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ESTIMATION OF PEER EFFECTS WITH PREDICTED SOCIAL TIES: EVIDENCE FROM TWO UNIVERSITIES IN BRAZIL AND RUSSIA[5]

Social interactions with peers during learning have a significant impact on university students' academic achievement. As social ties are voluntary, an empirical estimation of peer effects is exposed to a potential endogeneity problem. To overcome this issue, we propose to define the peer group of an individual as their predicted friends. The specific features of the learning environment in higher education institutions may affect dimensions along which friendship ties form. To test the presence of peer effects in different educational and cultural contexts, we use data on students studying in two universities located in two different countries, Brazil and Russia. We assume that friendship is affected by homophily in student attributes, such as having the same region of origin, the same gender, and sharing the same study group. In both institutions, we find positive externalities from having high-ability peers.

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Introduction

Higher education participation has expanded over the past decades both in developing and developed countries because of the establishment of new higher education institutions and increased enrolment in existing ones. Both in the public and private sector, growth is uneven and some universities end up with more resources than others. To provide high-quality education to a greater number of students, policy makers could set a goal to expand access to such universities. However, there are arguments as to why this policy may not be effective. Some of these arguments are related to peer effects. There are positive effects from the concentration of students of high quality because students benefit from a higher quality of social interactions and teachers "give more intense and efficient lectures" (Winston and Zimmerman 2004). Additionally, universities may pursue high ranking positions which are directly or indirectly associated with selectivity. These things can make the optimal reaction of an institution to increased demand be an increase in selectivity at admission rather than enrolment expansion.

Peer effects are not easy to measure. An important problem for the empirical estimation of peer effects is the correct definition of peer group. It is obvious that students interact with some students more often than with others, and form friendship ties with selected peers. Defining peer groups through student social networks is an attractive idea but the endogeneity of social ties is a serious problem for the empirical identification of peer effects. Moreover, information on actual social ties is usually inaccessible to the researcher. A possible solution, which we use in this paper is to explore certain regularities in the formation of the social networks, in which people tend to form friendship links with those who have similar characteristics and interests, and with whom they spend a considerable amount of time (McPherson et al. 2001).

This paper investigates the effect of the predicted friends on academic achievement. Our study contributes to the literature on educational peer effects in two main ways. First, we propose an approach based on the idea that peer groups may be defined through the predicted social ties of an individual. This approach occupies an intermediate position between the group interaction approach—that assumes that every student affects equally all other students—and the social network approach—where peer groups consist of students connected by actual personal ties. The use of predicted instead of actual ties eliminates the peer group endogeneity bias. Second, to demonstrate empirically how this approach works, we use data on students studying in two universities located in different countries, Brazil and Russia. The institutional environments of these universities have distinctive features that may mediate the formation of social ties. In both institutions, we find that the higher the admission test scores of a student's predicted friends, the higher that student's grades are. That is, there are positive externalities from having high-ability peers.

Studies of peer effects in higher education

In this section we review the literature on peer effects in postsecondary education in different institutional environments.

Student achievement is affected by a variety of factors such as personal ability, learning effort, family resources, and teaching quality. It is widely accepted that the characteristics and behaviour of peers can influence a student's performance. Peers may affect the academic results of a student through various channels. Peers influence a student's attitudes and aspirations (Davies and Kandel 1981; Buchmann and Dalton 2002; Legewie and DiPrete 2012), and form a reference group for individuals to make comparisons about their performance (Duncan, Haller, and Portes 1968; Cohen 1983; Stinebrickner and Stinebrickner 2006). In an interactive learning environment, students teach one another when working in the classroom (Mazur 1997). Beyond the classroom, students may work on homework together, and explain and share study materials. Obviously, the depth and mechanisms of student interaction depend on the learning environment and its competitive and cooperative features. The regulations of both national education systems and specific institutions have an impact on the learning environment, and it is no surprise that the empirical results of peer effect research display significant variation.

Many studies of peer effects on academic achievement have exploited the existence of institutional rules that assume a random assignment of peers. Several empirical studies were based upon the data analysis of dormitory roommates in the US. Sacerdote (2001) reveals that good students influence favourably the achievement of relatively less able students. Zimmerman (2003) finds negative peer effects on students in the middle of the verbal SAT score distribution from roommates with low grades. In Berea College, a roommate's high school GPA is positively related to a student's first semester grades, but only for females (Stinebrickner and Stinebrickner 2006). Foster (2006) does not find robust residential peer effects on undergraduate performance at the University of Maryland. McEwan and Soderberg (2006) come to a similar conclusion about roommate peer effects among students at Wellesley College. Griffith and Rask (2014) examine the presence of peer effects in two different colleges: a roommate's high school achievement has a significant impact on student achievement at the smaller college, while there is little peer effect in the larger university. Brunello, De Paola, and Scoppa (2010) find positive effects for Italian students specializing in engineering and mathematics; for humanities and social sciences, the effects are insignificant. Hasan and Bagde (2013) use data from an engineering college in India to estimate peer effects from randomly assigned roommates, chosen friends, and chosen study-partners. They find that students with able roommates perform better, and students benefit equally from same- and different-caste roommates, suggesting that social similarity does not strengthen peer effects. In

addition, the results suggest that roommates become study-partners, and in so doing, affect performance.

