column 1) and are negatively affected by the fraction of low-achieving immigrant peers (column 2). When including all treatments together, immigrants' test scores are only affected by the average ability of their immigrant peers (column 3).

Turning to native children (see columns 3-6), we find that the average peer ability of native students plays an important role in native students' outcomes: estimates are positive and significant both when analysed separately and together in the same specification. Moreover, when we exclude the average peer ability (column 2), we find that the fraction of high-achieving native peers has a positive and significant effect, while the fraction of native low-ability peers has a negative and significant one. Interestingly, in all specifications, immigrant students' average ability, as well as the share of high- or low-achieving immigrants, do not affect native students' achievements.

We interpret these results as evidence of homophily. The impact of peers is stronger among students that belong to the same group: immigrant (native) students mostly affect immigrant (native) students. This finding is consistent with Figlio and Özek (2019), and Figlio et al. (2021) finding zero to positive effects of immigrants on the educational outcomes of native students and with the existing evidence on racial peer effects, where most of the stud-

ies suggest that peer effects are larger within the same racial group than between groups (Hoxby (2000); Hanushek et al. (2003); Hanushek et al. (2009)), possibly because many more peer interactions take place within a race than across races (Hanushek et al. (2003)). As suggested by Fordham and Ogbu (1986) and Fryer Jr and Levitt (2010), this evidence can be interpreted as students placing different weights on peers from diverse backgrounds. In our context, immigrant (native) students might value more immigrant (native) peers than native (immigrant) ones. In other words, stronger within-group spillovers might reflect the fact that students respond more to peers who are more similar to them. This result is relevant in light of the debate on the impact of immigrant students on natives' educational performance. Despite the concerns in many advanced countries that the increasing shares of immigrants may be detrimental to native students' educational achievement, the empirical evidence of such spillover effects is scant, and our analysis seems to confirm the lack of such effect. In order to test if the effect of specific peers depends on the number of migrants in the class, we replicate the estimates in Table 8 by dividing our sample into two sub-groups according to whether the share of immigrant students in the class is above or below the median. The results are reported in Table A3 in the Appendix and indicate that the impact of immigrant peers' ability on immigrant performance is significant only in classes with a high share of migrants. Results align with findings in Schneeweis (2015) showing that immigrant students suffer in classes with a high share of migrants while no effect is detected on average for native students. The latter suggests that a potentially important mechanism for our results has to do with peer effects in the class forming along the ethnic dimension that hampers the educational integration of migrants by reducing their social interactions and learning opportunities from their native counterparts.

Table 8: Impact of peer quality on 8th-grade outcomes of immigrant and native students by the immigrant status of peers.

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | | **Immigrants** | | | **Natives** | |
| New peers' average score (natives) | 0.017* | | 0.015 | 0.036*** | | 0.036*** |
| | (0.010) | | (0.012) | (0.005) | | (0.006) |
| New peers' average score (immigrants) | 0.022*** | | 0.019** | 0.001 | | 0.001 |
| | (0.007) | | (0.007) | (0.003) | | (0.003) |
| Share of top 5% (new peers - natives) | | 0.802 | -0.366 | | 1.552** | 0.010 |
| | | (1.408) | (1.636) | | (0.638) | (0.737) |
| Share of top 5% (new peers - immigrants) | | 0.756 | -0.414 | | -0.095 | -0.187 |
| | | (1.141) | (1.206) | | (0.528) | (0.563) |
| Share of bottom 5% (new peers - natives) | | -2.479 | -1.666 | | -2.291*** | 0.105 |
| | | (1.592) | (1.686) | | (0.750) | (0.799) |
| Share of bottom 5% (new peers - immigrants) | | -1.659*** | -0.830 | | -0.289 | -0.120 |
| | | (0.642) | (0.688) | | (0.292) | (0.326) |
| Observations | 218,688 | 218,688 | 218,688 | 1,740,210 | 1,740,210 | 1,740,210 |

