

# Testing peer effects among college students: evidence from an unusual admission policy change in China

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**Abstract** This paper studies a natural experiment due to an unusual change in the college admission policy at a Chinese university, which brought a large number of low-score students into several academic departments in the university. Exploiting large variations in peer characteristics and strong interactions among peer groups, the analysis finds that specially admitted low-score students have substantially reduced the performance of regular students on English tests. This detrimental effect from specially admitted students is concentrated among regular students whose English ability was below average.

**Keywords** Peer effects · Admission policy · College students

## Introduction

It has long been believed that peers play an important role in determining an individual's behaviors and educational outcomes. Concern with peer effects can be traced back to 2,000 years ago in a Chinese story, "Three Moves of Meng's Mother."<sup>1</sup> Peer influence has been noted in a wide range of policy issues, including neighborhood relocation programs, desegregation, academic tracking, and affirmative action (Angrist and Lang 2004; Card and Krueger 2005; Duflo et al. 2011; Kling et al. 2007). Understanding the effects of peers on students is important for school management, admission policy, and school choice.

Despite strong academic interest in peer effects, several issues have contributed to a lack of clear evidence on peer effects among college students. Manski (1993) discusses reflection problems and points out that selection bias is one of the several major econometric challenges in identifying peer effects. Selection bias arises because individuals choose their peer group, which makes it difficult to separate true peer effects from the selection effect. To circumvent selection bias, several studies exploit random dormitory assignments in colleges in the US. Sacerdote (2001) presents evidence for peer effects, although regressing students' own college GPA on roommates' college GPA introduces endogeneity problems. Zimmerman (2003) estimates contextual effects and finds roommates' SAT scores have significant but not large impacts on one's own college GPA. Foster (2006) presents an IV estimation on academic peer effects, with results that are insignificant, but similar in size to those in Zimmerman (2003). Random dormitory assignment solves the selection bias problem, but it is questionable whether roommates are well-defined peers. Stinebrickner and Stinebrickner (2006) discuss that college students establish networks of friends extending beyond the roommate level and that interactions among roommates are limited. In other words, roommates may not be close peers, which may explain the modest or non-existent effects reported in these studies. Carrell et al. (2009) compared peers defined at the dorm level and at the classroom level and showed that classmates matter a good deal, while roommates do not. Another important issue in the empirical analysis for peer effects at the classroom

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<sup>1</sup> This is documented by Liu, Xiang (BC77–BC6). The story tells that Meng's mother is concerned about their social environment and moves several times to find a good location so that Meng can study well. Eventually, Meng becomes a philosopher famous in Chinese history.

level is whether there is enough variation in peer characteristics for precise estimation. For example, Lyle (2007) identifies peers as students who study and socialize together in a class of 35 students, but the randomization of students into classrooms according to academic backgrounds generates limited variations in peer baseline test scores.

This study provides new evidence on the classroom-level peer effects among college students by exploiting an unusual change in admission policy at a prestigious Chinese university. This design addresses selection bias and leverages strong peer interaction and wide variation in peer characteristics. The change in admission policy brought a large number of specially admitted low-score students into many academic departments which normally only admitted students with much higher scores on college entrance exams. The inflow of specially admitted students imposed an exogenous shock for the regular students by changing the composition of students' characteristics in the relevant academic departments. The number of specially admitted students varied across departments; some departments did not admit any low-score students, whereas the share of low-score students reached as high as 40 % in other departments. The school arrangement further facilitated the exploration of peer effects because all the specially admitted students lived and studied together with regular students, and students in the same department-cohort interacted intensively with each other.

This paper adopts a difference-in-difference estimation strategy similar to that in Imberman et al. (2012) and explores the relationships among the characteristics of specially admitted students and the test outcomes of the other students. We interpret the estimated effects as causal effects of low-score students on their peers given the following three findings: first, regular students in the same department are comparable across cohorts, and the inflow of low-score students does not seem to alter the backgrounds of regular students in the affected departments; second, the result suggests that other omitted variables do not seem to contribute to the estimated effects; third, the analysis controls for class size, the most important resource that could be affected by the inflow of low-score students.

Our data suggest that specially admitted low-score students have significantly reduced the performance of the regular students on College English Tests (CETs), a nationally administered English exam required for all college students in order to receive a bachelor's degree. These detrimental effects from specially admitted students are concentrated among regular students whose English ability was below average. Our results contribute to the literature on peer effects. In particular, they provide new evidence in the context of a developing country. In addition, we test peer influence due to an admission policy

change, which makes the results directly applicable to the design of admission policy.

This paper is organized as follows. Section “**Background**” provides background information on the admission policy change and the school arrangement in the sample university. Section “**Data**” describes the data and presents the summary statistics. Section “**Estimation**” conducts the estimation and presents results. Section “**Conclusion**” concludes the paper.

## Background

In the 1990s, Chinese students submitted college applications to the provincial Department of Education. College programs are ranked into different rounds in the admission process. Programs in earlier rounds are allowed to admit students earlier. Students admitted by programs in earlier rounds leave the applicant pool and are not available for programs in later rounds. Round-1 universities are the universities whose bachelor programs are allowed to admit students in the first round. In normal years, 1994 and 1995 in this study, Round-1 universities admitted students for their bachelor programs only during the first round. The number of students admitted for each academic department was predetermined.

In 1996, the province of Jiangsu created Round-3 bachelor programs, which allowed several Round-1 universities to admit students for their bachelor programs after Round-2 universities completed their bachelor program admission.<sup>2</sup> The creation of Round-3 bachelor programs was claimed to serve at least two purposes: to help universities increase funding and to train human resources for local governments. Given that there are about 150 Round-1 universities and 750 Round-2 universities, and the university under study is a top-ranked Round-1 university, it is not surprising to see that students admitted through the Round-3 programs (i.e., specially admitted students) differ markedly in educational backgrounds from the regular Round-1 students.

The number of Round-3 students varied across departments. There were three stakeholders involved in the Round-3 programs—local city government, Round-3 students and the university. Three factors are worth noting. First, the Round-3 program was a collaboration between several city governments and the university, and city governments had a demand for qualified employees; this explains the large Round-3 quota in academic fields such as public administration, social welfare, and city planning. Second, students had to pay abnormally high tuition, so

<sup>2</sup> Round-3 programs remain in the following years, but the method of admission changed a great deal after 1996.

they would not choose unpopular academic fields, such as geology, astronomy, aerology, and history, whose students were less likely to get a good job. Last, the university was also concerned about whether the low-score students could succeed in the rigorous coursework of many science fields, such as medicine, biochemistry, physics, and chemistry, so these departments admitted no or very few Round-3 students.