A lot of learning-related interactions between students occur in the classroom; therefore, it is reasonable to assume that the influence of classmates is greater than influence of roommates. However, the educational curriculum in many countries allows students to choose most of their courses, and this complicates the study of peer effects in student groups because of self-selection. There are specific educational environments where study groups are assigned. Several papers consider such groups in the US military institutions. Lyle (2007) finds a small, but not robust, positive relation between the current achievement of first year students and the average current achievement of the group in the US Military Academy. The increased dispersion of math SAT scores in a group improves student achievement, and this effect is achieved due to the presence of more talented students (Lyle 2009). Carrell, Fullerton, and West (2009) reveal significant peer effects for graduates of the US Air Force Academy. Random peer assignment is met in some non-military institutions. Ficano (2012) examines peer effects in a small US college where the first semester courses are selected prior to arriving on campus and the college assigns students to a given section of a course randomly. She identifies a positive significant male peer influence on male students; in contrast, females are unresponsive to either male or female peer average academic rating. Androushchak, Poldin, and Yudkevich (2013) use specific features of the Russian higher education system where the typical institutional environment is characterized by exogenously assigned study groups and a prevalence of compulsory courses in the curriculum: they find positive associations between student's grades and admission test scores of classmates.

Jain and Kapoor (2014) consider the relative influence of the interaction between study groups versus roommates at a business school in India. They find that informal social interaction with roommates has a significant positive impact on academic achievement, and lower ability students benefit from high ability students but not *vice versa*. Formal study group peers have a small and insignificant impact. The authors suggest that social interaction is more effective in boosting academic outcomes than study groups which are designed for learning.

Some studies estimate peer effects in situations where courses are selected. Using University of Maryland data, Arcidiacono *et al*. (2012) rely on a specific panel data model and find moderate peer effects, mostly for the social sciences and less for physics and mathematics. De Paola and Scoppa (2010) find statistically significant peer effects for the University of Calabria in Italy; the self-selection problem is handled through an instrumental variables approach.

A popular approach to peer effect studies for primary and secondary education uses variation in the composition of students by race (Hanushek, Kain, and Rivkin 2009), gender (Hoxby 2000; Lavy and Schlosser 2011; Schneeweis and Zweimüller 2012; Hill 2015) or other dimensions

(Carrell and Hoekstra 2010; Friesen and Krauth 2011; Bifulco, Fletcher, and Ross 2011). In higher education research, (Oosterbeek and van Ewijk 2014) examine gender compositional peer effects for first year students in a bachelor programme at the University of Amsterdam. They experimentally manipulate the share of female students in workgroups and find no substantial gender peer effects on achievement (in spite of student perceptions that their behaviour is influenced by the share of female students).

Not all members of a study group have the same influence on a given student. Several studies address the effects of social ties on the achievements of university students. Lomi et al. (2011) report that MBA students in an Italian university tend to assimilate the average performance of their friends and their advisors. In their study of students enrolled in an MBA program in an Italian University, Vitale, Porzio, and Doreian (2015) show that informal contacts, based on mutual interests and goals, are related to performance, while formal groups formed temporarily by the instructor have no such effect. In a Russian university, positive peer effects are found from the academic achievements of friends and study partners (Poldin, Valeeva, and Yudkevich 2015).

Many studies on student social networks show that interpersonal ties are often driven by homophily. Homophily reflects the fact that people prefer to form social relations with people who have similar characteristics and who are geographically close (McPherson, Smith-Lovin, and Cook 2001). Visible attributes such as gender, ethnicity, age, height and weight are much more important for student network formation than invisible ones such as psychological traits (van Duijn et al. 2003; de Klepper et al. 2010). Physical proximity, such as living in the same dormitory, studying in the same group or in the same cohort also determine social connections between students (Mayer and Puller 2008; Traud et al. 2011; Pilbeam and Denyer 2009; Carrell, Sacerdote, and West 2013).

As the studies above show, the empirical findings vary from institution to institution. The learning environment certainly affects student interactions, therefore comparative studies which examine how peers affect students in different universities are of great interest. Such studies are scarce, and this paper contributes to filling this gap.

Institutional background

In the recent decades, many countries worldwide have experienced drastic changes in their higher education systems. Both developing and developed countries have faced large enrolment expansion, and an accompanying transformations in their national economies, labour markets, political and social life. Despite the obvious fact that the situation differs from country to country, there are common concerns such as how to balance increased access to higher education, the diversification of the student population and to improve the quality of education. For BRICS countries these issues are the most relevant since they are experiencing the most rapid changes and face the largest

challenges in this regard. To deepen the mutual understanding of the corresponding higher education systems, it is important to know which factors affect learning.

At least since the Coleman Report (1966), much attention has been paid to students' peers as one of key determinants of student achievement. Despite much effort, the empirical evidence remains controversial, reflecting the differences in models, methods, and institutional environments. In this work, we use a novel definition of peer group, and compare peer effects in two institutions. These institutions are located in different countries, Brazil and Russia, both of them are among the most prestigious universities of the two countries.