Notes: The table shows WS estimates of the effect of the average quality of new peers, and the fraction of top and bottom new peers on students' 8th grade INVALSI test scores by immigrant status. Columns (1)-(3) refer to immigrant students while Columns (4)-(6) to native students. The dependent variables are the INVALSI test scores in reading and math. All test scores are standardised to have a mean of 200 and a standard deviation of 40 for each subject and cohort. The fraction of top (bottom) peers is defined as the class share of students at the top (bottom) 5 percent of the cohort-specific national distribution of 5th-grade INVALSI test scores. Peer measures are reported separately for immigrant and native children. Peer measures are built using the same ability distribution for immigrant and native students. All specifications include the average quality of old peers, gender-by-subject fixed effects and cohort-by-subject fixed effects. Robust standard errors (adjusted for clustering at the class level) are in parenthesis, *** p<0.01, **<0.05, * p<0.1.

# 7 Robustness checks and sensitivity

In this section, we present a number of tests on our identifying assumptions and several sensitivity checks to test the robustness of our findings.

First, we present a set of tests to support the causal interpretation of our results. Our approach permits estimating the causal effect of peers under the main identifying assumption that peers' subject-specific ability is not related to unobserved determinants of individual students' subject-specific skills. Therefore, the first threat to identification is the potential subject-specific sorting of peers across schools and classes, as explained in section 4. In fact, despite our specification controls for students' average ability across subjects, is still possible

that some residual correlation is left between the subject-specific 5th-grade within-student across-subjects variation and the variation of peers' quality across subjects in 8th grade. As an example, if students who are unobservably more able in reading are systematically assigned to classes with a higher fraction of top peers in reading, our peer quality coefficients would be upward biases. In order to assuage this concern, in Table 9, we first perform a falsification test (or placebo) where we regress peers' ability in grade 8 on students' own ability in grade 5 (see columns 1-3) and then we augment our baseline specification including student's 5th grade test score among the control variables.

The estimates from the falsification test reported in columns (1)-(3) of Table 9 show that the coefficients of the three peer quality measures are not statistically significantly different from zero, which reassures us that there is no significant correlation between the within-student across-subjects variation in prior achievements and the variation in peers' ability across subjects. For columns (3) and (4), the table also reports the p-values for the F-test testing the joint significance of peers' quality measures that are again strongly rejected. This evidence is also confirmed by the results in columns (4)-(6), which indicate that when we augment our baseline specification including students' lagged test scores at grade 5, our coefficients of interest remain remarkably stable compared to baseline results reported in Table 5. The effects of the average peer quality and of the share of top 5% peers in the class remain insignificant, while the impact of the bottom 5% peers only marginally drops from 0.75 to 0.73. This suggests that conditional on student fixed effects, peer quality in one subject is balanced with respect to students' own test scores in that subject at the end of primary school (grade 5) (see also (Lavy et al., 2012)). This evidence is not surprising in our context where, as explained in section 3.1, lower secondary schools are comprehensive and neither setting or tracking practices are allowed nor schools or classes can specialize in specific subjects.

Another potential threat to our identification strategy is the non-random allocation of teach-

Table 9: Identification tests: impact of peers ability on students ability in grade 5 (col 1-3) and on students ability in grade 8 controlling for grade 5 test scores (col. 4-6)

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| **Dep variable:** | **Test scores at grade 5** | | | **Test scores at grade 8** | | |
| New peers' average score | -0.002 | | -0.004 | 0.006 | | -0.007 |
| | (0.007) | | (0.008) | (0.010) | | (0.012) |
| Share of top 5% (new peers) | | -0.208 | 0.128 | | 0.095 | 0.717 |
| | | (1.401) | (1.585) | | (2.269) | (2.567) |
| Share of bottom 5% (new peers) | | -0.287 | -0.546 | | -6.843*** | -7.323*** |
| | | (1.350) | (1.462) | | (2.474) | (2.568) |
| *Control for own test score at grade 5* | - | - | - | *yes* | *yes* | *yes* |
| *F-test for joint significance* | - | *0.967* | *0.967* | - | - | - |
| Observations | 218,688 | 218,688 | 218,688 | 218,688 | 218,688 | 218,688 |

