Aim High and Persevere! Competitive Pressure and Access Gaps in Top Science Graduate Programs

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Abstract

In many modern societies, access to top science graduate programs is determined by standardized competitive exams. The ambition is to guarantee equal opportunities between candidates. However, female and low-income students are still largely underrepresented in these programs. Relying on a unique database on French *Grandes Écoles* graduate programs, this paper highlights one of the structural mechanisms of this differential selection, namely the fact that competitive entrance exams generally require lengthy preparation and that high-income male students have a greater propensity to repeat years of preparation and retake exams. Our data are consistent with a simple model in which high-income male students are more sensitive to small differences in prestige between programs and where the potential impact of year repetition on performance is very significant for most students.

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1 Introduction

In most societies, access to the best academic institutions is still extremely unequal between children from different social backgrounds. In the US, for example, 14.5% of Ivy-Plus students come from the top 1% richest families, while 13.5% come from the bottom 50% (Chetty et al., 2020). Moreover, within elite higher education itself, female students are still largely underrepresented in math-intensive fields, even though these fields are among the most dynamic in the labor market. In France, for example, female students outperform males in high school science, but make up less than 20% of students admitted to the most selective scientific *Grandes Écoles* (GEs), the country's most prestigious graduate programs.[1]

These access gaps have given rise to a large literature, but the mechanisms are still widely debated, and the role of selection systems remains unclear. Access to leading institutions generally requires hard work and high academic skills, but not only that. In many contexts, it also requires lengthy preparation and multiple applications. In Japan or France, for instance, access to the best universities or to the best GEs is restricted via standardized competitive exams that involve difficult preparation, and many candidates succeed in being admitted only after repeating and taking the exams several times. Competitive entrance exams are not specific to France or Japan: many other countries throughout the world use a similar system to select students into undergraduate or graduate programs (e.g., China, Taiwan, Korea, Russia, India, Chile, Brazil, Algeria, Morocco, and Tunisia). The possibility of applying multiple times to enter the most prestigious higher education programs is not specific to countries that rely on competitive exams. In Norway, for example, students apply to universities at the end of high school with their high school GPA. If they are not satisfied with their admission results, they can improve their GPA the following year by taking additional high school exams as private candidates and apply again for university.

Giving applicants the opportunity to apply multiple times mitigates the hazards that affect each individual application (illness, accidents, etc.). However, it also gives an advantage to applicants for whom it is less costly to persevere and reapply a larger number of times. This is true in the education system, but it is also true in most other competitive environments. Whether selecting the best candidate for a job or funding, most organizations generally allow applicants to apply more than once, which represents a potential mechanism for explaining the persistence of gender and social inequalities in access to the most sought-after positions. In this paper, we exploit a unique dataset on French GE entrance examinations to test this assumption in the academic context and analyze the extent to which the possibility of repeating years of exam preparation contributes to the strong overrepresentation of

[1] See the official website of GE competitive exams at https://www.scei-concours.fr/.

high-income male students in top science graduate programs.

Competitive entrance examinations to GE require two years of intense preparation after high school, in specific preparatory classes. There are more than 200 GE programs that use competitive exams as a means of recruitment, but only applicants ranked among the top 15% succeed in joining one of the first-tier programs (among the small dozen), which constitute the breeding ground of the French scientific and managerial elites. When the results obtained at their first attempt do not live up to their expectations, students are allowed to repeat a year and retake the exams the following year.

By comparing female and male students with similar results at their first attempt, we first show that female students tend to repeat and retake exams much less often than males, especially high-income males. In particular, when they marginally miss out on admission to a more prestigious program, about 20% of high-income male students choose to repeat a year, while narrowly failing to be admitted has almost no effect on other students. These differences in repetition rates are all the more significant as repetitions have a very positive effect on repeaters' outcomes. By comparing the results obtained by repeaters during their second and first attempts, we show that repetition is followed in a very large majority of cases by significant progress, for both female and male repeaters, high and low-income students alike. Furthermore, by comparing students just below and just above the different admission thresholds, we are able to develop a regression discontinuity (RD) analysis, which reveals that the impact of repetitions on marginal non-repeaters is about as large as the impact on average repeaters.

Overall, our results are consistent with a simple choice model in which high-income male students are much more sensitive to small differences in prestige between programs (which leads to more repetition) and in which repetition is highly beneficial for most students, regardless of their initial level of performance and expectations. In this context, differences in repetition rates between girls and boys or between boys from disadvantaged and advantaged families contribute to widening inequalities in access to the most prestigious programs. Specifically, according to our estimates, differences in repetition rates increase the gender gap in access to top-tier programs by about 47% and the gap between high-income and low-income male students by about 16%.

Women's pathway into higher education is often described as a "leaky pipeline", as their proportion decreases at multiple points along the path from high school to top graduate programs (see, e.g., Buckles, 2019; Ceci et al., 2014; Goulden et al., 2009). The first contribution of this paper is to highlight one of the structural mechanisms of this differential selection of male and female students, namely the greater propensity of males to repeat and retake exams, combined with the important benefits of repetition and exam retaking for access to the most selective programs. Several papers have shown—mostly through lab experiments—that females and low SES students are more likely to turn away from competitive settings than their male or high SES counterparts (see, e.g., Almås et al., 2016; Croson and Gneezy, 2009; Landaud, Ly and Maurin, 2020; Niederle and Vesterlund, 2011). Recent experimental findings have also shown that women are more likely than men to exit a low stake math competition after a setback (see Buser and Yuan, 2019; Ellison and Swanson, 2018), and tend to leave a TV game contest prematurely (see Hogarth, Karelaia and Trujillo, 2012). Our results are in line with these experimental findings, but—in a real-world, high-stakes context—they also suggest another basic explanation for female students' lower perseverance, namely, their lower sensitivity to small differences in prestige between programs and to gains in prestige that may be associated with greater perseverance. Our results also echo recent studies in political science that point out that differences in perseverance are likely to contribute to the underrepresentation of women in politics at the local level (Novaes, 2017; Wasserman, 2020) and among grant winners (Kolev, Fuentes-Medel and Murray, 2019).

