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PEER EFFECTS IN EXOGENOUSLY FORMED UNIVERSITY STUDENT GROUPS

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We estimate the influence of classmates' ability characteristics on student achievement in exogenously formed student groups. The study uses administrative data on undergraduate students at a large selective university in Russia. The presence of high-ability classmates has a positive effect on individual academic performance, and students at the top of the ability distribution derive the greatest benefit from their presence. An increase in the proportion of less able students has an insignificant or negative influence on individual grades.

Keywords: peer effects, higher education, exogenous assignment

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1. Introduction

Peer effects in education refer to the impact of classmates or schoolmates on educational outcomes for an individual student. James Coleman's "Equality of Educational Opportunity" report (Coleman 1966) drew attention to this effect. In fact, this was the first paper that had been conceived and prepared based upon the idea of profound complex analysis of the current situation in US schools related to the choice of key directions in educational policy.

One of the most acute problems to which Coleman reacted was the racial segregation policy in American schools. Thereby the idea of the report was to move from the political slogans of segregation partisans and antagonists to the field of constructive disputes on the influence of collective or separate tuition on students' achievement. In other words, for Coleman it was important to demonstrate that the isolation of African American children in ghetto schools deepened social dissociation, and one of the dissociation factors was the "trap" of low educational outcomes.

Due to the democratization of American schools within the last few decades, the study of peer effects has lost most of the political tint that it had earlier. Today, interest in the study of peer effects is connected to the formation of new approaches to the organization of the educational process. A number of recent studies demonstrate that the effectiveness of learning increases significantly when schools actively use elements of mutual education in student groups. In these schools, educational activities with interaction between students, such as collective/team work on learning tasks and project-based learning, become more and more prevalent, and the issue of student body composition acquires a new significance.

Our paper is one of the few empirical studies of peer effects based on the data on student achievement in exogenously formed groups. Unlike, for example, the American model of educational curriculum, undergraduate programs in Russian higher education institutions are characterized by the fact that most courses during first two years of study are compulsory, and the students are administratively appointed to particular study groups that are the same for each course of their curriculum. This excludes the problem of selection endogeneity emerging when students choose courses guided by their classmates and/or by easiness of these courses, and also allows us to work with the data to characterize peer effects immediately in exogenously formed student groups.

We found empirical evidence of significant peer effects in student groups. The grades in particular disciplines and first year GPA for individual students increased with the growth of classmates' abilities. In most cases, this effect had a nonlinear character: the higher the share of high-ability students in the group, the better the achievement of a student who related well to the most able. An increase in the percentage of less able students influences their classmates' achievement insignificantly.

2. Brief review of empirical literature

Many students and their parents, professors, and university administrators take it for granted that a student's classmates affect his achievement and behaviour. However, empirical assessments of peer effects in higher education demonstrate contradictory evidence (see, for example, the reviews of Sacerdote (2010), Epple and Romano (2010).

The earliest empirical studies of peer effects in universities are based upon data analysis of university roommates. Sacerdote (2001) revealed non-linear peer effects: average grades were higher for those students whose roommate was in the top 25% of the class. Good students favorably influenced the achievement of relatively less able students, while there was no such influence for students in the middle of distribution. In Zimmerman (2003), peer effects turned out to be caused by the students' grades on the verbal portion of the SAT, and non-linear effects appeared here also: students in the middle of the SAT score distribution got worse grades if their roommates were students with low grades. In Brunello, De Paola and Scoppa (2010), positive and significant effects were found for students specializing in engineering and mathematics; for humanities and social sciences, the effects turned out to be insignificant.

There are a few studies that focus on peer effects in student groups. Some of them test peer effects in very specific educational environments with intensive student interaction within group. Lyle (2007) found a significant connection between the current achievement of first year students and the average current achievement of the group in the US Military Academy. It was also revealed that the increased dispersion of math SAT scores in a group improved student achievement, and that the given effect was achieved due to the presence of more talented students (Lyle 2009). Carrell, Fullerton, and West (2009) revealed significant peer effects for graduates of the US Air Force Academy, especially in mathematics and scientific disciplines. Again, non-linear effects were found: students with low verbal SAT grades mostly benefited from their communication with students with high SAT results. De Paola and Scoppa (2010) found statistically significant peer effects for the University of Calabria in Italy. In the work of Arcjdjacono, Foster, Goodpaster, and Kinsler (2011), moderate but statistically significant peer effects were found, mostly for the social sciences and less for physics and mathematics. In some studies, no significant peer effects were found (Arcidiacono and Nicolson 2005; Foster 2006; Parker, Grant, Crouter, and Rivenburg 2010).