Notes: The table shows WS estimated coefficients of the average quality of new peers, the fraction of top and bottom new peers on students' test scores in 5th grade (columns 1-3) and 8th-grade standardized test scores (columns 4-6). "New peers" refer to students in grade 8th in a given cohort that do not come from the same primary school. All test scores are standardised to have a mean of 200 and a standard deviation of 40 for each subject and cohort. The fraction of top (bottom) peers is defined as the class share of students at the top (bottom) 5 percent of the cohort-specific national distribution of 5th-grade INVALSI test scores. All specifications include students' fixed effects, gender-by-subject fixed effects and cohort-by-subject fixed effects. Columns (4)-(6) additionally control for the average quality of old peers. Robust standard errors (adjusted for clustering at the class level) are in parenthesis, *** p<0.01, **<0.05, * p<0.1.

ers to classes. In this case, variation in students' ability across subjects may be correlated with teachers' characteristics. If for example students with higher ability in a specific subject were systematically paired with higher-quality teachers in the same subject, our estimates would be bound to be biased. In order to test for this possibility, we exploit the detailed data on teachers' characteristics provided by INVALSI for a nationally representative sample of teachers and we test whether subject-specific teachers' characteristics are systematically correlated with students' subject-specific ability measures in grade 5, prior to the assignment to lower secondary school classes.[9] We use four characteristics to proxy teachers' quality: (i) educational level, (ii) tenure (years of teaching experience) (iii) number of training courses attended by the teacher and (iv) type of contract relation, whether fixed- or indefinite-term. The usage of these characteristics to proxy teachers' quality is well established in the educational literature (Chetty et al. (2011); Hanushek and Rivkin (2006); Figlio and Özek

[9]Data on teachers' characteristics are available only for the school years 2016 and 2017, thus this analysis is only possible for these two school years.

(2019) among others) and descriptive statistics for these variables are reported in Table A5 of the Appendices. We then regress the four indicators of teachers' quality in each subject on subject-specific peer quality measures. The dependent variables are respectively defined as binary outcomes equal to one when teachers' education is higher than a master degree, the number of training courses attended is higher than the median, the number of years spent in the school is more than five and when teachers have a permanent contract. Intuitively, if high-(low-) ability students in a specific subject are systematically assigned to better teachers we should find that predetermined students' peer quality measures are strong predictors of teachers' quality. Table 10 reports the results. Encouragingly, they indicate that students' ability in primary school does not predict the type of teacher a student is assigned to in lower secondary school, consistent with the random allocation of teachers to classes. None of the measures of teachers' quality is in fact statistically significantly correlated to students' subject-specific ability.

Table 10: Identification tests: random allocation of teachers

| **Teachers' characteristics** | (1) **High education** | (2) **High training** | (3) **Long tenure** | (4) **Permanent contract** |
|---|---|---|---|---|
| Peers' average score | 0.000 | 0.001 | -0.002 | -0.001 |
| | (0.001) | (0.003) | (0.003) | (0.002) |
| Share of top 5% | 0.151 | -0.190 | -0.237 | 0.097 |
| | (0.251) | (0.379) | (0.379) | (0.263) |
| Share of bottom 5% | -0.095 | 0.579 | -0.170 | -0.072 |
| | (0.216) | (0.370) | (0.333) | (0.252) |
| Observations | 2,714 | 2,714 | 2,714 | 2,714 |

Notes: The table reports coefficients from a within-classroom across subject-specific teachers model. The dependent variables are defined as binary outcomes. Each of the four columns denotes a different teacher's characteristic: (1) an indicator for having an education level greater than a master degree, (2) an indicator for having attended more training courses than the average, (3) an indicator for having an experience greater than five years, (4) an indicator for having an open-ended contract. See A4 for variable definitions. The fraction of top (bottom) peers is defined as the class share of students at the top (bottom) 5 percent of the cohort-specific national distribution of 5th-grade INVALSI test scores. All specifications include class-fixed effects, the share of females per class, class-by-subject fixed effects and cohort-by-subject fixed effects. Regressions include only the classes (teachers) who were sampled to be part of the INVALSI nationally representative sample for the school cohorts 2016 and 2017. Robust standard errors (adjusted for clustering at the class level) are in parenthesis, *** p<0.01, **<0.05, * p<0.001.