Our paper also contributes to the small literature on the causal effect of exam retaking on student outcomes (see, e.g., Frisancho et al., 2016; Goodman, Gurantz and Smith, 2020; Vigdor and Clotfelter, 2003). This literature focuses mainly on exams taken by high school students (such as the SAT) in order to apply for university entrance. To our knowledge, our work is one of the first to analyze the impact of the decision to repeat a year and retake exams on the trajectory of students in higher education, in particular on their chances of being admitted to the most selective graduate schools.

Finally, our work contributes to a better understanding of why standardized national competitions do not necessarily guarantee equal opportunities between students. In many modern societies, access to elite institutions of higher education requires passing very selective standardized competitive exams. The idea is to eliminate the privileges of birth that prevent a student from attending prestigious institutions for the sole reason that he or she was not wellborn. Standardized competitive exams remain a fundamental principle of selection in France or Japan, but also in China, Taiwan, Korea, India, Brazil, Russia, Chile, Tunisia, Morocco, and Algeria. One basic appeal of competitive entrance exams is their transparency. Less transparent admission processes—as in the US—are often accused of covert discrimination (see, e.g., Arcidiacono, Kinsler and Ransom, 2019, 2020; Bell, 2005) as well as of making direct parental influence possible, within or beyond legality, as in the recent admissions scandal known as Operation Varsity Blues. However, our work highlights that transparent competitive entrance exams may not be as meritocratic as hoped, as students from different backgrounds are not necessarily equally equipped to prepare, take, and retake these exams.

The structure of this paper is as follows: in the next section, we describe the institutional framework.

Section 3 describes the data and provides some basic evidence on repetition behaviors. Section 4 develops a conceptual framework, and Section 5 presents the results from our RD approach. In Section 6, we discuss potential mechanisms behind our finding that women are less likely to repeat a year than their male counterparts. Finally, Section 7 concludes the paper.

2 Institutional Setting

Each year, between 20,000 and 25,000 French high school graduates are admitted to a *Classe Préparatoire aux Grandes Écoles scientifiques* (hereafter, CPGE). These students represent between 10% and 15% of high school graduates with a major in science and less than 3% of a birth cohort. Admission to a CPGE is based on high school records. High school students admitted to a CPGE program are typically among the best students of their senior classes (see, e.g., Bechichi and Bluntz, 2019).

CPGEs are spread over about 140 schools throughout the country.[2] The vast majority of these schools are public (or heavily subsidized), and the registration fees are almost nil. In addition, most schools offer boarding places at highly competitive rates (around 2000 euros per year, including meals and laundry, in 2014). About 25% of CPGE students are boarders. The proportion is similar for women and men. At the end of two years of preparation, CPGE students take national competitive exams to obtain admission to one of the GE program. There are more than 200 such programs, and they recruit approximately 15,000 CPGE students every year. There are huge differences in selectivity and prestige between the different GE programs, and the goal of most students is to join the most prestigious institution possible.

The curriculum of CPGE programs is the same (and very heavy) in all schools. The aim is to assimilate in two years several disciplinary curricula (in math, physics, engineering sciences, and computer science), each of which would be assimilated in three years by following a standard undergraduate university program. CPGE programs are notorious (and feared) for the sacrifices and very hard work they require. Students have tests of several hours each week (typically on Saturdays), and each test results in a ranking of students. An overall ranking is also established at the end of each semester as well as at the end of the first year. The highest ranked students at the end of the first year are grouped in the same classes in the second year (so-called *classes étoiles*).

The first year of preparation (known as *mathématiques supérieures* or *maths sup*) cannot be repeated and remains multidisciplinary, although a distinction must be made between MPSI-type programs (emphasis on math/physics, about 8,000 students each year) and PCSI-type programs (emphasis on

[2]There are also a few CPGEs that are not located in France (mainly in Morocco and Tunisia). The following analysis, however, focuses on students from CPGEs located in France.

physics/chemistry, about 8,000 students).[3]

The second year (known as *mathématiques spéciales* or *maths spé*) leads to a clearer specialization: students may choose to focus more on mathematics (MP track), physics (PC), or engineering sciences (PSI). At the end of this second year, students take competitive examinations for the first time. If they are not satisfied with the GEs to which they are admitted after this first attempt, they can repeat their *maths spé* year in order to take the entrance exams a second time. Each year, about 25% of students opt to repeat and retake the exams.

It should be emphasized that these repeaters are generally allowed to redo the preparation in the same CPGE program.[4] If their first-time results are considered promising (if they are eligible for admission to a good second-tier program, for instance), they may even be allowed to repeat in a more selective CPGE program. After a repetition and a second attempt, however, it is very rare to be allowed to repeat a year a second time (except in the case of health problems).