Round-3 students were not the only group of low-score students on campus. During normal years, such as 1994 and 1995, many academic departments in the sample university offered associate degree programs. Before 1996, the associate programs admitted students from the pool of potential applicants that failed to be admitted by Round-1 and Round-2 bachelor programs, just as the Round-3 bachelor programs did in 1996. The key difference between the Round-3 bachelor programs and the associate program is that the Round-3 students took classes and lived together with Round-1 students, while students in associate programs did not. During interviews, many Round-1 students of the 1996 cohort reported that while submitting the college application, they viewed the Round-3 bachelor programs as being similar to the associate programs and did not expect to be assigned into the same classroom as Round-3 students.

The admission of students into a university and then into a specific academic department follows a “120 % rule.” The “120 % rule” dictates that a university has to use the National College Entrance Exam (NCEE) total score as the major admission criterion. If a university wants to admit 100 students from a certain province, it can only admit students whose NCEE total scores ranked among the top 120 students of all applicants from that province, regardless of students’ preference for academic departments. Therefore, the variations of students’ NCEE scores across academic departments are largely restricted. As most students with NCEE scores in the top 120 % specify the popular departments as their top academic preference, popular departments usually admit students who have higher test scores and also list those departments as their top preference. As a result, departments of public administration, social welfare, or urban planning have to accept students who show little academic interest in them. One example is that, among 23 students of the 1995 cohort in public administration, fewer than 5 students had specified public administration as their department of interest.

The department-cohort is the primary unit of affiliation for students. Students are assigned to an academic department in the admission letter before they enter the university. It is difficult for students to change their assigned academic department, so nearly all students remain with their cohort over their 4 years of undergraduate study. Round-3 students had much lower scores in the college entrance exam and paid much higher tuition; except for that difference, all bachelor students in the same

department-cohort lived and studied together. All the students lived in university dormitories. Separated by gender, bachelor students in the same department-cohort were assigned to live together in the same room or neighboring rooms for 4 years.<sup>3</sup> Students in the same department-cohort took most classes together in the first 2 years. Many extracurricular activities were organized within the department-cohort, including class meetings, sports, trips, parties, and so on.

## Data

The data for this study are collected from the archived student academic records, which provide information on NCEE scores, CET outcomes, and some demographics, such as age, gender, and home address. We identify whether a student is a Round-3 student by using the Admission Approval Table, which documents the program to which a student is admitted. The data cover all the students in 23 academic departments entering the university in 1994, 1995, and 1996.<sup>4,5</sup>

Most students, except a group of recommended students who account for 5.7 % of all students, took the National College Entrance Exam to be admitted to college. Two sets of exams are administrated every year: the “art” set and the “science” set, each containing five subject exams. The English test is common to both sets. The total score is the sum of scores in the five subject exams. Because the National College Entrance Exam is administered by each province separately every year and the raw scores are not comparable across years even within provinces, we

<sup>3</sup> Male and female students in the same department-cohort do not live close to each other.

<sup>4</sup> The Archive Office was reluctant to provide data for all departments and wanted to release as little data as possible. But it allowed us to choose departments. We acquired data from both departments which admitted many Round-3 students and those which admitted no Round-3 students. We exclude the school of foreign languages, as its students did not normally take the CETs. We also exclude departments in law, physics and chemistry. They admitted no more than 5 Round-3 students, but their regular cohort was more than 80. In the meanwhile, the School of Law had another category of special students in 1995 and the Department of Physics started an elite class in 1996. A group of specially admitted elite science students was also excluded. The rest of the 23 departments (or schools) were all included for the analysis.

<sup>5</sup> For this analysis, we exclude students who do not study English as their first foreign language, who are admitted via the university but then sent to a joint program abroad, and who come from Hong Kong, Macau, or foreign countries. For the results presented, we exclude several students who had NCEE scores too low to be regular Round-1 students but who nevertheless cannot be identified as Round-3 students; however, excluding them does not affect the results.

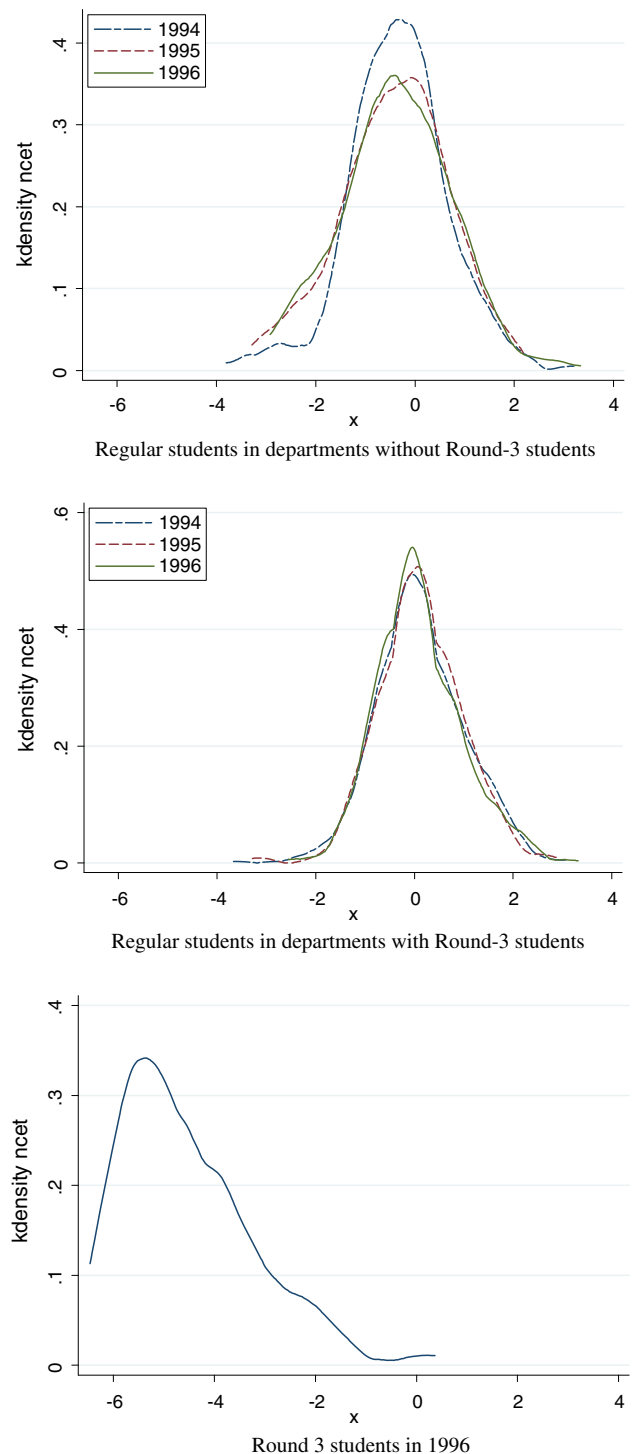
standardize all the scores using the averages and standard deviations calculated from the corresponding Round-1 students by year, province, and exam set or exam subject.<sup>6</sup> Round-3 students are mainly those who fail to be admitted by Round-1 and Round-2 programs. As the NCEE total score is the major criterion in college admission, it is expected that the NCEE scores of Round-3 students differ from those of regular students, as illustrated in Figs. 1 and 2. Because all Round-3 students are from Jiangsu, we compare the NCEE scores among students from Jiangsu. The top graph of Fig. 1 demonstrates the kernel density distributions of the NCEE total scores for the Round-1 students in departments which never admitted Round-3 students.<sup>7</sup> The average total scores are similar across years for departments without Round-3 students, but the scores are much more concentrated in 1994 than in 1995 and 1996. The middle graph of Fig. 1 displays the scores of regular Round-1 students in other departments which admitted Round-3 students, and the three density curves follow each other closely. The bottom graph is for the specially admitted Round-3 students in 1996, whose NCEE total scores fall mainly between -6 and -2. Figure 2 illustrates the distributions of the NCEE English scores. Overall, these figures suggest two things: Round-3 students are very different from Round-1 students, and Round-3 students caused little variation in the background of Round-1 students across years and departments, especially when compared to other variations.

