Do College Entrance Examination Scores Predict Undergraduate GPAs? A Tale of Two Universities

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Abstract:

Each year, millions of Chinese high school students sit the National College Entrance Examination (CEE). For the majority of students, the CEE score is the single determinant in whether they gain admission into a college and to what college they enter. The purpose of this paper is to determine whether and how well the CEE score predicts college academic success. We also consider high school achievement and admission route in predicting college grades. We obtain administrative data on CEE and undergraduate GPAs from two Chinese universities with very different rankings. We find that, for both universities the CEE total score predicts undergraduate GPAs for all four years in college. Even the size of the estimates for CEE is similar for the two universities. High school achievement and admission routes are also significant predictors of college grades. However, we do not find consistent results as to which CEE subject test scores predict students' academic performance in college.

JEL classification: I21; I23

Keywords: Undergraduate GPA; College Entrance Examination; High School Achievement; Admission Route

1. Introduction

Each year, millions of high school students in China sit the Chinese National College Entrance Examination (CEE; *gaokao*). The CEE is only offered once a year. For the majority of students, the CEE score is the sole determinant of college admission—students gain entry into ranked schools based solely on their CEE results. Only a very small number of students are exempt from the exam, because of a special talent, and they enter university via a recommendation ("*bao-song*"). In 2010, 9.5 million students sat the exam, of whom 6.5 million were admitted into a college (an admission rate of 68%); 5,000 students gained admission to a college without taking the test, accounting for less than 0.1% of the total exam-takers.[1] As the number of applicants far exceeds the admission quota, the competition to gain entry into a college, especially a prestigious one, is fierce, and the pressure to perform well in the exam is immense. Those who do not gain admission into a college may re-take the exam the following year or, instead, find employment.

Likewise, in the United States, students take Scholastic Aptitude Tests (SAT) or American College Testing (ACT). Their performance in these tests affects their chance of getting into a college. Our study is related to the general topic about the cost and benefit of using the standardized score such as CEE, SAT, and ACT scores in college admission decisions. The highly-varying high school quality as well as the widespread problem of high-school grade inflation makes the standardized test a fairer and more attractive tool to select students. Arguably, the standardized test offers a way to identify high-potential students in low-performing high schools. Without it, elite colleges are likely to draw most of their students from a set of elite high schools where wealthy families sent their children. On the other hand, for majority of students, the standardized test score may not provide much more additional information about their ability than the set of existing alternative measures, such as

[1] Data is sourced from gaokao.eol.cn and gaokao.chsi.com.cn, the two most prominent websites authorized by the Chinese Ministry of Education to release gaokao-related information and policy details.

high school grades and rank, personal statement, and recommendation letters. But since the stake of standardized tests is high, students often spend months preparing for the tests. Many of them take preparation classes where they learn little new knowledge but test-taking skills. Not surprisingly, for many students, studying for and taking the tests is such a negative experience.

In China, the CEE score accounts for an even higher weight in the college admission decision than its counterparts in the U.S. As a result, CEE places immense stress on students and their family. There have always been voices that wish to abolish the CEE. However, many people are concerned that if the CEE is abolished, students from the rural area or poor families would have even less chance to get into the college of their choice. In the last decade, while the CEE remains the single most important factor for college admission, policies have been introduced to allow selected universities a greater freedom in college admission. For example, some universities have been piloting a more flexible policy where students may be recommended by their high school or apply directly to the university, and after a very extensive screening including written tests, physical exams, and interviews organized by the university, those who passed are promised admission with a 10-40 point lower CEE score (known as *"zi zhu zhao sheng"*). In addition, students can be admitted into a college without CEE ("*bao song*"). They are usually the winners of National High-School Olympic Competition in mathematics and sciences. Because of the existence of such an admission route, many families sent their child to take special classes preparing for the competitions since the child was in an elementary school. Out of the concern for the welfare of young children, some provinces have decided to abolish such a "*bao song*" route. [2] As can be seen, the policies have swung back and forth between favoring the traditional selection criterion (CEE) and alternative admission criteria.

[2] Beijing's Bureau of Education Affairs has recently announced that since 2014, the winner of the National High-School Olympic Competition in mathematics and Sciences can no longer be exempt from CEE. However, they can be admitted into a college with a 10-20 point lower CEE score. http://edu.cnr.cn/list/201210/t20121030_511257355.html

One way to judge the effectiveness of these practices is to evaluate the validity of CEE to predict college academic success, and assess whether students admitted via the alternative routes appear to outperform those via CEE (the traditional route) in college. If the alternative practices are proved to be effective, they may be recommended for widespread adoption among universities. Besides, as universities gain greater autonomy in admission, they also need to be aware of other predictors of students' quality, such as high school performance indicators or winners of national awards. Under this general theme, we examine four empirical questions: (1) How well does the CEE score predict college GPAs? (2) Has the predictive power of CEE changed over time? (3) Do some high school achievement indicators predict college success for Chinese students? (4) Is a student's admission route (i.e. CEE or recommendation) predictive of a particular level of performance in college? Specifically, do those who are exempt from the CEE due to special talents perform better or worse than the students admitted on the basis of their CEE score?

Empirical research on the CEE exam would also be of some benefit to Western educators for two reasons: first, the CEE is a different scholastic ability test from the SAT. A detailed description of CEE is provided in Section 3. From the perspective of comparative education, a study of the CEE may serve as a reference for other countries. Western educators could draw lessons from China's experience to improve college admission tests in their own countries. Second, in recent years, increasing numbers of Chinese students have pursued graduate study at universities in the United States and other Western countries. Insights into the Chinese educational system in general, and the CEE in particular, could help Western universities to select quality students from China.

The remainder of the paper is organized as follows. Section 2 reviews related studies. Section 3 provides an overview of the CEE and college admission policies in China. Section 4 presents the data and variables used in the study. Section 5 reports empirical models and

results. Section 6 summarizes the results and concludes the paper.

2. Related studies

There are many empirical studies examining the link between SAT or ACT scores, high school performance, and college academic success in the United States. Betts and Morell (1999) analyzed the sample of 5000 students from the University of California, San Diego, and found that both SAT scores and high school GPA were significant predictors of college GPA. Cohn et al. (2004) used the data collected from undergraduates in the University of South Carolina and also found a significant relationship between high school GPA, SAT, and college performance. Since 2005 the SAT has undergone some substantial changes. Thus, recent studies have also examined how well the new SAT, particularly the new writing section, can predict undergraduate GPAs, using data from the University of Georgia (Cornwell, Mustard, and Van Parys, 2008).

There is also a bulk of studies on the predictive power of ACT for college performance. Most studies found a strong correlation between overall ACT scores and college performance (Bettinger et al., 2013; Noble and Sawyer, 2004; Munday, 1967; Price and Kim, 1976). However, it is less conclusive which is a more effective predictor of college GPAs, ACT scores or high school grades. Price and Kim (1976) showed that ACT was a better predictor of college GPAs than high school grades, while Noble and Sawyer (2004) found the opposite. Furthermore, Bettinger et al. (2013) suggested that different ACT sub scores may have a different predictive power and that colleges could improve their selection criteria by weighting the ACT sub scores differently. They found that among the four sub-tests of ACT, English and Mathematics were effective predictors of college outcome while Reading and Science provided no predictive power.

CEE is a completely different test from SAT or ACT. SAT has two components. SATI is an aptitude test, while SATII and ACT are subject-based. CEE, on the other hand, is

curriculum-based, and it tests students' mastery of subjects taught in high school. Atkinson (2001) argued that SATI was less relevant to high school curriculum, and its effectiveness to predict college grade diminished when students' social economic background was controlled for. Thus he proposed that American colleges should move away from aptitude tests to achievement tests in college admission. Recently, some universities, for example, the university of California system, has made SAT optional in college application (Robinson and Monks, 2005). The CEE, as an achievement test highly related to high school curriculum, may be a better predictor of college success than a general aptitude test. However, it is contingent on whether high school curriculum is correlated with college curriculum.

