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Heterogeneity in peer effects in random dormitory assignment in a developing country

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ABSTRACT

We study the effect of random dormitory assignment in a tertiary level educational institution in India on students' subsequent academic achievements. We examine the importance of interactions between the characteristics of the student and his peers for educational outcomes, including non-linear peer-effects and the importance of different socio-economic and geographical backgrounds. We find that peer ability effects are around one-third the size of the effects of one's own ability, and students from non-urban and non-English backgrounds do particularly better when assigned to higher-ability peers. We find that all groups of ability students gain from being matched to high-ability peers, but that this gain is highest for students who are themselves of higher-ability. Our results suggest peer effects are stronger in the first year in dorm. In terms of mechanisms, we find no evidence for effects of peers via mental health, life satisfaction, or risk attitudes. We observe that a roommate's study times is highly correlated with a student's own study times, but we see only a weak positive association between study habits and grades.

1. Introduction

A growing number of studies have examined peer effects in educational outcomes in developed countries (for a review, see Sacerdote, 2014). These studies generally show that an individual's peers influence a range of outcomes, such as the individual's personal wellbeing, knowledge and behaviour (Angrist and Lavy, 1999; Sacerdote, 2001; Zimmerman, 2003; Carrell et al., 2009; De Giorgi et al., 2010; Foster and Frijters, 2010; Shue, 2013; Carrell et al., 2013). A key emerging issue in the literature is the potential interaction between the characteristics of the individual and those of the peer, since it is the non-linearities in peer effects that arise from such an interaction that potentially allow improvements in average outcomes to be achieved. For instance, when examining peer effects among Katrina evacuees, Imberman et al. (2012) find that higher-ability peers help higher-ability students more than they help lower-ability students, suggesting the benefits of a policy of assortative matching.

Recent studies have cast doubt on the generalizability of the bilateral peer effects that have been found, even if identified via random assignment. Carrell et al. (2009) study found that higher-ability peers at the US Air Force Academy provided greater positive peer effects for lower-ability students than for middle-ability students. However, when Carrell et al. (2013) then looked at the results of truly assigning higher-ability students to lower-ability students, they found

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that the performances of lower-ability students who were assigned to higher-ability peers fell relative to those of their counterparts in the control group, which they take as evidence that their original study missed some complex interactions.[1] Guided by this recent evidence and debate, this paper pays particular attention to estimating peer effects in the context of a developing country, heterogeneity in the estimated peer effects and potential mechanisms.

Our study uses randomised dormitory assignments in a tertiary-level institution in Kolkata, India, to evaluate the evidence for peer effects in academic achievements. In the dormitories from which our data are drawn, typically four boys from very diverse backgrounds are selected randomly into each room, and they generally remain in those groups for three years, meaning that the interactions within these residential groups are sustained and quite extensive. We combine administrative records on students with data from a custom-built survey of the students, which allows us to disaggregate peers into particular groups based on their social, economic and geographical backgrounds. We are also able to estimate changes in effects over time and examine the evidence relating to effort and learning habits, in order to understand the channels through which peers exert influence.

Overall, our results suggest that strong peer effects do exist in tertiary education among randomly assigned roommates in Kolkata. The positive effects of high-ability peers are found to be highest for high-ability individuals, meaning that assortative matching on prior ability would maximise average scores. We also find that students from non-urban regions and non-English backgrounds benefit the most from high-ability peers suggesting non-assortative matching on students' social background.

In terms of mechanisms, there are two broad theories on which our case sheds some light. The first is that the actual presence of peers affect each other's skills via a variety of mechanisms, including helping each other and mimicking each other's habits. The second is that the mere visibility of the outcomes of peers (i.e. their abilities and academic achievements) creates a competitive reaction.

One way in which actual presence can matter is if peers 'help' each other, which we can understand as directly affecting each other's human capital. Spending time studying together, sharing knowledge, and teaching each other particular skills fall into this category. Under this theory, which was dominant in the early literature (Sacerdote, 2001), peers essentially exert a constant influence on the others, which means one expects to see increasing peer effects over time, such as changes in study habits. One then also expects peers who differ from each other more, and thus have something new to teach, to have greater effects on each other. Fafchamps and Mo (2018) find some support for this mechanism in their examination of peer effects on computer-assisted learning using randomized controlled trials in China. The results show that peers can improve both equity and efficiency by helping weak students to catch up with the rest of the class, without imposing any learning cost on other students, which is a clear example of the theory that students can add to others' human capital. We look for similar effects in our data.

A related mechanism is the 'demonstration effect' of peers, where students mimic the behaviours of those around them. This ultimately leads to the same outcome as the 'helping' possibility mentioned above, but the mechanism is subtly different: under a demonstration effect what a peer does is alert others to new possibilities, but still requires others to work out themselves how to understand things themselves. Under a helping effect, peers explain things to each other and thus actively try to communicate with each other, which should for instance show up as a measurable effect of joint study. Importantly, both demonstration effects and helping effects might depend on initial similarities in particular domains, in which case peer effects would be strongest inside homogenous groups, and very diverse groups should see weaker peer effects. Garlick (2018) showed that peer effects operate primarily within race groups, which is consistent with the idea of identity-mediated effects.

A different theoretical mechanism is via competition incentives. If people care about how they perform relative to those immediately around them, then peer quality should affect the perceived returns to effort. When there are many bunched closely in initial ability, each of the group close in ability can overtake many others with a small additional effort, which holds for all those in such a group, implying that we should see more effort if the whole distribution has less variance. Also, because the distance between them and the others in terms of ability is higher, those in the 'thin' areas of the distribution, which is likely to be at the ends of the distribution of initial ability, have lower incentives to change their effort in response to peers. If such distributional effects of peers matter (Tincani, 2014), own effort should be the primary mechanism (rather than joint study), and the background characteristics of the 'competitors' should be unimportant relative to their abilities. We find little evidence that these mechanisms are dominant in our case, with own effort being estimated to be relatively unimportant in terms of mechanisms, and background characteristics highly important, by contrast. Also, contrary to what one would expect if competition were dominant, the larger the variation in peer-abilities, the higher own outcomes.

The closest papers to this one are the studies that have focussed on differentiating amongst different potential mechanisms for peer effects, and particularly the few papers that have studied the effects of different socio-economic and demographic characteristics on the nature and strength of peer effects in a setting similar to ours. Studies such as Sacerdote (2014) and Booij et al. (2017) suggest that ability mixing is beneficial for both low-ability and medium-ability students, and does not reduce the test scores of high-ability peers. Feld and Zölitz (2017) find almost opposite results, with low-achieving students being harmed by high-achieving peers, potentially due to competition effects (Tincani, 2014).

[1] Tincani (2014), on the other hand, points to the possibility of endogenous effort depending on the whole distribution of peers, rather than on pairwise comparisons.

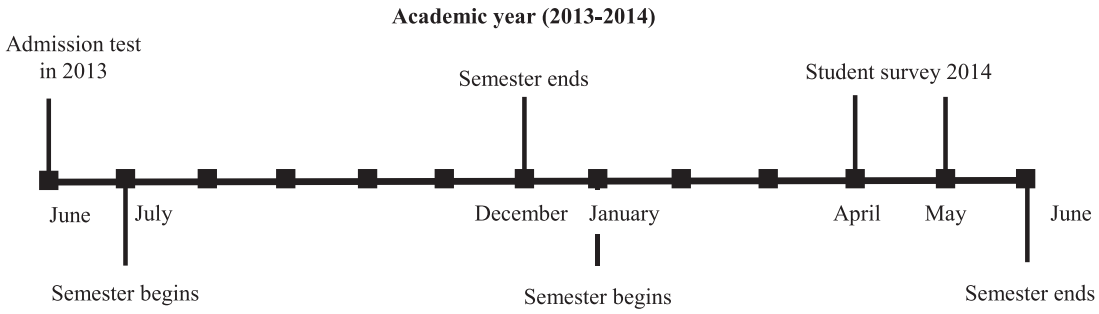

Fig. 1. Timeline of the project.

Garlick (2018) finds that living with higher-scoring peers raises students' achievement, particularly for low-scoring students, and peer effects are stronger between socially proximate students.