Brazilian higher education and the University of Campinas (Unicamp)

Brazil has attracted much attention in recent years as a strong emerging economy. With a GDP of US$ 2,2 trillion in 2012, Brazil is the world's seventh largest economy. It is also the largest country in the region and has a population of nearly 200 million inhabitants. Despite some important achievements in the last decades, inequality remains at relatively high levels for a middle-income country. After having reached universal coverage in primary education, Brazil is now struggling to improve the quality and outcome of its education system, especially at the primary and secondary levels. The country has a distinct post-secondary educational system, with a relatively small number of public (federal, state, or municipality) universities (around 25% of enrolments), and a large number of private institutions, both philanthropic/confessional and for-profit oriented (75% of enrolments). Higher education institutions are organized according to the European tradition.

Only about 10% of applicants to public higher education are accepted and this is linked to family background (parents mostly with tertiary education) and a good quality fundamental education (frequently private). Students with wealthier family background have an advantage over those with poor backgrounds and attend private institutions whose selection process has relatively little rigor and the overwhelming majority of the time has lower quality than the public. Many public universities have an extremely competitive selection system for prospective students, based on *numerus clausus*, called vestibular. To give an idea of this competitiveness, the 2014 vestibular held at the Unicamp, one of the most important public universities in Brazil, had approximately 77 146 candidates (just 30.2% of those graduated from public secondary schools) for 3 320 places, which means an acceptance rate of only 4.3%. For the programmes that are analysed in this paper, the last selection process had 2 473 candidates for Economics for 70 places, 35.3 candidates/place. In the case of Mechanical Engineering there were 4 072 candidates for 142 places, leading to 28.7 candidates per place (Comvest 2015).

Unicamp, located in state of São Paulo, is a public state university ranked second in Latin America (QS 2015) and ranked 42th in the ranking of the top 100 universities under 50 years old (THE 2015).

Russian higher education and the Higher School of Economics (HSE)

Although Russian higher education is still influenced by its Soviet legacy, it has experienced substantial change since 1991. This transformation reflects the general patterns of the social and economic transition of post-Soviet societies (Froumin and Kouzminov 2015). The emergence of the new market economy has caused an overall growth in demand for higher education and a shift from programs in natural sciences and engineering to business, law and the humanities. The education sector was opened to the market: public institutions were allowed to enrol fee-paying students along with state-funded students, and new, private higher education institutions opened. The number of higher education institutions has nearly doubled from 514 universities in 1991 to 969 in 2014. The number of students has risen from less than 3 million to 5.6 million over the same period. The participation rate is high: more than one third of people aged 17–25 study in higher education institutions. The emergent private sector has played a significant role in the expansion of higher education, 16% of students study in 391 private institutions. However, the private sector is generally associated with low-quality education.

Russian universities are very heterogeneous with respect to student quality, academic staff quality, infrastructure, and material resources. One criteria used to evaluate student quality is the average admission test score of enrolled students, in particular state-funded ones. In high-demand programs, competition among applicants to state-funded places is high, while less popular programs and intuitions are hardly able to fill their state-funded admission quotas. In the last decade, the Russian government has initiated several support programs which have resulted in an improvement of the quality of educational programs and research capacity in leading Russian universities (Yudkevich 2013).

In Russia, admission to state-funded positions is competitive. There are two ways in which secondary school graduates may be admitted. First, admission is granted to winners of school Olympiads. These are creative contests in selected fields of study aimed at developing the academic skills of secondary school students beyond the standard curriculum. Participation in the Olympiads is voluntary. Second, to fill in the remaining state-funded places the applicants are selected on the basis of admission test scores. Admission tests are the standardized tests, called the Unified State Examinations (USE). Tests in two disciplines, Russian and mathematics, are obligatory for each secondary school student. Tests in other disciplines are voluntary for each field of study, the Ministry of Education and Science defines a list of three or four required admission tests to the

universities that have state accreditation. Students who receive high enough USE results are state-funded, other students are charged tuition fees. The number of state funded places is limited and the cut-off depends on the number of applicants and their results.

HSE is one of the top-ranked universities in Russia. HSE is a highly selective university. In 2013, total enrolment at HSE was 4 300 students, the total number of applicants exceeded 24 800. About 2 700 students were enrolled to tuition-free positions. The average national university entrance exam scores of tuition-free students was 87%. Olympiad winners constituted 40% of the entire student population, while the national average proportion of students enrolled in institutions of higher education as Olympiad winners was about 5%. The HSE is located in Moscow, but 42 % of students arrived from outside of Moscow region.

Data and methods

Description of the data

In this paper we use data about students obtained from the administration of the universities. The data on students of Unicamp refer to students admitted to two bachelor programmes, mechanical engineering and economics from 2009 to 2011. The students in the sample from HSE were admitted to five bachelor programmes: management, law, economics, international economics and policy, and business information in 2013.

