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The effect of peer group stability on achievements: Evidence from Poland

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Abstract

This article reports on a study using data from nation-wide standardised examinations in Poland. We analysed the extent to which grade 9 student achievements have depended on the stability of their peer group over the course of middle school. We controlled for the fixed effects of schools attended by the students, as well as for individual achievements prior to middle school enrolment. To mitigate the risk for endogeneity, analysis was informed by a consideration of the fact that middle schools operate in different institutional relations with nearby primary schools. This also allowed us to distinguish between the effect related to peer group stability and the one connected to the stability of the learning environment in general. The results of our analysis show that instability significantly reduces students' expected performance in mathematics and science. The impact of peer group stability on test achievements varies strongly across the student ability distribution. Very low-performing students and top performers were most affected. The average students were largely unaffected. One category of students that seems to benefit from the change when moving to middle school are students from very competitive primary schools who have average skills.

1 | INTRODUCTION

Peer effects are a subject of great interest in research on education because of their supposed impact on the learning process and student achievements (Paloyo, 2020; Sacerdote, 2011). The most common approach to peer effects in education refers to measuring the impact of peers' socio-economic status, or their average school outcomes, on the achievements of individual students.

In the study on which we report in this article, we explored a largely neglected aspect of peer effects in education; namely, how the stability of peer groups can affect school performance. This issue deserves attention independent of the effect of the average ability of classmates, which we also control for in our model. Our goal is to better understand the nature of peer effects, along with the potential trade-off between the stimulating and adverse effect on different groups of students when they change learning environment. This study is unique in its focus and methodological approach. It sheds light on a previously under-investigated subject and contributes to the debate on peer effects in education.

Our study draws on administrative data from Poland. In the period covered by this research (2007–2015) compulsory general education in Poland remained split into two tiers: primary school (six grades), and middle school (three grades). Only after graduating from the latter stage were students tracked into either a three-year general secondary school, three- to four-year vocational secondary school, or basic vocational education directly preparing students to enter the labour market. We examined the change in the composition of peer groups resulting from the transition of Polish students from primary to middle school, and we assess how this change influenced student achievement at the end of grade 9 (when students graduate from middle school). We used the variation in the share of classmates that a middle school student knows from his or her previous school, to identify transitions that place a student in an entirely new environment. These transitions were distinguished from transitions in which, immediately after a change of school, the student is familiar with the majority of, or even all their classmates. In the latter case, the grade configuration functionally resembles a single structure K-9 model, rather than a separated two-tier system.

Our analysis is inspired by the earlier works by Pokropek (2013), Humenny et al. (2014) and Herczyński and Sobotka (2017), who also relied on standardised test results in Polish schools to address the issue of peer group effects. Compared to the aforementioned works, in this article we propose a number of enhancements. We run analysis on individual data covering six consecutive cohorts of students. We introduce additional control variables, and we directly address the issue of endogeneity. Using a range of techniques, we account for the non-randomness of peer group stability stemming from school location (urban vs. rural), the decisions of local authorities to create a particular functional type of middle school, and the differentiated admission strategies for high and low performing students and class assignment policies. We also make an attempt to disentangle the effect of peer group stability and the stability of the more broadly understood learning environment. Finally, we carefully investigate the heterogeneity of the peer group stability effect on student achievement.

Although this research is set in the context of the education system in Poland, it is relevant to policy dilemmas that exist in most countries, whether at the central or local level. New insights on the role of peer group stability in the education process can help policymakers and headmasters around the world optimise their decisions on school grade configuration, the spatial distribution of schools, school catchment areas, and class assignments. We show that peer group stability is an important part of the environmental conditions of learning and—similarly to factors such as the socio-economic status of peers and their academic abilities—that it affects the educational progress of group members.

This article is organised as follows. First, we discuss the existing evidence on peer effects in education. Next, an identification strategy is presented. The data and estimation methods are described. The section on results elaborates on the empirical results of the model estimation. In the final conclusions, the comparatively greater impact of transitions on low-performing students and top performers is underscored.

2 | IMPACT OF SOCIAL RELATIONS ON SCHOOL OUTCOMES

The impact of social relations and interactions on school achievements is explored in the literature from different angles. The most developed strand of research in this area is analysis of peer effects, but there are also many studies exploring how friendships, network formation, and social capital can affect academic achievements.

What is commonly understood by peer effects are any externalities of the peer group such as socio-economic background, behaviour, school outcomes, attitudes, or other student characteristics (gender, disability status, ethnicity) affecting the school achievements of a student, their behaviour, preferences, or choices (Paloyo, 2020; Sacerdote, 2011). Class composition is perceived next to family background as one of the key elements of an education production function which makes understanding the complexity of peer effects important for the optimal planning of schools and classes. The most commonly mentioned channels of peer influence are by students teaching one another, sharing information, or affecting the teacher's attention. Peer effects are also related to the teacher's or administrator's way of reacting to students, the classroom atmosphere (e.g., racial or income tensions), establishment of social norms, and class interaction (Carrell et al., 2009; Hoxby, 2000; Sacerdote, 2001).