In the context of India, Jain and Kapoor (2015) find that informal social interactions with *roommates* have significant positive impacts on academic achievements. On the other hand, they find the effects of peers in *study groups* are small and insignificant. Sen et al. (2012) find that having higher caste students in a peer group has a positive effect on lower caste students (which in India are often termed 'Scheduled Caste' or 'Scheduled Tribe' because their disadvantaged position is scheduled and therefore subject to government programs), but a negative effect on other higher caste students, suggesting the existence of an asymmetry in learning opportunities. Sekhri (2011), on the other hand, finds that the college exit test scores of low-caste students are adversely affected by the average quality of high-caste students in their peer group, which could indicate the dominance of discouragement effects. These disperse findings show the literature is not yet settled on a clear conclusion.

2. Background and data

Our subjects are dormitory students from a residential boys' college (Ramakrishna Mission Residential College Narendrapur (also referred to as RKMRC)) in Kolkata.[2] The students at RKMRC mostly live on campus in one of the three residential halls, and come from a range of socio-economic and regional backgrounds in the 19 districts of West Bengal. They come from rural, semi-urban and urban regions, belong to both forward (also referred to as general category) and backward social classes (such as scheduled castes (SC), scheduled tribes (ST) and other backward classes (OBC)), with their prior education sometimes having been in English and sometimes not. They come from both poor[3] as well as non-poor economic status.

All prospective students who are interested in studying at the RKMRC have to pass a college-level entrance exam usually conducted during the month of June. Fig. 1 shows the timeline of the academic year, including admission test and semester periods in 2013–14 when the survey was conducted. Generally, RKMRC follows this calendar in all academic years.

The eligibility criteria[4] for the entrance exam are set by the Administration, and only students who satisfy the criteria are selected to sit for the entrance exam – a written test. The top scorers in this written test are then invited to appear for a face-to-face interview with the selection committee, with those with the highest composite scores being admitted. A final list of the students admitted is then prepared by the Administration Office and sent to the Housing Office for room assignments. Separate student lists are prepared for those enrolled in the different programs (undergraduate and postgraduate). The students are first allotted randomly[5] to one of the three residential halls (hostels) by the Housing Office and then to one of the hostel rooms by the respective hostel authority, which ensures that undergraduate and Masters students are not assigned to the same room. There is no preferential treatment for students from SC, ST or OBC groups in terms of roommate assignments. See Fig. 2 for a diagrammatic representation of the residential halls at the institution.[6]

[2] Many students who are interested in non-engineering and non-medical careers prefer this institution, as it is one of only a few premier residential colleges in Kolkata and is relatively cheap compared to other institutions.

[3] A student is defined as belonging to a poor household if his reported parental income is below the median income of all the families of the students in the sample.

[4] The eligibility criteria for sitting for admission test for UG courses are usually 60% for Arts and 70% for Science subjects, with a 5% relaxation in aggregate for SC/ST candidates, while for PG courses the criteria are 50% for Science and 45% for Arts (in the Honours subject), again with a 5% relaxation for SC/ST students (as part of an affirmative action plan of the Indian Government).

[5] Students are assigned to their rooms randomly, irrespective of their academic abilities. Due to confidentiality regulations, only the Administration Office keeps a copy of the students' past academic transcripts and uses it to verify their eligibility during the application process; this information is not shared with the Housing Office. Students with disabilities, like blindness (about 1% of the sample), are not assigned randomly, as they are usually assigned to particular rooms with specific facilities.

[6] There are three halls; the first hall has two wings N and S with three floors, the second hall has two wings E and W with three floors and finally the third hall has only one wing with three floors. In our empirical specification, each floor-wing in a hall is treated as a dorm as they are separate from each other, allowing us to estimate dorm-specific fixed effects to control for any mixing of students within the dorm. In total there are fifteen dorms (3 dorms in N; 3 in S; 3 in E; 3 in W and only 3 in the third hall) based on the different wings (N/S/E/W) and floors of the halls, nine floors (three in each hall as each hall has three floors), and three halls.

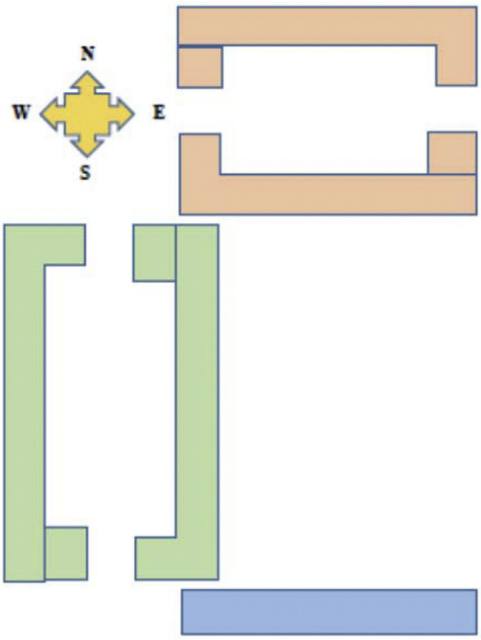

Fig. 2. Map of the residential complex.
Notes: There are fifteen dorm fixed effects based on the wings (North/South/East/West) on different floors of the halls, nine floor fixed effects (three in each hall), and three hall fixed effects. Note that there are two halls with two distinct wings each, facing North-South and East-West, respectively.

The data used in the analyses are from the graduating classes of 2014, 2015 and 2016, i.e., those who enrolled in the three-year undergraduate degree (Bachelors) program between 2011 and 2013 or in the two-year Masters program in 2012 or 2013. The final dataset includes residential hall assignments and information from the application forms that were filled in by the students at the time of their admission. The application forms include detailed personal and household-specific information, such as household income and anthropometric information. From the Examination Office, we also have a full history of the students' academic records since their admission. This official dataset is merged with a detailed dataset collected by the enumerators at the time of the survey.[7] The survey contains detailed information about adolescent friendship and peer networks; personal characteristics such as educational background, health status, past schooling history, social and family relationships; and information about cognitive and non-cognitive skills. The students also identified up to five best friends from the college roster, which allows us to map the geometric structure of the friendship network at this institution.

We use the students' average test scores from their grades ten and twelve exams[8] to create a pre-treatment academic ability variable. Our main post-treatment outcome variables are the test scores after admission into the RKMRC. These include (i) marks obtained in the honours (major) subject in the *current* (last) semester, which captures performances in written exams, practical work and group projects; (ii) *cumulative marks* in the honours subject, aggregated over all the semesters in which the student was registered; and (iii) *total marks* obtained in all subjects, including honours (major), general (minors), and all compulsory subjects like English, second language (which refers to regional languages like Bengali/Hindi, often the students' mother tongue), Environmental Science, etc.

There were 515 students listed officially in these three dorms. In total, we could survey 489, a response rate of 94 percent. Out of 489 students surveyed, we did not have detailed semester-wise marks from the Examination Office for 6 students.[9] We could verify the current room assignment for only 481 students and initial roommate assignment for 467 students. The number of students with full academic records, survey information and initial roommates' assignment were 463. Of them we could not verify current roommates' assignment for 5 students. Hence, we have information for 458 students with both current and initial roommates verified.

[7] The student survey was conducted between April–May 2014, i.e. at the end of year 1 for students admitted in the first year of the program in July 2013, at the end of year 2 for students enrolled in July 2012 and so on.

[8] The total marks in the board exams for the standard X exams range from 800 among the West Bengal board secondary level institutions to 1000 among students graduating from Indian Certificate of Secondary Education (ICSE) and Central Board of Secondary Education (CBSE) boards. The standard XII marks, on the other hand, range from 500 for West Bengal higher secondary level students to 1000 among Indian School Certificate (ISC) and CBSE Standard XII students. The marks obtained in the standard X and XII exams and academic ability have therefore been expressed in percentage terms to make them comparable across students from different boards.

[9] We were careful to include all students in dormitories into the survey. If a student was not found in the dormitory at the time of survey, the enumerators collected their contact information (e.g., mobile number), and went back to survey them when they were available during the survey period mentioned above.

Table 1
Summary statistics by residential hall.