Overall, the tests described above point to the validity of our identification strategy and

confirm that we can attach a causal interpretation to our regression results.

In the following tables, we present additional sensitivity checks to test the robustness of our specification. In Table 11, we test whether our results are robust to alternative samples. In our main analysis, we considered all students in public schools in Northern and Central Italy. In column (1) of Table 11 we run our baseline specification as in Table 5, now including the Southern regions in the estimation sample. In columns (2) and (3), we run our baseline analysis in a sub-sample of schools (column 2) and provinces (column 3) with a higher share of immigrants compared to the median. The estimates reported in the table suggest that our results are robust to the inclusion of Southern regions and indicate that the effect of bottom peers on immigrant students is larger in schools and provinces where most immigrants are concentrated. This result is in line with findings in Table 8, which highlighted that spillovers are stronger within the group of immigrants and are larger in contexts where the presence of immigrant students is more pervasive.

Table 11: Robustness of results to alternative samples

| | (1) **Include Southern regions** | (2) **Schools with high share of immigrants** | (3) **Provinces with high share of immigrants** |
|---|---|---|---|
| New peers' average score | -0.018 | -0.006 | -0.004 |
| | (0.011) | (0.015) | (0.016) |
| Share of top 5% (new peers) | 0.523 | -0.099 | -1.362 |
| | (2.392) | (3.105) | (3.305) |
| Share of bottom 5% (new peers) | -6.830*** | -8.447*** | -9.287*** |
| | (2.458) | (2.952) | (3.282) |
| Observations | 246,808 | 162,164 | 145,204 |

Notes: The table shows the WS estimated coefficients of the average quality of new peers, the fraction of top and bottom new peers on students' 8th-grade standardized test scores. "New peers" refer to students in grade 8th in a given cohort that do not come from the same primary school. All test scores are standardized to have a mean equal to 200 and a standard deviation equal to 40 for each subject and cohort. The fraction of top (bottom) peers is defined as the class share of students at the top (bottom) 5 percent of the cohort-specific national distribution of 5th-grade INVALSI test scores. All specifications include students' fixed effects, gender-by-subject fixed effects and cohort-by-subject fixed effects. In columns (2) and (3), we define schools and provinces to have a high share of migrants if the share of migrants is higher than the median. Robust standard errors (adjusted for clustering at the class level) are in parenthesis, *** p<0.01, **<0.05, * p<0.1.

Next, we test the robustness of our main results to an alternative empirical approach. Our empirical strategy, described in Section 4, exploits the random variation in peer quality across subjects within each student. This strategy allows to absorb individual unobserved heterogeneity and accounts for the non-random sorting of students across classes. However, we are not able to capture ability spillovers across subjects that may arise if, for example, peers' ability in reading affects students' performance in math. In Table 12, we investigate if our main finding of the negative impact of very low-achieving peers holds when using an alternative empirical strategy commonly used in several existing studies and relying on within-school variations in students' ability across adjacent cohorts or across different classes. Table 12 presents the results from our within-school across cohorts strategy on students' performance for three specifications that progressively add peers' quality measures. Specifications in columns (4)-(6) additionally include indicators for gender, quarters of birth, immigrant status (first- or second-generation immigrant) and the ESCS index measured in 5th grade. Consistently with our main specification, we find that the share of very weak students worsens students' educational achievements, lending support to our results.

Finally, in Table 13 we test the sensitivity of our results to changes in the thresholds defining high(low)-achieving peers. In our baseline estimates, we define the fraction of high- and low-achieving peers as the fraction of top and bottom *5%* students in the cohort-specific national distribution. In principle, other thresholds might have been chosen, potentially changing the reported effects of peers' quality.[10] In Table 13, we replicate our baseline specification, using alternative cutoffs to define peers at the top and bottom of the ability distribution. In columns (1)-(4), we report estimates defining the fraction of low(high)-achieving students as those in the (i) 1% (ii) 5% (our baseline) (iii) 10% (iv) 20% of the cohort-specific national distribution.