As many studies show, peers matter, but the magnitude of the measured effects is vastly context-specific. For example, the importance of peers depends on students' age (stronger effects are observed among young students) and on the intensity of interactions between agents (Carrell et al., 2009; Burke & Sass, 2013; Díaz & Penagos, 2018; Paloyo, 2020).

Making friends and forming networks is not a random process. People often make relations with those having similar characteristics to themselves, which explains why low-achieving students do not always benefit from the presence of high-ability peers (Carrell et al., 2013).

The way students are assigned to classes and other groups can affect their self-esteem, which eventually determines their further achievements and behaviour. Cicala et al. (2018) showed that a drop in a student's relative rank within a classroom leads to an increase in the probability of serious behavioural incidents and, conversely, that upward motion in the achievement distribution results in a further boost of the student's academic performance. Friendship and peer relations have also been proven to mitigate the detrimental effects of school transition on school outcomes. Such effects were observed in middle schools in Israel (Lavy & Sand, 2018), high schools in France (Ly & Riegert, 2014), and in middle schools in north-eastern United States (Goldstein et al., 2015).

The change of learning environment is frequently suspected to impact disproportionately certain groups of children. In both academic and practitioner debates on middle schools, school transition is sometimes perceived as having a heterogeneous impact on the top performing and struggling students. Some experts stress that changing the school environment may be beneficial for children with low socio-economic status, those attending low-quality primary schools with poorly qualified teachers, and those with special educational needs (Herbst & Wojciuk, 2014). In turn, some research proves that low-performing students are those most affected by the adverse effects of middle school transition (Dhuey, 2013; Rockoff & Lockwood, 2010).

Studies on peer effects are frequently based on linear-in-means models assuming that the impact of peers is homogenous, regardless of student characteristics and position in the ability distribution (Sacerdote, 2011). However, more and more studies explore heterogeneous effects on changes in class composition on different groups of pupils, showing a much more complex picture of both (1) which student characteristics matter and (2) what the size of the effect is on different groups of students. There are different models of peer effects distinguished in the literature: the *bad apple* model (one disruptive student can negatively affect all other students); the *shining light* model (one extraordinary student can inspire other students); the *invidious comparison* model (the success of a better student decreases the outcomes of other students as their relative position is lower); the *boutique* model (higher outcomes when a student is surrounded by students with similar characteristics); the *focus* model (a homogenous learning environment raises outcomes); the *rainbow* model (heterogeneous learning environment positively affects school achievements); the *single crossing* (high achieving students benefiting from the presence of other high ability students; Sacerdote, 2011). These patterns are reflected in many empirical studies (Carrell et al., 2018; Ding & Lehrer, 2007; Hoxby & Weingarth, 2005).

3 | ANALYTICAL STRATEGY

3.1 | Measurement of peer group stability and model specification

In order to measure the integration challenge faced by students due to the transition to middle school, we observed the degree to which their classroom composition changed. More precisely, for each student *i* in school *j* we calculated c_{ij}: the percent of a student's middle school classmates who attended with him/her to one class in a primary school. As we use data from the Central Examination Committee in Poland, we can only observe the composition of classes in the concluding grades of respective schools, when final examinations are administered. However, Polish students are typically assigned to a class for the whole period of education in a given school. Repeating a grade is very rare (only 1.05% students in middle school repeated a grade in 2018/2019; Główny Urząd Statystyczny, 2019). As a result, peer group stability in grade 3 of middle school is very close to stability observed in grade 1.

Variable c_{ij} is an explanatory variable in the equation determining the student test score at the end of middle school:

Model 1

$$s_{ij} = \beta_0 + \beta_1 c_{ij} + \beta_2 sp_{ij} + \beta_3 \overline{sp}_{ij} + \sum_{l=4}^{m} \beta_l X_{lij} + \varepsilon_{ij}$$

Note: s_{ij} is the score achieved by student *i* in school *j* in the math-science part of the final test written by all students at the end of middle school[1]; sp_{ij} denotes the score of a student *i* from school *j* achieved in the primary school final test, taken by all students in sixth grade; $\overline{sp}_{ij}$ denotes the leave-out mean of the primary school final test among students in *i*'s class in middle school *j*; X_{ij} denotes the vector of *m* control variables characterizing student *i*, his/her school *j* and the district.