2.1 Competitive Exams

There are several competitive exams (known as *concours*), and each one is organized by a group of GEs. If we focus on the three main types of second-year tracks (i.e., MP, PC, or PSI), the most prestigious *concours* are the *concours X-ENS* (organized by the *École Polytechnique* and the four *Écoles Normales Supérieures*, ENS); the *concours commun Mines-Ponts* (CCMP, 10 different GE programs); and the *concours CentraleSupelec* (CCS, 10 programs). Among the other (less selective) *concours*, the most popular are the *concours commun polytechnique* (CCP, about 70 GEs use this competition to recruit their students) and the *concours E3A* (about 60 GEs).

Most students take the CCMP, CCS, and CCP at the end of their preparation. The best students also take the X-ENS exams (often instead of CCP), whereas the weakest take the E3A exams. The 12 GEs generally considered to be the most prestigious are the *École Polytechnique*, the four ENS, the two most selective GE in the CCS competition (*CentraleSupelec* and *Centrale Lyon*), and the five most selective schools in the CCMP competition. Given the number of seats offered in these 12 GE, one must be among the top 15% CPGE students to be admitted to one of them.[5]

For each one of these different concours, students have to first take written assessments (over a period

[3]There are other types of less selective, more specialized scientific CPGE such as PTSI type programs (technology/engineering sciences, 3,000 students) or BCPST classes (biology/chemistry, 3,000 students).

[4]The few students who are not allowed to repeat a year in any institution can always prepare for competitive examinations outside the preparatory class system. It is possible to sit in for the competitive entrance examinations without coming from a preparatory class.

[5]Many CPGE rankings are published each year, and the most widely considered (published by the magazine *L'Étudiant*) uses the proportion of students admitted to these 12 schools as the main ranking criterion.

of approximately three to four days).[6] If they pass these written exams, they take additional oral tests. The written exams begin every year in late April, and oral exams end by late July. In August, after the last oral exams, students are ranked, and GE assignment is processed by a centralized system that takes into account students' final rankings in the various competitive exams as well as their preferences of GE programs. By the end of August, all students are informed about the GE to which they have been admitted. They must then decide either to register or to repeat a year in order to retake competitive exams the following year.

2.2 The Concours Commun Mines-Ponts

In this paper, we will focus on students from the MP and PSI tracks who participate in the CCMP at the end of their second CPGE year (i.e., the end of their first year of *mathématiques spéciales*).[7]

As mentioned above, the CCPM is organized by ten GE programs, including some of the oldest and most prestigious.[8] It attracts about 5,500 MP applicants and 3,500 PSI applicants every year, i.e., about 75% of students in these tracks. It is also one of the most selective competitive exams: only about 30% of applicants pass the written exams and are allowed to take the oral exams. Eventually, to obtain an offer of admission from one of the five most prestigious institutions in this competition, one must generally be ranked among the top 15% of applicants. Approximately 25% of students choose to repeat after their first CCMP participation, and of these, almost all retake the CCMP exams the following year. Our basic research question will be to identify the impact of repetition on final ranking, as well as the variation in this impact across gender and social groups. Before moving on to this analysis, it should be noted that first-time candidates receive a bonus of points, which corresponds to an average gain of about 15 percentile ranks in the overall ranking (as discussed in Appendix B). The bonus is the same for all students. In the remainder of the paper, we will look at the impact of repetition on both unadjusted and adjusted outcomes for these bonus points.

[6]There are typically two math tests, two physics tests, a computer science test (as well as an engineering science test for PSI students), a French language test, and an English language test. The content of the tests is different for MP and PSI students. The duration of the tests varies between 2 h and 4 h.

[7]Note that this sample restriction is purely data-driven: we do not have individual information on other competitive exams than the CCMP, and we do not have information on CCMP applicants from other tracks than the MP and PSI tracks.

[8]These programs are *École Supérieure des Mines de Paris*, *École Nationale des Ponts et Chaussées*, *École Nationale Supérieure des Télécommunications* (known as Telecom, with two different programs, admission thresholds, and locations, in Paris and Nice), *École Nationale Supérieure des Techniques Avancées*, *Institut Supérieur de l'Aéronautique et de l'Espace* (known as Supaéro), *École Nationale de la Statistique et des Études Économiques* (ENSAE), *École Nationale Supérieure des Mines de Nancy*, *École Nationale Supérieure des Mines de Saint-Etienne*, and *École Nationale Supérieure des Télécommunications de Bretagne* (*Telecom Bretagne*). The first five are the most selective and belong (as mentioned above) to the small group generally considered to constitute the most elite GE programs.

3 Data and Basics Facts

The administrative data used in this paper come from the statistical service of the Ministry of National Education and the statistical service of the CCMP, one of the most popular and prestigious competitive examinations taken by CPGE students. The data from the CCMP statistical service cover all students registered for this examination in the MP and PSI tracks for all sessions between 2012 and 2017. We have detailed information on their CPGE schools of origin as well as on whether they are taking competitive exams for the first time or the second time (repeaters). With regard to performance in the competition itself, these data specify for each student whether he or she was eligible for the oral examinations (i.e., in the top 30% at the written exams) and, if so, his or her final ranking.

Data from the Ministry of National Education provide information on all students enrolled in CPGE programs located in France, for each academic year between 2011–2012 and 2016–2017. These data are anonymous but contain a student identifier that makes it possible to follow students from one academic year to the next. It is possible to distinguish between students enrolled for the first time in the second year of preparation and students repeating their second year of preparation. These data also contain information on students' date of birth, gender, scholarship status, as well as on the type of track attended (MP or PSI) and the type of class attended (star or non-star classes). We also have detailed information on students' results at the end of high school national exams.