Androushchak (2005) observed peer effects in data on undergraduate students in the economics department of the Higher School of Economics (Russia). It was found that student achievement was negatively affected by the achievement of most able classmates and was positively affected by the achievement of less able classmates, which can be explained by competition for high grades.

3. Methodology of empirical study

The tendency of people belonging to one group to behave alike is usually explained by three effects (Manski 1993) that may be incorporated in the following model of individual achievement:

$$Y_i = \alpha + \beta X_i + \gamma X_{-i}^{peer} + \phi Y_{-i}^{peer} + \theta Z_{-ii} + \varepsilon_i \qquad (1)$$

where Y_i is the index of the achievement of student i, X_i is the vector of individual characteristics of i, X_{-i}^{peer} is the vector of exogenous characteristics of the students studying with i (exogenous effects), Y_{-i}^{peer} is the index of achievement of the students studying with i (exogenous effects), Z_{-ii} is shared characteristics of the student and his classmates (correlated effects), and ε_i are random disturbances. Coefficients for the corresponding variables describe the quantitative influence of each factor on student achievement.

The indicators of achievement are usually students' average grades during various years (most often during the first year) or grades in particular disciplines or groups of disciplines. The characteristics of a student and his classmates primarily include the level of ability. The abilities themselves are hard to measure, therefore various proxy variables are used such as the results of standardized tests.

The estimation of model (1) involves some difficulties (Manski 1993; Epple and Romano 2010). The problem of simultaneity (reflection) is caused by the fact that not only does the achievement of a student's peers influences his academic grades, but his individual behaviour affects his classmates as well. For this reason, the estimates of coefficients are biased. Characteristics that are common for a student and his environment often cannot be supervised, and this impedes the estimation of the corresponding coefficient. Therefore, the following reduced form is commonly estimated in practice:

$$Y_i = \alpha + \beta X_i + \gamma X_{-i}^{peer} + \varepsilon_i \qquad (2)$$

Consequently, it becomes possible to evaluate the overall peer effect without differentiating between endogenous and exogenous effects.

If exogenous characteristics of classmates are their means, $X_{-i}^{peer} = \bar{X}_{-i}$, then model (2) is called linear-in-means. Such approach has its shortcomings (see, for example, Hoxby (2000) and Hoxby and Weingarth 2005)). With the linear-in-means model it is impossible to estimate non-linear, asymmetric models of peer effects that are found empirically. For example, in the study of peer effects among college roommates, Sacerdote (2001) found that the least able students in the sample benefited the most from their proximity to high-ability peers. Asymmetric peer effects are significant from the point of view of educational policy. If the benefit from interaction with high-ability classmates is greater for able students than for low-ability students, then grouping students with similar abilities would increase overall performance.

4. Research context and data description

The empirical basis of our paper consists of data on students who entered the economics department at the National Research University - Higher School of Economics (HSE) in 2009. As of that year, the Unified State Examination (USE) became obligatory for all high school graduates.

To obtain a general certificate of secondary education, a high school graduate is obliged to successfully pass the USE test in two compulsory disciplines: the Russian language and mathematics. Exams in other disciplines are taken voluntarily. Throughout Russia, the USE consists of standardized tasks and a unified grading scale. Therefore, the results of the exam can be considered an objective assessment of the quality of training.

The principal application of the USE is that its results are acknowledged by universities as the results of entrance examinations in the corresponding general disciplines. For each field of study, the Ministry of Education and Science defines the list of three or four entrance examinations to the universities that have state accreditation. The USE scores in Russian and profile disciplines are compulsory for the entrance for all fields of study. Thus, the USE as the entrance examination is used as selection tool and should help predict the achievement of all applicants in their future studies.

The winners of some Olympiads[5] have the right to priority enrolment in public universities for tuition-free places. The selection of applicants without these privileges for the remaining tuition-free places is made according to the students' USE scores. The other enrolled students are charged tuition fees.

To enter the economics department of HSE based on the results of entrance examinations, it is obligatory to present USE results in four disciplines: mathematics, social studies, Russian language, and foreign language. The winners of some Olympiads who had the right of prior enrolment presented their results only on the Russian language and mathematics examinations.