Regarding existing studies on CEE, Han and Li (2009) examined the residential peer effect in Chinese colleges and found that female students' college academic performance and social outcomes were affected by peer influence whereas male students were not. As a byproduct, the authors found that the college entry test score was significantly and positively associated with college GPAs. Li and Zhang (2010) showed that college GPAs were significant predictors of students' employment success at graduation, especially for females, and with the inclusion of college GPAs, CEE scores were insignificant in predicting employment outcomes.

American scholars have also examined various admission policies, such as early admission decisions (Jensen and Wu, 2010; Avery and Levin, 2010) and replacing affirmative action with a race-neutral top 10% rule (Dickson, 2006; Niu, Tienda, and Cortes, 2006), and their impact on college admission and students' academic success. This research highlights the importance of different admission policies in determining quality of admitted students and their later academic performance. In addition to CEE, China's colleges have alternative admission routes, which are different from admission policies in the U.S. It is equally interesting to examine how these policies affect the quality of students and their success in

college.

3. CEE and College Admission in China

The College Entrance Examination (CEE) was introduced in China in the 1950s. The Cultural Revolution, 1965–1976, put the CEE on hold until it was resumed in 1977. The CEE consists of three mandatory subjects—mathematics, Chinese, and foreign language (for the majority of students, English)—and optional subjects including chemistry, physics, biology, geography, history, and politics. After several major reforms, the CEE adopted the current "3+X" format in 1994. The "3"represents the three mandatory subjects required for all college applicants. The "X" component consists of a group of subject tests that differ for students depending on whether they pursue liberal arts or science and engineering majors in college. For those pursuing liberal arts (liberal-art track), the "X" component consists of history, politics, and geography, and for those pursuing science and engineering (science–engineering track) it includes physics, chemistry, and biology (Liu and Wu, 2006; Wang, 2006; Davey, Lian, and Higgins, 2007).

Before 2000, identical national CEE tests were given across provinces with the exclusion of the municipality of Shanghai, which had been piloting their own version of exams with the permission of the Ministry of Education since the mid1980s. In the early 2000s, Beijing and Tianjin were permitted to develop and administrate their own exams. By 2006, a total of 16 provinces, municipalities, and autonomous regions were providing exams independently under the national curricular guidelines (Wang, 2006).For majority of provinces, a perfect CEE score is 750 points, with 150 points for each mandatory subject test and 300 points for the "X" component. In a few provinces such as Guangdong, standardized scores within province are calculated and reported to students.

The college admission process in China begins with a college application. As of 2010, in

Beijing, Shanghai, and Tianjin, students must file a college application before taking the CEE; in Shanxi, Liaoning, Jiangxi, Tibet, and Xinjiang, students file an application after they have taken the exam but before they know their score; in the remaining provinces[3]students file an application after receiving the CEE score reports.[4]

Chinese universities offer two types of degrees: a 4-year degree and a 3-year professional and technical degree. Universities are divided into several categories: special universities, such as military, police, and art academies; 4-year degree universities; and 3-year professional and technical colleges. There are three tiers of 4-year degree universities: the first tier includes the most prestigious state universities; the second tier less prestigious state universities; and the third tier includes the rest private universities In the college application form, students may apply to two special universities, three universities from each tier of 4-year degree universities, and three 3-year degree colleges. They can apply for any subset of these universities. Within each tier, students rank their choices.

Each year, under the guidance of the Ministry of Education, each college and university sets the target number of examinees to be admitted from each province. Universities and colleges begin their admission in the following order: first, special colleges; second, the first-tier universities; third, the second-tier universities; and finally, junior colleges. Each university and college selects applicants based on the applicants' CEE score from the highest to the lowest until the admission quota is reached. By the end of the admission process, each student gets one offer. A student can choose not to go to the offered school. In such case, the student will need to re-take the CEE next year and go through the application and admission procedure again.

There are also policies that enable students to enter a university with a low CEE score. These students include those from ethnic minorities, students with an art or sports specialty,

[3] Including Hebei, Inner Mongolia, Jilin, Heilongjiang, Jiangsu, Zhejiang, Anhui, Fujian, Shandong, Henan, Hubei, Hunan, Guangdong, Guangxi, Hainan, Chongqing, Sichuan, Guizhou, Yunnan, Shaanxi, Gansu, Qinghai, and Ningxia

[4] Data source: gaokao.eol.cn, http://gaokao.eol.cn/kuai_xun_3075/20100610/t20100610_484751.shtml

and those with disabilities. These policies vary slightly across the provinces. Generally, these students may be accepted by a university with a score that is 10–30 points lower than the minimum score required for admission (Davey, Lian, and Higgins, 2007).

A small number of students may be exempt from the CEE and, instead, are recommended to a university ("*Bao Song")*. The Ministry of Education (2010) has specified eight types of students that are eligible for such recommendations, including those who are awarded the provincial-level title of outstanding student (usually only a few students are awarded this title in a province each year) and winners of national competitions in mathematics and science (such as physics, chemistry, biology, and information technology).Not all universities accept recommended students. In 2010, only 50 or so universities in China had permission from the Ministry of Education to accept recommended students.[5]They are the most prestigious universities in China.

Finally, some universities have been experimenting new admission methods. High school seniors with high enough GPAs or class ranks may be recommended or apply directly to the university ("*Zi Zhu Zhao Sheng*"). They will take a series of tests offered by the university, including written, physical tests and interviews, which usually take place roughly half a year before the CEE exam. Those who perform well on these tests are promised admission to the university with a lower CEE score. Although students still need to sit CEE exams, the CEE is no longer the only chance to enter into the university. By 2010, over thirty universities had adopted this practice. They are all leading universities among the first-tier 4-year degree universities.

4. Sample and variables

4.1 Samples

We obtained administrative data from two universities in China.

[5]The list of the universities that accept recommended students is published at http://gaokao.eol.cn/baosong_3126/.

Sample 1- University A

University A is a top-tier four-year university in China. In 2010, it was ranked 54th worldwide and 2nd in mainland China by *US News and World Report*'s World's Best Universities ranking.[6] **University A** is a general university with 16 schools and 56 academic departments. Each year it admits approximately 3700 undergraduate students for 66 academic majors. The university is strong in almost every academic area and selects top-scoring students for every major.[7] We are only able to get the data from the School of Economics and Management of **University A** that has 4 undergraduate majors, economics, accounting, finance, and management information system. However, we managed to get the enrollment and undergraduate GPA data for the entire class of students who entered the school from 1995 to 2005. The total sample size is 1436 for ten years.

An econometric challenge we faced, using data from one top university such as University A, was that the estimation of the effect of CEE on undergraduate GPAs was subject to the problem of restriction of range. The range is restricted because admission to the university is highly selective, and admitted students tend to have significantly higher average scores and a narrower range of scores than the larger examinee pool (Kobrin et al., 2008). With this problem, regression coefficients could still be estimated without bias, but the estimate of R^2 would be inconsistent (Rothstein, 2004). This problem is common in all previous studies that use data from a single university or institute, such as Betts and Morell (1999), Cohn et al. (2004), Cornwell, Mustard, and Van Parys (2008), and Jensen and Wu (2010). In addition, although an advantage of the data from University A is that it is longitudinal, so that we can study the change in the CEE's predictive power over time, a disadvantage is that it only covers economics and management majors. To address these data

[6]World's Best Universities: US News and World Report, available at http://www.usnews.com/articles/education/worlds-best-universities/2010/09/21/worlds-best-universities-top-400-.html.
[7]According to the Chinese university ranking (again available at http://edu.sina.com.cn/focus/utop.html), as of 2009, University A is ranked 1st in engineering, management, 2nd in medicine, and 5th in law, science, and social science.

problems, we obtain data from another university.

Sample 2- University B

University B is a second-tier four-year university in China. In 2010, it was ranked no.175 among all four-year universities in mainland China.[8]**University B** is a general university with 27 schools, and admits approximately 9000 undergraduate students each year for 72 majors. The university is known for its strong Chinese literature and education majors.[9] Unlike the longitudinal data we collected from University A**,** from **University B** we obtained data only for the 2005 entry class and their undergraduate GPA for four years. We were provided with data for 8 majors. Although we could not access the data for all majors, the data we got showed significant diversity in student majors with two majors each from the School of Chinese Literature, the School of Foreign Language, and the School of Engineering, and one each from the School of Business and the School of Science. We got data for 1240 students. After dropping observations with missing values, the sample size is 1106.