Round-3 students are measured in two ways, as shown in Panel A of Table 1. “Round-3 Number” measures the total number of Round-3 students in a department-cohort. It ranges from 2 to 38 in the affected departments in 1996, and zero otherwise. “Round-3 Share” is the percentage of Round-3 students in a department-cohort, obtained by dividing the number of Round-3 students by the size of a department-cohort. Given that the size of a department-cohort ranged from 15 to 131 in 1996, the department-cohort with the largest number of Round-3 students does not coincide with the department-cohort with the largest share of Round-3 student.

We measure students’ performance in College English Test Level 4 (CET-4) and Level 6 (CET-6) exams, which offer several advantages over other possible outcomes. First, the CETs are important for students. Most students study English for more than four classroom hours/week for

<sup>6</sup> After standardization, the scores are still not comparable across provinces. It is also arguable whether the scores are comparable across years within provinces, especially for those provinces with a small number of admission quotas for the sample university, because the allocation of quotas to academic departments tends to vary greatly across years in those provinces.

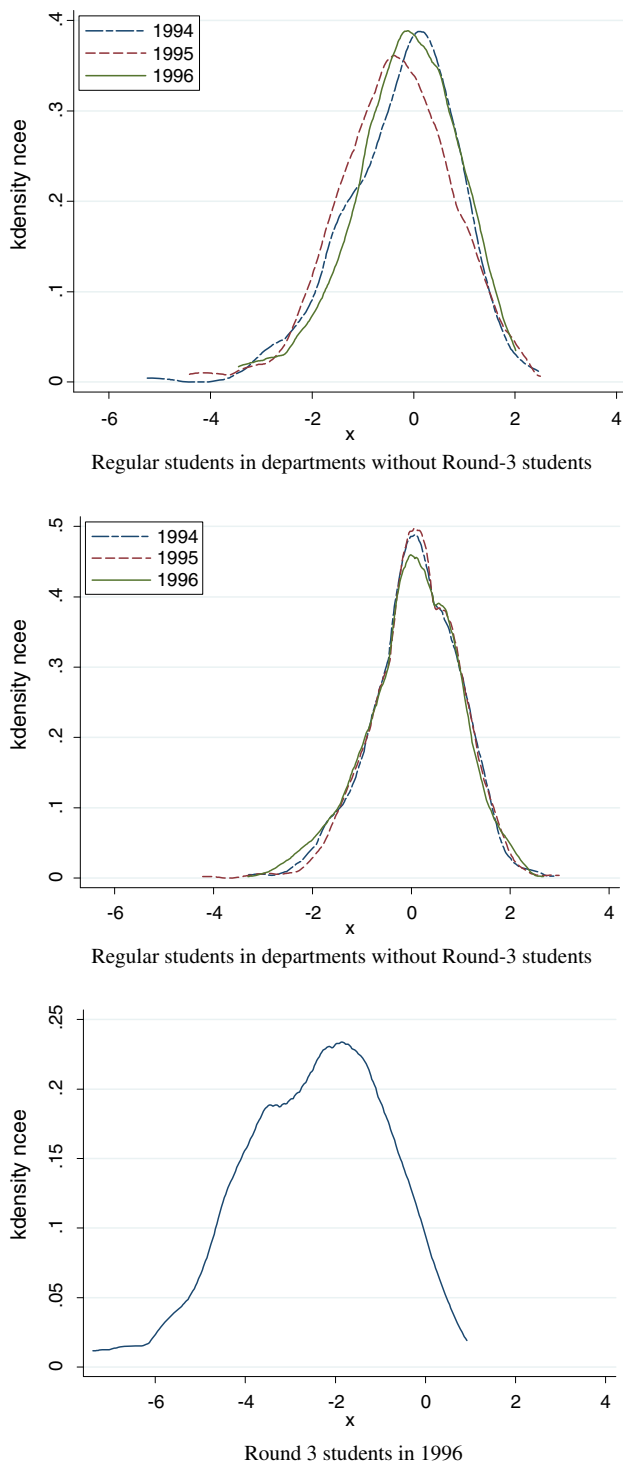
<sup>7</sup> Students who gain admission via recommendation are not included since they do not have official NCEE scores.



**Fig. 1** NCEE total scores among students from Jiangsu

four semesters. Passing the CET-4 is required for all college students to obtain a bachelor degree certificate.<sup>8</sup>

<sup>8</sup> Normally, when they graduate, students can obtain two certificates—a graduation certificate and a bachelor degree certificate. Students can still graduate with a graduation certificate if they cannot pass the CET-4. Students can be exempt from the CET-4 if they study



**Fig. 2** NCEE English scores among students from Jiangsu

Footnote 8 continued  
 another foreign language as their first foreign language or if their major is a foreign language. In these cohorts, more than 99 % of the students chose English as their first foreign language. Those who chose other foreign languages had to pass similar tests.