One of the most important elements of the study of peer effects is the correct identification of students who interact in the process of learning. In our study, a student group was chosen as the environment influencing student achievement. HSE students spend a significant amount of study time during their classes in groups of up to 30 members. Lectures are usually delivered to several groups simultaneously, while seminar classes are delivered to each group separately. The university administration forms these groups. Compulsory courses constitute the majority of the educational curriculum in the first two years, and they are attended by all students. Thus, it can be considered that the peer group is formed exogenously. That allows us to avoid bias in peer effect estimation due to endogenous group formation.

The grades in several disciplines and the sum of grades for the first and the second years of study are used as the achievement measures in this work. The total score of each HSE student characterizes his general academic performance. It is formed as the sum of grades in single disciplines with weight coefficients equal to the credit quantities of the educational load in a given discipline. HSE uses a ten-point grading scale. Grades lower than four are unsatisfactory. The maximum total score for one year is 600 (grades of 10 in all disciplines multiplied by the annual workload of 60 credits). The current total score of HSE students is updated once mid-year.

Individual abilities were measured by a student's USE scores in Russian language and mathematics and by an indicator variable of whether the student had enrolled with Olympiad results from the All-Russian School Olympiad or the Interregional Olympiad. The All-

[5] The list of such Olympiads is approved by the Ministry of Education and Science. An Olympiad is a form of creative contest in selected field of study. The most prestigious one is the All-Russian School Olympiad, which has the largest number of participants from all over the country. Many leading universities organise their own Olympiads.

Russian School Olympiad is organised by the Ministry of Education and Science, while the Interregional Olympiad is carried out by HSE in cooperation with other universities.

The peer group was characterized by the average USE scores of a student's classmates in Russian language and mathematics, as well as the percentage of students in the group with low and high grades in mathematics.

Descriptive statistics of the variables used in the research are given in Table 1.

5. The results of peer effects estimation

For more detailed analysis of classroom peer effect, the sample of students was divided by ability into three subgroups. We used methodology applied to the estimation of non-linear peer effects as in Carrell, Fullerton, and West (2009) and Carrel, Sacerdote, and West (2011).

The bottom, middle, and top subgroups were based on the distribution of predicted total score in the 1st and 2nd year using a student's own ability characteristics: the USE scores in mathematics and Russian language and the indicator of winners of the All-Russian School Olympiad or the Interregional HSE Olympiad. The regression results are shown in Table 2. All of the explaining variables are significant at the level of 1%. The coefficient of determination for the 2nd year regression is smaller than that for the 1st year, and this provides evidence of the diminishing role of pre-university training as time goes on. The USE math coefficient in the 1st year is higher than that in the 2nd, which might be caused by the decreasing number of mathematical disciplines in the curriculum. The "premium" for those who were admitted through the Olympiad is quite large: winners of the All-Russian Olympiad receive an extra 100 points (out of the maximum of 600) and winners of the Interregional Olympiad receive an extra 62 points.

The predicted total scores for the 1st and the 2nd years were built upon the results of regressions. The entire sample of students was divided into three sub-groups. One third consisted of the students with the highest predicted total scores (the top of the distribution), one third of the students with the lowest predicted total scores (the bottom of the distribution), and the remaining third consisted of the "middle" students (the middle of the distribution). Peer coefficients were estimated both for the entire sample and for the top/middle/bottom thirds of the distribution.

We consider two specifications of an empirical model of peer effects. In model 1, the peer variables are mean scores on the USE in mathematics and Russian language of a student's classmates. The corresponding coefficient shows how much (on average) the student’s grade changes when the peer group mean USE score increases by one. In model 2, the share of peers in the group who have relatively high and low USE scores in mathematics were used as explaining variables. We defined USE scores as low if they were in the bottom quartile of the year-cohort USE distribution. Respectively, high USE scores were in the top 25%. The student’s own USE scores in mathematics and Russian language and the dummy variables for Olympiad winners were included as control variables in all regressions.

As it was noted previously, disciplines that are compulsory for all students are a significant part of the educational program during the first two years (90% of total workload). Among these disciplines are macroeconomics, microeconomics, economics of the firm, economic history, calculus, linear algebra, and differential equations.