4.2 Variables

Our data were sourced from the university's admission and registrar's offices. Because universities across China have similar registration requirements and documentations, the data we collected from the two universities are comparable in format and variables.

Dependent variable: the first, second, third-year GPAs and cumulative GPAs

The registrar's office provided us with the list of courses that students had taken, and term and year, the number of credits, and grades for each course. Same as most other universities in China, the 100-point grading system is used for most courses in both universities. Very few courses such as Physical Education are graded with "Pass" or "Fail", which are excluded from the GPA calculation. Using these data, we calculate students' GPAs

[8] The ranking is from "the Chinese University Evaluation Report 2010" was done by CUAA.NET.http://www.gaokao.com/e/20100113/4b8bd6b4a08ac.shtml. There are 150 first-tier four-year degree universities, and 300-400 second-tier universities. Therefore, University B is at the top of second-tier universities.

[9]According to the Chinese university ranking (again available at http://edu.sina.com.cn/focus/utop.html), as of 2009, **UniversityB i**s ranked 38st in education, 64th in Chinese Literature.

for the first, second, third year, and also for all four years by the same method. GPAs are equal to the weighted average of all course grades, and the weight is the ratio of the number of credits of a course to the total credits of all courses. Since a course grade is between 0-100, the calculated GPAs are also in the range of 0-100.

Independent Variables:

CEE total and subject scores: the data was also sourced from the admission office. If the student gained entry through the CEE exam, then the student's total CEE scores and subject test scores were obtained. The maximum total score is 750, and the maximum score for subject tests, such as mathematics, English, and Chinese is 150. The CEE subject composite test has the maximum score of 300, and is different for science-engineering and liberal-art track students. We convert CEE subject and total scores to a 100-point scale by dividing a student's score by the maximum score and then multiplied by 100. [10]

Admission Route: the data was sourced from the admission office of the two universities. It indicates whether a student entered the university via the college entrance exam or by recommendation without a CEE score ("*Bao Song"*), and whether a student was accepted with a lower test score either due to passing university-administered screening tests ("*Zi Zhu Zhao Sheng"*) or due to art and sport specialty. Dummy variables, *Recommendation-1*, *Recommendation-2*, and *art_ sports_specialty,* are created to indicate admission routes for "*Bao Song", "Zi Zhu Zhao Sheng",* and those admitted with a lower CEE score because of art and sport specialty.

University A accepts students by "*Bao Song"* and has started accepting students with a lower CEE score who passed university-administered screening tests (*"Zi Zhu Zhao Sheng")* since 2003. Therefore, for Sample 1, explanatory variables include both *Recommendation-1* and *Recommendation-2*. Universities B has not been accepting students by recommendation

[10] The total CEE score is calculated as the reported CEE total score/750*100; and a subject test score is calculated by the reported score/150*100.

(neither "*Bao Song*" nor "*Zi Zhu Zhao Sheng*"). Therefore, in the University-B sample, there is only an indicator of whether a student was admitted with a lower CEE score because of art and sport specialties.

Liberal-art or science–engineer track exam-taker is a dummy variable to indicate whether a student took a liberal-art CEE exam or science-engineering CEE exam. The base group is science-engineering exam takers. Since the exam paper is different for the two tracks, the CEE score of the two tracks may have a different effect on undergraduate GPAs. In order to capture this effect, we incorporate the interaction of CEE scores and the liberal-art track in the regression model.

A first-time test-taker or re-taker is a dummy variable to indicate whether a student took the CEE for the first time or was a repeated exam taker.

High school achievements: As high school GPAs are not used to determine admission, the admission office does not collect high school GPA data. However, there are some indicators of the students' high school performances in the dataset, specifically, whether a student received any award in high school. Generally, there are two types of awards. The first is the title of "outstanding student" awarded to students who demonstrate excellence in both academic and extracurricular activities. The title may be awarded by a school, district, city, or at the highest level, by a province. The higher the level of the title, the greater the competition is to win it. The second award is given to the winners of competitions in mathematics, science, and technology, organized at district, city, province, and national levels. The winners of the lower level competitions continue competing until they reach the national championships. In addition to the above two types, students may receive other awards, e.g. winners of speech, calligraphy or painting contests. Based on this information, we create two award-level and three award-type dummy variables. The base groups are those who did not receive any award.

Personal variables: the admission office also held data on the students' personal

characteristics, such as gender, birth year and month, ethnicity, the province from which they were admitted (which is usually also where they completed high school), and whether the students were from a rural or urban area. In China, urban areas offer better education opportunities and greater access to higher education than rural areas (Liu and Wu, 2006). In terms of access to higher education, it is only in recent years that the gap between rural and urban areas has decreased (Li et al., 2008).

Appendix Table 1 lists definition and summary statistics of key variables for the two samples. The average total CEE score is 85 for University A and 75 for University B. The average score of CEE subject tests are also 10-15 points higher for University A than University B. This confirms the different rankings and hence different admission scores of the two universities. Nearly half of the students in the sample of University B are liberal-art track exam-takers while they are only 5% in University A. It is largely because the University-B sample includes more students with liberal art majors. Appendix Table 1 also shows that University B has more female students and fewer ethnic-minorities or students from urban areas. About 40% of the students in the sample of University B are not the first-time exam takers, which is why the students' average age at enrollment is one and half year older in University B. The four year GPAs are comparable between two universities. For example, the freshman year's GPA is 82 for University A and 83.8 for University B.[11]

5. Results

5.1 Empirical Model

First, we estimated the predictive power of the CEE on the undergraduate GPAs, using the sample of students admitted via the entrance exam, as those admitted by recommendation do not have a CEE score. The models are specified as follows:

[11] To further check whether course grades are comparable between two universities, we used the raw data to show the distribution of the grades for two common courses, College Calculus and College English. Both courses were first-year mandatory courses in the two universities. For University 1, the sample included economics and management majors; for University 2, we selected students from liberal art and social science majors for comparison. As shown by Appendix Figure 1, the distribution of the grades is similar for the two universities.

$$Y_i = \alpha + \beta X_i + \delta CEE_i + \gamma_t + \varepsilon_i \quad (1)$$

$$Y_i = \alpha + \beta X_i + \delta_1 CEE\_math_i + \delta_2 CEE\_Chin_i + \delta_3 CEE\_lang_i + +\delta_4 CEE\_comp_i + \gamma_t + \varepsilon_i \quad (2)$$

Where Y_i denotes undergraduate GPA including the first, second, and third year GPAs, and the 4-year cumulative GPA. X_i is a vector of explanatory variables including *female*, *minority*, *age at enrollment*, *urban*, *first-time exam-taker*, *liberal-art track exam taker, the interaction of liberal-art track exam taker and CEE scores, academic majors,* and *high school award*. Other than X_i, the total CEE score is included in equation (1), while the four CEE subject test scores, including mathematics, Chinese, foreign language, and subject-composite scores, are used to predict college GPAs in equation (2). γ_t denotes enrollment year dummies that control for any time-specific effect. For University B, since there is only one-year data, γ_t is dropped. Provincial dummies are included to control for the provincial variation such as different exam papers. For all the regressions, robust standard errors are reported.

Second, we examined the non-linear effect of CEE on undergraduate GPAs. We classified students into five quantiles based on their total CEE score and included quantile dummies in the regression. The model is specified as follows:

$$Y_i = \alpha + \beta X_i + \delta_1 Quantile2_i + \delta_2 Quantile3_i + \delta_3 Quantile4_i + \delta_4 Quantile5_i + \gamma_t + \varepsilon_i \quad (3)$$

where *Quantile2- Qauntile5* are dummy variables, indicating that a student's CEE score is in the 20-40th, 40-60th, 60-80th, and above 80thpercentile of the CEE distribution, respectively. The bottom 20% students are left out as the base group for comparison. To test the non-linear effect of CEE, we test equality of δs both jointly and in pair. For example, if there is a disproportionally bigger effect of CEE at the top end of the CEE distribution, we expect to find an extensively larger δ_4. Again, γ_t is dropped for University B. [12]

[12] We also estimate equation (3) with the polynomial of CEE, including CEE and CEE squared. The quantile dummy specification is more flexible, and provides more information about the different effects of CEE on GPAs at different levels of CEE. We report the quantile dummy results in the paper, but the results of the polynomial specification are also available upon request.