**Table 1** Summary statistics

	Department-cohorts	Mean <sup>a</sup>	SD <sup>a</sup>	Minimum	Maximum
<i>Panel A: Class characteristics</i>					
Round-3 Number in 1996	23	12.74	11.42	0	38
Round-3 Share in 1996	23	0.151	0.119	0	0.403
Class size in all years	69	26.91	5.501	13	37
	Students <sup>b</sup>	Mean	SD	Minimum	Maximum
<i>Panel B: CET performance (academic achievements)</i>					
Round-1 students					
CET-4 Pass	3020	0.962	0.191	0	1
CET-6 Pass	2966	0.624	0.485	0	1
CET-4 Excellence	2689	0.189	0.391	0	1
CET-6 Excellence	2966	0.047	0.211	0	1
Round-3 students					
CET-4 Pass	229	0.760	0.428	0	1
CET-6 Pass	229	0.166	0.373	0	1
CET-4 Excellence	213	0.005	0.069	0	1
CET-6 Excellence	229	0	0	0	0
	Students	Mean	SD	Minimum	Maximum
<i>Panel C: Baseline characteristics</i>					
Round-1 students					
Age entering college	3,020	18.45	0.795	15.5	22.75
Being male	3,020	0.678	0.467	0	1
From rural areas	3,020	0.279	0.449	0	1
From Jiangsu	3,020	0.503	0.500	0	1
Being recommended student	3,020	0.057	0.232	0	1

<sup>a</sup> The changing number of students is due to the data availability. The CET-6 outcomes are missing for students in the department of biology-medicine in 1996. The department of computer science does not provide data on the CET-4 Excellence if a student passes CET-6; therefore, we code CET-4 Excellence to be missing for all the students in computer science

<sup>b</sup> They are weighted by the number of regular students in the department-cohorts

Passing the CET-6 serves to further signal a student's English ability. The CET certificates are important documents in the job application package. Second, CET test outcomes are comparable across academic departments. The CETs are organized at the national level and graded at the provincial level. In addition, 90 % of the score is determined objectively; only 10 % of the score is determined by an essay. In general, the grading is reliable.

Third, English classes tend to be organized on the department-cohort basis, so students in a department-cohort without Round-3 students would not take an English class with any Round-3 students, which makes the number and the share of Round-3 at the department-cohort relevant

for capturing the possible interaction inside an English class. If the size of the department-cohort is large, students will be separated into several sections. Students are sorted based on the “alphabetical” order of their last names, and then every  $n$ th student is assigned to the same section, where  $n$  is the number of English sections that a department-cohort is divided into.<sup>9</sup> Round-1 students and Round-3 students are randomly mixed in the English sections.<sup>10</sup> In this case, the share of Round-3 students in a department-cohort is still a good indicator for the share of Round-3 students in an English section.

Finally, all the English sections use the same syllabus and English teachers are assigned to sections at the university level. English teachers are affiliated with the Division of College English rather than any specific academic department, so the inflow of Round-3 students may increase the teaching loads of all teachers but would not make some teachers particularly overloaded. As the university cares about the CET pass rates, the Division of College English had an incentive to avoid sorting low-quality teachers into sections with many Round-3 students.

Table 1 presents the summary statistics for the CET outcomes in Panel B. The raw scores for the CETs are on the scale of 0–100, and a student earns a “Pass” with a score above 60 and an “Excellent” if the score is above 85. If students fail, they are allowed to repeat the exam, but they can not repeat a Pass to attempt an Excellent. The data are the eventual CET outcomes when students left the university, and the record only documents whether students earn “Pass” or “Excellent” rather than their raw scores. The CET-4 is compulsory in the sense that all the students are required to pass it to be awarded a bachelor degree certificate, so it is not surprising to see that the average CET-4 passing rate is higher than 96 % for regular students. Even for Round-3 students, 76 % of them passed the CET-4. The CET-6 is voluntary, and passing CET-4 is the prerequisite for taking the CET-6. Given the importance of the CET-6 certificate and the low monetary cost for taking the test, most students took the CET-6 when they were eligible to and repeated it if they failed earlier. The passing rate for the CET-6 is approximately 62 % for regular students and 17 % for Round-3 students. The “Excellent” rates are 19 and 5 % for CET-4 and CET-6, respectively, for regular students and are nearly zero for Round-3 students.

<sup>9</sup> The term “alphabetically” is defined in the Chinese way.

<sup>10</sup> Although many universities divided students into different English classes based on their initial English ability, the sample university was strict about allowing students to start English class at the advanced level. As a result, most students in the affected departments took English classes with their classmates, with 5 % students as exceptions each cohort.

The inflow of Round-3 students enlarged the size of the affected department-cohorts. But the class size of the English class was not increased as much as the department-cohorts because large department-cohorts are divided into several sections for English classes. There is no explicit cap for the English class size. We contacted many students in the relevant department-cohorts and obtained the numbers of English classes into which the department-cohorts were divided.<sup>11</sup> We estimated class size by dividing the number of students in a department-cohort with the number of classes. Class size averaged 27 and ranged from 13 to 37.

Panel C of Table 1 shows several background characteristics of regular Round-1 students. Upon entering college, students were on average 18.45 years old, with ages ranging from 15.5 to 22.75. Male students accounted for 67.8 % of the student body. Among all the students, 27.9 % were from rural areas. Roughly half of the students came from Jiangsu, the home province of the university.

## Estimation

The inflow of low-score Round-3 students in 1996 into some academic departments makes the difference-in-difference (DiD) method a potential estimation strategy for identifying peer effects of Round-3 students on regular students, as illustrated by the table below. Slightly different from the basic DiD setup, the treatment variable is not binary but continuous, because the number of Round-3 students or the share of Round-3 students varies across the treated departments.

Cohort	Untreated departments	Treated departments
1994	Control	Control
1995	Control	Control
1996	Control	Treatment (number/ share of R3 students)

### Estimating peer effects of Round-3 students

Equation (1) is used to estimate the peer effects of Round-3 students on the academic performance of regular students.

<sup>11</sup> Although more than ten years had passed, the contacted students could report the number of students in their department-cohorts, which roughly agree with the numbers in the dataset, so we believe the numbers of classes they report are correct.

**Table 2** Effects of Round-3 students on CET-4 Pass of regular students

Key predictors	Dependent variable: CET-4 Pass				
	(1)	(2)	(3)	(4)	(5)
<i>Regressions using Round-3 Number</i>					
Round-3 Number	-0.0435** (0.0205)	-0.0446** (0.0223)	-0.0435* (0.0243)	-0.0410 (0.0265)	-0.0438* (0.0254)
Marginal effect	-0.0014**	-0.0014**	-0.0014*	-0.0013	-0.0014*
<i>Regressions using Round-3 Share</i>					
Round-3 Share	-4.0090*** (1.5319)	-4.1790** (1.6511)	-4.2993** (1.9075)	-4.1179** (2.0429)	-4.6274** (2.0589)
Marginal effect	-0.1279***	-0.1334**	-0.1372**	-0.1314**	-0.1477**
Observations	2,540	2,540	2,540	2,528	2,528
<i>Control variables</i>					
Department fixed effects	Yes	Yes	Yes	Yes	Yes
Cohort fixed effects	Yes	Yes	Yes	Yes	Yes
Class size	-	Yes	Yes	Yes	Yes
Individual characteristics	-	-	Yes	Yes	Yes
Province fixed effects	-	-	-	Yes	Yes
NCEE English scores	-	-	-	-	Yes