Tables 3 and 4 show the estimates of models 1 and 2 for economic courses: microeconomics taken in the first year (6 credits) and in the second year (8 credits), macroeconomics (4,5 credits), economic history (3 credits), and economics of the firm (3 credits). In Table 5, the results of model 2’s estimation are presented for mathematical courses: calculus (8 credits), differential equations (3 credits), and linear algebra (3 credits).

In almost all the regressions, the scores are positively influenced by peer USE scores in mathematics and the share of students with high USE scores in mathematics. This effect is dissimilar for different thirds of the distribution. Classmates’ mean USE math scores are statistically significant at the level of 5% or lower for grades in macroeconomics, economic history, and economics of firm for the entire sample and the top third of the distribution. The effect of peer share with high USE scores in mathematics is significant for microeconomics grades in the 2nd year; for macroeconomics and economics of the firm grades for the entire sample and for the top third; for microeconomics grades in the 1st year for the entire sample and for the top and bottom thirds; and for linear algebra grades for the top third.

In some regressions, the USE scores in Russian language had a negative though statistically insignificant influence on grades, which can be explained by multicollinearity due to correlation between the peer USE scores in the two disciplines. Another finding that contradicts intuition is the significantly positive influence of students with low USE scores in mathematics on grades for the economics of the firm (for the top third of the distribution).

The effect of classmates depends on the particular discipline, peculiarities of teaching methods, the proportion of lecture vs. seminar classes, types of homework assignments, etc. Thus, estimation of peer effects for the aggregated outcome measure is of great interest.

The total score of a student reflects general achievement in all disciplines, including electives. For each elective course, a particular group is formed. Therefore, it erodes the effect of influence from the students of the administratively formed group. However, the academic environment within the exogenously formed groups can affect students even when they attend classes in individually chosen disciplines. A general attitude toward studies may serve as the channel of peer influence in this case [6].

Table 6 shows the estimates for model 1 for total score in the 1st and the 2nd year. The estimates for model 2 are shown in Table 7.

The effect of peer USE math scores and of the share of students with high math USE scores in the group is positively and statistically significant at the 5% level for the first year total score for the quartile of the most able students.

Summing up, we found evidence that students benefit from learning with their most able classmates. This effect is most vivid when a student also belongs to this high-ability group. An increase in the percentage of students with low USE scores usually did not influence student achievement.

6. Conclusion

In the paper we tested the presence of peer effects in a student group, specifically the influence of the ability of other students on student achievement. The empirical base of the research was administrative data on students in the economics department of one of the leading Russian universities in the field of social sciences. Exogenous formation of student groups and the prevalence of compulsory disciplines in the program in the first two years exclude the bias problem that might arise for endogenously formed study groups.

As a measure of student ability, we used the results of the national standardized tests in Russian language and mathematics that are taken by every secondary school graduate in Russia. The classroom peer effect was estimated with two different peer variables: classmates' average test scores in mathematics and Russian language and the share of students in the top and bottom quartile of the mathematics test score distribution. For analysis of the non-linear nature of peer effects, the whole student cohort was divided into subgroups with relatively high ability, low ability and middle ability students. Estimates for peer effect coefficients were calculated for each subsample.

We found some empirical evidence of peer effects in a student group, with a non-linear influence of other students on student outcomes: the higher the percentage of the most

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[6] The importance of attitude toward studies as a peer effect mechanism is noted, for example, in Stinebrickner and Stinebrickner (2008) and Parker, Grant, Crouter and Rivenburg (2010).

able students in a group, the better the achievement of a student from the top third of the ability distribution. An increase in the percentage of less able students did not have a statistically significant effect in most cases.

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Table 1. Descriptive statistics

Variables	Obs	Mean	Std. Dev.	Min	Max
USE score in Russian	235	79.2	9.8	47	100
USE score in Math	235	75.3	8.7	26	100
Winner of All-Russian Olympiad	235	0.14	0.34	0	1
Winner of Interregional Olympiad	235	0.17	0.38	0	1
Total score in the 1st year	235	380.8	94.1	119.5	580.5
Total score in the 2nd year	203	349.9	99.2	102.3	561.6
Peer group mean USE score in the Russian language (1st year)	235	77.7	2.2	71.3	81.1
Peer group mean USE score in mathematics (1st year)	235	73.0	3.6	63.1	78.8
Share of peers in group with low USE score in mathematics (1st year)	235	0.21	0.15	0	0.71
Share of peers in group with high USE score in mathematics (1st year)	235	0.22	0.10	0.04	0.38
Peer group mean USE score in the Russian language (2nd year)	203	79	1.6	75.2	81.0
Peer group mean USE score in mathematics (2nd year)	203	75.7	2.7	70.6	80
Share of peers in a group with low USE score in mathematics (2nd year)	203	0.11	0.06	0	0.23
Share of peers in a group with high USE score in mathematics (2nd year)	203	0.27	0.11	0.10	0.42
Grade in microeconomics in the 1st year	195	6.0	1.4	4	10
Grade in microeconomics in the 2nd year	196	5.3	1.5	1	10
Grade in macroeconomics	195	6.2	1.7	4	10
Grade in economic history	195	7.7	1.5	4	10
Grade in economics of the firm	195	6.2	1.7	4	10
Grade in calculus	194	6.7	2.0	4	10
Grade in linear algebra	195	6.7	2.0	4	10
Grade in differential equations	195	7.1	2.0	4	10