To construct our working sample, we matched CCMP data with data from the Ministry at the individual level, using information on exact date of birth, CPGE schools, CPGE tracks, CPGE class, scholarship status, and first- or second-time status from both sources. This matching procedure makes it possible to reconstitute for 94% of first-time participants a set of variables describing whether they repeated a year, and, if so, whether they participated again in the CCMP the following year and the evolution of their ranking. The working sample is made up of the 29,206 students who took part in CCMP at the end of their second year of preparation between academic years 2011–2012 and 2015–2016, with information on their results at the end of high school national examinations, the type of CPGE they attended, their ranking in the CCMP at the end of their first attempt, as well as whether they chose to repeat their second year of preparation. In the latter case, we know whether they retook the CCMP and, if so, their ranking at the end of this second attempt. Eventually, we were able to augment this dataset with information on students' ranking adjusted for the bonus points obtained by first-time participants. Specifically, we built on an auxiliary dataset (from a specific CPGE school) with full information on students' ranking, bonus points, and total number of points obtained at the CCMP, to construct a precise correspondence table between students' unadjusted and adjusted rankings (for more details, see Appendix B).

3.1 The Effect of Repetition on Repeaters

One of the strengths of our dataset is that it makes it possible not only to identify repeaters but also to measure the effect of repetition on their performance directly. Figure 1 shows how the probability of repeating a year varies across groups of applicants defined by their level of performance at their first attempt. Not surprisingly, the figure shows that the lower the level of performance at that first attempt, the higher the probability of repeating a year. This probability is close to zero for first-time applicants who are eligible for admission to the most prestigious CCMP program (i.e., the Mines de Paris),[9] and it is about 0.32 for first-time applicants who are eliminated at the end of the written exams and are not eligible for admission to any CCMP program.

Table 1 provides additional evidence on how repetition rates vary across subgroups of first-time applicants, as well as on the effect of repetition on repeaters' outcomes. The table first reveals that female students repeat significantly less often than male students. For example, if we focus on first-time participants eligible for admission to a second-tier program, the repetition probability is about 12.3% for female students against 19.3% for males. This gap is all the more striking because female students are even more rarely admitted than males to one of the few programs likely to be preferred to CCMP programs, namely the ENS, *École Polytechnique* or *École CentraleSupelec*.[10] As discussed below, there are several possible explanations for this repetition gap between female and male students, including the lower sensitivity of female students to the prestige gains that can be achieved by repeating a year.

With respect to the effect of repetitions on repeaters, the table shows that repetitions are followed by significant improvements in outcomes for both repeaters who were eligible for admission to at least one program at first attempt, and repeaters who did not pass the written exams and were not eligible for admission to any program (and, consequently, were not ranked). Among the latter, about 25% end up being eligible for admission to at least one program on their second attempt. Among the former, about 81% obtain a better ranking at their second attempt. Further investigations show that these ranking gains are in most cases significant enough to give access to a more selective program: among repeaters who were eligible for at least one program initially, about 74% of males and 69% of females end up being

[9] A few students eligible for admission to the *Mines de Paris* (the most selective CCMP program) choose to repeat a year because they absolutely want to join the *École Polytechnique* or the ENS, but this is very rare.

[10] For example, between 2012 and 2016, in the MP track, female students make up on average about 18% of students admitted to at least one CCMP program, but only 7% of those admitted to an ENS, 14% of those admitted to *École Polytechnique*, and 14% of those admitted to *CentraleSupelec*.

eligible for admission to a more selective program after repeating (see Table A1 in the Online Appendix).

Positive effects dominate for both female and male repeaters, as well as for both high-income and low-income repeaters. It should be noted, however, that—among repeaters who were initially eligible for admission to at least one program—the risk of not making progress and falling back in the ranking is not zero and tends to be higher for female than for male students (0.22 vs. 0.13). Further explorations show that among repeaters who were initially eligible for admission to at least one CCMP program, the proportion who failed to achieve admission to any CCMP program on repeating is about 13.1% for females against 8.2% for males, while the proportion who ended up being eligible for a less prestigious CCMP program only is about 8.4% for females and 4.6% for males. At their second attempt, the stakes are higher, because, as mentioned above, the chances of repeating a second time are very low. The fact that female repeaters have a somewhat higher failure risk than male repeaters is consistent with the literature suggesting that girls tend to perform less well when the pressure and the stakes are higher (see, e.g., Azmat, Calsamiglia and Iriberri, 2016; Bertrand, 2011; Cai et al., 2019; Niederle and Vesterlund, 2011).

4 Conceptual Framework

In the previous section, we highlighted that repetition has a positive effect on most repeaters, including on those who initially managed to be eligible for admission to at least one program. In the rest of the paper, we try to find out whether this effect of repetition on repeaters represents a good proxy for the effect of repetition on non-repeaters, should they decide to repeat. Ultimately, the objective is to better understand the effect of encouraging a larger share of students to spend three years rather than only two years in preparatory classes.

To shed light on this issue, we compare students whose initial ranking falls either just below or just above an admission threshold. Students who are just below an admission threshold are eligible for admission to one program less than students just above and, as we shall see, have a greater likelihood of repeating a year, the question being whether this ultimately leads them to obtain better results than students just above the threshold. Before moving on to this RD analysis, we develop a simple conceptual framework, to better define the parameters that are identified with this strategy.