Variables of interest	All students		Hall I		Hall II		Hall III	
	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev
Academic achievements								
Current marks	65.77	12.79	66.44	12.29	65.25	13.24	65.17	13.16
Cumulative marks	66.03	12.38	66.04	12.16	65.94	12.83	66.16	12.22
Overall marks	66.75	10.18	66.86	9.86	66.67	10.35	66.62	10.69
Own academic ability	81.30	6.62	81.14	7.08	81.20	6.57	81.80	5.59
Roommate's academic ability	81.33	5.00	81.23	5.20	81.24	5.19	81.74	4.15
Friend's academic ability	82.14	4.93	82.25	5.03	81.51	5.05	83.04	4.37
Individual characteristics								
Age (in years)	20.03	1.56	20.10	1.52	19.83	1.49	20.23	1.72
Medium of instruction English dummy	0.27	0.45	0.27	0.45	0.28	0.45	0.25	0.44
UG program dummy	0.80	0.40	0.82	0.39	0.83	0.37	0.69	0.46
General category dummy	0.77	0.42	0.79	0.41	0.76	0.43	0.76	0.43
Urban dummy	0.42	0.49	0.46	0.50	0.42	0.49	0.33	0.47
Semi-urban dummy	0.16	0.36	0.15	0.36	0.13	0.33	0.22	0.42
Rural dummy	0.42	0.49	0.38	0.49	0.46	0.50	0.45	0.50
Limiting Illness dummy	0.04	0.20	0.05	0.22	0.05	0.21	0.01	0.10
Observations	483		218		166		99	

Notes: "Std. Dev" is standard deviation. "Current marks" is the marks obtained in the "major" subject in the last semester, "Cumulative marks" is the marks obtained in the "major" subject, averaged over all semesters to date, and "Overall marks" is the average of the marks obtained in all subjects, which includes the major, minor, English and other compulsory subjects. Academic ability is the average of standard X and XII marks. Medium of Instruction English is a dummy for students with English as their first language at school, mostly students from Indian Certificate of Secondary Education (ICSE) and Central Board of Secondary Education (CBSE) backgrounds. The other category here includes students from Bengali medium schools, such as West Bengal Board of Secondary Education (WBBSE). Backward class includes all students belonging to the SC/ST/OBC categories, while others fall into the General category. Non-urban background includes students from both semi-urban and rural areas.

Table 1 contains the summary statistics for the complete set of students in the sample, and for each of the three residential halls separately. The summary statistics show that the group characteristics (both means and standard deviations) are balanced, i.e., the average levels of ability and observable characteristics do not differ significantly across the three halls at the 5% confidence level. The table also shows that about 58% of the students are from semi-urban or rural regions. A quarter of them are from backward social classes such as SC, ST or OBC, and only about 27% of these students had English as their medium of instruction at the high school level. Appendix Table A1 shows the summary statistics based on social class (general or backward), region of residence (non-urban or urban), medium of instruction (English or non-English) and economic status (poor/non-poor) based on past family income. Table A1 shows that students from urban and lower background class have lower test scores. Interestingly, we see students from non-English and poorer backgrounds have slightly higher test scores, partly reflecting the fact that students from higher socio-economic status (who are also more likely to graduate from a high school with medium of instruction as English) enter into elite private schools or go abroad. Fig. 3 presents the distribution of the pre-admission indicator of students' academic abilities[10] across each of the three residential halls, which suggest that the randomisation across halls has had the intended effect of balancing the averages.

3. Randomization checks

We conduct a number of formal tests to check that roommate assignments within the dorms were indeed random. First, we regress own academic ability on roommate's academic ability, including program, year, dorm/floor/hall fixed effects, and limiting illness dummies as control variables.[11] All pre- and post-treatment test scores have been standardized so that they have a mean of zero and standard deviation of one. The results reported in Table 2 (and other tables) are robust to the inclusion of full set of interactions of program (degree) and year fixed effects. We find no significant association between a roommate's academic ability and own academic ability. When we look at the relationship between own academic ability and those of self-reported closest friends, though, we do find significant positive correlations, which are robust to the inclusion of dorm, floor and residential hall fixed effects. The results presented in Table 2 support the hypothesis that the roommate assignment is indeed random and that abilities between roommates are uncorrelated.

We also use an alternative strategy following Guryan et al. (2009), who show that the typical test for the random assignment of individuals to groups (e.g., Sacerdote, 2001) is generally not well-behaved. Guryan et al. (2009) show that a mechanical negative correlation exists between the characteristics of individuals and their peers, even when the group assignment is random. This negative correlation occurs because sampling of individuals is done without replacement: a stu-

[10] The pre-admission academic ability used here is the average of standard X and XII grades.

[11] The Housing Office only has information about the program the student is enrolled in (as Masters students are separated from undergraduate students), the cohort the student belongs to, and whether the student has any limiting illness, in which case the student is assigned to a specific room.

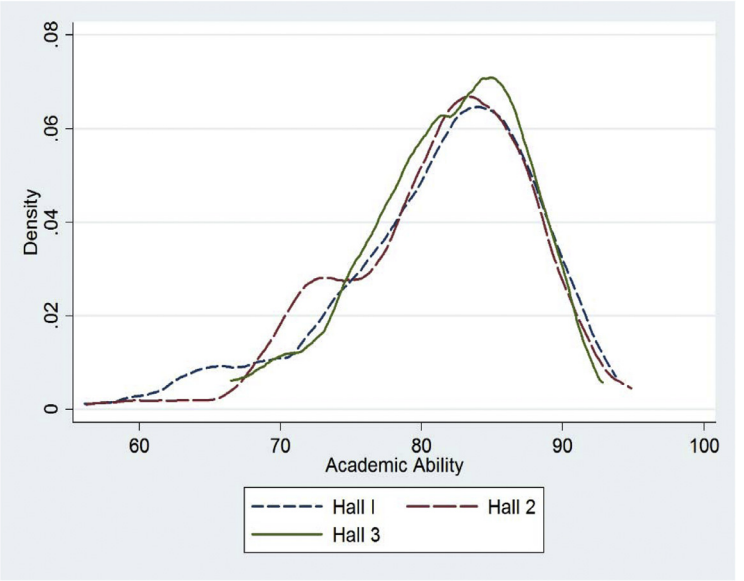

Fig. 3. Distribution of academic ability across the three residential halls.

Table 2
Test for random roommate assignment.

	Dependent variable: own academic ability							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Roommate's ability	0.106	0.099	0.105	0.102	0.042	0.034	0.041	0.041
	(0.065)	(0.069)	(0.068)	(0.066)	(0.067)	(0.067)	(0.069)	(0.067)
Friend's ability					0.192***	0.180***	0.186***	0.190***
					(0.050)	(0.052)	(0.051)	(0.051)
Constant	0.479***	0.427***	0.540***	0.527***	0.434***	0.342**	0.507***	0.493***
	(0.072)	(0.135)	(0.085)	(0.091)	(0.077)	(0.137)	(0.103)	(0.104)
Dorm fixed effects	No	Yes	No	No	No	Yes	No	No
Floor fixed effects	No	No	Yes	No	No	No	Yes	No
Hall Fixed effects	No	No	No	Yes	No	No	No	Yes
Observations	467	467	467	467	403	403	403	403
R^2	0.270	0.283	0.277	0.271	0.309	0.323	0.315	0.311

Notes: All ability variables have been standardized. Sample size in columns 5–8 are lower as individuals with no best friends from college were dropped out from the regressions when we control for friend's academic ability. The other control variables that were included in the regressions are program, year fixed effects and whether the student has a limiting illness. This is the information that the Housing Office has access to when assigning roommates. There are fifteen dorm fixed effects based on the different wings (N/S/E/W) and floors of the halls, nine floor fixed effects (three in each hall), and three hall fixed effects. Refer to Fig. 2. There are three halls; the first hall has two wings N and S with three floors, the second hall has two wings E and W with three floors and finally the third hall has only one wing with three floors. Each floor-wing in a hall is treated as a dorm. Clustered standard errors at the room-year level are given in parentheses.

*** $p < 0.01$.

** $p < 0.05$. * $p < 0.1$.

dent cannot be his/her own peer. Thus, the peers of high-ability individuals are chosen from a group with a slightly lower mean ability than those of low-ability individuals, implying that one should get a negative correlation between own and peer abilities. Guryan et al. (2009) propose controlling for the mean ability of all individuals in the sample of interest, excluding individual i in the peer effects estimation. The results are presented in Appendix Table A2, where we control for the mean ability of possible peers in the roommate specifications[12] in order to correct for a mechanical negative bias. The addition of this control also makes the test for randomization well behaved, and the results support the null hypothesis of a random assignment.