Unicamp

In the mechanical engineering programme students take classes together in the majority of theoretical subjects, and are divided into smaller groups for laboratory work. Almost all the subjects in the economics programme are core for the entire group. In the following years (mechanical engineering is a 5-year degree and economics is a 4-year degree), the group usually shrinks, as a consequence of some students failing some subjects. Additionally, students can choose different subjects per semester, according to their personal preference. Students spend much of their free time together. The majority of the students come from different cities from all over the country, and they often rent big houses close to the campus, usually shared by 5–6 students. The absence of family for such young students (17–19 years old) can be an important factor in social interaction, although this requires another study. The grade for each subject is the weighted average of preliminary and final exams, homework, essays, and other academic activities. A 10-point grade system is used. If a student receives a grade of less than 5.0, he or she has a chance to take a final exam that is averaged with the final grade. If the final grade is equal to or higher above 5.0, the student is considered to have passed. If not, the subject must be taken again in another semester. A minimum of 75% of

attendance is required for each subject. The weekly classroom workload at the university in the economics programme is from 20 to 24 hours, while in mechanical engineering it varies from 30 to 36 hours. The students have the possibility to engage in many extracurricular group activities.

HSE

Before the beginning of the academic year the university administration allocates first-year students to student groups, in which students work for the first three years of study. Typically, a group has up to 30 members. Lectures are usually delivered to several groups simultaneously, while seminars and tutorials are delivered to each group individually. Therefore, HSE students spend one part of their study time all together and the other part in groups. The bachelor's program lasts four years. Most of the courses in first three years of study are compulsory. At HSE, a 10-point grade system has been adopted. If a student receives a grade of less than four, he or she has two chances to re-take the exam. The typical course grade is the weighted average of midterm and final exams, homework tasks, essay and other academic activities. The weekly workload at the university is from 20 to 24 hours, so the students spend a significant amount of time together. It is common practice for students to discuss learning material after classes in the classroom, by email and using online social networks.

Dependent variable

As a dependent variable we consider a student's achievement in the first year of study. The commonly used indicator of achievement are a student's grade point average (GPA) or grades in particular courses. At Unicamp, students select courses and the number of courses attended varies from student to student. Therefore, we use course grades as the outcome variable. At HSE most courses are compulsory therefore we use GPA. The GPA is computed as a simple arithmetic mean of all course grades for each individual.

Independent variables

The student characteristics primarily include the level of ability and preparedness. The abilities themselves are hard to measure, therefore various proxy variables are widely used such as the results of standardized tests (Burton and Ramist 2001; Noble and Sawyer 2002; Frey and Detterman 2004; Shaw et al. 2012). As admission tests scores measure student achievement prior to university study, they are independent of peer influence. Student characteristics also include gender.

In the Russian sample, some students were enrolled as Olympiad winners and do not have admission tests scores in all subjects. We assign Olympiad winners the greatest possible scores.

Peer background characteristics are the mean admission test scores of the student's peers. We define peers as those who are likely to form a friendship connection with the student. For a prediction of social ties we rely on the hypothesis of homophily, or assortativity. This hypothesis

implies that personal networks are homogeneous with regard to the characteristics of the connected people (McPherson et al. 2001).

For the Brazilian students, we use two factors that may affect friendship. First, we suppose that the region of origin matters: if two students have been born in the same region, their chance of becoming friends increases.[6] The second factor is gender, that is, two students of the same gender are more likely to be friends.

For the Russian students, we use sharing the same study group and having the same gender as the factors predicting friendship.

In the peer effect literature, the strength of peer influence is often measured by standardized regression coefficients of peer variables. The standardized coefficient represents the change in the dependent variable induced by a change of one standard deviation in an independent variable. This scale-free property is convenient in situations when there is a need to compare quantitative effects in different settings. As we use data from different universities, programmes and years, we standardized both own and peer achievement: in each year and programme, course grades, the GPA, the admission tests scores of a student, and the mean admission test scores of student's peers have been rescaled to have a mean of zero and a standard deviation of one.

The descriptive statistics of the variables used in our study are reported in Tables 1 and 2. Comparing the samples, we observe that Unicamp female students account for significantly fewer than half of all students, while at HSE the shares of male and female students are almost even. The number of predicted peers for students of the mechanical engineering programme is much higher than for students of the economics programme and than for all Russian students.

[6] By the region of origin we imply the town unless the number of students born in the same town is less than four. If the number of students from the same town of birth equals one, two or three, the region denotes the state of birth.