Table 2. The prediction of total scores of the students after the 1st and the 2nd years

	(1)	(2)
	Total score in the 1st year	Total score in the 2nd year
USE score in mathematics	3.439**	2.367**
	(0.767)	(0.776)
USE score in Russian language	2.478**	2.604**
	(0.498)	(0.623)
Winner of the Interregional Olympiad	62.396**	62.180**
	(12.735)	(15.341)
Winner of All-Russian Olympiad	100.330**	97.482**
	(11.046)	(16.645)
Constant	–98.801	–65.434
	(60.618)	(53.885)
R-squared	0.452	0.316
Observations	235	203

Robust standard errors are reported in parentheses. The symbol ** indicates that coefficients are statistically significant at the 1 percent level.

Table 3. Estimates of peer group effects for grades in economic courses (model 1)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	microeconomics year 1		microeconomics year 2		macroeconomics		economic history		economics of the firm	
Peer group mean USE score in mathematics										
All	0.102		0,054		0.145*		0.158**		0.224**	
	(0.056)		(0,053)		(0.064)		(0.051)		(0.065)	
Top		0.182		0,114		0.203*		0.253**		0.363**
		(0.095)		(0,103)		(0.094)		(0.077)		(0.106)
Middle		0.039		0,023		0,184		0,101		0,203
		(0.094)		(0,097)		(0,121)		(0,083)		(0,113)
Bottom		0.055		0,065		–0,007		0,074		0,001
		(0.079)		(0,083)		(0,108)		(0,111)		(0,097)
Peer group mean USE score in Russian language										
All	–0.043		–0,091		0.202		–0.101		–0.322**	
	(0.092)		(0,087)		(0.105)		(0.082)		(0.101)	
Top		–0.130		–0,045		–0.243		–0.161		–0.501**
		(0.150)		(0,172)		(0.159)		(0.118)		(0.147)
Middle		0.111		–0,174		–0,222		–0,018		–0,260
		(0.152)		(0,158)		(0,184)		(0,147)		(0,184)
Bottom		–0.072		–0,054		–0,082		0,090		–0,037
		(0.134)		(0,126)		(0,181)		(0,176)		(0,167)
Control variables	Own USE in mathematics and the Russian language, winner of the Interregional Olympiad, winner of All-Russian Olympiad									
R-squared	0.390	0.407	0.292	0.307	0.308	0.333	0.301	0.323	0.328	0.364
Observations	195	195	196	196	195	195	195	195	195	195

Robust standard errors are reported in parentheses. The symbols **, * indicate that coefficients are statistically significant at the 1 and 5 percent level, respectively.

Table 4. Estimates of peer group effects for grades in economic courses (model 2)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	microeconomics year 1		microeconomics year 2		macroeconomics		economic history		economics of the firm	
Share of peers with low USE scores in mathematics										
All	–0.029 (0.709)		2,770 (2,204)		1.405 (0.843)		–1.035 (0.697)		1.317 (0.712)	
Top		0.489 (1.516)		4,928 (4,537)		2.185 (1.577)		–1.340 (1.715)		3.407* (1.564)
Middle		–1.410 (1.028)		2,986 (3,440)		–0,446 (1,058)		–1,798 (0,970)		–0,351 (1,009)
Bottom		1.550 (0.993)		–0,462 (3,646)		3,311* (1,397)		0,202 (1,193)		1,603 (1,254)
Share of peers with high USE scores in mathematics										
All	3.609** (1.082)		2,555* (1,141)		4.064** (1.244)		2.055 (1.055)		4.521** (1.269)	
Top		5.563** (2.034)		5,188* (2,090)		5.706** (2.001)		3.043 (1.708)		8.666** (2.225)
Middle		2.086 (1.850)		1,279 (1,945)		2,639 (2,379)		1,362 (1,633)		2,090 (2,200)
Bottom		3.085* (1.378)		1,087 (1,637)		3,693 (2,181)		1,160 (2,307)		2,232 (1,813)
Control variables	Own USE score in mathematics and the Russian language, winner of the Interregional Olympiad, winner of All-Russian Olympiad									
R-squared	0.413	0.435	0.305	0.318	0.330	0.358	0.281	0.296	0.332	0.370
Observations	195	195	196	196	195	195	195	195	195	195