Finally, we follow Fafchamps and Mo (2018) and construct a distribution of the coefficients estimated from the randomization test, with own ability as the dependent variable and roommate ability as the independent variable. We scramble the order of students within each room artificially, to reassign them into counterfactual random sets of roommates. The

[12] We use all students in the same category (defined by ability quartiles) within the hall as an additional control in the test for randomization.

objective is to calculate the distribution of estimated coefficients from the counterfactual random matches under the null of random assignment and compare it to that of the actual estimated coefficient in order to get its *p*-value. We run over 200 randomly assigned counterfactual matches. The results of this test are presented in Appendix Fig. A1, where the vertical line is the estimated coefficient from the randomization test, presented in Table 2. We find that the simulated distribution of estimated coefficients is centred at 0.07, with 29% of the simulated coefficients being larger than the coefficient estimated from the sample, 0.106. From this, we conclude that we cannot reject the null hypothesis of random roommate assignment, with a *p*-value of 0.29.[13]

4. Regression analyses

We start with the following reduced form regression for estimating linear peer effects:

$$Y_i = \alpha + \beta_0 Z_i + \beta_1 Z_j + \gamma X_i + \in_i \quad (1)$$

where Y_i is the post-admission academic outcome of the student *i*, while the variables Z_i and Z_j capture the pre-admission academic abilities of the student *i* and his roommates *j*. These academic abilities are measured using their past (average of school-level grade ten and grade twelve GPAs) academic achievements. As an individual has multiple peers, we use average of peers' academic ability. All outcome and ability variables have been standardized with a mean of zero and standard deviation of one. X_i includes controls for other individual and household-level background characteristics for student *i*, such as age, caste, medium of instruction and region of residence. Our focus is on the sign and magnitude of the estimated coefficients β_0 and β_1.

The usual problem when estimating this relationship is that peers are not assigned randomly but the outcome of individual choice. Individuals at colleges can generally self-select into groups and rooms, which makes it difficult to separate out the selection effect from the actual peer effect. The random assignment of students to rooms in dormitories overcomes this problem. Each student is allotted a room during the first year of their program, but is moved to a new room at the beginning of each year; however, they normally remain with their initial set of roommates. Only if a student has serious issues with their existing roommates will they be re-assigned to a different room,[14] with a new set of roommates. In the results below, we use the initial room assignment at the beginning of the first year as a source of random variation. We also use the current set of roommates as a robustness check, and then we consider initial assignments as an instrument for current roommates. As shown below, the results are very much the same.

Table 3 shows the estimates of the effects of own and roommate's ability on academic achievements. Panel A, columns 1–3, reports the results using *initial* roommate assignment. The estimated roommate peer effect lies somewhere between 0.11 SD and 0.15 SD, about one-third the size of own effects, which lies between 0.33 SD and 0.45 SD. Roommate-specific ability is found to have a slightly larger effect on cumulative (0.14 SD) and overall (0.15 SD) marks than on current marks (0.11 SD), but these small differences are not significantly different from each other.

In Panel B of Table 3, we report the IV results by using initial assignment as an instrument for the current roommate assignment. The table shows that the estimated peer effects are very similar qualitatively. The F-statistic from the first-stage regressions of Table 3 confirms that the initial roommate assignment is a very good predictor of the current roommate assignment. This is not surprising, given that more than 95% of current roommates are those assigned initially.[15]

In Table 4, we report the results by separating out the peer effects by the year of study i.e. first year versus later years. This is important in terms of the probable channel through which peer effects work: if peer effects accumulate over time because of human capital investments, then one would expect the effects to strengthen as the same people stay around each other for longer and have longer to do homework together, influence each other's preferences, and teach each other the idiosyncratic skills they initially possessed. However, if peer effects capture a synchronisation of attitudes ('mimicking' or 'demonstration' effects), then we would expect the effects to be strongest when individuals are isolated from other influences, which is more likely to occur in the first year of being assigned to each other: as students are on campus longer, they have more chances of being influenced by students outside of their dormitory and lecturers, and the initial assignment becomes less important.

Our results based on first year and later year students show that peer effects are generally stronger in the first year than the later years. This could be due to the fact that students get to know each other in the first year and they spend more time for the first time with each other. Hence, a lot of things they do are more common in the early year of their dormitory. However, as time progresses students outside the dormitory arguably become more influential and the initial effects of the same roommates diminish. These results indicate that peer effects are relatively quickly acquired. This goes against the idea

[13] Finally, we also checked that roommates are randomly assigned based on the different background of the students. The results not reported over here do not show any significant relationship for students with peers from rural or urban area or from socially backward classes and their academic ability. Overall, all our results confirm that roommates were assigned randomly.

[14] Less than 5% of the students in the sample ever changed either their rooms or their initial set of roommates assigned by the Housing Office and the hostel authorities. This result is robust to the definition of roommate assignment used (initial or current set of roommates). Most of our students had at least one year of interactions in the dorm, and about 60% students had two to three years of interactions.

[15] We control for a number of fixed effects including past 'board' fixed effects to control for the fact that students sat for the exams conducted by different boards such as WBBSE & ICSE/CBSE in the past (during standard X and XII). The results are robust to including the board fixed effects. Note that only 10% of the sample is from ICSE/CBSE board.

Table 3
Peer effects in academic achievements.

Panel A: OLS regressions	All sample		
Initial assignment	Current	Cumulative	Overall
Own academic ability	0.335***	0.408***	0.445***
	(0.047)	(0.044)	(0.048)
Roommate's academic ability	0.113**	0.135***	0.146***
	(0.050)	(0.050)	(0.050)
Observations	463	463	463
R^2	0.182	0.231	0.283
Panel B: IV regressions	All Sample		
Current assignment	Current	Cumulative	Overall
Own academic ability	0.320***	0.393***	0.432***
	(0.049)	(0.046)	(0.048)
Roommate's academic ability	0.164***	0.193***	0.204***
	(0.059)	(0.058)	(0.058)
Observations	458	458	458
R^2	0.182	0.231	0.285
F-stat from the first stage regression	129.94	129.94	129.94

Notes: The table presents the results for the reduced form model presented in Eq. (1). All outcome and ability variables have been standardized. All Sample includes students from both first as well as other years. The sample size differs slightly between panel A and panel B as the initial room assignment was missing for some students while their current room allotment was available. In case of IV regression in panel B, we use samples for students for whom we have both current and initial assignment available. The other control variables that were included in the regressions are age of the student (in years), medium of instruction, region of residence, caste of the student (forward or backward class), degree and year fixed effects and whether the student has a limiting illness. The results are robust to the inclusion of dorm, floor, hall and program-year fixed effects and also to the inclusion of board fixed effects. Results can be made available upon request. The F-stat from the first stage regressions suggest that initial roommate assignment is a good instrument for current roommate assignment. Clustered standard errors at the room-year level are given in parentheses.

*** $p < 0.01$.

** $p < 0.05$. * $p < 0.1$.

Table 4
Dynamic peer effects- results by year of study.

Panel A: OLS regressions	Current		Cumulative		Overall	
Initial assignment	First year	Later years	First year	Later years	First year	Later years
Own academic ability	0.431***	0.264***	0.443***	0.385***	0.523***	0.389***
	(0.073)	(0.062)	(0.075)	(0.055)	(0.084)	(0.058)
Roommate's academic ability	0.267***	0.042	0.277***	0.070	0.257***	0.094*
	(0.074)	(0.057)	(0.076)	(0.058)	(0.081)	(0.054)
Observations	203	260	203	260	203	260
R^2	0.313	0.123	0.312	0.196	0.325	0.279
p-value (AI)	0.08		0.53		0.18	
p-value (RAI)	0.02		0.03		0.08	
Panel B: IV regressions	Current		Cumulative		Overall	
Current assignment	First year	Later years	First year	Later years	First year	Later years
Own academic ability	0.429***	0.245***	0.442***	0.364***	0.522***	0.367***
	(0.070)	(0.067)	(0.072)	(0.060)	(0.081)	(0.061)
Roommate's academic ability	0.263***	0.085	0.274***	0.135	0.254***	0.170**
	(0.069)	(0.091)	(0.072)	(0.087)	(0.076)	(0.083)
Observations	203	255	203	255	203	255
R^2	0.316	0.116	0.314	0.188	0.332	0.275
p-value (AI)	0.08		0.45		0.15	
p-value (RAI)	0.20		0.29		0.52	

Notes: See footnote of Table 3. AI refers to own academic ability and RAI to roommate's academic ability. The p-values report the results from the t-test associated with the difference in the estimated coefficients between first year and later years.

that it is about slowly learning what others know, which occurs only gradually, and more about quickly acquired influences that dissipate as alternative influences become available.

We ran a number of robustness analyses to see whether the particular choices of variables mattered and to shed some initial light on potential mechanisms. The coefficients presented in Tables 3 and 4 are thus robust to the inclusion of dormitory fixed effects, floor fixed effects and hall fixed effects (which represent joint shocks). Finally, even though the way in which we constructed our peer measures (that is, via the leave-one-out mean of the peers) means that our results should not suffer from the bias identified by Angrist (2014), we still followed Angrist's (2014) suggestion of running placebo tests with artificial peer groups (conditioning on the actual one). Those tests failed to find a bias in our Table 3 results (results available upon request).