Since we measure the effect of peer group stability as late as three years after transition, it can be easily confounded with the compositional effect of the new classroom. For example, mixing high performing students from a few primary schools can lead to a positive outcome. This is not because students know each other (and thus, the transitional cost is low), or they do not know each other (and they positively respond to the new challenge). The positive outcome reflects student knowledge and skills, and the positive pressure students have on each other during middle school. As we need to distinguish the stability effect from the composition effect, we control for the average class achievement, which is calculated for each student excluding his/her own score (leave-out mean). In order to avoid the reflection problem (statistical artefact wrongfully suggesting causal relationship), as discussed by Manski (1993) and Angrist (2014), we use the ability measure determined prior to middle school transition, i.e., the test score at the end of grade 6.

In turn, the inclusion of individual student achievement in grade 6 on the right side of the equation implies that we consider the endogenous variable (grade 9 test score) in terms of value added in the course of education in middle school. This helps us to at least partially control for some of the unobserved student characteristics, such as parents' educational attainment and economic status.

3.2 | Endogeneity problem and its resolution

The percentage of a student's classmates known by the student from the preceding stage of education is likely to be correlated with some characteristics of a student or school. Such non-randomness of peer group stability is a source of endogeneity, exacerbating the precision of estimates and may lead to biases of varying size and shape.

3.2.1 | Focusing on rural schools

All kinds of selection are more likely to take place in an urban environment, where the authorities have more options for shaping the school network, and students may choose from a larger number of middle schools as compared to rural municipalities.[2] As a first step in overcoming the selection problem we therefore restricted the sample to students attending middle schools in rural municipalities, leaving aside the cities. We also included in the specification a variable for students who attended primary and middle school in two different municipalities.

3.2.2 | Fixed effects of primary and middle schools

In order to account for the unobserved characteristics of schools at both the primary and middle tier, we exploit the dynamic nature of our dataset. We introduce primary and middle school fixed effects, as well as the cohort fixed effect in a student level model.

Model 2

$$s_{ij} = \beta_0 + \beta_1 c_{ij} + \beta_2 sp_{ij} + \beta_3 \overline{sp}_{ij} + \sum_{l=4}^{m} \beta_l X_{lij} + \eta_j + \theta_{prim} + \varphi_{cohort} + \varepsilon_{ij}$$

Note: η_j and θ_{prim} represent the fixed effects of middle and primary schools respectively; φ_t is the fixed effect of the cohort.

3.2.3 | Effect by functional type of middle schools

In the next step, following Herczyński and Sobotka (2017), we classified middle schools into three functional types and applied Model 2 separately for each of them. This procedure allowed us to disentangle peer group stability and the stability of the learning environment writ large, including student-teacher relations.

Herczyński and Sobotka argued that standalone middle schools face very different organisational and pedagogical challenges than middle schools which are institutionally linked (grouped) with primary schools. In the latter case the middle and primary school usually share the building, administration, facilities, and even some part of teaching staff.[3] However, *grouped* schools are heterogeneous in terms of the proportion of students coming from the institutionally linked primary school. Some of them come in fact very close to a single structure model, with more than 95% of students originating from linked primary institutions that serve as feeder schools. In these middle schools the percent of classmates who know each other prior to the first day of school depends only on the policy of class assignment. Others, however, accept many students from outside the group, and their catchment areas are not represented by feeder schools. In our analysis we refer to the three aforementioned types of schools as *standalone*, *single structure*, and *joint*.

4 | DATA AND ESTIMATION METHOD

We use individual data on student achievement from grade 9 (end of middle school). The data is from national tests of cognitive skills, and it is merged case-wise with achievements from tests taken in grade 6 (at the end of primary school). The data include middle school test outcomes from 2010 to 2015, and the corresponding results in primary school tests from 2007 to 2012. The results presented in this article rely on pooled data covering all six editions of the tests. The data cover the full population of students; however, in accordance with our sampling strategy, we focused on students attending middle schools in rural municipalities. The total number of our observations is 671,286. In the fixed effects model we group our observations into 2,785 schools and six cohorts.

As our data has a hierarchical structure (e.g., students were clustered by classes and schools), we use cluster-robust standard errors on the level of class and cohort (Cameron & Miller, 2015; Wooldridge, 2003). We also tested the multilevel mixed-effects approach, introducing random intercepts at the level of school and class, as well as random slopes by the main explanatory variables at the level of class. The results did not differ strongly from results from the Ordinary Least Squares model (OLS). As the outcomes from fixed effects specification turned out more conservative (smaller magnitude of the effect), we decided to stick with the fixed effects with clustered standard errors. For purposes of comparison, however, we show the outcomes from all three approaches in the first table presenting the results of estimation in Table 2.

Data on individual test scores is from the Central Examination Committee (CKE) in Warsaw. It also contains some student characteristics which we apply in the specifications (see Models 1–2). These include information on gender, diagnosed dyslexia, competitive achievements in cognitive knowledge, school size, and class size. We also use dummy variables for students in public schools, and those who attended primary and middle school in the same municipality (non-migrants).