Table 1: Descriptive statistics: Unicamp

	Mechanical engineering		Economics	
	Mean	SD	Mean	SD
Female	0.12	0.33	0.31	0.46
Admission test scores (standardized)	0.00	1.00	0.00	1.00
Course grade (standardized)	0.00	1.00	0.00	1.00
Number of courses attended	12.7	1.73	11.7	1.69
Number of peers from the same region	52.6	44.1	27.6	20.7
Number of peers from the same region and of same gender	40.6	38.2	15.8	13.4
Peers' admission test scores (standardized)	0.00	1.00	0.00	1.00
Number of students	417		203	

Table 2: Descriptive statistics: HSE, all programmes

	Mean	SD
Female	0.53	0.50
Admission test scores (standardized)	0.00	1.00
First year GPA (standardized)	0.00	1.00
Number of peers from the same group	21.5	2.50
Number of peers from the same group and of same gender	11.2	3.33
Peers' admission test scores (standardized)	0.00	1.00
Number of students	891	

Empirical methodology

Our base model to estimate peer effects is the following commonly used linear model of the relationship between individual achievement and explanatory variables:

$$\begin{aligned} achievement_i = \beta_0 + \beta_1 \cdot female_i + \beta_2 \cdot admission\ scores_i \\ + \beta_3 \cdot peers'\ admission\ scores_i + \varepsilon_i, \end{aligned} \quad (1)$$

where *achievement* of a student is measured by the grades for the first year of study, *female* is an indicator variable, *admission scores* is the mean value of admission tests scores of an individual, *peers' admission score* is the mean value of admission tests scores of student's peers, and ε_i are random disturbances.

The right-hand-side of (1) lacks a term containing achievements of the peers of student *i*. Were it included, the correct estimation of (1) would be complicated by the problem of simultaneity (Manski 1993; Brock and Durlauf 2001). The problem of simultaneity, or the reflection problem, is caused by the fact that not only does peer achievement influence a student's grades, but the student's achievement affects the peers as well. For this reason, the OLS estimates of coefficients would be biased.

For Unicamp, region and gender factors affect friendship formation. We examine two non-overlapping peer group variables. The first peer group consists of peers who are from same region and of same gender. The second peer group consists of peers who are from same region as the student but of opposite gender. We estimate the model separately for two programmes. Year fixed effects are added to control for variation in the grades across years. The model is:

$$\begin{aligned} achievement_i = {} & \beta_0 + \beta_1 \cdot (female)_i + \beta_2 \cdot (admission\ scores)_i \\ & + \beta_3 \cdot (admission\ scores\ of\ 'same\ region\ \&\ same\ gender'\ peers)_i \\ & + \beta_4 \cdot (admission\ scores\ of\ 'same\ region\ \&\ opposite\ gender'\ peers)_i \\ & + \delta_1 \cdot (year = 2009)_i + \delta_2 \cdot (year = 2010)_i + \delta_3 \cdot (year = 2011)_i + \varepsilon_i . \end{aligned} \quad (2)$$

For HSE, we also examine two non-overlapping peer groups. The first peer group consists of peers from same study group and of same gender; the second peer group consists of peers from group region and of opposite gender. We pool the samples from all five programmes and use programme fixed effects. The estimated model is:

$$\begin{aligned} achievement_i = {} & \beta_0 + \beta_1 \cdot (female)_i + \beta_2 \cdot (admission\ scores)_i \\ & + \beta_3 \cdot (admission\ scores\ of\ 'same\ group\ \&\ same\ gender'\ peers)_i \\ & + \beta_4 \cdot (admission\ scores\ of\ 'same\ group\ \&\ opposite\ gender'\ peers)_i \\ & + \delta_1 \cdot (programme = 1)_i + ... + \delta_5 \cdot (programme = 5)_i + \varepsilon_i . \end{aligned} \quad (3)$$

Results

Tables 3–5 present the OLS estimates of the peer effect models described in the previous section. The first column shows the estimates for the full sample, and the second and the third for males and females, respectively.

Table 3 report the results from regressing the course grades on the explanatory variables, as described by (2), for mechanical engineering at Unicamp. Results for the mixed sample (column 1) indicate that having two factors in common, region and gender, is associated with better grades. The coefficient value of 0.09 in the first row means that a one standard deviation increase in the predictor variable is associated with the course grade increase by 0.09 standard deviations. The peer effect is large: it is 45% of the effect from own admission test scores (0.2). Having peers from same region and of opposite gender yields much smaller effect (0.039). The results in the mixed sample

are driven by male students as seen from the figures in the columns 2 and 3. The correlation between female student's grade and female peers is small and insignificant, while the effect on female from male peers is larger and significant at 10% level. The gender difference may be explained by the disproportional gender composition (88% of students are males) and the specific nature of the programme (mechanical engineering).

Table 4 contains estimates for the economics programme. In the mixed sample, there are positive peer effects from those peers who are from same region and of same gender. The size of the effect is smaller (0.038) than in the mechanical engineering programme (0.09). In gender specific samples, we observe positive effects from same-gender peers and negative effects from opposite-gender peers.

The estimates for HSE are shown in Table 5. In the mixed sample, the results indicate that there is a significant association between student's GPA and the admission test scores of peers from same group and of same gender as the student. The size of this effect (0.082) is about 20% of the influence of own admission tests scores (0.413). For females, the qualitative results mirror those in the mixed sample; in absolute terms the peer effect is greater than in the mixed sample (0.109 vs. 0.082), and this is again 20% of own admission tests scores impact. For males, the admission test scores of peers are positive but statistically insignificant.

The above results provide evidence that there are positive peer effects in both the universities we consider in our study, although the size of the effects depends on the institution and programme specifics. Taken together, these results are consistent with the hypothesis that defining peer group through predicted friendship may be useful in situations where actual social ties of students are unknown.