Our effect size is larger than those reported in Sacerdote (2001) and Stinebrickner & Stinebrickner (2006), but similar to those reported by Jain and Kapoor (2015). The effect size is significantly smaller than Imberman et al. (2012) and Feld and Zölitz (2017), and marginally smaller than Booij et al. (2017). We are not quite sure why our effect sizes are in the middle of these papers, but we think it is a combination of the intensity of social contacts and the particular setting: peer effects are probably stronger in developing countries. This is because poor students with parents and family members who are not that educated, have more to gain more from social interactions with peers, an effect that is likely to be smaller in a more developed country, where most students will have academically-trained family members (e.g. in the study by Sacerdote, 2001). On the other hand, the students in our sample have quite regimented lives, wherein many aspects are the same for everyone and not dependent on their roommates, limiting the peer effects. Arguably, the interactions within squadrons at the US Airforce Academy are stronger because those students have to cooperate more intensely. Similarly, the students in the study by Booij et al. (2017) had an intensive yearlong co-study interaction.[16]

4.1. Roommate-specific peer effects by background characteristics

Table 5 looks at the interaction between own and roommate's academic abilities with socio-economic and regional backgrounds. The first panel (Panel A) of Table 5 investigates whether members of backward classes such as SC/ST/OBC benefit more from the assignment of high ability peers as their roommates, by using an "own backward class dummy" which takes the value of 1 if the student belongs to a backward class and 0 otherwise. Overall, the results in Panel A suggest that the interaction between peer ability and whether one is from a backward class has an insignificant and small effect, meaning that peer effects do not depend on class membership. Members of both categories (forward and backward) gain significantly from high ability peers, but students from backward social classes have significantly lower own ability effects, about half as strong as those in individuals from the general category, suggesting that this group have a problem converting ability into outcomes. An alternative interpretation could be that prior school results (which are used to measure own academic ability) are less informative for this group.

Panels B and C provide robust evidence that those from disadvantaged backgrounds, i.e., those who are from non-urban regions or have not attended an English-medium school, have significantly lower own ability effects than those from privileged backgrounds. Again, this can be interpreted as either being a problem in converting ability to outcomes for this group, or as suggesting that previous grades are simply less good at measuring ability in these groups, something that we also found for the main results. In terms of peer effects, both groups (students from non-urban regions or non-English-medium school) gain significantly more from high-ability peers. The results suggest that students from disadvantaged backgrounds could potentially benefit from having high-ability peers as their roommates. Similarly, from Panel D in Table 5 we find that own ability effects are lower for students belonging to poor economic background. We also observe smaller, insignificant but positive peer effects for students with lower economic background.[17]

4.2. Non-linear peer effects and ability mixing

An important extension to the reduced form baseline regression presented in Eq. (1) is to allow for non-linearities: as Hoxby and Weingarth (2005) pointed out, peer effects with non-linearities may be much more interesting, since non-linearities imply that some assignment schemes have higher average outcomes than others. We extend this idea to estimate a general peer effects equation that has the following basic shape:

$$Y_i = \alpha + \beta \sum_j f\left(Z_i, Z_j\right) + \gamma X_i + \in_i \tag{2}$$

where $f(Z_i, Z_j)$ is a peer-interaction function that depends on the initial abilities of both individual i (Z_i) and their peer j (Z_j).

[16] Note that these results are not directly comparable with our estimates, given the random assignment was done in a different setting where students are from a developing country with different socio-economic background, such as from lower and upper caste mixing together in dormitories.

[17] Note that these heterogeneity analyses based on different background characteristics are not mutually exclusive. The characteristics themselves are correlated. For example, students from a backward class or non-English background are more likely to be from poorer family. High ability students are more likely to come from an Urban, English, non-poor and non-backward class family.

Table 5
Peer effects in academic achievement by background characteristics.

Panel A: peer effects by social class	Current	Cumulative	Overall
Own academic ability	0.407***	0.476***	0.526***
	(0.057)	(0.054)	(0.056)
Own academic ability × own backward class dummy	−0.266***	−0.234**	−0.293***
	(0.089)	(0.090)	(0.086)
Roommate's academic ability	0.096*	0.117**	0.112**
	(0.056)	(0.056)	(0.056)
Roommate's academic ability × own backward class dummy	0.027	0.026	0.099
	(0.091)	(0.093)	(0.086)
R^2	0.194	0.240	0.297
Panel B: peer effects by region of residence	Current	Cumulative	Overall
Own academic ability	0.613***	0.633***	0.623***
	(0.083)	(0.079)	(0.091)
Own academic ability × own non-urban background dummy	−0.429***	−0.353***	−0.277***
	(0.093)	(0.092)	(0.103)
Roommate's academic ability	0.014	0.040	0.043
	(0.069)	(0.069)	(0.074)
Roommate's academic ability × own non-urban background dummy	0.159**	0.157**	0.175**
	(0.078)	(0.076)	(0.079)
R^2	0.214	0.249	0.296
Panel C: peer effects by medium of instruction	Current	Cumulative	Overall
Own academic ability	0.719***	0.732***	0.669***
	(0.109)	(0.098)	(0.095)
Own academic ability × own non-English background dummy	−0.504***	−0.427***	−0.294***
	(0.119)	(0.110)	(0.107)
Roommate's academic ability	−0.015	0.005	0.028
	(0.087)	(0.085)	(0.080)
Roommate's academic ability × own non-English background dummy	0.177*	0.184*	0.171*
	(0.099)	(0.095)	(0.093)
R^2	0.219	0.258	0.297
Panel D: peer effects by economic background	Current	Cumulative	Overall
Own academic ability	0.567***	0.614***	0.640***
	(0.095)	(0.084)	(0.068)
Own academic ability × own poor economic background dummy	−0.367***	−0.322***	−0.318***
	(0.101)	(0.093)	(0.080)
Roommate's academic ability	0.041	0.079	0.110*
	(0.060)	(0.058)	(0.059)
Roommate's academic ability × own poor economic background dummy	0.145*	0.112	0.068
	(0.080)	(0.079)	(0.085)
R^2	0.224	0.269	0.298

Notes: All outcome and ability variables have been standardized. The other control variables that were included in the regressions are age of the student (in years), medium of instruction, region of residence, caste of the student (forward or backward class), degree and year fixed effects and whether the student has a limiting illness. Clustered standard errors at the room-year level are given in parentheses.

*** $p < 0.01$.
** $p < 0.05$.
* $p < 0.1$.

We attempt to avoid pre-judging the shape of the peer interactions by dividing the distributions of own ability and peer (roommate) ability into three separate groups: those lying in the bottom 25%, middle 50% and top 25% of the ability distribution. This allows for nine different combinations of academic abilities of individuals and their peers, where we interact the ability group of individual i with the proportion of peers belonging to each of the three different ability groups. In principle, we could divide the distribution into more segments and thus get arbitrarily close to any continuous function $f(.,.)$, but data limitations restrict us to nine points of support.

Table 6 presents the results of this non-linear specification with nine possible combinations of own and peer ability, which displays strong non-linearities in peer effects. Firstly, all students gain from being matched to more-able peers, so there is no evidence for anything like a 'discouragement effect': the outcomes are estimated to be strictly increasing the higher the proportion of more-able peers at the expense of the proportion of lower-able peers. Secondly, the gain from going from low-ability to high-ability peers is highest for those of high ability (1.581 = 1.458—0.123), then for those of low-ability (1.083), then for those of medium ability (0.643). In each case these gains are significant at the 5% level. Thirdly, the gain of being matched to the middle-group rather than the lowest group is highest for those of high ability (0.595), then for those of medium ability (0.586), then for those of lowest ability (0.253).

Table 6
Non-linearity in peer effects.

Regression adjusted Coefficients of the interaction terms Own academic ability	Proportion of roommates from		
	Bottom 25%	Middle 50%	Top 25%
Bottom 25%	−1.275***	−1.022***	−0.192
	(0.260)	(0.247)	(0.430)
Middle 50%	−0.586**	–	0.057
	(0.287)		(0.295)
Top 25%	−0.123	0.472	1.458***
	(0.508)	(0.314)	(0.278)

Notes: We only report the estimated coefficients from the interaction terms. All outcome variables have been standardized. The other control variables that were included in the regression are age of the student (in years), medium of instruction, region of residence, caste of the student (forward or backward class), degree and year fixed effects and whether the student has a limiting illness. Clustered standard errors at the room-year level are given in parentheses.