We also use municipality revenues per capita, which captures the general level of local wealth. This data is from the Bank of Local Data run by the Central Statistical Office in Warsaw.

Table 1 shows all the variables included in the model with their descriptions and basic statistics.

5 | RESULTS

5.1 | Overall results

Table 2 shows the results of the Ordinary Least Squares, mixed effects, and fixed effects models. In all specifications the dependent variable is the individual score at the mathematics and science test taken by students approaching graduation from middle school (grade 9 of comprehensive education) from 2010 to 2015.

All variants of estimation show that continuing education in grades 7 to 9 within the perfectly familiar peer group ($c = 1$), compared with the experience of entering an entirely new environment ($c = 0$), leads to higher achievement at the end of grade 9. Stability is associated with significantly higher achievement in mathematics and science tests. When the OLS or multilevel models are used, the estimated gains are about 0.12–0.14 of standard deviation (see column 1 and 2 in Table 2). The results of the fixed effects model (column 3 in Table 2) confirm that the effect of peer group stability is positive and significant, but its magnitude is smaller compared to the previous estimations. The coefficient drops to 0.064 of standard deviation, indicating that some part of the previously observed effect was due to the unobserved characteristics of students' learning environment in either primary or middle school. Although it is difficult to determine which of the mechanisms discussed earlier in this text stand behind this endogeneity of peer group stability, it is clear that further discussions of the results should be based on the model with school fixed effects, as its estimates are most conservative.

The effect of the average ability of classmates, measured independently from the impact of peer group stability, turns out insignificant in the fixed effect estimations, although it is positive, and significant in the other two models. This effect is in line with results from Pokropek (2013) who finds a statistically significant and positive but very small in magnitude effect of class composition in lower secondary schools.

When it comes to individual student characteristics in the observed sample from Poland, gender had a significant effect on student performance in mathematics and science—boys on average performed better than girls. The size of the gender effect is about 0.17 of standard deviation. This is not unexpected given the subjects covered by the test, and the findings of earlier studies on gender differences in school achievements. While boys tend to score higher in mathematics and science, girls outperform boys in humanities (Halpern et al., 2007).

TABLE 1 Descriptive statistics for students in rural municipalities

Variable name	Description	Mean	St.dev.
Math-science score (Grade 9)*	Test score in math/science achieved by student *i* in the middle school final test	26.209	10.051
Sixth grade score*	Test score achieved by student *i* in the primary school final test	24.159	7.491
Peer stability	Percent of student *i*'s classmates who attended with him/her to one class in a primary school	0.538	0.302
Dyslexia primary	Nominal variable denoting dyslexic students	0.068	0.252
Laureate primary	Nominal variable denoting laureates of educational contests (in primary school)	0.001	0.035
Public primary	Nominal variable denoting students attending public (versus non-public) primary school	0.989	0.103
Public middle	Nominal variable denoting students attending public (versus non-public) middle school	0.992	0.088
School size primary	Size of the cohort in student's primary school	29.463	19.527
School size middle	Size of the cohort in student's middle school	97.198	57.224
Same municipality (no migration)	Nominal variable denoting students attending both primary and middle school within the same municipality	0.947	0.225
Gender	Gender (female = 1)	0.504	0.500
Log local revenues	Log of municipal revenues per capita in 2015	6.954	0.479

Note: Data pooled from 2010 to 2015.

Source: Authors.

*Variables measuring student achievements were standardised to facilitate the interpretation of regression coefficients.

Not surprisingly, dyslexia affects student performance significantly and negatively. Awards won in cognitive contests during primary school education are predictors of further performance in mathematics and science. The middle school test score is however not dependent on whether a student attended public or private primary school. The evidence on the importance of school size is mixed. In general, students graduating from larger primary schools eventually achieve higher scores on math and science test, but the size of the middle school has a small and negative effect on student performance.

Table 3 presents results based on the fixed effects specification shown in Table 2—but estimated separately for the three major functional types of middle schools in Poland. As it turns out, the significance and magnitude of the effect of peer group stability on student achievement does not vary meaningfully between the different types of middle schools. The effect estimated for standalone schools, ones that are not institutionally linked to any primary institution, is very similar to the one observed for *joint* and *single structure* arrangements, in which the middle school shares some facilities, infrastructure, administration, and even teaching staff with a primary school. Importantly for our concerns about endogeneity, standalone middle schools are much more likely to impose their own policies for assigning students to classes than are single structure or joint institutions. For schools of the latter kind, the transition of whole classes from the primary school seems a natural solution. If we observe similarly strong effects of peer group stability on student achievement within all types of middle schools, it suggests that neither class assignment policies nor other aspects of the learning environment introduce strong bias to the estimation.