There are two possible interpretations why predicted friends have an impact on student grades. First, it may be actual interpersonal ties that matter in the peer effect mechanism. In this case, the measured peer influence is underestimated because we cannot predict friends perfectly and, therefore, use peer group of both influential and non-influential peers. The second explanation assumes that not only connected peers affect student's achievement, but also those who have similar attributes. For example, a female student may compare herself with other female classmates who are not necessary her friends. Similarly, students in the same study group interact frequently by arrangement, and even mere observing the activity of other students may affect their own behaviour. To distinguish between these two hypotheses, further research is required using information on actual friendships.

Table 3. Estimation of peer effects for Unicamp: Mechanical engineering

	All students	Females	Males
	(1)	(2)	(3)
Peers' admission test scores (standardized):			
Peers are from same region and of same gender	0.090***	0.007	0.107***
	(0.013)	(0.023)	(0.016)
Peers are from same region and of opposite gender	0.039***	0.092*	0.037**
	(0.013)	(0.055)	(0.015)
Own admission test scores (standardized)	0.200***	0.237***	0.184***
	(0.013)	(0.028)	(0.015)
Female	-0.025		
	(0.037)		
Constant	0.001	0.015	0.006
	(0.025)	(0.065)	(0.026)
N	5310	694	4616
R^2	0.059	0.150	0.050

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4. Estimation of peer effects for Unicamp: Economics

	All students	Females	Males
	(1)	(2)	(3)
Peers' admission test scores (standardized):			
Peers are from same region and of same gender	0.038*	0.129***	0.085***
	(0.023)	(0.043)	(0.028)
Peers are from same region and of opposite gender	-0.023	-0.070*	-0.079***
	(0.022)	(0.041)	(0.027)
Own admission test scores (standardized)	0.243***	0.172***	0.276***
	(0.021)	(0.037)	(0.026)
Female	0.155***		
	(0.043)		
Constant	-0.038	-0.260***	0.068*
	(0.036)	(0.097)	(0.040)
N	2371	763	1608
R^2	0.068	0.067	0.093

Standard errors in parentheses
* $p < 0.1$, *** $p < 0.01$

Table 5. Estimation of peer effects for HSE

	All students	Females	Males
	(1)	(2)	(3)
Peers' admission test scores (standardized):			
Peers are from same group and of same gender	0.082**	0.109**	0.072
	(0.034)	(0.045)	(0.047)
Peers are from same group and of opposite gender	-0.007	-0.039	0.080
	(0.030)	(0.034)	(0.074)
Own admission test scores (standardized)	0.413***	0.500***	0.350***
	(0.027)	(0.037)	(0.038)
Female	0.187***		
	(0.069)		
Constant	-0.030	0.241**	-0.123
	(0.084)	(0.100)	(0.111)
N	891	469	422
R^2	0.204	0.235	0.162

Standard errors in parentheses
** $p < 0.05$, *** $p < 0.01$

Discussion and conclusion

Studying the influence of student social interaction on their academic achievements attracts considerable interest, as it enhances our understanding of the nature of the educational process and may be utilized to increase of the productivity of learning. In practice, one of problems of peer effect estimation is correctly identifying the peer group of an individual, that is, those students who affect the motivation of, give advice to, co-operate in doing homework with, or influence the achievement of this individual in some other way.

In this study, we assume that peer groups consist of those students who have similar observable characteristics. It is well known that similar people tend to interact and to form social ties more often than dissimilar. Therefore, a set of students with homogeneous attributes will have a higher probability of being connected by friendship ties. The use of predicted ties instead of actual ties allows us to overcome the problem of self-selection which is a significant complication of empirical peer effect identification in social networks.

To test the presence of peer effects, we use data on students studying in two universities located in two different countries, Brazil and Russia. The specific features of the learning

environment in each university condition our choice of dimensions along which friendship ties presumably form. For the Brazilian students, we use the students' region of origin and gender as factors that shape friendship. For the Russian students, we use sharing the same study group and having the same gender. In both cases, we find a positive statistical relationship between a student's achievement and academic preparedness of that student's peers. This result is evidence in favour of the hypothesis that predicted friends form peer groups that affect student academic achievement.

Positive externalities from peer ability may explain why academically strong students prefer to apply to selective academic programmes and the resulting concentration of student quality in such programmes. However, the existence of peer effects does not lead to conclusion that the stratification of higher education institutions with respect to student quality is socially optimal. The nonlinearity of peer effects matters, for example, low achieving students may benefit more from high ability peers than high achieving students. In this case, to maximize overall achievement, a diverse student population may be preferable to a homogenous one.

We examined peer effects in two different institutions. Obviously, many other environments influence student interactions and their impact on academic achievement. People form relationships based on a wide range of factors. For example, in ethnically diverse societies race and ethnicity play an important role in shaping the social networks. Students from ethnical minorities may be in a situation where they have a less privileged background in comparison to other students. Being connected mainly to people like themselves, such students will suffer from a limited social environment. Thus, homophily here puts limitations on how information flows through networks and preserves the differences between groups. Fortunately, a reasonable education policy is able to ease these limitations. University administration may facilitate communication among students, manipulate the composition of study groups or the allocation of roommates in dormitories in order to widen and diversify the range of an individual's contacts.