Third, we tested whether students with different admission status perform differently in college by estimating the following equation for University A:

$$Y_i = \alpha + \beta X_i + \delta_1 recommendation-1_i + \delta_2 recommendation-2_i + \delta_3 arts\_sports\_specialty_i + \gamma_t + \varepsilon_i \quad (4)$$

"Recommendation-1" and "Recommendation-2 are dummy variables indicating whether a student was admitted by recommendation without the CEE score or passed university pre-CEE screening tests and was accepted with a lower CEE score. "Arts_sports_speciality" is another dummy variable that indicates whether a student was admitted with a lower CEE score owing to an arts or sports specialty. The remainder of the students who were admitted via the CEE exam with a standard admission score were omitted and used as a reference group. For University B, we only test whether students who were admitted with a lower score because of an arts and sports specialty performed differently from those who were admitted with a standard admission score.

5.2 The impact of CEE total score on college performance

First, we estimated equation (1) with and without controls for personal characteristics X_i, using data from the two universities. The estimates are reported in Tables1A and 1B.The CEE scores predicted undergraduate GPAs for all four years for both universities. The coefficient estimate of the CEE score is similar for the two universities. It is slightly higher for the first 2 years, suggesting that the CEE score is a better predictor of the first 2 years' academic performance. As the CEE scores are converted to a 100-point scale, the coefficient estimates in Columns (5) – (8) of Tables 1A and 1B imply that a 1-point increase in the CEE total score is associated with a 0.19-0.23 point higher undergraduate GPA for University A, and a 0.22-0.29 point higher GPA for University B, with all else controlled for. After controlling for personal characteristics, the model's fitness (adjusted R^2) increased by 0.07-0.1 for University A and by 0.16-0.4 for University B, suggesting that personal characteristics add to the

explanatory power of the model.

The interaction of the liberal-art track and CEE captures the different effects of CEE liberal-art and the science-engineering track exams on college GPAs. The estimates in Table 1A and Table 1B suggest that college GPAs are considerably lower for liberal-art track examinees than the science-engineering track in both universities. The interaction of the liberal-art track and CEE is significantly positive for University B, suggesting that the effect of the liberal-art CEE score on college GPAs is stronger. This effect is of the same direction but not significant for University A, which is likely because of the small number of liberal-art exam takers in the University-A sample.[13]

Moreover, several individual characteristics are highly correlated with college performance. The sign of the estimates is similar for both universities, except that for University A the estimates for *first-time exam takers* are statistically significant, while for University B, first-time exam takers are insignificant but the estimate for *urban* is significant. For both universities, gender is significantly correlated with college grades, suggesting that females have higher undergraduate GPAs than males throughout the 4 years of study.

Since we only obtained the longitudinal data from University A, we estimated equation (1) using data for each entry class from 1995 to 2005 in University A. To save space, we only reported the coefficient estimate for the CEE score and R^2 for the regression of the freshman year GPA. Without the control for provincial dummy variables, R^2 and coefficient estimates for CEE both declined from the 1995 to 2005 class. But after we controlled for provincial fixed effects, the pattern changed. *R2* and coefficient estimates first declined then increased (Figure 1). After year 2000, many provinces were given authority to write their own exam papers under the same general guideline. The decline in the explanatory power of CEE

[13] The number of liberal-art track students is 73 for University A, and is 542 for University B.

without control for provincial fixed effects could be because of differences in exam papers between provinces.[14]

5.3 The effect of CEE subject test scores on college performance

In Tables 2A and 2B, undergraduate GPAs are regressed on CEE subject test scores (equation (2)). We include four subject test scores simultaneously. Alternatively, we have also run regressions including subject test scores individually. The results do not differ notably. We found that CEE subject test scores had different predictive power for the two universities. As can be seen from Table 2A, among the CEE subject tests, mathematics, foreign language, and composite scores have a large and significant effect on college GPAs, while the CEE Chinese test score does not predict college GPAs for University A. On the other hand, Table 2B suggests that the Chinese test score predicts college GPAs for University B, while the effect of the foreign language score is weaker. The inconsistent results between the two universities could be due to the differences in students' majors and course requirements. The four majors from University A are all economics and management related, requiring advanced mathematical courses, and the undergraduate program in these majors is also highly internationalized with courses taught in English. Thus, mathematical and foreign language skills are important to achieving better grades in these majors. On the other hand, the sample from University B covers many liberal art majors, as well as science and engineering majors; therefore Chinese language skills are also important to college grades.

Columns (5)-(8) in Table 2A and 2B report the estimation for the models incorporating the interactions of CEE subject scores with the liberal-art track. The estimates for the interaction

[14]We estimated Swamy's (1970) random coefficient model using the pooled cross-sectional data from University A and test parameter constancy across the different CEE coefficient estimates over time. Swamy's random coefficient model is specified as: $Y_t = \alpha + \delta_t CEE_t + \varepsilon_t$, where t =1…T denotes year t, and each Y_t and CEE_t is a vector containing i=1…I individuals for year t. The null hypothesis is: $\delta_1 = \delta_2 = ... = \delta_T$ .The test statistic follows a Chi2 distribution. The test results are available upon request.

of the liberal-art track with the CEE subject composite score are significantly positive for University B, indicating that CEE liberal-art and science-engineering composite scores have a different predictive power for college performance.

5.4 Non-linear effect of CEE scores on college performance

Third, Tables3A and3B display the estimates of equation (3), where CEE quantile dummy variables are included in the regression. We find the evidence of the non-linear effect of CEE on undergraduate GPAs for both universities, although the pattern is different for the two universities. For University A, the test of equality of regression coefficients indicates that students with a CEE score in the 40-60th and 60-80th percentiles had similar undergraduate GPAs, while those below the 40th percentile had significantly lower GPAs and those above the 80th percentile had a significantly higher GPA but only for the freshmen year. For the third year, the GPAs differences between five quantiles are no longer significant. For University B, the estimates suggest that students with CEE score below the 40th percentile had significantly lower GPAs than those above. This pattern is consistent for the four years.

5.5 The effect of high school achievement on college performance

In Tables 4A and 4B, we further explore the predictive power of high school performance with respect to college GPAs. We add high school award levels and types into the regressions, and the estimates are reported in Columns (1)-(4) and Columns (5)-(8), respectively. For University A, the results show that students who have won the national, province or lower level award all have significantly higher college GPAs than those who did not win an award in high school. Those who have won a higher level award performed better than those with a lower level award; but this difference is insignificant based on F-test statistics. For University B, the pattern is similar, yet the coefficient estimate for the national-level reward is not significant, which is likely because of fewer observations of winning national awards in University B. These finding supports the use of high school award as a criterion to select

students while the level of award is not important.

With regard to the type of award, we found that students who won a science competition or were awarded an "outstanding student" title had a better academic performance in college than those without any award, but other types of awards did not predict college performance. This finding is consistent for both universities. But for University B, the effect is weaker. For both universities, those winning a science competition had a better performance than those with an outstanding student title; we observed that this difference diminished with the year that students were in. Moreover, we found that the effects of CEE and high school awards on undergraduate GPAs were both statistically significant in Table 4A/B. This finding indicates that both CEE and high school awards provide predicting power for college GPAs.