*** $p < 0.01$.

** $p < 0.05$. * $p < 0.1$. The results are robust to the use of both current and overall marks.

Together, if we take the point-estimates as the causal relationship and we interpret the error-term as unrelated to any matching scheme, this implies that the matching scheme that maximizes the average scores would be pure assortative matching (high ability matched to high ability, medium to medium, and low to low). The loss of matching the highest ability students to each other would be highest for the low-ability group that loses out more to now being matched to those of higher ability than the medium-ability group. Yet, the caveats involved in this are strong because we do then need to assume that the error-term (which covers 70% of the variation) does not contain complex interactions or other peer effects that would affect academic outcome in a different direction. Given that the cell-sizes are small and that the data does not permit full interactions between all the major characteristics of a student with those of the peers, we can hence only offer this result as tentative.

4.3. Understanding the possible channels

4.3.1. Interactions with roommates

In this section, we look at the plausible mechanisms through which peers affect a student's post-admission academic outcomes by using the information collected through the detailed time-use module of the survey, which focuses on the total time spent by each student in (i) self-study, (ii) group-study (in general) and (iii) tuition classes.[18] We then see how own and peer study behaviours affect current academic outcomes.

The coefficients associated with own effort (measured in hours) are presented in the top panel of Table 7, while the bottom panel reports the effect of roommate's effort on own academic achievement. We find that the total time (in hours) spent studying alone in a week is associated with higher scores in the honours\major subject (both current and cumulative). We also see that the amount of effort put into group-study is associated with higher overall scores, including both major and minor subjects. Specifically, the conditional association is that one extra hour of self-study increases both current and cumulative marks by only 0.005SD. Yet, the coefficient associated with cumulative marks is only significant at 10% level.

The results in Table 7 also show that additional effort in group-study has a statistically insignificant but positive correlation with overall marks (0.013SD). Surprisingly, we find evidence that students who attend tuition classes have significantly lower academic grades. The results are however not statistically significant, and is probably due to reverse causality where students who are struggling academically attending tuition more than others. Overall, we do not observe any strong relationship between own grades and roommates' self-reported study habits.

What about the effects of what the roommate does? The results presented in the bottom panel of Table 7 show that an extra hour of group study by roommates lead to only an 0.022 SD increase in overall marks. The corresponding coefficient is significant only at 10% level. Tuition by roommates is positively related to own academic achievements (though insignificant), even though tuition might be an indication of learning difficulties. As we regress post-treatment study habits on post-treatment academic outcomes, the results presented in Table 7 should be interpreted as mere associations and do not necessarily capture any causal relationships. Compared to the effects of own ability, these effects are furthermore tiny.

We examine in Panel A of Table 8 how effort of the student (self-study and group study) responds to roommate's (baseline) ability. We see significant positive association between roommate's academic ability and group-study, both overall and

[18] Tuition classes are taken outside schools hours, either before or after school from private tutors who are generally top-performing senior year students from the same discipline. Such private tutoring is a fee-based teaching provided in a group or individual setting that is arranged and paid by student to aid formal classroom teaching materials. Private tutoring is a very common practice in India and many other developing countries.

Table 7
Potential mechanisms for peer effects in academic achievement.

	Current	Cumulative	Overall
Own academic ability	0.351***	0.426***	0.464***
	(0.052)	(0.050)	(0.054)
Own effort (measured in hours)			
Self-study (Total)	0.005	0.005*	−0.001
	(0.003)	(0.003)	(0.003)
Group-study (Total)	0.002	−0.000	0.013
	(0.009)	(0.009)	(0.009)
Tuition (Total)	−0.026	−0.008	−0.027
	(0.044)	(0.042)	(0.033)
Roommate's effort (measured in hours)			
Self-study (Total)	−0.004	−0.003	−0.004
	(0.004)	(0.004)	(0.004)
Group-study (Total)	0.009	0.011	0.022*
	(0.014)	(0.014)	(0.013)
Tuition (Total)	0.075	0.076	0.064
	(0.051)	(0.051)	(0.048)
Observations	463	463	463
R^2	0.184	0.229	0.285

Notes: All outcome and ability variables have been standardized. The other control variables that were included in the regressions are age of the student (in years), medium of instruction, region of residence, caste of the student (forward or backward class), degree and year fixed effects and whether the student has a limiting illness. Clustered standard errors at the room-year level are given in parentheses.
*** $p < 0.01$. ** $p < 0.05$.
* $p < 0.1$.

Table 8
Demonstration effects: coordination in study patterns.

Panel A: effect of ability	Group-study (in hours)			Self-study (in hours)		
	Overall	Weekday	Weekend	Overall	Weekday	Weekend
Roommate's academic ability	0.589**	0.527**	0.063	1.172	0.826	0.345
	(0.268)	(0.229)	(0.063)	(0.794)	(0.542)	(0.300)
Observations	467	467	467	467	467	467
R^2	0.035	0.040	0.040	0.137	0.136	0.113

Panel B: effect of study pattern	Group-study (in hours)			Self-study (in hours)		
	Overall	Weekday	Weekend	Overall	Weekday	Weekend
Roommate's group study hours	0.345***	0.346***	0.099			
(during the reference period)	(0.095)	(0.088)	(0.102)			
Roommate's self study hours				0.215**	0.207**	0.194**
(during the reference period)				(0.094)	(0.094)	(0.087)
Observations	467	467	467	467	467	467
R^2	0.087	0.091	0.042	0.153	0.149	0.127

Note: All ability variables have been standardized and study hours is measured in hours spent doing the activity during the specified period. The other control variables that were included in the regressions are age of the student (in years), medium of instruction, region of residence, caste of the student (forward or backward class), degree and year fixed effects and whether the student has a limiting illness. Clustered standard errors are given in parentheses.
*** $p < 0.01$.
** $p < 0.05$. *$p < 0.1$.

during weekdays. The correlation coefficient is larger but statistically insignificant for own study time. In Panel B of Table 8, on the other hand, we see that roommate's group study time is significantly associated with a student's group study. Roommate's own study time (outside group study) is also significantly and positively correlated with self-study time of a student. The variance explained by the study habits of the roommate is also significantly higher than what is otherwise explained by the ability of the roommate. These results suggest strong demonstration-type effects: a student does more group study if the roommates do this, and works harder alone when the other roommates do this.

We consider other potential channels such as the importance of health and mental health of peers. We regress own life satisfaction, health, mental health, and risk attitudes on roommates' pre-treatment characteristics to test if there are peer effects on these outcomes that might explain part of the peer effects on academic outcomes. Table A3 in the Appendix report these results. We did not find any significant association between a student's own or roommate's academic abilities

and one's life satisfaction, self-assessed health, mental health and risk attitudes. So peer effects are unlikely to be driven by (mental) health interactions or risk attitudes of peers.

Finally, Table A4 in the Appendix follows the suggestion of Tincani (2014) and includes the variation in ability of the peers in the basic peer regression. When we compare estimates between Table 3 and Table A4 we observe that conditioning on the variance of peer ability has no marked effect on the primary effects of own and peer ability, though the (adjusted) R-squared does increase by about 1.3 percentage points. The peer ability variation turns out to have a positive effect, which runs counter to the idea that competition effects are dominant: if competition effects were important, a smaller variation would imply that there is a greater bunching in abilities, and hence a greater 'rank return' to effort. The positive effect of variation is more in line with the idea that diverse groups have more to learn from each other.

4.3.2. The influence of friendship

We examine the students' friendship information to understand how random assignment influences the friendship which could subsequently impact the post-admission test scores. However, we cannot estimate the effects of friends' ability, as friends are not randomly assigned. In our survey, we asked each and every respondent to name five of their best friends (both from within and outside the institution). We then identify via college roster which of these best friends are from the current institution and are also roommates. We can also identify the students who have friends that are roommates, as well as friends who are not roommates. Appendix Fig. A2 displays the number of friends nominated from the college. We use the variation within this group to see if it matters whether a friend is a roommate or not. These results are suggestive and can't be interpreted as causal because of unobserved heterogeneity as to why certain roommates became friends while others are not.