References

Androushchak, G., O. Poldin, and M. Yudkevich. 2013. "Role of Peers in Student Academic Achievement in Exogenously Formed University Groups." *Educational Studies* 39 (5): 568-81.

Arcidiacono, P., G. Foster, N. Goodpaster, and J. Kinsler. 2012. "Estimating Spillovers Using Panel Data, with an Application to the Classroom." *Quantitative Economics* 3 (3): 421-70.

Bifulco, R., J. M. Fletcher, and S. L. Ross. 2011. "The Effect of Classmate Characteristics on Post-Secondary Outcomes: Evidence from the Add Health." *American Economic Journal: Economic Policy* 3 (1): 25-53.

Brock, W. A., and S. N. Durlauf. 2001. "Interactions-Based Models." In *Handbook of Econometrics*, edited by J. Heckman James and Leamer Edward, 3297-380. Elsevier.

Brunello, G., M. De Paola, and V. Scoppa. 2010. "Peer Effects in Higher Education: Does the Field of Study Matter?" *Economic Inquiry* 48 (3): 621-34.

Buchmann, C., and B. Dalton. 2002. "Interpersonal Influences and Educational Aspirations in 12 Countries: The Importance of Institutional Context." *Sociology of Education* 75: 99-122.

Burton, N. W., and L. Ramist. 2001. "Predicting Success in College: Sat Studies of Classes Graduating since 1980." In.: College Entrance Examination Board Research Report 2001-2.

Carrell, S. E., R. L. Fullerton, and J. E. West. 2009. "Does Your Cohort Matter? Measuring Peer Effects in College Achievement." *Journal of Labor Economics* 27 (3): 439-64.

Carrell, S. E., and M. L. Hoekstra. 2010. "Externalities in the Classroom: How Children Exposed to Domestic Violence Affect Everyone's Kids." *American Economic Journal: Applied Economics* 2 (1): 211-28.

Carrell, S. E., B. I. Sacerdote, and J. E. West. 2013. "From Natural Variation to Optimal Policy? The Importance of Endogenous Peer Group Formation." *Econometrica* 81 (3): 855-82.

Cohen, J. 1983. "Peer Influence on College Aspirations with Initial Aspirations Controlled." *American Sociological Review* 48 (5): 728-34.

Comvest. 2015. "Estatísticas." http://www.comvest.unicamp.br/estatisticas/numeros.html.

Davies, M., and D. B. Kandel. 1981. "Parental and Peer Influences on Adolescents' Educational Plans: Some Further Evidence." *American Journal of Sociology* 87: 363-87.

de Klepper, M., E. Sleebos, G. van de Bunt, and F. Agneessens. 2010. "Similarity in Friendship Networks: Selection or Influence? The Effect of Constraining Contexts and Non-Visible Individual Attributes." *Social Networks* 32 (1): 82-90.

De Paola, M., and V. Scoppa. 2010. "Peer Group Effects on the Academic Performance of Italian Students." *Applied Economics* 42 (17): 2203-15.

Duncan, O. D., A. O. Haller, and A. Portes. 1968. "Peer Influences on Aspirations: A Reinterpretation." *American Journal of Sociology* 74: 119–37.

Ficano, C. C. 2012. "Peer Effects in College Academic Outcomes – Gender Matters!" *Economics of Education Review* 31 (6): 1102-15.

Frey, M. C., and D. K. Detterman. 2004. "Scholastic Assessment or G?: The Relationship between the Scholastic Assessment Test and General Cognitive Ability." *Psychological Science* 15 (6): 373-8.

Friesen, J., and B. Krauth. 2011. "Ethnic Enclaves in the Classroom." *Labour Economics* 18 (5): 656-63.

Froumin, I., and Y. Kouzminov. 2015. "Supply and Demand Patterns in Russian Higher Education." In *Higher Education in the Brics Countries*, edited by Simon Schwartzman, Rómulo Pinheiro and Pundy Pillay, 97-123. Springer Netherlands.

Griffith, A. L., and K. N. Rask. 2014. "Peer Effects in Higher Education: A Look at Heterogeneous Impacts." *Economics of Education Review* 39: 65-77.

Hanushek, E. A., J. F. Kain, and Steven G. Rivkin. 2009. "New Evidence About Brown V. Board of Education: The Complex Effects of School Racial Composition on Achievement." *Journal of Labor Economics* 27 (3): 349-83.

Hasan, S., and S. Bagde. 2013. "The Mechanics of Social Capital and Academic Performance in an Indian College." *American Sociological Review* 78 (6): 1009-32.

Hill, A. J. 2015. "The Girl Next Door: The Effect of Opposite Gender Friends on High School Achievement." *American Economic Journal: Applied Economics* 7 (3): 147-77.

Hoxby, C. 2000. "Peer Effects in the Classroom: Learning from Gender and Race Variation." *National Bureau of Economic Research Working Paper Series* No. 7867.