5.6 The influence of admission routes on college performance

We examined whether students with different admission routes performed differently in college. The estimates are reported in Tables 5A and 5B. As can be seen from Columns (1) to (4), compared with the students entering school via the entrance exam with a regular admission score, students admitted by recommendation without CEE (*Recommendation-1*) had a higher GPA (by approximately 1 point in the first three years; those admitted with a lower CEE score due to an arts or sports specialty had a lower GPA by 4-5 points; those who passed university-administered tests and were admitted with a lower CEE score (*recommendation-2*) did not perform significantly different from students admitted by CEE with a regular score. In Table 5B, we reported the estimates for University B. There were no "*Recommendation-1*" and "*Recommendation-2*" students in University B. We found that students admitted with a lower CEE score due to an arts or sports specialty had lower GPAs than regularly admitted students, which are consistent with the findings for University A; however, the effect is insignificant. The results suggest that the different admission routes have different effects on college GPAs.

6. Conclusions

The CEE is one of the most important exams in the academic life of Chinese students. Except for a very small number of students, the CEE score is the sole determinant of admission to a university. Despite the importance of the CEE, there have been few previous validity studies. In the absence of sufficient empirical evidence, it is unclear whether the CEE score predicts a student's future academic performance in college. Our study contributes to the literature by investigating four empirical questions concerning the predictive power of the CEE with respect to college performance. We obtained administrative data from two different universities, and the data covers a diverse set of majors.

The findings that are consistent between the two universities include the following: the CEE is a significant predictor of undergraduate GPAs for all 4 years. It is also proved that, with CEE and all else controlled for, female students perform better in college. In addition to the CEE, high school performance measured by whether a student has received any award in high school and the level and types of award also significantly predict academic performance in college. For both universities, the effect of CEE on college performance is nonlinear – those at the bottom of the CEE distribution had the worst college performance, while those in the middle and top of the distribution did not differ significantly in college GPAs. For both universities, students admitted with a lower CEE score because of an art or sport specialty had lower undergraduate GPAs, but the effect is insignificant for University B.

We also obtained some less conclusive results with regard to whether CEE subject test scores predict undergraduate GPAs. For University A, Chinese test scores did not show a strong correlation with college GPAs, while for University B the Chinese test score was a significant predictor of college performance. Finally, we only have longitudinal data from University A, and found evidence that R^2 of the regression model and the coefficient estimate of CEE fluctuated from 1995 to 2005.

Our findings have some important implications for the admission policies and practices of universities. While the use of CEE scores as an admission criterion is a valid process for Chinese universities, they should also consider other information when making admission decisions, such as students' high school performance, including high school GPA and class ranks. As shown in our study, high school achievement, measured by student awards in high school, was a significant predictor of college GPAs for our student samples. Moreover, the current practice of admitting students by recommendation with an exemption of CEE score has been proven to be somewhat effective for universities. However it will require further study to determine whether this practice can be generalized to other universities.

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Table 1A Predictive power of CEE total score**- University A**

	Dependent variables: undergraduate GPAs							
	First year	Second year	Third year	Cumulative- all courses	First year	Second year	Third year	Cumulative-all courses
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
CEE	0.313***	0.272***	0.254***	0.257***	0.234***	0.201***	0.183***	0.190***
	(0.070)	(0.060)	(0.062)	(0.055)	(0.065)	(0.056)	(0.058)	(0.052)
Female					1.489***	3.396***	3.245***	2.746***
					(0.246)	(0.310)	(0.341)	(0.274)
Minority					-0.231	0.327	0.311	0.113
					(0.564)	(0.590)	(0.639)	(0.541)
Age at enrollment					-0.012	0.134	-0.126	-0.005
					(0.191)	(0.234)	(0.253)	(0.214)
Urban					-0.040	-0.123	-0.411	-0.193
					(0.330)	(0.431)	(0.484)	(0.383)
First-time exam-taker					1.497***	2.303***	1.884**	1.741**
					(0.540)	(0.752)	(0.863)	(0.694)
Liberal- art track					-16.343	-16.106	-14.220	-12.694
					(11.229)	(14.046)	(16.316)	(11.945)
CEE *Liberal-art track					0.145	0.152	0.145	0.120
					(0.134)	(0.167)	(0.191)	(0.141)
Academic Major					0.327	0.046	1.048**	0.539
MIS					(0.391)	(0.485)	(0.523)	(0.441)
Finance					0.816**	0.627	1.474***	0.977**
					(0.392)	(0.483)	(0.549)	(0.446)
Accounting					0.176	-0.481	-0.499	-0.385
					(0.352)	(0.431)	(0.464)	(0.386)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Provincial dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	49.652***	51.036***	53.059***	53.336***	55.578***	50.635***	57.387***	56.184***
	(5.911)	(5.896)	(5.763)	(5.035)	(7.279)	(6.824)	(7.844)	(6.518)
Observations	1257	1257	1257	1257	1212	1212	1212	1212
Adjusted R^2	0.23	0.17	0.18	0.18	0.30	0.27	0.26	0.27

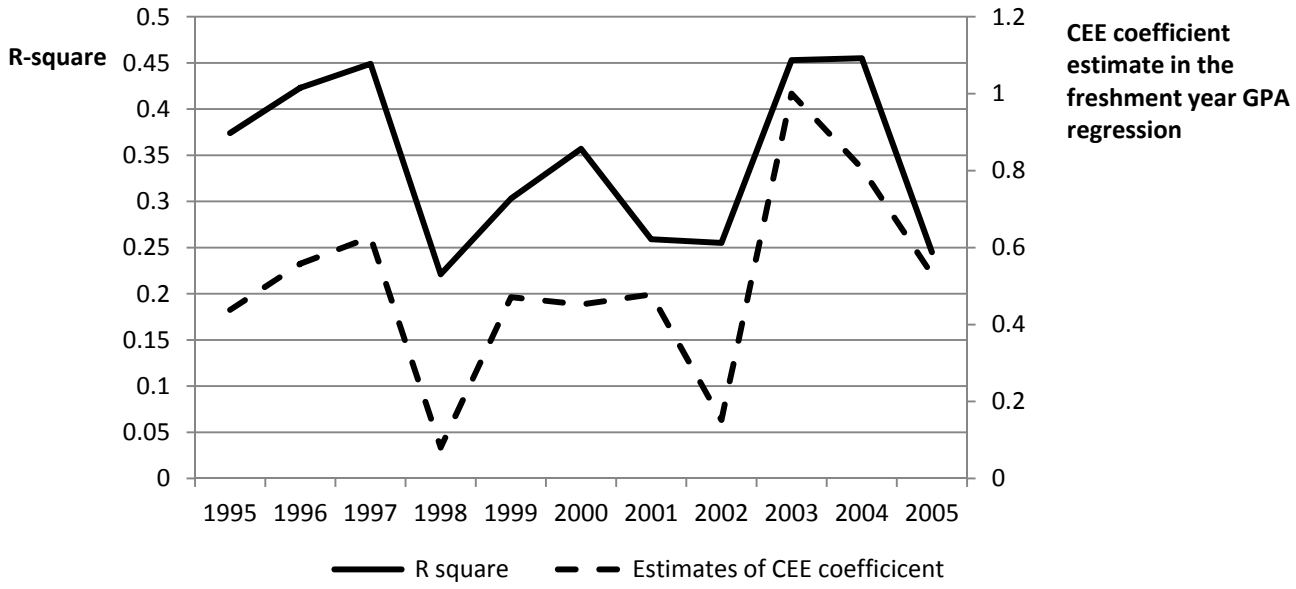
Note: coefficient estimates are reported. Robust standard errors are in parentheses. *, **, and *** indicates the significance level at 10, 5, and 1percent, respectively. CEE score is converted to a 100-point scale. The base groups are male, Han-majority, students from rural areas, repeated exam-takers, science-engineering track, and economics major.