The effects of Round-3 indicators are estimated separately. Each estimate is from a different logistic regression. In total, 10 regressions are conducted for this table. The coefficients are in log odds ratios. The dependent variable is whether a regular Round-1 student passed the CET-4, which is equal to 1 if pass and 0 otherwise. The unit of observation is a regular student entering the sample university in the years 1994, 1995 and 1996. Individual characteristics include age, age squared, gender and living in rural or urban areas. NCEE English scores are interacted with home province dummies to allow differential effects of NCEE English scores from provinces on CET performances. SEs clustered by department in parenthesis. Marginal effects are calculated at  $p = 0.967$ , the average CET-4 passing rate of students in 1994 and 1995. The change in the number of observations from column 3–4 is due to the drop of observations whose CET-4 passing statuses are perfectly predicted by province dummies

\* Significant at 10 %; \*\* significant at 5 %; \*\*\* significant at 1 %

$$Y_{idt} = \gamma^d + \lambda^t + \beta \text{Round-3}_{dt} + \eta \text{ClassSize}_{dt} + \delta X_{idt} + e_{idt} \tag{1}$$

The left-hand variable  $Y_{idt}$  is the 0/1 coded academic outcome of interest (CET 4 Pass, CET 6 Pass, CET4 Excellence, or CET 6 Excellence) of a regular student  $i$  at department  $d$  in cohort  $t$ ;  $\text{Round-3}_{dt}$  is one of the Round-3 indicators—the number of Round-3 students or the share of Round-3 students;  $\text{ClassSize}_{dt}$  is the size of the College English class;  $X_{idt}$  are the pretreatment characteristics of individual students, including age, gender, prefecture type, home province, and NCEE scores. Because the NCEE scores are not comparable across provinces, we interacted NCEE English scores with the 26 province dummies to allow for a differential effect of province-specific NCEE score on CET outcomes. For the group of recommended students, who do not have official NCEE scores, their NCEE scores are coded as 0, and we include a dummy variable indicating whether the student is a recommended student. The coefficients  $\gamma^d$  and  $\lambda^t$  capture department and cohort fixed effects. The addition of department and cohort fixed effects makes this a difference-in-differences

specification, in which changes in outcomes before and after 1996 in departments that admitted more Round-3 students are compared with changes in departments that received fewer or no Round-3 students.

Because all the CET outcomes are binary, and both the CET-4 passing rate and the CET-6 Excellence rate are at extremes, we choose the logistical model for the main analysis to gain more precise estimation, and the results are reported in Tables 2, 3, 4 and 5. For comparison, the results from the linear probability model are reported in Table 6, showing that the marginal effects from the two models are close.<sup>12</sup> Standard errors (SEs) are clustered by departments

<sup>12</sup> We are aware of the potential incidental parameter problem in the panel data setting, but we do not think it is likely in our setting. Our fixed effect is at the department level, and the smallest department contains 45 students. We check the marginal effects estimated from the logistic model with those from the linear probability model. For the CET-6 passing rate, both the magnitudes and the significance levels are similar; for the CET-4 passing rate, the magnitudes are similar, but the logistic model provides more precise estimates, which confirms our expectation that the linear probability model tends to give less precise estimates when the probability rate is at an extreme end.

**Table 3** Effects of Round-3 students on CET-6 Pass of regular students

Key predictors	Dependent variable: CET-6 Pass				
	(1)	(2)	(3)	(4)	(5)
<i>Regressions using Round-3 Number</i>					
Round-3 Number	-0.0223*** (0.0074)	-0.0250*** (0.0093)	-0.0255*** (0.0097)	-0.0242** (0.0103)	-0.0238** (0.0105)
Marginal effect	-0.0051***	-0.0058***	-0.0059***	-0.0056**	-0.0055**
<i>Regressions using Round-3 Share</i>					
Round-3 Share	-0.9867 (0.7030)	-1.1392 (0.7608)	-1.1316 (0.9471)	-1.0148 (0.9583)	-0.9326 (0.8387)
Marginal effect	-0.2273	-0.2625	-0.2607	-0.2338	-0.2149
Observations	2,966	2,966	2,966	2,966	2,966
<i>Control variables</i>					
Department fixed effects	Yes	Yes	Yes	Yes	Yes
Cohort fixed effects	Yes	Yes	Yes	Yes	Yes
Class size	-	Yes	Yes	Yes	Yes
Individual characteristics	-	-	Yes	Yes	Yes
Province fixed effects	-	-	-	Yes	Yes
NCEE English scores	-	-	-	-	Yes

The effects of Round-3 indicators are estimated separately. Each estimate is from a different logistic regression. In total, 10 regressions are conducted for this table. The coefficients are in log odds ratios. The dependent variable is whether a regular Round-1 student passed the CET-6, which is equal to 1 if pass and 0 otherwise. The unit of observation is a student entering the sample university in the years 1994, 1995 and 1996. Individual characteristics include age, age squared, gender and living in rural or urban areas. NCEE English scores are interacted with home province dummies to allow differential effects of NCEE English scores from provinces on CET performances. SEs clustered by department in parenthesis. Marginal effects are calculated at  $p = 0.640$ , the average CET-6 passing rate of students in 1994 and 1995

\* Significant at 10 %; \*\* significant at 5 %; \*\*\* significant at 1 %

to account for the possible correlation in the residual  $e_{idt}$  in the same department over time.

To emphasize, the left-hand variable  $Y_{idt}$  in Eq. (1) includes the CET outcomes of regular students only. It cannot include those of Round-3 students; otherwise, the low passing or excellence rates of Round-3 students would make the coefficients of  $Round3_{dt}$  negative even if regular students were not affected. The number and the share of Round-3 students are two potential variables for  $Round3_{dt}$ , but the high correlation between these two variables does not allow them to be included together in one regression, so we estimate them in separate regressions.

Table 2 reports the empirical estimates of the effect of Round-3 students on the CET-4 passing rate of the regular Round-1 students. The dependent variable equals 1 if a student has passed the CET-4 and 0 otherwise. As the effects of two Round-3 indicators are estimated separately, each coefficient is from a different regression. In other words, 10 regressions are conducted for Table 2. The coefficients are in log odds ratios; we calculate the marginal effects at 0.967, the average CET-4 passing rate of regular students in 1994 and 1995. The marginal effects multiplied by 100 can be interpreted as the changes in percentage points. In column 1, we report estimates

controlling for the department and year fixed effects only. A one-student increase in the number of Round-3 students in a department-cohort reduces the rate of passing CET-4 by 0.14 % points. Similarly, increasing the share of Round-3 students by 10 % reduces the passing rate by 1.3 % points.