Estimates in column (1) show that when defining top (bottom) peers as those in the top

[10]Despite being reasonable, the choice of the cutoff has been made also to ease the comparison with existing results in the literature (Lavy et al., 2012).

Table 12: Robustness of results to alternative empirical approaches: school fixed effects

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| New peers' average score | 0.085*** | | 0.071*** | 0.076*** | | 0.061*** |
| | (0.007) | | (0.010) | (0.007) | | (0.009) |
| Share of top 5% (new peers) | | 6.999*** | -1.014 | | 6.267*** | -0.693 |
| | | (1.404) | (1.679) | | (1.383) | (1.656) |
| Share of bottom 5% (new peers) | | -13.822*** | -7.258*** | | -13.041*** | -7.342*** |
| | | (1.384) | (1.543) | | (1.366) | (1.529) |
| Demographic controls | *no* | *no* | *no* | *yes* | *yes* | *yes* |
| School fixed effects | *yes* | *yes* | *yes* | *yes* | *yes* | *yes* |
| Observations | 218,688 | 218,688 | 218,688 | 217,338 | 217,338 | 217,338 |

Notes: The table reports the regressions' coefficients of the average peer quality (columns 1-2), the fraction of top and bottom peers (columns 3-4) and average peer quality and the fraction of top and bottom peers (columns 5-6) on immigrant students' 8th grade standardized test scores. The dependent variables are the INVALSI 8th-grade test scores in reading and math. All test scores are standardized to have a mean of 200 and a standard deviation of 40 for each subject and cohort. The fraction of top (bottom) peers is defined as the class share of students at the top (bottom) 5 percent of the cohort-specific national distribution of 5th-grade INVALSI test scores. All specifications include controls for school fixed effects, gender-by-subject fixed effects and cohort-by-subject fixed effects. Columns (2),(4) and (6) additionally control for cohort fixed effect, gender, immigrant status and quarters of birth. Robust standard errors (adjusted for clustering at the class level) are in parenthesis, *** p<0.01, **<0.05, * p<0.1.

Table 13: Impact of peer quality on 8th grade outcomes of immigrant students - Different thresholds to define the groups of top and bottom peers.

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Thresholds | 1% | **5%** | 10% | 20% |
| Mean score new peers | -0.000 | **-0.008** | -0.006 | -0.005 |
| | (0.011) | **(0.012)** | (0.014) | (0.016) |
| Fraction top new peers | 3.042 | **0.758** | 0.808 | 0.362 |
| | (5.274) | **(2.61)** | (2.053) | (1.737) |
| Fraction bottom new peers | -9.792* | **-7.409*** ** | -3.256* | -2.032 |
| | (5.851) | **(2.626)** | (1.971) | (1.661) |
| Observations | 218,688 | 218,688 | 218,688 | 218,688 |

Notes: The table shows WS estimates of the effect of the average quality of new peers, and the fraction of top and bottom new peers on immigrant students' 8th-grade standardized test scores by different definitions of treatments. The dependent variables are the INVALSI test scores in reading and math. All test scores are standardized to have a mean of 200 and a standard deviation of 40 for each subject and cohort. Columns (1)-(4) differ according to the thresholds used to define the top and bottom peers, which are 1% in column (1), 5% in column (2), 10% in column (3), 20% in column (4). All specifications include old peers' average quality, gender-by-subject fixed effects and cohort-by-subject fixed effects. Robust standard errors (adjusted for clustering at the class level) are in parenthesis, *** p<0.01, **<0.05, * p<0.001.