Note that once students are assigned in a room they are more likely to become friends as well. Indeed, we find that about 56% of the respondents nominated their roommates as their best friends, indicating that long term friendships are partially being decided via these randomized peer allocations. Appendix Fig. A3 shows the estimated non-parametric relationship between roommate's and friend's academic ability, which reveals a strong and positive correlation. The results presented in Appendix Table A5 add friend's academic ability separately (columns 1–3), and then use initial (randomly assigned) roommate ability as an instrument for friend ability. The results show that the effects of friends are as large as that of own ability. Yet, we don't want to over-interpret those results as it is unlikely that the only effects that roommates have is via friendships.[19]

5. Conclusion

The objective of this paper was to determine whether randomly-assigned roommates have an influence on learning outcomes, measured in terms of academic grades. We combine administrative data on students' academic ability and outcomes with our own detailed survey data on students to estimate the effect of pre-admission own and roommate specific peer abilities on subsequent academic achievements, as well as possible underlying channels through which peer effects operate. We also separate out the peer effects based on previous background characteristics such as social class (general or forward caste categories), region of residence (urban or non-urban), medium of instruction at high school (English or native) and economic status of the household (poor or non-poor) and understand the interactions among peers using data on detailed study habits, which we believe is novel in this literature.

We find robust evidence that peers do matter for academic achievements, with roommate-specific peer effects being about one-third of the effects of own ability. These effects were also found to be non-linear, and to vary across socio-economic and geographical backgrounds. We find evidence that students from dis-advantaged socio-economic and geographical backgrounds have significantly lower own ability effects compared to their relatively more advantaged counterparts, which might indicate that their initial ability is measured with greater error or that they have a problem converting ability into outcomes. We also found that students from non-urban and non-English backgrounds, benefitted significantly more from having high-ability peers, which suggests that the optimal strategy for achieving higher average grades is to mix high-ability students from disadvantaged backgrounds with high-ability students from the city and from English-speaking backgrounds, an asymmetric effect. This found asymmetry is subtly different from that found by Fafchamps and Mo (2018), who use data on peer interactions in homogenous villages where the flow of help went from the most computer-able to the least computer-able.

When we looked at interactions between own ability and the proportion of the peers in three ability groups (top 25%, middle 50%, bottom 50%) we found in all cases that students benefited from more-able peers, implying there is always a loss to some group from applying more assortative matching. Nevertheless, we also found that the highest gains from being matched to the highest group were for the high-able students themselves, and that even the gain from being matched to the middle group was higher for the middle group than for the low-able group. At face value, this favours assortative matching as a means to maximise mean outcomes, though the fact that 70% of the variance is unexplained and the analysis

[19] Although beyond the scope of our analysis because of the data limitation, one interesting aspect of the analysis could be understanding how friend-based peer influences outcomes more than other peers following the analysis similar to Mehta, Stinebrickner & Stinebrickner (2019). They find that freshman students whose friends studied more in high school is predictive of receiving higher grades. Consistent with this, they find that the amount that friends studied in high school is a very strong predictor of own study time.

is constrained by the limited number of observations, means this is only tentative. In terms of mechanisms, we find no significant importance for peer effects via mental health or life-satisfaction or risk attitudes. We see quite significant effects of the study activities of the peers on own activities (ie hours spent studying), but when we look at how much these study habits affect overall marks, the association with peer effort is not very large and only borderline significant (10% level). So the results do not offer evidence of a strong relationship between own grades and roommates' self-reported study habits.

Altogether, we thus find that in the quite constrained environment where all the students share the same eating facilities and are under the watchful eyes of the campus administration, the remaining peer effects are about one-third of the effects of own ability on academic outcomes. We find the importance of these effects to reduce from the first year to the subsequent years, even though students usually remain with the same roommates, suggesting they get influenced more by others in later years.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jebo.2019.04.025.

Appendix

Tables A1–A5

Table A1
Summary statistics by background characteristics.

Variables of interest	Social class		Region of residence		Medium of instruction		Economic status	
	General	Backward	Urban	Non-urban	English	Non-English	Non-poor	Poor
Academic achievements								
Current marks	66.33	63.84	64.53	66.69	63.80	66.51	64.70	67.06
Cumulative marks	66.54	64.27	64.68	67.04	64.05	66.78	64.89	67.42
Overall marks	66.97	65.96	66.39	67.01	66.04	67.01	66.80	66.97
Own academic ability	82.16	78.34	82.40	80.49	83.23	80.57	83.09	79.59
Roommate's academic ability	81.44	80.95	81.66	81.09	81.20	81.38	82.00	80.79
Friend's academic ability	82.50	81.03	82.59	81.83	83.19	81.77	83.38	81.00
Individual characteristics								
Age (in years)	20.00	20.15	20.03	20.03	19.96	20.06	19.73	20.28
Medium of instruction English dummy	0.31	0.14	0.47	0.13	–	–	0.46	0.10
UG program dummy	0.82	0.72	0.86	0.75	0.91	0.76	0.93	0.70
General category dummy	–	–	0.87	0.70	0.89	0.73	0.85	0.70
Urban dummy	0.47	0.24	–	–	0.73	0.31	0.61	0.24
Semi-urban dummy	0.17	0.13	–	–	0.15	0.16	0.20	0.12
Rural dummy	0.36	0.63	–	–	0.12	0.53	0.20	0.64
Limiting Illness dummy	0.04	0.04	0.04	0.04	0.02	0.05	0.03	0.05
Observations	374	109	206	277	132	351	235	232

Notes: "Std. Dev" is standard deviation. "Current marks" is the marks obtained in the "major" subject in the last semester, "Cumulative marks" is the marks obtained in the "major" subject, averaged over all semesters to date, and "Overall marks" is the average of the marks obtained in all subjects, which includes the major, minor, English and other compulsory subjects. Medium of Instruction English is a dummy for students with English as their first language at school, mostly students from ICSE and CBSE backgrounds. The other category here includes students from Bengali medium background. Backward class includes all students belonging to the Scheduled Caste/Scheduled Tribe/Other Backward Classes, while others fall into the General category. Non-urban background includes students from both semi-urban and rural areas.

Table A2
Robustness check: test for random roommate assignment using Guryan et al. (2009).

	Dependent variable: own academic ability							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Roommate's academic ability	0.001	−0.003	−0.001	0.001	0.005	0.002	0.002	0.005
	(0.024)	(0.026)	(0.024)	(0.024)	(0.023)	(0.025)	(0.024)	(0.022)
Friend's academic ability					0.011	0.006	0.011	0.011
					(0.024)	(0.025)	(0.025)	(0.024)
Constant	0.068**	0.030	0.025	0.081	0.061**	−0.009	0.025	0.076
	(0.032)	(0.052)	(0.063)	(0.050)	(0.030)	(0.052)	(0.055)	(0.048)
Dorm fixed effects	No	Yes	No	No	No	Yes	No	No
Floor fixed effects	No	No	Yes	No	No	No	Yes	No
Hall fixed effects	No	No	No	Yes	No	No	No	Yes
Observations	467	467	467	467	403	403	403	403
R^2	0.834	0.839	0.837	0.834	0.848	0.852	0.851	0.848

Notes: There are fifteen dorm fixed effects based on the wings (North/South/East/West) of different floors of the halls, nine floor fixed effects (three in each hall), and three hall fixed effects. All ability variables have been standardized. Sample size in columns 5–8 are lower as individuals with no best friends from college were dropped out from the regressions when we control for friend's academic ability. The other control variables that were included in the regressions are program, year fixed effects and whether the student has a limiting illness. All of the specifications in the table include the average ability of all of the other students in their hall-by-category (not including the student), following Guryan et al. (2009). Clustered standard errors at the room-year level are given in parentheses.
***$p < 0.01$.
** $p < 0.05$. * $p < 0.1$.

Table A3
Other potential mechanisms for peer effects in academic achievements.