Table 1B Predictive power of CEE total score-**University B**

	Dependent variables: undergraduate GPAs							
	First year	Second year	Third year	Cumulative-all courses	First year	Second year	Third year	Cumulative - all courses
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
CEE	0.396***	0.202***	0.130***	0.203***	0.287***	0.259***	0.182***	0.218***
	(0.053)	(0.042)	(0.045)	(0.038)	(0.055)	(0.051)	(0.054)	(0.044)
Female					4.098***	4.673***	5.031***	4.377***
					(0.370)	(0.391)	(0.378)	(0.309)
Minority					0.416	0.913	0.508	0.625
					(0.838)	(0.813)	(0.813)	(0.637)
Age at enrollment					-0.056	-0.202	-0.048	-0.084
					(0.198)	(0.193)	(0.196)	(0.155)
Urban					-0.806***	-1.014***	-1.236***	-0.968***
					(0.301)	(0.304)	(0.298)	(0.242)
First-time exam-taker					0.406	0.538	0.555	0.525*
					(0.350)	(0.359)	(0.349)	(0.283)
Liberal- art track					-13.113***	-11.765**	-10.638**	-10.389***
					(5.010)	(4.752)	(4.699)	(3.982)
CEE *Liberal-art track					0.164**	0.154**	0.137**	0.132**
					(0.066)	(0.063)	(0.062)	(0.053)
Academic Major					3.931***	2.902***	-0.455	2.319***
Chinese Literature					(0.926)	(0.762)	(0.690)	(0.636)
Foreign Language					4.801***	-1.268	-1.063	0.230
					(0.922)	(0.800)	(0.711)	(0.654)
Science					3.342***	1.526	-4.555***	0.556
					(1.023)	(0.952)	(0.833)	(0.760)
Engineering					3.828***	-2.269**	-6.701***	-1.614**
					(0.995)	(0.930)	(0.829)	(0.737)
Provincial dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	50.132***	65.104***	74.354***	65.573***	57.558***	64.789***	75.013***	66.422***
	(3.557)	(2.823)	(2.997)	(2.545)	(5.999)	(5.630)	(6.022)	(4.801)
Observations	1101	1101	1101	1101	1101	1101	1101	1101
Adjusted R^2	0.12	0.04	0.02	0.05	0.28	0.34	0.42	0.37

Note: coefficient estimates are reported. Robust standard errors are in parentheses. *, **, and *** indicates the significance level at 10, 5, and 1percent, respectively. CEE score is converted to a 100-point scale. The base groups are male, Han-majority, students from rural areas, repeated exam-takers, science-engineering track, and business major.

Figure 1 Predictive power of CEE total score for different years-**University A**



Note: The figure shows the coefficient estimate of CEE total score in the regression of the freshman year GPA and R^2 of the model for each year. Figure1 reports the estimates of the regressions with provincial dummies controlled.

Table 2A Predictive power of CEE subject scores-**University A**

	Dependent variable: Undergraduate GPA							
	First year	Second year	Third year	Cumulative – all courses	First year	Second year	Third year	Cumulative – all courses
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
CEE_math	0.126***	0.100***	0.075***	0.091***	0.129***	0.100***	0.078***	0.092***
	(0.021)	(0.023)	(0.024)	(0.018)	(0.021)	(0.023)	(0.024)	(0.018)
CEE_chin	-0.016	-0.046	-0.011	-0.027	-0.020	-0.050	-0.016	-0.030
	(0.025)	(0.031)	(0.031)	(0.027)	(0.026)	(0.031)	(0.031)	(0.027)
CEE_lang	0.164***	0.182***	0.209***	0.180***	0.163***	0.182***	0.208***	0.179***
	(0.023)	(0.025)	(0.042)	(0.024)	(0.024)	(0.025)	(0.043)	(0.025)
CEE_composite	0.069***	0.048**	0.035	0.042**	0.067***	0.048**	0.033	0.041**
	(0.019)	(0.022)	(0.025)	(0.019)	(0.020)	(0.022)	(0.025)	(0.019)
Liberal- art track	-4.266***	-3.743***	-2.182**	-2.851***	-12.412	-20.764	-19.338	-14.488
	(0.648)	(0.802)	(0.866)	(0.674)	(24.588)	(30.627)	(28.454)	(24.533)
CEE_math* Liberal- art track					-0.039	0.047	-0.011	-0.002
					(0.112)	(0.127)	(0.149)	(0.118)
CEE_chin* Liberal- art track					0.057	0.130	0.120	0.071
					(0.141)	(0.201)	(0.160)	(0.144)
CEE_lang* Liberal- art track					0.035	0.022	0.065	0.052
					(0.112)	(0.139)	(0.134)	(0.103)
CEE_composite*Liberal- art track					0.052	0.004	0.036	0.019
					(0.047)	(0.062)	(0.069)	(0.050)
Personal characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Provincial Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	43.879***	41.457***	47.926***	47.393***	45.483***	46.392***	51.125***	50.339***
	(5.177)	(7.092)	(7.537)	(6.094)	(5.363)	(7.343)	(7.900)	(6.329)
Observations	1174	1174	1174	1174	1174	1174	1174	1174
Adjusted R^2	0.34	0.30	0.29	0.31	0.34	0.30	0.29	0.30

Note: coefficient estimates are reported. Robust standard errors are in parentheses. *, **, and *** indicates the significance level at 10, 5, and 1percent, respectively. CEE, CEE_math, CEE_chin, CEE_lang and CEE_composite are all converted to a 100-point scale. Undergraduate GPAs are also in a 100-point scale. Regressions include control for personal characteristics and year dummies. Personal characteristic variables are female, minority, age at enrollment, urban, first-time exam taker, and academic majors.

Table 2B Predictive power of CEE subject scores-**University B**

Dependent variable: Undergraduate GPA								
	First year	Second year	Third year	Cumulative – all courses	First year	Second year	Third year	Cumulative – all courses
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
CEE_math	0.085***	0.059***	0.052***	0.054***	0.071***	0.043*	0.038	0.039*
	(0.019)	(0.017)	(0.017)	(0.014)	(0.024)	(0.026)	(0.026)	(0.021)
CEE_chin	0.088***	0.109***	0.091***	0.092***	0.067***	0.103***	0.077***	0.087***
	(0.019)	(0.018)	(0.018)	(0.014)	(0.024)	(0.024)	(0.026)	(0.020)
CEE_lang	0.062**	0.078**	0.051	0.057**	0.053	0.047	0.035	0.035
	(0.031)	(0.033)	(0.031)	(0.026)	(0.039)	(0.040)	(0.042)	(0.033)
CEE_composite	0.151***	0.130***	0.083***	0.111***	0.120***	0.092***	0.053**	0.075***
	(0.028)	(0.024)	(0.022)	(0.021)	(0.029)	(0.027)	(0.026)	(0.022)
Liberal- art track	-0.451	0.025	-0.181	-0.307	-10.486*	-12.520**	-10.349*	-10.740**
	(0.414)	(0.391)	(0.360)	(0.321)	(5.816)	(5.694)	(5.448)	(4.526)
CEE_math* Liberal- art track					0.017	0.025	0.019	0.022
					(0.027)	(0.029)	(0.028)	(0.023)
CEE_chin* Liberal- art track					-0.005	0.046	0.014	0.028
					(0.053)	(0.057)	(0.054)	(0.045)
CEE_lang* Liberal- art track					0.044	0.017	0.031	0.015
					(0.030)	(0.030)	(0.029)	(0.024)
CEE_composite*Liberal- art track					0.075*	0.079**	0.069**	0.073**
					(0.039)	(0.038)	(0.032)	(0.030)
Personal characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Provincial Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	56.064***	52.177***	61.957***	56.669***	61.515***	59.375***	67.589***	62.812***
	(6.851)	(6.300)	(6.076)	(5.272)	(7.023)	(6.525)	(6.497)	(5.375)
Observations	999	999	999	999	999	999	999	999
Adjusted R^2	0.28	0.35	0.43	0.38	0.28	0.35	0.43	0.39

Note: coefficient estimates are reported. Robust standard errors are in parentheses. *, **, and *** indicates the significance level at 10, 5, and 1percent, respectively. CEE, CEE_math, CEE_chin, CEE_lang, and CEE_composite are all converted to a 100-point scale. Undergraduate GPAs are also in a 100-point scale. Regressions include control for personal characteristics dummies. Personal characteristic variables are female, minority, age at enrollment, urban, first-time exam taker, and academic majors.