Interestingly however, *standalone* schools are the only category for which we observe a positive and significant effect of the average ability in the classroom on the achievement of individual students. This effect is non-existent

TABLE 2 Ordinary least squares, multilevel mixed-effects, and fixed-effects regression outcomes

	(1)	(2)	(3)
	Math-science OLS	Math-science ME-ML	Math-science FE
Peer stability	0.136***	0.119***	0.064***
	(0.00432)	(0.00440)	(0.00570)
Grade 6 score	0.754***	0.753***	0.756***
	(0.000905)	(0.000801)	(0.000913)
Class mean score	0.030***	0.014***	0.006***
	(0.00399)	(0.00351)	(0.00394)
Gender	−0.173***	−0.172***	−0.172***
	(0.00174)	(0.00157)	(0.00171)
Dyslexia primary	−0.181***	−0.170***	−0.170***
	(0.00358)	(0.00318)	(0.00349)
Laureate primary	0.486***	0.462***	0.462***
	(0.0255)	(0.0220)	(0.0256)
Same municipality	−0.003	0.012**	0.00497
	(0.00493)	(0.0043)	(0.00937)
Public primary	0.017	−0.001	-
	(0.0109)	(0.00888)	
School size primary	0.001***	0.002***	0.001***
	(0.000)	(0.00006)	(0.000189)
Public middle	−0.028	−0.026	-
	(0.0165)	(0.0222)	
School size middle	0.000***	0.0001*	−0.000
	(0.0000)	(0.00005)	(0.0001)
Log local revenues	−0.011***	−0.006	−0.002
	(0.0284)	(0.00444)	(0.00796)
Constant	0.0646*	0.033	
	(0.0285)	(0.0400)	
N	671,286	671,286	670,064
R^2	0.571		0.603
Wald Chi2 Prob		0.0000	

Note: Standard errors in parentheses.
Source: Authors.
Abbreviations: FE, fixed effects; ME-ML, mixed effects multilevel; OLS, ordinary least squares.
$^{*}p<.05$; $^{**}p<.01$; $^{***}p<.001$.

in the *joint* school, and negative in *single structure* institutions, which provide a smooth continuation of primary school, without major transitional shock. What it suggests is that students face a certain trade-off. Changing the learning environment is associated with a cost of losing peers, which negatively affects the achievements. On the other hand, being assigned to a new classroom together with high performing students may result in better individual outcomes. But the latter effect only works if the change in learning environment is sufficiently profound. This advantage of a new situation is experienced by students in *standalone* middle schools, where most peers are new to each other and to the teachers.

TABLE 3 Fixed effects regression results for the tests in mathematics/science by type of middle school

	(1)	(2)	(3)
	Math-science		
	Standalone	Joint	Single structure
Peer stability	0.062***	0.0707***	0.0697**
	(0.00907)	(0.0090)	(0.0225)
Sixth grade score	0.757***	0.756***	0.758***
	(0.00146)	(0.00148)	(0.00267)
Class mean score	0.028***	−0.002	−0.054***
	(0.0061)	(0.0066)	(0.0117)
Gender	−0.170***	−0.170***	−0.178***
	(0.00270)	(0.00274)	(0.00520)
Dyslexia primary	−0.192***	−0.157***	−0.144***
	(0.00546)	(0.0056)	(0.0113)
Laureate primary	0.456***	0.509***	0.273***
	(0.0435)	(0.0356)	(0.0824)
Same municipality	−0.017	−0.067**	0.0253
	(0.0201)	(0.0245)	(0.0640)
Primary school size	0.001**	0.001**	−0.000
	(0.00033)	(0.00018)	(0.0007)
Middle school size	−0.000	−0.000	0.000
	(0.00017)	(0.000149)	(0.000350)
Log local revenues	−0.008	−0.000	−0.006
	(0.0125)	(0.0132)	(0.0225)
N	270,332	256,665	70,875
R^2	0.598	0.607	0.610

Note: Standard errors in parentheses.
Source: Authors.
$^*p<.05$; $^{**}p<.01$; $^{***}p<.001$.

Overall, the results show that the effect of peer group stability on the achievements of average students is statistically significant and robust to sensitivity test. Whether its magnitude is meaningful in practice is another question, one which will be elaborated on in the discussion section. Before that, we outline the heterogeneity of the phenomena observed so far in the course of the analysis.