Jain, T., and M. Kapoor. 2014. "The Impact of Study Groups and Roommates on Academic Performance." *Review of Economics and Statistics*.

Lavy, V., and A. Schlosser. 2011. "Mechanisms and Impacts of Gender Peer Effects at School." *American Economic Journal-Applied Economics* 3 (2): 1-33.

Legewie, J., and T. A. DiPrete. 2012. "School Context and the Gender Gap in Educational Achievement." *American Sociological Review* 77: 463-85.

Lomi, A., T. A. B. Snijders, C. E. G. Steglich, and V. J. Torló. 2011. "Why Are Some More Peer Than Others? Evidence from a Longitudinal Study of Social Networks and Individual Academic Performance." *Social Science Research* 40 (6): 1506-20.

Lyle, D. S. 2007. "Estimating and Interpreting Peer and Role Model Effects from Randomly Assigned Social Groups at West Point." *Review of Economics and Statistics* 89 (2): 289-99.

Lyle, D. S. 2009. "The Effects of Peer Group Heterogeneity on the Production of Human Capital at West Point." *American Economic Journal-Applied Economics* 1 (4): 69-84.

Manski, C. F. 1993. "Identification of Endogenous Social Effects: The Reflection Problem." *Review of Economic Studies* 60 (3): 531-42.

Mayer, A., and S. L. Puller. 2008. "The Old Boy (and Girl) Network: Social Network Formation on University Campuses." *Journal of Public Economics* 92 (1-2): 329-47.

Mazur, E. 1997. *Peer Instruction: A User's Manual*. Upper Saddle River, N.J.: Prentice Hall.

McEwan, P. J., and K. A. Soderberg. 2006. "Roommate Effects on Grades: Evidence from First-Year Housing Assignments." *Research in Higher Education* 47 (3): 347-70.

McPherson, M., L. Smith-Lovin, and J. M. Cook. 2001. "Birds of a Feather: Homophily in Social Networks." *Annual Review of Sociology* 27: 415-44.

Noble, J. P., and R. L. Sawyer. 2002. "Predicting Different Levels of Academic Success in College Using High School Gpa and Act Composite Score." In.: ACT Research Report Series.

Oosterbeek, H., and R. van Ewijk. 2014. "Gender Peer Effects in University: Evidence from a Randomized Experiment." *Economics of Education Review* 38: 51-63.

Pilbeam, C., and D. Denyer. 2009. "Lone Scholar or Community Member? The Role of Student Networks in Doctoral Education in a Uk Management School." *Studies in Higher Education* 34 (3): 301-18.

Poldin, O., D. Valeeva, and M. Yudkevich. 2015. "Which Peers Matter: How Social Ties Affect Peer-Group Effects." *Research in Higher Education*.

QS. 2015. "QS University Rankings: Latin America 2015." Quacquarelli Symonds. http://www.topuniversities.com/university-rankings/latam-university-rankings/2015#sorting=rank+region=+country=+faculty=+stars=false+search=.

Sacerdote, B. 2001. "Peer Effects with Random Assignment: Results for Dartmouth Roommates." *Quarterly Journal of Economics* 116 (2): 681-704.

Schneeweis, N., and M. Zweimüller. 2012. "Girls, Girls, Girls: Gender Composition and Female School Choice." *Economics of Education Review* 31 (4): 482-500.

Shaw, E. J., J. L. Kobrin, B. F. Patterson, and K. D. Mattern. 2012. "The Validity of the Sat for Predicting Cumulative Grade Point Average by College Major." In.: Research Report 2012–6. New York: College Entrance Examination Board.

Stinebrickner, R., and T. R. Stinebrickner. 2006. "What Can Be Learned About Peer Effects Using College Roommates? Evidence from New Survey Data and Students from Disadvantaged Backgrounds." *Journal of Public Economics* 90 (8-9): 1435-54.

THE. 2015. "100 under 50 Rankings 2015." https://www.timeshighereducation.co.uk/world-university-rankings/2015/one-hundred-under-fifty#/sort/0/direction/asc.

Traud, A. L., E. D. Kelsic, P. J. Mucha, and M. A. Porter. 2011. "Comparing Community Structure to Characteristics in Online Collegiate Social Networks." *SIAM Review* 53 (3): 526-43.

van Duijn, M. A. J., E. P. H. Zeggelink, M. Huisman, F. N. Stokman, and F. W. Wasseur. 2003. "Evolution of Sociology Freshmen into a Friendship Network." *The Journal of Mathematical Sociology* 27 (2-3): 153-91.

Vitale, M. P., G. C. Porzio, and P. Doreian. 2015. "Examining the Effect of Social Influence on Student Performance through Network Autocorrelation Models." *Journal of Applied Statistics*: 1-13.

Yudkevich, M. 2013. "Leading Universities in Russia: From Teaching to Research Excellence." *Journal of International Higher Education* 6 (3): 113-6.

Zimmerman, D. J. 2003. "Peer Effects in Academic Outcomes: Evidence from a Natural Experiment." *Review of Economics and Statistics* 85 (1): 9-23.

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