Table 3A Non-linear effect of CEE on undergraduate GPA-**University A**

Dependent variables: Undergraduate GPAs				
	First year	Second year	Third year	Cumulative - all courses
	(1)	(2)	(3)	(4)
CEE score				
Quantile2	2.287***	2.245***	1.935***	2.076***
	(0.426)	(0.547)	(0.546)	(0.455)
Quantile3	3.238***	3.189***	2.764***	2.955***
	(0.453)	(0.550)	(0.589)	(0.507)
Quantile4	2.949***	2.714***	2.192***	2.466***
	(0.488)	(0.601)	(0.571)	(0.499)
Quantile5	3.809***	3.382***	2.801***	3.044***
	(0.597)	(0.694)	(0.721)	(0.607)
Personal characteristics	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes
Provincial Dummies	Yes	Yes	Yes	Yes
Constant	72.177***	64.255***	70.171***	69.211***
	(4.134)	(4.658)	(5.760)	(4.506)
Observations	1212	1212	1212	1212
Adjusted R^2	0.30	0.27	0.26	0.27

Note: Coefficient estimates are reported. Robust standard errors are in parentheses. *, **, and *** indicates the significance level at 10, 5, and 1 percent, respectively. Students are grouped into five quantiles based on their total CEE scores: 0-20th percentile; 20-40th percentile; 40-60th percentile; 60-80th percentile; and the 80th percentile and above. The bottom 20% students are left out as the base group for comparison. Undergraduate GPAs are in a 100-point scale. Regressions include control for personal characteristics, year and provincial dummies. Personal characteristic variables are female, minority, age at enrollment, urban, first-time exam taker, liberal-art track, and academic majors.

Table 3B Non-linear effect of CEE on undergraduate GPA-**University B**

Dependent variables: Undergraduate GPAs				
	First year	Second year	Third year	Cumulative - all courses
	(1)	(2)	(3)	(4)
CEE score				
Quantile2	2.394***	2.779***	2.575***	2.335***
	(0.716)	(0.658)	(0.656)	(0.554)
Quantile3	4.298***	4.886***	4.413***	4.018***
	(0.773)	(0.688)	(0.664)	(0.577)
Quantile4	4.229***	4.320***	3.844***	3.733***
	(0.792)	(0.727)	(0.704)	(0.603)
Quantile5	4.522***	4.822***	3.657***	4.067***
	(0.834)	(0.773)	(0.780)	(0.646)
Personal characteristics	Yes	Yes	Yes	Yes
Provincial Dummies	Yes	Yes	Yes	Yes
Constant	76.050***	81.449***	86.643***	80.327***
	(3.885)	(3.720)	(3.836)	(3.013)
Observations	1101	1101	1101	1101
Adjusted R^2	0.26	0.34	0.43	0.37

Note:
Coefficient estimates are reported. Robust standard errors are in parentheses. *, **, and *** indicates the significance level at 10, 5, and 1 percent, respectively. Students are grouped into five quantiles based on their total CEE scores: 0-20th percentile; 20-40th percentile; 40-60th percentile; 60-80th percentile; and the 80th percentile and above. The bottom 20% students are left out as the base group for comparison. Undergraduate GPAs are in a 100-point scale. Regressions include control for personal characteristics and provincial dummies. Personal characteristic variables are female, minority, age at enrollment, urban, first-time exam taker, liberal-art track, and academic majors.

Table 4A CEE, high school performance and undergraduate GPAs-**University A**

	Dependent variable: Undergraduate GPA							
	First year	Second year	Third year	Cumulative - all courses	First year	Second year	Third year	Cumulative - all courses
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
CEE	0.223***	0.193***	0.173***	0.181***	0.222***	0.192***	0.173***	0.180***
	(0.064)	(0.056)	(0.058)	(0.051)	(0.064)	(0.056)	(0.057)	(0.051)
High school award level								
National	1.030***	0.865**	0.975**	0.871**				
	(0.315)	(0.424)	(0.416)	(0.351)				
Province and lower	0.842***	0.460	0.718*	0.712**				
	(0.299)	(0.356)	(0.377)	(0.302)				
High school award type								
Science competition					1.098***	0.847*	0.850*	0.754**
					(0.323)	(0.432)	(0.454)	(0.365)
Outstanding student title					0.710***	0.423	0.686**	0.659**
					(0.274)	(0.339)	(0.329)	(0.281)
Other					-0.327	-0.572	-0.751	-0.706
					(0.555)	(0.731)	(0.861)	(0.657)
Personal characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Provincial Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	55.897***	50.961***	57.708***	56.455***	56.437***	51.363***	58.296***	57.027***
	(7.261)	(6.802)	(7.876)	(6.507)	(7.222)	(6.756)	(7.778)	(6.431)
Observations	1212	1212	1212	1212	1212	1212	1212	1212
Adjusted R^2	0.31	0.27	0.26	0.27	0.31	0.27	0.27	0.27

Note: coefficient estimates are reported. Robust standard errors are in parentheses. *, **, and *** indicates the significance level at 10, 5, and 1percent, respectively. CEE and undergraduate GPAs are in a 100-point scale. Regressions include control for personal characteristics, year and provincial dummies. Personal characteristic variables are female, minority, age at enrollment, urban, first-time exam taker, liberal-art track, interaction of CEE and liberal-art track and academic majors. The base group is those who did not receive any award in high school.

Table 4B CEE, high school performance and undergraduate GPAs-**University B**

	Dependent variable: Undergraduate GPA							
	First year	Second year	Third year	Cumulative - all courses	First year	Second year	Third year	Cumulative - all courses
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
CEE	0.285***	0.257***	0.180***	0.217***	0.286***	0.260***	0.180***	0.218***
	(0.056)	(0.052)	(0.054)	(0.045)	(0.056)	(0.051)	(0.054)	(0.044)
High school award level								
National	2.190	2.348	0.826	1.616				
	(2.030)	(2.472)	(2.094)	(1.963)				
Province and lower	1.444**	1.285*	1.095	1.061*				
	(0.635)	(0.738)	(0.702)	(0.575)				
High school award type								
Science competition					2.411	2.923**	0.527	1.844
					(1.698)	(1.313)	(2.084)	(1.256)
Outstanding student title					1.239*	1.323	0.565	0.809
					(0.693)	(0.829)	(0.803)	(0.655)
Other					0.180	-0.220	0.773	0.191
					(1.151)	(1.199)	(0.978)	(0.932)
Personal characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Provincial Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	57.521***	64.761***	74.975***	66.395***	57.565***	64.743***	75.107***	66.433***
	(6.013)	(5.642)	(6.029)	(4.813)	(6.009)	(5.619)	(6.029)	(4.811)
Observations	1101	1101	1101	1101	1101	1101	1101	1101
Adjusted R^2	0.28	0.35	0.42	0.37	0.28	0.35	0.42	0.37

Note: coefficient estimates are reported. Robust standard errors are in parentheses. *, **, and *** indicates the significance level at 10, 5, and 1percent, respectively. CEE and undergraduate GPAs are in a 100-point scale. Regressions include control for personal characteristics and provincial dummies. Personal characteristic variables are female, minority, age at enrollment, urban, first-time exam taker, liberal-art track, interaction of CEE and liberal-art track and academic majors. The base group is those who did not receive any award in high school.

Table 5A Admission routes and undergraduate GPAs -**University A**

	Dependent variable: Undergraduate GPA			
	First year	Second year	Third year	Cumulative - all courses
	(1)	(2)	(3)	(4)
Recommendation-1	0.797*	1.039**	1.096*	0.343
	(0.477)	(0.442)	(0.561)	(0.636)
Recommendation-2	0.098	-0.241	-0.374	-0.210
	(0.628)	(0.483)	(0.633)	(0.727)
Arts_sports_specialty	-4.142***	-5.121***	-4.528***	-3.888***
	(0.770)	(0.740)	(0.977)	(0.966)
Personal characteristics	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes
Provincial Dummies	Yes	Yes	Yes	Yes
Constant	73.807***	71.628***	65.662***	69.388***
	(1.896)	(3.492)	(5.135)	(5.344)
Observations	1429	1373	1373	1373
Adjusted R^2	0.13	0.26	0.24	0.23

Note: Recommendation-1 refers to students who enter the school by recommendation without taking CEE; Recommendation-2 are those who enter the school by recommendation but have taken CEE and were admitted with a 10-20 point lower score . Arts_sports_specialty are those admitted with a lower score due to art and sports talent. Coefficient estimates are reported. Robust standard errors are in parentheses. *, **, and *** indicates the significance level at 10, 5, and 1percent, respectively. Undergraduate GPAs are in a 100-point scale. Regressions include control for personal characteristics, year and provincial dummies. Personal characteristic variables are female, minority, age at enrollment, urban, first-time exam taker, liberal-art track, and academic majors.