Robust standard errors are reported in parentheses. The symbols **, * indicate that coefficients are statistically significant at the 1 and 5 percent level, respectively.

Table 5. Estimates of peer group effects for grades in math courses (model 2)

	(1)	(2)	(3)	(4)	(5)	(6)
	calculus		differential equations		linear algebra	
Share of peers with low USE score in mathematics						
All	–0.115 (0.863)		1.492 (1.278)		–0.619 (0.947)	
Top		–0.247 (2.582)		3.799 (1.945)		0.190 (1.883)
Middle		–1,526 (1,182)		0,642 (1,871)		–2,118 (1,257)
Bottom		1,191 (1,017)		0,773 (2,573)		0,871 (1,514)
Share of peers with high USE score in mathematics						
All	1.130 (1.394)		2.700 (1.679)		3.914** (1.491)	
Top		4.498 (2.596)		3.790 (2.626)		3.463 (2.235)
Middle		–2,226 (2,184)		2,451 (2,930)		3,221 (2,786)
Bottom		–0,667 (2,240)		0,248 (3,338)		4,863 (2,477)
Control variables	Own USE score in mathematics and the Russian language, winner of the Interregional Olympiad, winner of All-Russian Olympiad					
R-squared	0.387	0.432	0.160	0.182	0.296	0.314
Observations	194	194	195	195	195	195

Robust standard errors are reported in parentheses. The symbol ** indicates that coefficients are statistically significant at the 1 percent level.

Table 6. Estimates of peer group effects for total scores in the 1st and 2nd year (model 1).

	(1)	(2)	(3)	(4)
	Total score in the 1st year		Total score in the 2nd year	
Peer group mean USE score in mathematics				
All	2.120 (2.400)		2.028 (3.238)	
Top		8.767* (4.061)		4.027 (6.948)
Middle		0,995 (3,581)		–0,698 (5,782)
Bottom		1,897 (4,430)		5,501 (5,190)
Peer group mean USE score in Russian language				
All	1.093 (3.894)		–7.055 (5.408)	
Top		–6.488 (6.298)		–7.381 (10.728)
Middle		3,795 (5,966)		–8,013 (9,901)
Bottom		0,344 (7,105)		–8,105 (8,889)
Control variables	Own USE score in mathematics and the Russian language, winner of the Interregional Olympiad, winner of All-Russian Olympiad			
R-squared	0.462	0.493	0.322	0.333
Observations	235	235	203	203

Robust standard errors are reported in parentheses. The symbol * indicates that coefficients are statistically significant at the 5 percent level.

Table 7. Estimates of peer group effects for total scores in the 1st and 2nd year (model 2).

	(1)	(2)	(3)	(4)
	Total score in the 1st year		Total score in the 2nd year	
Share of peers with low USE score in mathematics				
All	–53.720 (34.724)		134.72 (118.732)	
Top		–4.852 (78.138)		6.337 (293.586)
Middle		–78,361 (46,285)		156,52 (197,822)
Bottom		–102,203 (61,085)		184,299 (138,499)
Share of peers with high USE score in mathematics				
All	40.808 (59.580)		87.46 (69.409)	
Top		207.899* (89.050)		25.815 (130.428)
Middle		15,319 (92,855)		33,088 (117,801)
Bottom		–110,485 (120,022)		200,203 (103,536)
Control variables	Own USE score in mathematics and the Russian language, winner of the Interregional Olympiad, winner of All-Russian Olympiad			
R-squared	0.464	0.501	0.321	0.331
Observations	235	235	203	203

Robust standard errors are reported in parentheses. The symbol * indicates that coefficients are statistically significant at the 5 percent level.

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