Panel A: with roommate controls	Life satisfaction	Self-assessed health	Mental health	Risk index
Own academic ability	0.073	0.031	−0.073	−0.040
	(0.061)	(0.043)	(0.057)	(0.056)
Roommate's academic ability	−0.004	−0.052	0.002	0.002
	(0.051)	(0.056)	(0.052)	(0.062)
Observations	463	463	463	463
R-squared	0.018	0.068	0.077	0.022
Panel B: without roommate controls				
Own academic ability	0.073	0.027	−0.081	−0.040
	(0.061)	(0.045)	(0.056)	(0.057)
Roommate's academic ability	−0.005	−0.040	−0.016	0.005
	(0.050)	(0.053)	(0.058)	(0.061)
Observations	463	463	463	463
R-squared	0.018	0.027	0.059	0.018
Panel C: without any controls				
Own academic ability	0.069	0.014	−0.041	−0.035
	(0.053)	(0.044)	(0.047)	(0.051)
Roommate's academic ability	0.011	−0.036	−0.061	−0.011
	(0.043)	(0.050)	(0.049)	(0.053)
Observations	463	463	463	463
R-squared	0.005	0.001	0.007	0.002

Notes: All outcome and ability variables have been standardized. The other control variables that were included in the regressions in Panel A and B are age of the student (in years), medium of instruction, region of residence, caste of the student (forward or backward class), degree and year fixed effects and whether the student has a limiting illness. Panel A also controls for the same roommate variables. Life satisfaction is the student's response to the question: "All things considered, how satisfied are you with your life? Pick a number between 0 and 10 to indicate how satisfied you are." The Self-Assessed Health variable records their response to the question: 'In general, would you say your health is: 1 "excellent", 2 "very good", 3 "good", 4 "fair", or 5 "poor"?'. Note that these responses have been rescaled so that 5 refers to "excellent" and 1 to "poor". Mental Health is an individual's response to the GHQ-12 questions, where lower number means better mental health outcomes. The risk index is the student's response to the following question: 'Generally, some people like taking risks, while others try to avoid any risk. If we rank risk-taking from low to high as 0 to 10, where 0 is "never take risks" and 10 is "most likely to take risks", which level do you belong to?' Clustered standard errors at the room-year level are given in parentheses.
***$p < 0.01$.
**$p < 0.05$.
*$p < 0.1$.

Table A4
Robustness of the functional form in peer effects.

Variables of interest	Current	Cumulative	Overall
Own academic ability	0.349***	0.418***	0.459***
	(0.047)	(0.045)	(0.048)
Roommate's academic ability	0.169***	0.178***	0.202***
	(0.049)	(0.051)	(0.051)
Roommate's academic ability (Variance)	0.004***	0.003**	0.004**
	(0.001)	(0.001)	(0.001)
Observations	463	463	463
R^2	0.195	0.239	0.296

Notes: All outcome and ability variables have been standardized. The other control variables that were included in the regressions are age of the student (in years), medium of instruction, region of residence, caste of the student (forward or backward class), degree and year fixed effects and whether the student has a limiting illness. Clustered standard errors at the room-year level are given in parentheses.
*** $p < 0.01$.
** $p < 0.05$. * $p < 0.1$.

Table A5
Friendship effects in academic achievement.

	OLS regressions			IV regressions		
Variables of interest	Current	Cumulative	Overall	Current	Cumulative	Overall
Own academic ability	0.360***	0.419***	0.463***	0.285***	0.330***	0.376***
	(0.059)	(0.054)	(0.057)	(0.067)	(0.064)	(0.061)
Roommate's academic ability	0.099*	0.118**	0.115**			
	(0.059)	(0.057)	(0.057)			
Friend's academic ability	0.042	0.068	0.099*	0.327**	0.408***	0.432***
	(0.061)	(0.056)	(0.055)	(0.133)	(0.126)	(0.136)
Observations	400	400	400	400	400	400
R^2	0.187	0.239	0.303	0.141	0.172	0.237
F-stat from the first stage regression				36.45	36.45	36.45

Note: All outcome and ability variables have been standardized. Sample sizes are lower as individuals with no best friends from college were dropped out from the regressions when we control for friend's academic ability. The other control variables that were included in the regressions are age of the student (in years), medium of instruction, region of residence, caste of the student (forward or backward class), degree and year fixed effects and whether has limiting illness. Clustered standard errors at the room-year level are given in parentheses.
*** $p < 0.01$.
** $p < 0.05$.
* $p < 0.1$. The F-stat from the first stage regressions suggest that roommate ability is a good instrument for friend's ability.

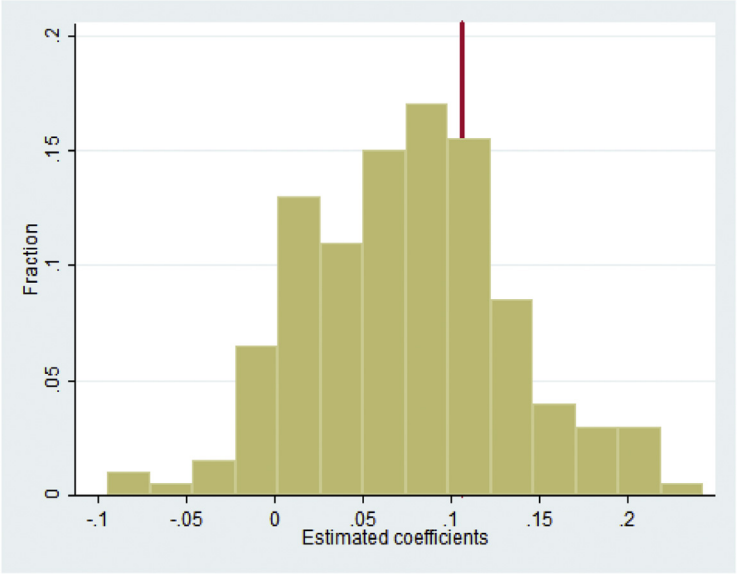

Fig. A1. Distribution of estimated coefficients from the randomization test.
Notes: This is the distribution of the coefficients estimated from the randomization test with own ability as the dependent variable and roommate ability as the independent variable, run over 200 randomly assigned counterfactual matches. The vertical line is the estimated coefficient from the randomization test, presented in Table 2. The simulated distributions of estimated coefficients under the null hypothesis of a random assignment are centred at 0.07, with 29% of the simulated coefficients being larger than that estimated from the sample, 0.106. We conclude from this that the p-value is 0.29: we cannot reject the null hypothesis of random assignment.

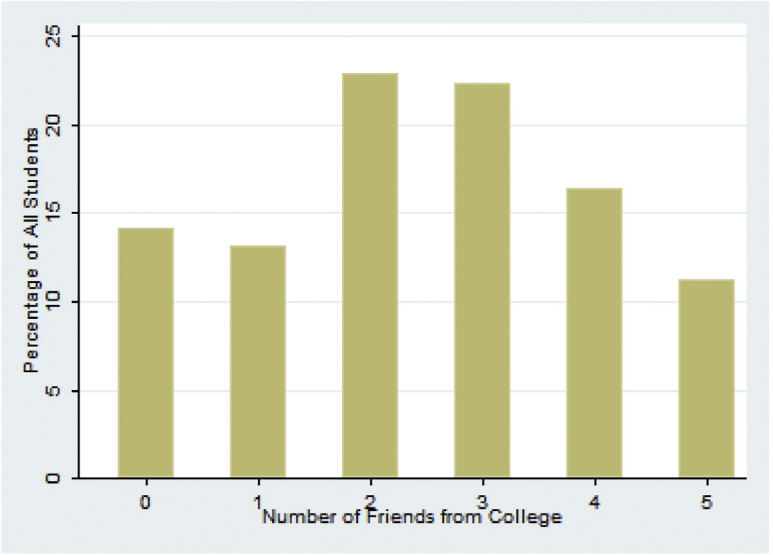

Fig. A2. Distribution of friendship nominations from college.

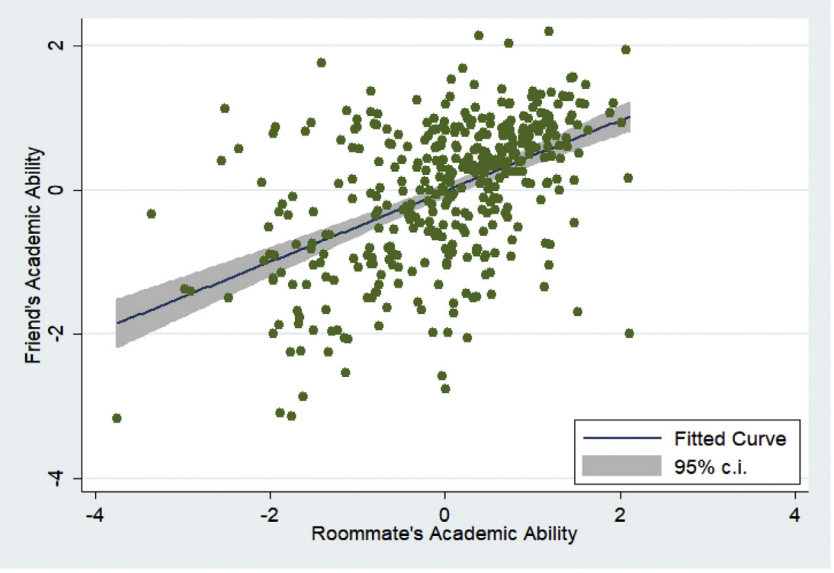

Fig. A3. Estimated non-parametric relation between peer academic ability.

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