5.2 | Heterogeneity of the effect

By estimating Models 1 and 2, we only assessed the average effect of peer group stability on student achievement in the context of transition from primary to middle school. We will now attempt to verify whether effects are significantly different between genders, and across the skill distribution. First, we estimate a variant of specification shown in the equation for Model 2, including the interaction between the main explanatory variable (c_i) and student gender. Then, we address the issue of heterogeneity with respect to skill level, by including in the model specification the interactions between the group stability variable and the categorical variables describing the position of a student *i* and his/her primary school in the respective distributions of grade 6 test scores. Depending on whether we consider only student initial skills, or both the initial performance of student and his/her primary school, the specification takes the following forms:

Model 3

$$s_{ij} = \beta_0 + \beta_1 c_{ij} + \beta_2 sp_{ij} + \beta_3 \overline{sp}_{ij} + \sum_{l=4}^{m} \beta_l X_{lij} + \sum_{g \in (1,2\ldots10)} \tau_g DI_{gij} c_{ij} + \eta_j + \theta_{prim} + \varphi_{cohort} + \varepsilon_{ij}$$

Model 4

$$s_{ij} = \beta_0 + \beta_1 c_{ij} + \beta_2 sp_{ij} + \beta_3 \overline{sp}_{ij} + \sum_{l=4}^{m} \beta_l X_{lij} + \sum_{g \in (1,2\ldots10)} \tau_g D_{gij} DS_{hij} c_{ij} + \eta_j + \theta_{prim} + \varphi_{cohort} + \varepsilon_{ij.}$$

Note: DI_{gij} is a dummy variable equal to 1 if the individual score of the 6th grade test of student *i* is in the g decile group and 0 otherwise; DS_{hij} is a dummy variable equal to 1 if the average score of the 6th grade test of the primary school of student *i* is in the h decile group and 0 otherwise.

The idea is to test whether good students are affected by the transition to the new environment in a different way than are students with low cognitive skills. Similarly, we want to understand whether the transition from the high performing primary school (independent on the individual student score) has different implications compared to the transfer from the struggling school.

In the first step we examined whether peer group stability has a different effect on student achievements by gender. The interaction of the main independent variable with the variable for student gender manifests a strong effect for both genders, with rather negligible difference between them. The coefficient of interest is only slightly higher for men (0.064 compared to 0.059 for women).[4]

Further results of the heterogeneity analysis are shown in Figure 1 which illustrates Model 3 including just the interaction between the decile of student initial skills and the peer stability measure. The coefficients are illustrated using ten variables resulting from the interactions in Figure 1. For a more complex specification, including the three-element interaction between peer stability and the initial skills measured both for individual students and their primary schools, the coefficients of interest are shown in the form of a heat map in Figure 2.

As shown by the results in Figure 1, a change of environment is particularly harmful for students in the lowest decile of achievements (about 0.26 of standard deviation). Average students (deciles 2–7) seem to be less affected (in absolute terms) by the instability of their peer group. In contrast, for students within deciles 3 to 6 the change seems to be beneficial, as the effect of stability turns negative. However, for the top performing students the effect of peer group stability again becomes highly important and positive. The impact measured for the 10th decile reaches 0.44 of standard deviation.

The effects measured at both ends of the student skill distribution are therefore much stronger compared to the impact of peer group stability on the achievement of *average* students.

The heat map presented in Figure 2 allows us to better understand the difference between the transition of students at various levels of cognitive skills to the new social environment, and the transition between schools of different quality. Although individual achievements are undoubtedly correlated with the quality of the given school, there also are weak students graduating from good schools and those performing well in schools with low average test scores. From the policy perspective, it seems important to understand whether the distributional pattern of the peer group stability effect refers more to individual student skills, or the quality of the learning environment at the stage of primary education. The latter can be measured by the average grade 6 test score in the school from which student *i* has graduated.

The results make it clear that the magnitude of the peer group stability effect may depend both on the student's position in the individual skills distribution, and on the quality of the student's primary school. With respect

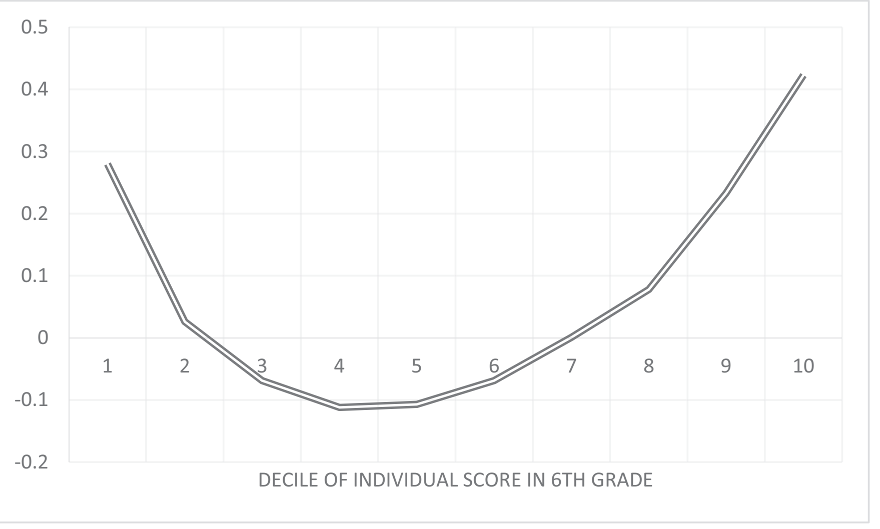

FIGURE 1 Peer group stability effect on the score in math and science. Peer group stability effect on the score in math/science in grade 9, calculated using student performance scores in grade 6 test. *Source*: Authors.