(bottom) 1% of the distribution, coefficients increase in magnitude compared to those in column (2), our baseline estimates. The share of bottom peers has a larger negative effect and turns significant also for natives. The share of top peers has no significant effect but the magnitude is again larger. On the other hand, columns (3) and (4) show that the more comprehensive the definition of top (bottom) peers the more the effect fades away. Interestingly, the effect of very good and very bad peers in column (3) drops by more than 50 percent. We interpret this dramatic drop as suggesting that our baseline definitions of top and bottom peers are the most appropriate, capturing the most relevant group of peers at the extreme of the ability distribution.

# 8 Conclusions

Recent years have seen growing interest in the impact of immigrants' concentration in the class on native children's outcomes. However, little research has been conducted into empirical support for policies that promote and foster immigrant students' learning. Surprisingly, no studies have yet explicitly explored how the ability composition of a class affects immigrant children's educational outcomes. In fact, it remains an open question under which circumstances the class environment promotes immigrant students' academic performance. This is a particularly relevant issue considering that a successful education is crucial to overcome the disadvantages of immigrants in European societies and fostering their integration.

This article fills that gap by providing an empirical investigation into the effect of both immigrant and native classmates' academic ability on the educational achievement of immigrant students in Italy. In particular, by making use of an identification strategy that exploits within-student variation in ability across subjects, we explore the roles played by the peers' average academic ability and by the fraction of peers' at the extreme tails of the national cohort-specific ability distribution.

Importantly, our results show that ability peer effects exist for both natives and immigrants. However, native and immigrant students are affected by the performance of their peers differently. While natives are affected mainly by the average quality of classmates, immigrant students are detrimentally influenced by the share of very low-achieving peers. Our analysis further reveals that the share of weak peers is especially harmful to most fragile and less integrated immigrant children (those who do not use the Italian language at home or have both parents born abroad). In addition, we show that immigrants and natives tend to have different reference groups, with immigrants mainly affected by the performance of their immigrant peers and natives affected by the ability of their native peers. This finding is in line with the literature on racial peer effects emphasizing that peer effects are greater intra-race than across races (Hoxby (2000); Hanushek et al. (2003); Hanushek et al. (2009)). Moreover, it seems to suggest that the widespread perception of immigrant students imposing adverse peer effects on their native-born peers may not be empirically grounded.

As policymakers increasingly look for policies to help migrants' integration to host countries' educational systems, we show that taking into account class ability composition might be a promising and low-cost tool to help improve immigrant students' educational performance, especially for the disadvantaged ones. Our results in fact indicate that immigrant students, especially the most fragile ones, are particularly vulnerable to the composition of the class and to the exposition of academically weak students. Because of their disadvantaged background and lack of home resources, immigrant children might be more dependent on the school context for their learning. One might argue that concentrating more fragile children within the same class might help teachers tailor the educational offer and recognize the specific needs of struggling students. Our findings instead suggest that in order to foster immigrant children's learning, it is important to avoid the concentration of very weak students in the same class, especially when these low-achieving peers are migrants. From a policy perspective, our results indicate it is possible to achieve some gains in immigrant students' performance by reorganizing peer groups and increasing the ability mix and het-

erogeneity in the class. Immigrant students appear to benefit from a more even distribution of low-ability and foreign-born students across schools, which encourages the enforcement of such measures as residential desegregation policies or transport subsidies that promote a more heterogeneous pool of students for class formation. Our findings are also critical in the light of the current debate regarding the possible expansion of school choice (see Gibbons and Telhaj (2016)), which may lead to a higher degree of sorting across schools along lines of prior ability, harming the school attainment of migrants.