4.1 A Model of Competitive Exams

We assume that students take J different standardized competitive exams. Each competitive exam provides access to K types of GE programs, listed in ascending order of selectivity and prestige: $1-type$ programs are the least prestigious and $K-type$ programs are the most prestigious. All students agree with these rankings, even if they do not all give the same importance to differences in prestige across types of programs.

For each competitive exam j (with $j = 1, ..., J$), we denote s_{kj} the (percentile rank) admission threshold that correspond to type k programs in j, with $0 < s_{1j} < ... < s_{Kj} < 100$. In order for a participant in competitive exam j to be admitted to a $k - type$ program in j, his/her percentile rank at the end of exam j must be greater than s_{kj}. The different types of programs each student is admitted to may vary from one competitive exam to another, as do the admission thresholds.

At the end of his/her initial attempt at the different competitive exams, we define $k_{1i}(j)$ as the best type of program to which student i is admitted in competitive exam j, and we define $k_{1i} = max(k_{1i}(j),\ for\ j = 1, ..., J)$ as the best type of program to which i is admitted (all competitive exams combined). In addition, we define $k_{1i}(-j)$ as the best type of program to which student i is admitted in competitive exams other than j. Eventually, we denote $U_i(k)$ as the utility for student i to join a $k-type$ program.

With these notations, the level of utility that student i achieves at the end of his/her first attempt is $U_{i1} = U_i(k_{1i})$ (if he/she chooses not to repeat), whereas the level of utility that he/she expects to achieve a year later (if he/she chooses to repeat a year and retake exams) is $U_{i2}^e = p_{i1}U_i(1)+...+p_{ik}U_i(k)+...+p_{iK}U_i(K)$, where p_{ik} represents the subjective probability of being admitted to a $k-type$ program at the end of the following year.

Finally, we assume that student i repeats a year at the end of his/her first attempt if and only if the expected welfare gain from repeating (as measured by $U_{i2}^e - U_i(k_{1i})$) is greater than the expected cost (denoted c_i). Hence, denoting R_i the dummy variable indicating that i chooses to repeat, we have (omitting subscript i):

$$R = 1 \Leftrightarrow U_2^e - U(k_1) - c > 0 \tag{1}$$

The probability of repetition can be expected to be lower for students who perform better initially (higher k_1), but also for students who have the least confidence in their ability to progress (smaller p_k, for $k > k_1$) as well as for those who experience the least satisfaction in studying in the highly competitive context of preparatory classes (i.e., stronger c). Also, the probability of repeating is expected to be smaller for students who are the most risk averse, that is, for students who perceive potential welfare losses ($U(k_1) - U(k)$, for $k < k_1$) to be much larger than the potential welfare gains ($U(k) - U(k_1)$, for $k > k_1$).

4.2 A Regression Discontinuity Design

In this setup, we consider a specific competitive exam j_0, and our main objective is to evaluate the impact of repeating a year on students' performance in j_0. Specifically, if we denote by y_1 the percentile rank of students at the end of their first attempt at j_0 and by y_2 their percentile rank at the end of their second attempt (in case they choose to repeat), our purpose is to evaluate $y_2 - y_1$. The number of candidates and their baseline ability distribution are assumed to be constant over time so that $y_2 - y_1$ provides a measure of the impact of year repetition on students' human capital.

For repeaters, we observe both y_1 and y_2, so that the impact ($y_2 - y_1$) of repetition on their performance is also directly observed in the data. For non-repeaters, the estimation is less straightforward because y_2 is not observed. The only outcome variable that is observed for both repeaters and non-repeaters is the final outcome y, with $y = R \times y_2 + (1 - R) \times y_1$. It is possible to circumvent this problem, however, by comparing the repetition decisions (R) and final outcomes (y) of students whose ranking y_1 is either just below or just above the different admission thresholds. Assuming that students' potential outcomes y_2 do not change discontinuously at the thresholds, this RD analysis provides us with an evaluation of the impact of repetition on non-repeaters who are on the margin of repetition.

To understand why this is the case (and who exactly are the compliers), let us consider students whose initial ranking y_1 falls either just above or just below the k^{th} admission threshold s_{kj_0}. For those students who have not managed to do better than being eligible for admission to a $(k-1)-type$ program in the other competitive exams (i.e., $k_1(-j_0) < k$), the best option k_1 varies abruptly at the threshold, and there is no reason for any other key parameter to vary discontinuously as well. Specifically, for those below the threshold, we have $k_1 = k - 1$, whereas for those above the threshold, we have $k_1 = k$. Hence, for those for whom $k - type$ programs represent the minimum acceptable outcome, the repetition decision depends on whether y_1 falls just below or just above the threshold. Specifically, the expectations of these "marginal" students satisfy ($U(k-1) + c < U_2^e \leq U(k) + c$), and they choose to repeat when y_1 falls just below the threshold (because $U(k-1) + c < U_2^e$), but they choose not to repeat when y_1 falls just above the threshold (because $U_2^e \leq U(k) + c$).[11]

[11]By contrast, those whose expectations are such that $U_2^e > U(k) - c$ choose to repeat, regardless of whether y_1 falls below or

At the end of the day, the comparison of repetition rates just above and just below the k^{th} threshold of j_0 identifies the proportion of students for whom $k-type$ programs represent the minimum acceptable outcome, but who did not manage to do better than being admitted to a $(k-1)-type$ program in the other competitive exams.[12] In addition, the comparison of final outcomes y just above and just below the same threshold makes it possible to identify the causal impact of repetition on the final outcomes of these compliers, namely the following RD parameter:

$$G_c(k) = E(y_2 - y_1 \mid y_1 = s_{kj_0},\ U(k-1) + c < U_2^e \leq U(k) + c,\ k(-j_0) \leq k-1) \tag{2}$$

It is possible to compare this parameter with the average effect of repetition on repeaters whose y_1 falls just above the threshold. This average effect is identified by comparing the performance of these repeaters at their first and second attempts and can be written as:

$$G_r(k) = E(y_2 - y_1 \mid y_1 = s^+_{kj_0},\ U_2^e > U(k) + c) \tag{3}$$

Compared with compliers, repeaters performed better overall (their best outcome k_1 is at least as high as that of compliers) and have higher expectations (their U_2^e is higher than that of compliers). Hence, assuming, for example, that there is no significant difference between G_r and G_c, this would suggest that the effect of repetition on students' achievement in a given competitive exam is not much higher for students with the highest academic potential and the highest expectations.