In column 2, we add class size as a control. In the existing literature, class size is documented as one of the most important factors that could affect students' English scores. The effects of Round-3 indicators remain stable in magnitude after controlling for class size, suggesting that the estimated impact of Round-3 students is probably not due to the possible changes in this educational resource. From column 3–5, we gradually add individual characteristics, home province dummies, and province-specific NCEE English scores as additional control variables. All the coefficients remain relatively stable as more control variables are added; in the specification with all the control variables, the coefficients are statistically significant at 0.1 and 0.05, respectively, for the number and the share of Round-3 students. By multiplying the per-unit reduction with the average levels of Round-3 indicators in the year 1996, we see that Round-3 students reduce the CET-4 passing rate of the regular students by 1.5–2 % points,



**Table 4** Effects of Round-3 students on CET-4 Excellent of regular students

Key predictors	Dependent variable: CET-4 Excellent				
	(1)	(2)	(3)	(4)	(5)
<i>Regressions using Round-3 Number</i>					
Round-3 Number	-0.0093 (0.0080)	-0.0139 (0.0097)	-0.0128 (0.0100)	-0.0129 (0.0109)	-0.0158 (0.0119)
Marginal effect	-0.0015	-0.0022	-0.0020	-0.0021	-0.0025
<i>Regressions using Round-3 Share</i>					
Round-3 Share	-0.7974 (0.7661)	-1.2957 (0.8333)	-1.1671 (0.9247)	-1.1984 (0.9758)	-1.5089 (0.9978)
Marginal effect	-0.1273	-0.2069	-0.1864	-0.1914	-0.2410
Observations	2,689	2,689	2,689	2,665	2,665
<i>Control variables</i>					
Department fixed effects	Yes	Yes	Yes	Yes	Yes
Cohort fixed effects	Yes	Yes	Yes	Yes	Yes
Class size	-	Yes	Yes	Yes	Yes
Individual characteristics	-	-	Yes	Yes	Yes
Province fixed effects	-	-	-	Yes	Yes
NCEE English scores	-	-	-	-	Yes

The effects of Round-3 indicators are estimated separately. Each estimate is from a different logistic regression. In total, 10 regressions are conducted for this table. The coefficients are in log odds ratios. The dependent variable is whether a regular Round-1 student obtained an Excellent in the CET-4, which is equal to 1 if pass and 0 otherwise. The unit of observation is a student entering the sample university in the years 1994, 1995 and 1996. Individual characteristics include age, age squared, gender and living in rural or urban areas. NCEE English scores are interacted with home province dummies to allow differential effects of NCEE English scores from provinces on CET performances. SEs clustered by department in parenthesis. Marginal effects are calculated at  $p = 0.200$ , the average CET-4 Excellence rate of students in 1994 and 1995. The change in the number of observations from column 3–4 is due to the drop of observations whose CET-4 Excellence statuses are perfectly predicted by province dummies

\* Significant at 10 %; \*\* significant at 5 %; \*\*\* significant at 1 %

which represents more than a one-third reduction in the overall CET-4 failure rate (<4 % points).

Table 3 presents the estimates of the effect of Round-3 students on the CET-6 passing rate of regular students. Unlike CET-4, passing which is required for a bachelor certificate, CET-6 is taken voluntarily. A passing grade on CET-6 is important in that it signals good English ability and offers a big advantage in the job market. The variable “CET-6 Pass” equals 1 if a student takes the exam and passes it and 0 otherwise. The marginal effect is calculated at 0.640, the average CET-6 passing rate of students in 1994 and 1995. A one-student increase in the number of Round-3 students in a department-cohort significantly reduces the CET-6 passing rate by about 0.5 % points. On average, Round-3 students reduce the CET-6 passing rate in 1996 by around 7 % points. Table 4 also suggests that the measurement of peer groups is important. Although all the estimates for Round-3 Number are statistically significant, the share of Round-3 students is not significantly correlated with CET-6 passing rates.

Tables 4 and 5 present the estimation results for the excellence rates on CET-4 and CET-6, respectively. All the estimates are negative but none of them is statistically

significant. The overall effects of Round-3 students, calculated by multiplying the marginal effect by the average of Round-3 indicators in 1996, are only around one-half of the standard deviations of the excellence rates, so we interpret these results as little evidence for the effects of Round-3 students on the excellence rates.

All the CET outcomes are binary, and students with abilities around the cutoffs tend to be affected, so the effects of Round-3 students have a local-effect interpretation, even though the “local” cannot be precisely determined. Given that the CET-4 and CET-6 passing rates are 96.2 and 62.4 %, and both rates are significantly affected by Round-3 students, we can generally interpret the results as showing that Round-3 students have strong negative impacts on the English test performance of regular students whose English ability is distributed around the bottom 5–40 %, or roughly speaking below average. However, for students with better academic backgrounds in English, we lack the statistical power for evidence of detrimental effects. These results are largely consistent with the findings in Lavy et al. (2012) that negative peer effects matter significantly. In addition, Sekhri (2012) is similar to our analysis in that Sekhri also explores the classroom peer

**Table 5** Effects of Round-3 students on CET-6 Excellent of regular students

Key predictors	Dependent variable: CET-6 Excellent				
	(1)	(2)	(3)	(4)	(5)
<i>Regressions using Round-3 Number</i>					
Round-3 Number	−0.0166 (0.0179)	−0.0163 (0.0180)	−0.0161 (0.0201)	−0.0154 (0.0203)	−0.0211 (0.0231)
Marginal effect	−0.0009	−0.0009	−0.0009	−0.0009	−0.0012
<i>Regressions using Round-3 Share</i>					
Round-3 Share	−1.0528 (1.0389)	−0.9954 (1.3505)	−1.0158 (1.4898)	−0.9478 (1.5269)	−1.8736 (1.9538)
Marginal effect	−0.0594	−0.0561	−0.0573	−0.0535	−0.1057
Observations	2,679	2,679	2,679	2,420	2,420
<i>Control variables</i>					
Department fixed effects	Yes	Yes	Yes	Yes	Yes
Cohort fixed effects	Yes	Yes	Yes	Yes	Yes
Class size	–	Yes	Yes	Yes	Yes
Individual characteristics	–	–	Yes	Yes	Yes
Province fixed effects	–	–	–	Yes	Yes
NCEE English scores	–	–	–	–	Yes

The effects of Round-3 indicators are estimated separately. Each estimate is from a different logistic regression. In total, 10 regressions are conducted for this table. The coefficients are in log odds ratios. The dependent variable is whether a regular Round-1 student obtained an Excellent in the CET-6, which is equal to 1 if pass and 0 otherwise. The unit of observation is a student entering the sample university in the years 1994, 1995 and 1996. Individual characteristics include age, age squared, gender and living in rural or urban areas. NCEE English scores are interacted with home province dummies to allow differential effects of NCEE English scores from provinces on CET performances. SEs clustered by department in parenthesis. Marginal effects are calculated at  $p = 0.060$ , the average CET-6 Excellence rate of students in 1994 and 1995. The change in the number of observations from column 3–4 is due to the drop of observations whose CET-6 Excellence statuses are perfectly predicted by province dummies

\* Significant at 10 %; \*\* significant at 5 %; \*\*\* significant at 1 %

effects among college students in the setting of a developing country—India—by exploiting the variations of peer quality across department-cohorts. Although Sekhri's focus is on peer effects across different caste groups, she also shows that peers of one's own caste group have a positive effect within each group. This is comparable with our findings, as our regular students and specially admitted students differed only in academic background.