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# Appendices

Table A1: Impact of new peers' quality on 8th grade outcomes of native students

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| New peers' average score | 0.011** | | 0.009 | 0.040*** | | 0.038*** |
| | (0.005) | | (0.006) | (0.005) | | (0.006) |
| Share of top 5% (new peers) | | 1.681 | 0.793 | | 4.695*** | 1.046 |
| | | (1.027) | (1.150) | | (1.052) | (1.171) |
| Share of bottom 5% (new peers) | | -0.894 | -0.205 | | -2.687** | 0.142 |
| | | (1.200) | (1.268) | | (1.233) | (1.296) |
| Control for old peers' quality | *yes* | *yes* | *yes* | *no* | *no* | *no* |
| Observations | 1,740,210 | 1,740,210 | 1,740,210 | 1,740,210 | 1,740,210 | 1,740,210 |

Notes: The table shows the estimated coefficients of the average quality of new peers and the fraction of top and bottom new peers on students' 8th-grade standardized test scores. "New peers" refer to students in grade 8th in a given cohort that do not come from the same primary school. All test scores are standardized to have a mean equal to 200 and a standard deviation equal to 40 for each subject and cohort. The fraction of top (bottom) peers is defined as the class share of students at the top (bottom) 5 percent of the cohort-specific national distribution of 5th-grade INVALSI test scores. All specifications include students' fixed effects, gender-by-subject fixed effects and cohort-by-subject fixed effects. Columns (1)-(3) also control for the average grade 5th test scores of old peers. Robust standard errors (adjusted for clustering at the class level) are in parenthesis, *** p<0.01, **<0.05, * p<0.1.

Table A2: Impact of peer quality on 8th grade outcomes of immigrant and native students, separate ability distribution.

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | **Immigrants** | | | **Natives** | | |
| New peers' average score (natives) | 0.017* | | 0.015 | 0.036*** | | 0.037*** |
| | (0.010) | | (0.013) | (0.005) | | (0.006) |
| New peers' average score (immigrants) | 0.022*** | | 0.021*** | 0.001 | | 0.001 |
| | (0.007) | | (0.007) | (0.003) | | (0.003) |
| Share of top 5% (new peers - natives) | | 0.782 | -0.351 | | 2.423*** | -0.004 |
| | | (1.408) | (1.642) | | (0.644) | (0.738) |
| Share of top 5% (new peers - immigrants) | | 0.779 | -0.377 | | -0.212 | -0.377 |
| | | (0.812) | (0.885) | | (0.392) | (0.425) |
| Share of bottom 5% (new peers - natives) | | -2.461 | -1.646 | | -1.556** | 0.228 |
| | | (1.505) | (1.617) | | (0.710) | (0.752) |
| Share of bottom 5% (new peers - immigrants) | | -1.521* | -0.580 | | -0.263 | -0.150 |
| | | (0.812) | (0.835) | | (0.378) | (0.401) |
| Observations | 218,688 | 218,688 | 218,688 | 1,740,210 | 1,740,210 | 1,740,210 |

Notes: The table shows WS estimates of the effect of the average quality of new peers, and the fraction of top and bottom new peers on students' 8th grade INVALSI test scores by immigrant status. Columns (1)-(3) refer to immigrant students while Columns (4)-(6) to native students. The dependent variables are the INVALSI test scores in reading and math. All test scores are standardized to have a mean equal to 200 and a standard deviation equal to 40 for each subject and cohort. The fraction of top (bottom) peers is defined as the class share of students at the top (bottom) 5 percent of the cohort-specific national distribution of 5th-grade INVALSI test scores. Peer measures are reported separately for immigrant and native children. Peer measures are built using the same ability distribution for immigrant and native students. All specifications include old peers' quality measures, gender-by-subject fixed effects and cohort-by-subject fixed effects. Robust standard errors (adjusted for clustering at the class level) are in parenthesis, *** $p<0.01$, ** $<0.05$, * $p<0.1$.

Table A3: Impact of peer quality on 8th-grade outcomes of immigrant students, by the immigrant status of peers and by the share of immigrants in the class.