Table 5B Admission routes and undergraduate GPAs – **University B**

Dependent variable: Undergraduate GPA				
	First year	Second year	Third year	Cumulative - all courses
	(1)	(2)	(3)	(4)
Arts_sports_specialty	-0.237	-1.018*	-0.130	-0.375
	(0.605)	(0.583)	(0.538)	(0.470)
Personal characteristics	Yes	Yes	Yes	Yes
Provincial Dummies	Yes	Yes	Yes	Yes
Constant	77.677***	83.065***	87.508***	81.726***
	(3.869)	(3.737)	(3.831)	(3.013)
Observations	1101	1101	1101	1101
Adjusted R^2	0.22	0.30	0.40	0.33

Note: Arts_sports_specialty are those admitted with a lower score due to art and sports talent. Coefficient estimates are reported. Robust standard errors are in parentheses. *, **, and *** indicates the significance level at 10, 5, and 1percent, respectively. CEE and undergraduate GPAs are in a 100-point scale. Regressions include control for personal characteristics dummies and provincial dummy. Personal characteristic variables are female, minority, age at enrollment, urban, first-time exam taker, liberal-art track, and academic majors.

Appendix Table 1: Variable definition and summary statistics

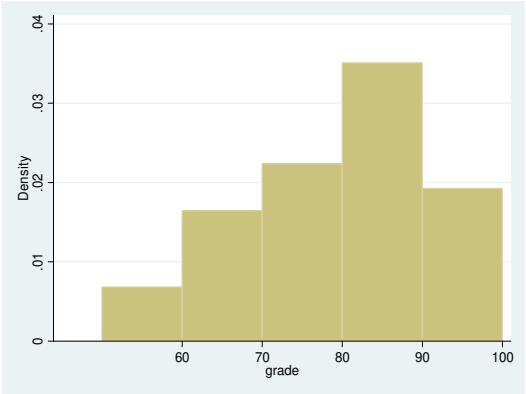
		University A (Obs.=1436)		University B (Obs.=1106)	
	Variable Definition	Mean	Std. dev.	Mean	Std. Dev.
CEE	The total CEE score (Scale 0-100)	84.924	5.451	74.658	5.590
CEE_math	The CEE subject test score for mathematics (0-100 points)	86.778	8.278	70.991	14.688
CEE_chin	The CEE subject test score for Chinese (0-100 points)	77.737	7.178	74.846	15.665
CEE_lang	The CEE subject test score for Foreign language (0-100 points)	85.760	6.806	73.438	5.909
CEE_composite	The CEE subject test score for science/liberal art composite(0-100 points)	87.142	10.045	76.763	11.877
Arts_sports_specialty	The CEE exam takers admitted with a lower score due to an art or sports specialty	0.030		0.075	
First-time exam taker	=1 if a student is a first-time CEE taker, and 0 for re-takers	0.899		0.613	
Liberal-art track	=1 for liberal art track students	0.051		0.490	
Female	=1 for female students	0.501		0.652	
Minority	=1 for ethnic minority	0.058		0.048	
Age at enrollment	Age when entering the school	17.442	0.725	18.844	0.946
Urban	=1 for students from urban areas and 0 for those from rural areas	0.822		0.527	
MIS	=1 if academic major is management information system	0.202			
Finance	=1 if academic major is finance	0.229			
Accounting	=1 if academic major is accounting	0.394			
Economics	=1 if academic major is economics	0.176			
Chinese Literature	=1 if academic major belongs to the Chinese literature catalogue			0.390	
Foreign Language	=1 if academic major belongs to foreign language catalogue			0.222	
Business	=1 if academic major belongs to the business catalogue			0.034	
Science	=1 if academic major belongs to science catalogue			0.177	
Engineering	=1 if academic major belongs to engineering catalogue			0.176	
High school award					
National level	=1 if winning a national-level science completion or awarded a province-level outstanding title	0.208		0.005	
Province and lower level	=1 if receiving a lower level award in high school	0.280		0.074	
High school award type					
Science competition	=1 if winning a science competition in high school (math., physics, chemistry, biology, or computer science)	0.189		0.005	
Outstanding student title	=1 if awarded "outstanding student" title in high school	0.269		0.056	
Other	=1 for other types of award in high school	0.048		0.014	
First year GPA	1st year undergraduate GPA	82.034	4.845	83.767	5.408
Second year GPA	2nd year undergraduate GPA	81.827	6.210	78.956	5.812
Third year GPA	3rd year undergraduate GPA	82.328	6.457	78.762	6.086
Cumulative GPA- all	4-year cumulative GPA for all courses	82.182	5.333	78.705	4.765

Note: mean and standard deviation are reported for continuous variables; and the sample proportion is reported for dummy variables. For University A, mean and standard deviation of CEE subject and total scores are calculated based on the sample admitted via CEE (1264 obs.) Other variables for university A and all variables for university B are calculated with the full sample.

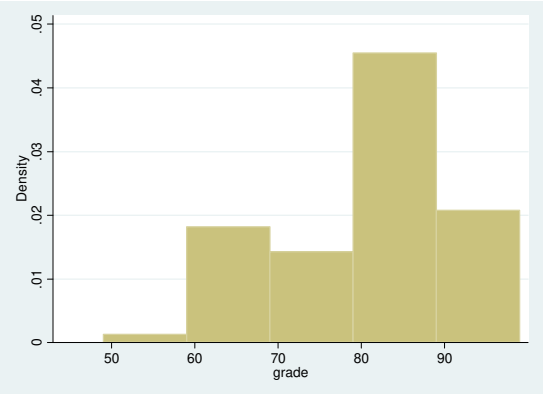
Appendix Figure 1: Comparison of the distribution of course grades in two universities.

Course: College Calculus

University 1 (n=322)

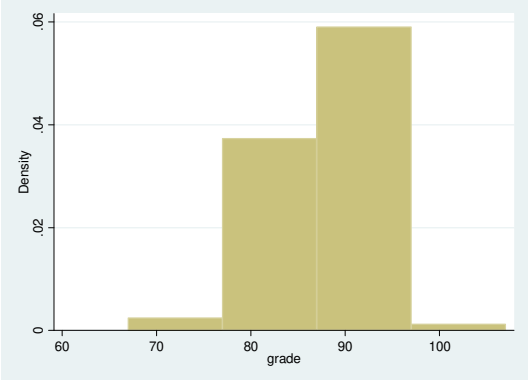


University 2 (n=109)

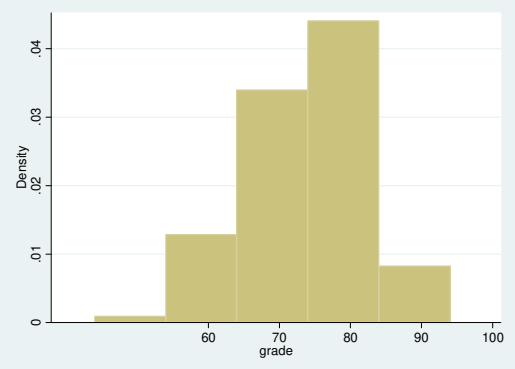


Course: College English-level 1

University 1 (n=322)



University 2 (n=109)



Note: University A included economics and management majors. To make it more comparable, we included only students majored in liberal art and social sciences from the University B sample. For both universities, the sample included the 2005 class. College Calculus and English were both first-year mandatory courses in the two universities.