We explore whether there are heterogeneous gender effects along two dimensions. The first is whether male Round-3 students tend to exert more negative impacts than do female Round-3 students. The second is whether male Round-1 students are more affected. We do not find differential effects along either dimension (results are available upon request). In contrast, Lavy and Schlosser (2011) suggest that boys tend to be more disruptive and violent in Israeli schools, but our study does not deal with the same age groups.

#### Exogenous assignment of Round-3 students

Selection bias may arise in our sample if the Round-3 admission discouraged applications for the relevant

academic departments and led to academically weaker regular students in the affected departments in 1996. The difference-in-difference method requires that regular students in the treatment group were otherwise comparable with corresponding students in the control group from the same departments, except that the treatment group had low-score classmates. As the treatment variable is continuous rather than 0/1 coded, we conduct the following test for detecting selection bias.

$$X_{idt} = \gamma^d + \lambda^t + \beta \text{Round-3}_{dt} + \varepsilon_{idt} \quad (2)$$

The variable  $X_{idt}$  represents a background variable of Round-1 student  $i$  in department  $d$  of entering year (cohort)  $t$ . The background variable  $X_{idt}$  could be NCEE total score, NCEE English score, or other demographic characteristics. The key predictor  $\text{Round-3}_{dt}$  indicates Round-3 Number or Round-3 Share. The coefficients  $\gamma^d$  and  $\lambda^t$  are the fixed effects for departments and cohorts, respectively. Only data from regular Round-1 students are included for the analysis.

If high-score potential applicants would switch from an affected department to another department or university, the NCEE total score and English score would be lower in

**Table 6** Effects of Round-3 students on CET outcomes of regular students using linear probability model

Key predictors	Dependent variables			
	CET-4 Pass	CET-6 Pass	CET-4 Excellent	CET-6 Excellent
<i>Regressions using Round-3 Number</i>				
Round-3 Number	-0.0012 (0.0008)	- 0.0045** (0.0019)	-0.0012 (0.0012)	0.0000 (0.0006)
<i>Regressions using Round-3 Share</i>				
Round-3 Share	-0.1342* (0.0662)	-0.1686 (0.1485)	-0.1228 (0.0927)	0.0158 (0.0535)
Observations	3,020	2,966	2,689	2,966
<i>Control variables</i>				
Department fixed effects	Yes	Yes	Yes	Yes
Cohort fixed effects	Yes	Yes	Yes	Yes
Class size	Yes	Yes	Yes	Yes
Individual characteristics	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes
NCEE English scores	Yes	Yes	Yes	Yes

The effects of Round-3 indicators are estimated separately. Each estimate is from a different linear probability model. In total, eight regressions are conducted for this table. The unit of observation is a regular student entering the sample university in the years 1994, 1995 and 1996. Individual characteristics include age, age squared, gender and living in rural or urban areas. NCEE English scores are interacted with home province dummies to allow differential effects of NCEE English scores from provinces on CET performances. SEs clustered by department in parenthesis

\* Significant at 10 %; \*\* significant at 5 %; \*\*\* %significant at 1 %

the affected departments in 1996, because their positions have to be filled by other students with lower scores. Because we are particularly concerned about the selection bias among students from Jiangsu, the first two columns in Table 7 focus on regular students from Jiangsu. The admission of Round-3 students is not significantly associated with the NCEE total scores and English scores for regular students from Jiangsu, and all the point estimates are positive. The third and fourth columns repeat the same tests for all the students. The number of Round-3 students is positively related to the NCEE total scores at the 5 % level, which suggests that the affected departments might have attracted better students and implies that the estimated results might be lower bounds of the effects from Round-3 students. However, the standardized NCEE scores can be very volatile and not comparable across years for students from provinces whose admission quotas varied dramatically among academic departments each year, so we should

interpret these results with caution. Nevertheless, the effect is opposite to what selection bias would indicate.

We also test whether there are changes in students' demographics, including living in rural or urban area, age, and gender. In addition, we check whether the number of recommended students and the number of students from Jiangsu are significantly correlated with Round-3 indicators; these two numbers are not subject to the choice of applicants, but they may affect the quality of attending Round-1 students. Column 5–9 in Table 7 show that Round-3 indicators are not significantly related to those characteristics, which suggests that, after controlling for the cohort effect, students in the same department are comparable across years, and there does not seem to be a selection bias along those aspects either.

The null effects of Round-3 indicators on regular students' backgrounds are not simply due to the lack of power or numerical coincidence, but result from the college admission and application system for the following three reasons. First, potential applicants from other provinces did not get the information on Round-3 admission when submitting applications. Therefore, Round-3 admission could not affect applications in provinces other than Jiangsu. Second, the university normally offered associate degree programs, which were ranked after Round-2 bachelor programs and brought many low-score students to its campus, similar to the situation of Round-3 programs in 1996. The introduction of Round-3 programs was not likely to discourage potential applicants from applying for Round-1 programs. Third, the "120 % rule" in the admission process limited selection bias even if potential applicants switched out of the affected departments. In regular years, the majority of students admitted to strongly affected departments do not apply for those departments, so there is a limited possibility for selection bias or additional mismatch.