| **Immigrant share in the class** | (1) **High** | (2) **Low** | (3) **High** | (4) **Low** | (5) **High** | (6) **Low** |
|---|---|---|---|---|---|---|
| New peers' average score (natives) | 0.014 | 0.045 | | | 0.014 | 0.025 |
| | (0.011) | (0.029) | | | (0.013) | (0.035) |
| New peers' average score (immigrants) | 0.022*** | -0.008 | | | 0.019** | -0.003 |
| | (0.007) | (0.044) | | | (0.008) | (0.051) |
| Share of top 5% (new peers - natives) | | | -0.096 | 7.920** | -1.186 | 6.140 |
| | | | (1.499) | (4.040) | (1.736) | (4.704) |
| Share of top 5% (new peers - immigrants) | | | 0.806 | -1.111 | -0.372 | -0.958 |
| | | | (1.150) | (8.918) | (1.216) | (9.279) |
| Share of bottom 5% (new peers - natives) | | | -2.737 | 0.089 | -1.979 | 1.241 |
| | | | (1.684) | (4.745) | (1.787) | (4.982) |
| Share of bottom 5% (new peers - immigrants) | | | -1.663** | 1.026 | -0.826 | 0.919 |
| | | | (0.648) | (3.860) | (0.695) | (4.386) |
| Observations | 188,442 | 30,246 | 188,442 | 30,246 | 188,442 | 30,246 |

Notes: The table shows WS estimates of the effect of the average quality of new peers, fraction of top and bottom new peers on students' 8th-grade INVALSI test scores by immigrant status. The dependent variables are the INVALSI test scores in reading and math. All test scores are standardized to have a mean equal to 200 and a standard deviation equal to 40 for each subject and cohort. The fraction of top (bottom) peers is defined as the class share of students at the top (bottom) 5 percent of the cohort-specific national distribution of 5th-grade INVALSI test scores. Peer measures are reported separately for immigrant and native children. All specifications include old peers' quality measures, gender-by-subject fixed effects and cohort-by-subject fixed effects. Robust standard errors (adjusted for clustering at the class level) are in parenthesis, *** $p<0.01$, ** $<0.05$, * $p<0.1$.

Table A4: Definition of variables and sources.

| Variable | Description | Source |
|---|---|---|
| **Test scores** | | |
| 5th grade Reading test score | WLE 200 Rasch Score in Reading test | INVALSI |
| 5th grade Math test score | WLE 200 Rasch Score in Math test | INVALSI |
| 8th grade Reading test score | WLE 200 Rasch Score in Reading test | INVALSI |
| 8th grade Math test score | WLE 200 Rasch Score in Math test | INVALSI |
| **Students' characteristics (individual level)** | | |
| Female | dummy=1 if female | INVALSI |
| Immigrant I generation | dummy=1 if child is immigrant II generation | INVALSI |
| Immigrant II generation | dummy=1 if child is immigrant I generation | INVALSI |
| Age | child year of birth | INVALSI |
| II quarter month of birth | dummy=1 if child is born in second quarter | INVALSI |
| III quarter month of borth | dummy=1 if child is born in third quarter | INVALSI |
| Native parents | dummy=1 if mother & father were born in Italy | INVALSI |
| Student ESCS | Student's economic social and cultural status | INVALSI |
| Student language | | |
| mostly spoken at home | dummy=1 if equal to Italian | INVALSI |
| **Teachers' characteristics** | | |
| High education | dummy=1 if educational level higher than master | INVALSI |
| High tenure | dummy=1 if tenure in the school higher than 5 years | INVALSI |
| High training | dummy=1 if training courses attended higher than the median | INVALSI |
| Permanent contract | dummy=1 if permanent contract | INVALSI |

Table A5: Teachers Descriptive Statistics

| | Mean | Standard Deviation | Observations |
|---|---|---|---|
| *Dependent variables* | | | |
| Low education | 0.923 | 0.267 | 2714 |
| High education | 0.077 | 0.267 | 2714 |
| Low training | 0.541 | 0.498 | 2714 |
| High Training | 0.459 | 0.498 | 2714 |
| Low tenure | 0.379 | 0.485 | 2714 |
| High Tenure | 0.621 | 0.485 | 2714 |
| Fixed-term contract | 0.128 | 0.334 | 2714 |
| Permanent contract | 0.872 | 0.334 | 2714 |

Notes: The Table shows descriptive statistics for the dependent variable used in Table 10 on a nationally representative sample of teachers in the school years 2016 and 2017.

Figure A1: Distribution of differences in subjects' averages within classes