5 Results

In this section, we consider our working sample of first-time participants who are eligible for admission to at least one CCMP program, and we compare those whose first-time rankings fall just below an admission threshold with those whose first-time rankings fall just above a threshold.[13]

To begin with, Figure 2 focuses on the probability of repeating a year and reveals that this probability is significantly higher for students just below than for students just above the admission threshold. Specifically, the repetition probability is on average about 0.12 for first-time participants just below

above the threshold. Symmetrically, those whose expectations are such that $U_2^e \leq U(k-1) + c$ choose not to repeat, regardless of whether y_1 falls below or above the threshold.

[12] If it appears that this proportion is zero for a group of students, this will suggest that this group of students is insensitive to elementary variations in prestige between $(k-1)-type$ and $k-type$ programs (so that their expectations satisfy $U(k-1) = U(k)$, and the $(U(k-1) + c < U_2^e \leq U(k) + c)$ interval is empty). As we shall see, our data suggest that girls (and low-income boys) are indeed largely insensitive to variations in prestige between the programs that are close to each other in the hierarchy.

[13] As mentioned in Section 3, our working sample excludes students who are located around the admission threshold of the least selective program, as very few students obtain a ranking below the admission threshold of this program.

a cutoff point, but only about 0.10 for those just above. Students below a threshold are eligible for admission to exactly one program less than those above the same threshold, and the figure shows that this is enough to increase their probability of repeating a year and retaking exams by about 2 percentage points (i.e., about 20%). This result is consistent with the assumption that there are on average about 2% of applicants who choose to repeat if they just fail to be admitted to a program, but who choose not to repeat if they just succeed. Using the same notations as in the previous section, this shift in repetition rate identifies the average value of $Pr((U(k-1)+c < U_2^e \leq U(k)+c),\ k(-j_0) \leq k-1,\ y_1 = s_{kj_0})$ across thresholds. Assuming that there is no discontinuity in students' expectations (i.e., no discontinuity in U_2^e) at the cutoff points, the fact that the average shift in repetition rate is significant implies that a significant share of students are sensitive to small variations in program prestige, namely placing a significant value on being able to join a $k - type$ program rather than a $k-1$ one (i.e., $U(k-1) < U(k)$).

Given these facts, the next question is whether we observe a similar shift in students' final outcomes. Figure 3 suggests that it is the case. The figure focuses on the same sample of students as Figure 2 and plots the probability that their final ranking y is better than their initial one y_1, namely the probability of observing $y - y_1$ positive.[14] As it turns out, we observe almost exactly the same significant decline in this probability (2 percentage points) at the cutoff as the decline in the probability of observing $R = 1$ in Figure 2. Assuming that there is no discontinuity in students' potential outcomes at the cutoff points, this result suggests that the decline in the probability of repeating a year in Figure 1 is almost entirely driven by a decline in the joint probability of repeating a year and achieving a higher ranking at the second attempt. Put differently, the vast majority of students who are close to repeating a year (our compliers) are students for whom repeating a year would lead to a better final ranking. Figure 4 further suggests that in the vast majority of cases, the ranking gain would actually be greater than that required to gain admission to a more selective program. Specifically, the figure plots the probability that the difference $y - y_1$ between the final ranking and the ranking at the first attempt is greater than the 10.2 percentile rank (where the 10.2 percentile rank represents the average gap between two successive admission cutoffs), and the figure reveals that this probability is itself nearly 2 percentage points higher for students just below the cutoff point,[15] namely a shift that is almost as significant as the shifts shown in Figure 3 or 2.

The hope of any repeater is to achieve a better ranking the following year. The major risk, however, is to fail completely and not even manage to be ranked the following year. We checked, however, that the

[14]Because $y - y_1 = R \times (y_2 - y_1)$, the probability of achieving a final ranking higher than the initial ranking is the joint probability of repeating a year and achieving a higher ranking on the second attempt.

[15]Let us emphasize that the graphical analysis in Figures 3 and 4 is performed on unadjusted rankings. We get exactly the same diagnoses when we use rankings adjusted for the bonus of points granted to first-time participants (see Appendix A Figure A1).

joint probability of year repetition and complete failure is both very low (less than 0.01) and very similar for students below and above admission thresholds (see Figure A2 in the Online Appendix).

Building on this result, Figure 5a focuses on the subsample of students who do not lose eligibility status between their first and last attempts, and plots the difference between their last- and their first-attempt ranking (i.e., it plots $y - y_1 = R \times (y_2 - y_1)$).[16] Figure 5b plots the same difference after adjusting for the bonus point granted to first-time participants. Figure 5a shows that the rank difference is about 0.5 percentile rank larger for students just below an admission threshold than for those just above, which suggests that the causal effect of year repetition on compliers' ranking is on average about 25 percentile rank (where $25 = \frac{0.5}{0.02}$). Figure 5b confirms that the impact would be even larger (50 percentile rank) if no bonus points were granted to first-time participants.