#### Placebo testing

If other phenomena associated with Round-3 admission also occurred in 1996 but went unobserved by our research, we may wrongly attribute the correlation with the causal peer effects from Round-3 students. Suppose, in 1996, the government announced that it would increasingly recruit staff from college students who studied public administration, social welfare, and city planning. The announcement may have motivated the creation of the Round-3 programs. At the same time, the announcement might also have affected students' efforts in the relevant departments. For example, regular students entering in 1996, compared with previous students in the same department, might have thought that they could find a job relatively easily, and therefore, they might have put less effort into their studies

**Table 7** Testing for exogeneity of Round-3 students

Key predictors	Pretreatment variables								
	(1) NCET Total score Jiangsu	(2) NCET English score Jiangsu	(3) NCET Total score All	(4) NCET English score All	(5) Rural area	(6) Entering age	(7) Being male	(8) From Jiangsu	(9) Recommend students
Round-3 Number	0.0052 (0.0048)	0.0017 (0.0043)	0.0061** (0.0028)	-0.0035 (0.0026)	-0.0010 (0.0012)	0.0009 (0.0011)	0.0008 (0.0025)	0.0019 (0.0012)	-0.0004 (0.0006)
Round-3 Share	0.7232 (0.5027)	0.3286 (0.4472)	0.5156 (0.4077)	-0.2244 (0.2888)	-0.0894 (0.1258)	0.0978 (0.1128)	-0.0954 (0.2757)	0.1832 (0.1407)	-0.0392 (0.0579)
Observations	1,409	1,409	2,847	2,847	3,020	3,020	3,020	3,020	3,020
<i>Controlled for:</i>									
Department fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cohort fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The correlations of the two Round-3 indicators with baseline characteristics are estimated separately. In total, 18 regressions are conducted for this table. The unit of observation is a regular student entering the sample university in the years 1994, 1995 and 1996. SEs clustered by department in parenthesis

\* Significant at 10 %; \*\* significant at 5 %; \*\*\* significant at 1 %

**Table 8** Placebo testing

Key predictors	Dependent variables			
	CET-4 Pass	CET-6 Pass	CET-4 Excellence	CET-6 Excellence
Round-3 Number	0.0351 (0.0377)	0.0057 (0.0098)	-0.0070 (0.0100)	0.0154 (0.0231)
Round-3 Share	5.5657 (3.5670)	1.3942 (1.1969)	-1.1653 (1.3002)	1.0935 (2.1866)
Observations	1,283	1,847	1,650	1,448
<i>Control variables</i>				
Department fixed effects	Yes	Yes	Yes	Yes
Cohort fixed effects	Yes	Yes	Yes	Yes
Class size	Yes	Yes	Yes	Yes
Individual characteristics	Yes	Yes	Yes	Yes
Home province	Yes	Yes	Yes	Yes
NCEE English scores	Yes	Yes	Yes	Yes

The effects of Round-3 indicators are estimated separately. Each estimate is from a different logistic regression. In total, eight regressions are conducted for this table. The coefficients are in log odds ratios. The unit of observation is a student entering the sample university in the years 1994 and 1995 but not in 1996. Individual characteristics include age, age squared, gender and living in rural or urban areas. NCEE English scores are interacted with home province dummies to allow differential effects of NCEE English scores from provinces on CET performances. SEs clustered by department in parenthesis

\* Significant at 10 %; \*\* significant at 5 %; \*\*\* significant at 1 %

than the previous students did. In that case, even in the absence of Round-3 students, the government announcement would have lowered the academic performance of regular students.

Students were expected to take the CET-4 and the CET-6 by the end of their second and third years, respectively. Most students who entered the university in 1994 had already passed the CET-4 before the Round-3 admission in 1996. But students of Cohort 1995 would study for one more year to take the CET-4 after the entry of the Round-3 students. Similarly, for the CET-6, students of Cohort 1995 also experienced the influence of omitted variables, if any, for one more year than did students of Cohort 1994. Therefore, we should be able to detect any possible omitted variable bias with the following equation.

$$Y_{idt} = \gamma^d + \lambda^t + \beta \text{pseudo\_Round-3}_{dt} + \eta \text{ClassSize}_{dt} + \delta X_{idt} + \varepsilon_{idt} \tag{3}$$

In Eq. (3),  $\text{pseudo\_Round-3}_{dt}$ , is generated by assuming that the same Round-3 students were admitted in 1995 rather than in 1996. For example, the Department of Public Administration admitted 29 Round-3 students in 1996, so we assign 29 to  $\text{pseudo\_Round-3}_{dt}$  for students of Cohort 1995 in the Department of Public Administration. The School of Medicine did not admit any Round-3 students, so its 1995 cohort members are assigned 0. For all the students of Cohort 1994,  $\text{pseudo\_Round-3}_{dt}$  is 0. The cohort t is restricted to either 1994 or 1995, and students in 1996 are dropped from the analysis. As no Round-3 students were

actually admitted in 1995, the coefficient  $\beta$  should be zero if it captures only the causal effect of Round-3 students. If the coefficient  $\beta$  is different from zero, then there must be something else correlated with Round-3 students that had affected Round-1 students' CET outcomes.

Table 8 shows that the number of Round-3 students by departments in 1996 does not predict the test performance of students admitted in 1995, compared with those admitted in 1994 for the same departments. All the results are estimated with the full set of control variables. None of the coefficients is significant at the level of 0.1. For CET-4 and CET-6 passing rates, all the four coefficients are positive, and the null effects between pseudo\_Round-3<sub>dt</sub> and the passing rates are not simply due to a lack of statistical power.

Equation (3) will be a valid test for the omitted variable bias under the assumption that there are no spillover effects across students of different years in the same department. Because the spillover effects across years and the omitted variable effects act in the same direction and do not cancel out each other, the null effect of pseudo\_Round-3<sub>dt</sub> indicates that there is no omitted variable bias and there are no spillover effects across years.

## Conclusions

This study exploits an unusual change in the admission policy in a Chinese university and examines the impact of specially admitted low-score students on the academic performance of their classmates. The arrangements in the sample university facilitate the study of peer effects because the specially admitted students lived and studied together with regular students in the same department-cohort. The exogenous inflow of specially admitted students, the large differences in academic backgrounds between specially admitted students and regular students, and the strong interactions among these two groups overcome the well-documented empirical problems associated with identifying peer effects.

Our estimates suggest that specially admitted low-score students strongly reduced the College English Test passing rates of regular students in the same department-cohorts. On average, specially admitted students reduced the CET-4 passing rate by 1.5–2 % points, a sizable proportion given that the overall failure rate of the CET-4 is <4 %. The specially admitted students also significantly affected whether regular students passed the CET-6 and reduced the passing rate of that test by around 7 % points. However, the presence of specially admitted students does not seem to have significantly impacted the likelihood of obtaining a grade of excellent on those tests.

We carefully test whether the specially admitted low-score students are associated with any changes in the background of regular students and use placebo testing to identify possible omitted variable bias. Both tests support the causal interpretation that low-score students negatively affected regular high-score students. However, given that there are only three cohorts of students in this study, the limited number of cohorts makes the results subject to fluctuation and instability.

Nevertheless, to our knowledge, this is the first study on peer effect consequences of an admission policy change among college students, and it sheds some light on potential outcomes of college admission policy changes. In addition, this study analyzes peer effects in a developing country setting and extends our understandings of peer effects among college students to a broader context.

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