to achievement in mathematics and science, as mentioned earlier, both very good and very weak students suffer from a radical change in learning environment, while for students in the middle of the skill distribution the effect of transition is close to zero. The only category of students that seems to benefit from the change (in terms of eventual achievement in mathematics and science), while moving to middle school, are students from very competitive primary schools who have average skills.

6 | DISCUSSION OF RESULTS AND LIMITATIONS

6.1 | Main findings

Using pooled data for the cohorts of Polish students graduating from middle school in the years 2010–2015, and controlling for the fixed effects of schools and cohorts, we found that instability of the peer group significantly reduces the expected performance of students in mathematics and science. According to the most conservative result, obtained through estimation via fixed effects, the difference between the two extreme scenarios (all classmates are familiar vs nobody is familiar) is associated with a gap of 0.06 of the standard deviation in the math and science score. The magnitude of the average effect observed is about 35–40% of that of gender or dyslexia, which suggests it should be considered meaningful. On the other hand, this standardised effect can be translated into 0.6–0.8 points on the actual scale in which the test was graded (depending on the year), which suggests it is hardly perceptible to the average student.

However, it is worth recalling that the estimated effect refers to the achievements measured three years after school transition. Based on evidence from other research (e.g., Hanushek et al., 2004; Kerbow, 1996), we expect the immediate effect of peer group decomposition on student performance to be much stronger, and that it fades out with time.

Moreover, the heterogeneity of the effect, which shows how peer group stability affects students in different areas of skills distribution, seems much more important than its average magnitude. As discussed earlier, some authors have, in line with Coleman et al. (1966) shown that low ability students stand to gain from being mixed in with high performing students, while the latter may suffer from such policy. In turn, those authors who focused on

QUALITY OF STUDENT'S PRIMARY SCHOOL (DECILE)

DECILE OF INDIVIDUAL SCORE IN 6TH GRADE	1	2	3	4	5	6	7	8	9	10
1	0.38	0.35	0.30	0.30	0.27	0.28	0.23	0.23	0.21	0.19
2	0.13	0.10	0.07	0.05	0.02	0.03	0.00	-0.02	-0.06	-0.10
3	0.06	0.01	-0.02	-0.03	-0.05	-0.06	-0.10	-0.11	-0.18	-0.26
4	0.03	0.00	-0.05	-0.05	-0.11	-0.11	-0.15	-0.18	-0.23	-0.30
5	0.05	0.01	-0.02	-0.05	-0.11	-0.07	-0.13	-0.18	-0.22	-0.34
6	0.09	0.06	0.01	0.01	-0.03	-0.05	-0.10	-0.12	-0.19	-0.31
7	0.16	0.15	0.08	0.09	0.05	0.02	-0.03	-0.05	-0.08	-0.24
8	0.20	0.20	0.19	0.15	0.14	0.11	0.09	0.02	0.00	-0.17
9	0.37	0.35	0.32	0.32	0.28	0.26	0.23	0.20	0.17	0.06
10	0.44	0.47	0.46	0.50	0.48	0.46	0.44	0.43	0.40	0.29

FIGURE 2 Peer group stability effect on math and science scores, interaction of student and school performance. Peer group stability effect on the score in math and science calculated by the interaction of students' performance and their primary school average performance on the same test. *Source*: Authors.

the effect of school transition itself, found it detrimental for low performing students, which suggests that a policy of mixing is not implicitly beneficial for weak students (Dhuey, 2013; Rockoff & Lockwood, 2010).

Our research shows that both views may be correct to some extent, as the transition to a new environment proves particularly harmful for students with very low abilities, but also for those performing very high. In both cases, the effect is much stronger than what is observed for average students, as it approaches 0.5 of standard deviation. Therefore, at least in the context of middle schools in Poland, the results support the mechanism described in the *focus*, or *invidious comparison* models, rather than the *shining light* model (Sacerdote, 2011).

One possible interpretation in the spirit of the two latter models would imply that in a very heterogeneous classroom, a lot of time is needed for the teacher to organise work; recognise challenges; and to adjust the teaching level and methods. For very advanced students this may entail lost time, especially in that the ultimate teaching agenda may turn out to be below their capabilities and ambitions.