In Appendix A, we provide additional figures showing that there is no significant discontinuity in students' baseline characteristics (gender, social background, and scores at the end of high school national exams) at the cutoff.[17] This is consistent with our identifying assumption that there is no discontinuity in students' expectations or potential outcomes at the cutoff. We also provide additional figures suggesting that the discontinuities in repetition rates and final outcomes are much sharper for high-income male students than for females or low-income males (see Figures A4 and A5). The sharper discontinuity in repetition rates for high-income males is suggestive that this group of students is more sensitive to the difference in prestige between programs than the other groups. The sharper discontinuity in their final outcomes is consistent with the assumption that changes in final outcomes at the cutoff are driven by changes in repetition rates.

5.1 Econometric Analysis

To test the robustness of our graphical findings and explore heterogeneous effects, this section provides a RD analysis of the impact of being eligible for admission to one additional (more selective) program on students' outcomes. Specifically, we consider the same working sample as Figure 2, and, for each individual i and each program k, we assume the following RD model:

$$Y_i = \alpha \mathbb{1}\left\{y_{1,i} - s_k \geq 0\right\} + \eta\left(y_{1,i} - s_k\right) + \lambda\left(y_{1,i} - s_k\right) \times \mathbb{1}\left\{y_{1,i} - s_k \geq 0\right\} + X_i \gamma + u_i \tag{4}$$

where Y_i represents the outcome of student i, while y_{1i} denote his/her first-attempt ranking, and s_k

[16] Focusing on the subsample of students who do not lose eligibility status between their first and last attempts is made legitimate by the fact that, as discussed just above, the probability of losing one's eligibility status is unaffected by falling above a threshold rather than below, that is, unaffected by being eligible for admission to one additional program.

[17] See Figures A3a–A3c in Appendix A.

the admission threshold of program k. Variable X_i is a set of control variables (including year dummies, CPGE track, and school dummies as well as student's age, gender, low-income status, and high school graduation results),[18] and u_i the unobserved determinants of student's final outcome.

Following Pop-Eleches and Urquiola (2013), we estimate α after stacking the observations below and above the different admission thresholds, so that every student can be used as an observation for every admission threshold, and we cluster standard errors at the student level. We follow Calonico, Cattaneo and Titiunik (2014) to define the optimal bandwidth around the cutoff points (this optimal bandwidth is of 21 percentile ranks), and we use a triangular kernel centered around admission cutoffs. In Appendix A, we show that our results are robust to alternative functional forms, bandwidths, and sets of control variables.

Under the maintained assumption that there is no discontinuity in the distribution of u_i at the cutoffs, the parameter α can be interpreted as the local average effect of eligibility for admission to a more selective GE program on outcome Y. Table A2 in the Online Appendix reports the results of regressing students' predetermined individual characteristics (gender, low-income status, age, and high school graduation results) on a dummy indicating eligibility for admission into a more prestigious GE program using the same RD model. Consistent with our identifying assumption, we do not find evidence of any discontinuous variation in baseline characteristics at the eligibility cutoff. Finally, we build on McCrary (2008) to test for possible manipulation of the running variable around the cutoff. Figure A6 does not show any significant difference in the (log) height at the cutoff.

Table 2 shows the main regression results for the full sample (panel A) as well as for the female subsample[19] (panel B), and the male subsample (panel C), which we further divided into a low-income male subsample and a high-income male subsample.

Consistent with our graphical findings, the first column of panel A shows that eligibility for admission to one additional program significantly reduces the probability of repetition for first-time participants. Specifically, we see a negative shift of about –1.6 percentage points in repetition probability at the cutoff. The two following columns confirm that this decline in repetition coincides with a decrease of almost exactly the same magnitude in the probability that students retake exams the following year, as well as in the probability that they have improved their ranking by repeating (i.e., $y - y_1 > 0$).

These results are consistent with the assumption that there is an almost one-to-one relationship between year repetition, exam repetition, and improvement in ranking between first and last attempts. In

[18] We rely on a double-lasso procedure to define the subset of controls that are actually included in each regression.

[19] The sample of female students is too small for performing robust estimation of the RD model separately on the low- and high-income groups.

addition, column (4) shows that the decline in repetition at the cutoff coincides with a decrease of –1.5 percentage points in the probability that the difference $y - y_1$ between last and first ranking is greater than the average gap between two successive admission cutoffs. Hence, taken together, results in columns (1) and (4) suggest that, in about 94% of the cases, repeating a year would allow marginal non-repeaters (our compliers) to become eligible for a more prestigious program (where $0.94 \approx \frac{1.5}{1.6}$). Ultimately, column (6) confirms that eligibility for admission to one additional program at the first attempt coincides with a significant decrease in students' ranking between their first and last attempts (–0.396 percentile rank). Taken together, results in columns (1) and (6) suggest that repeating a year would allow marginal non-repeaters to gain on average about 25 percentile ranks in rankings (where $25 \approx \frac{0.396}{0.016}$). Finally, column (8) confirms that the average gain would be about twice as significant if no bonus point was granted to first-time participants.