For low-achievers in turn, there still may not be enough time to catch up—moreover, they can be intimidated by the skill gap between themselves and their better performing peers. This reasoning seems very much in line with the evidence provided by Duflo et al. (2011), who ran a randomised tracking experiment in Kenyan schools and found that underachieving students were better off when grouped together with other low-performers, as this allowed teachers to better address their educational needs. However, proper verification of the aforementioned hypotheses would require further research on the composition of peer groups in terms of academic achievements, and not just stability of the peer group.

Our findings also provide some support to the *invidious comparison* mechanism, which is closely related to the well-established notion of academic self-concept as a determinant of academic success (Marsh, 1993; Marsh & Craven, 2006; Valentine et al., 2004). What supports this line of reasoning is the way in which the change in peer group composition affects students in the middle of the skills distribution, but also the top-performing students originating from low-performing primary schools. The mediocre students were not affected negatively by the transition; on the contrary, they may even benefit from the change. In particular, change works in favour of those who are in the middle sections of the skills distribution, but who originate from the very competitive primary schools, where their early achievements were low relative to peers. In turn, high ability students clearly benefit from the higher stability of the learning environment in which they are established as academic stars. As such, our findings seem to correspond to the Big Fish Little Pond Effect (Marsh & Parker, 1984). As self-beliefs are formed in relation to the observed performance of peers, mediocre students in very competitive schools may underestimate their abilities based on their relative performance. By changing learning environment, they gain the opportunity to redefine their self-belief which eventually leads to higher achievements. By contrast, those students who are highly appreciated in their learning environment seem better off if they do not switch peer group.

Our evidence seems also to speak against pushing out very low-performing students to an entirely new learning environment. Such a policy proves detrimental (at least in terms of academic achievements) for these struggling children, no matter if they previously attended a competitive or low-profile primary school. Still, even for the weakest students from the first decile in grade 6 test scores, the largest benefits from the stability of the peer group are observed among graduates of the weakest primary schools (see the upper row of Figure 2). For the vast majority of students (particularly those between deciles 2 and 8), the estimated gain or loss from changing the learning environment clearly depends not only on their individual performance, but also on the competitiveness of their previous peer group. This result supports the intuition of the relative nature of academic self-concept.

6.2 | Limitations

The results obtained in this study from Poland should be considered a contribution to the debate on desirable ways of managing class assignment and school grade configuration. This contributes to an international discourse that is relevant beyond the borders of specific education systems. We derive our findings from a careful analysis of a large sample of 671,286 students and 2,785 schools. Due to the scale of our study, the results are robust, and we provide nuanced insights on the heterogeneity of observed effects, subject to a number of factors. However, the context of national institutions and particular policy arrangements remains important, and it needs to be kept in mind when considering the external validity of any empirical study in the social sciences. For example, the observed effect of peer group stability on achievements may in part be a result of insufficient class integration efforts at schools in Poland. Alternatively, it may reflect insufficient teacher qualifications on this topic. The situation may be different in other countries, even though students in these countries, similarly to those in Poland, experience transitions to new peer groups.

Importantly, our analysis focused on the stability of the peer group, though we are observing neither the intensity of contacts between particular students nor the nature of these contacts. Yet, as demonstrated by earlier studies (e.g., Díaz & Penagos, 2018), the strength of within-group relations may have a significant impact on educational peer effects and thus it would be (if the data allowed us) a valuable addition to our research.

Finally, the present study could be expanded on with further analysis of the heterogeneity of the stability effect due to the diversity of a new peer group in terms of academic skills. Although such analysis would certainly require writing another full-length article, it would undoubtedly help us to even better distinguish between the effect of peer group stability and the impact of change in peer group composition.

6.3 | Conclusion

Our study shows that the transition to a new school environment affects the subsequent achievements of students, and that the necessity to integrate within a new class and school decreases the outcomes of at least some individuals at the end of the middle tier of education. This applies in particular to students with very low achievements prior to transition, but also to those at the opposite end of the skills distribution. This does not mean that heterogeneity in the class should be avoided, or that a single structure of comprehensive education (K-8, K-9) is necessarily superior to the model with two distinct educational stages carried out in separate schools. However, it is clear that to achieve potential benefits from diversity, and particularly gains for underperforming students who change their learning environment, additional measures are required.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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ENDNOTES

[1] We focus on the math-science part of the test and leave aside the part measuring the achievements in humanities, as the latter is considered less objective and more prone to measurement errors (Meier & Knoester, 2017).

[2] Both primary and middle schools in Poland have catchment areas and are obliged to accept students residing in these areas. However, students (parents) are free to apply to any school outside the area, and they are accepted conditionally on the availability of places. All catchment areas within one municipality form a school district, as running primary and middle schools is a municipal responsibility.

[3] According to 2015 data from Education Information System (SIO) 33.2% of all middle school teachers also taught in one or more primary schools.

[4] To limit the length of the article we decided to report the outcome by gender in the text without adding an additional table with full results of the estimation.

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