The last four panels confirm that the effects are mainly driven by the group of high-income male applicants (who represent about 50% of our sample). When we focus on this group, the probabilities of repetition, exam retaking, and ranking improvement all decrease significantly, by nearly 3 percentage points at the cutoff, namely twice the magnitude of the decline observed in the full sample. Similarly, the estimated decrease in students' ranking at the cutoff is twice as important when we consider the high-income male subsample as when we consider the full sample, regardless of whether we consider adjusted or unadjusted rankings. By contrast, when we focus on the two other subgroups (female or low-income male), we see no significant variation in the probabilities of repetition, exam retaking, or ranking improvements at the cutoff.[20]

The fact that the shift in performance at the cutoff is observed for almost exactly the same share of students as the shift in repetition probability is consistent with the assumption that the decline in final performance at the cutoff is essentially driven by the decline in repetition probability. Under this maintained assumption, Table 3 shows the results of a 2SLS estimation of the causal effect of repetition on (marginal) students' outcomes, where we use the discontinuity in repetition at the cutoff as a source of identification. Consistent with our previous analysis, these 2SLS estimates suggest that the final ranking of compliers would be improved with a probability of about 1 if they decided to repeat, and their (adjusted) gains in ranking would then be on average about 35 percentile points (which corresponds on average to being admitted to 3 or 4 more programs). The table also provides a comparison between these 2SLS estimates and the average effects of repetition on repeaters whose ranking fell just above an admission

[20]When we look separately at the subsamples of low-income and high-income female students, we still get nonsignificant results, and the parameters are even less well estimated.

cutoff (i.e., between the cutoff itself and 5 percentiles above). Using the notation of our conceptual model, it amounts to comparing $G_c(s)$ and $G_r(s)$ for students near cutoff points. This comparison shows that 2SLS estimates of the impact of repetition on compliers at the margin of repetition are as strong and significant as the effect of repetition on average repeaters. This finding confirms that students with higher expectations and a greater propensity to repeat are not necessarily those for whom the impact of repetition is higher.

In this analysis, we have measured student performance based on their final rankings across all candidates. It is also possible to measure their performance based on their ranking among first-time participants only. This measure is less direct, but has the advantage of being independent of the proportion of students choosing to repeat a grade.[21] Tables A3 and A4 in Appendix A provide a replication of Tables 2 and 3 using this alternative measure. Not surprisingly, the diagnoses are similar.[22] Eventually, Figure A7 and Table A5 show that results are robust to alternative specifications for the RD model.

5.2 Contribution of Repetition to Access Gaps

Three major results emerge from our empirical explorations. First, repetition has a very significant effect on all repeaters, whether male or female or belong to the low- or high-income group. Second, repetition would probably have an equally important effect on non-repeaters if they decided to repeat. Finally, female students repeat significantly less than males, especially males in the high-income group. In the last section, we will come back to the interpretations that can be given for this last result.

From this set of results, it emerges that inequalities in access to elite programs between female and male students (or between low-income and high-income males) would probably be less pronounced if inequalities in repetition between female and male students could be reduced, either by encouraging many more non-repeaters to repeat, or, conversely, by drastically limiting the possibilities of repetition.

To give a more specific idea of the contribution of repetitions to inequalities between gender and social groups, Table 4 compares the performance of the different groups at their last attempt (i.e., possibly after repeating a year) with their performance at their first attempt. The table shows that 18.9% of male students qualify for admission to a top-tier program, possibly after repeating a year, while only 16.0% of them have access to the same programs at their first attempt. For female students, the corresponding

[21] For a given impact of repetition on students' academic ability, the lower the impact of repetition on rankings, the higher the proportion of students choosing to repeat.

[22] When we focus on the subsample of students near the specific threshold that marks the boundary between first- and second-tier programs, we can check that eligibility for first-tier programs induces a decrease in the repetition rate and performance that is of the same order of magnitude for women and men. Due to the small number of observations, however, estimates are not significant at usual levels (analysis available on request).

proportions are 14.8% and 13.0%. The final gap between female and male students is therefore 4.1 percentage points (4.1 = 18.9 − 14.8), while the gap at the first attempt is only 3.0 percentage points (3 = 16 − 13). Hence, repetitions increase the gap between females and males by about 37%. When we adjust students' final outcomes for the bonus points granted to first-time participants, the contribution of repetitions increases to 47%.

With respect to inequalities between high- and low-income groups, the table suggests that repetition tends to increase this as well, although to a lesser extent. For example, the table shows that the final gap in access to elite programs between high- and low-income male students is about 12.1 percentage points, whereas the gap at the first attempt is only about 10.4 percentage points, namely a 16% increase in the gap between first and last attempts. The increase is about the same when we adjust final outcomes.

6 Discussion

We have shown that female students (and low-income male students) are less inclined to repeat a year and retake exams in the highly competitive context of GE preparatory classes, and this helps to explain why they ultimately have less access to the most selective and prestigious GE programs. In this last section, we discuss in turn some of the mechanisms that may explain these perseverance gaps between female and male students.

6.1 Sensitivity to Programs' Prestige

A first possible reason for the lower perseverance of female students is that they are less sensitive to differences in prestige between programs, so that repeating a year to get into a more prestigious program does not necessarily make sense to them. Consistent with this assumption, our RD analysis reveals that missing admission to a more prestigious program has no significant impact on the probability of repetition for female students, whereas it increases the probability of repetition for male students by 20%. Female students are not completely insensitive to differences in prestige between programs (without which they would not repeat at all), but only the main differences between the major program categories seem to matter to them.

One reason for female students' lower sensitivity to programs' prestige could simply be that they tend to be less ambitious, but it could also be that they have fewer long-term benefits to expect from joining a more prestigious program. However, this is not exactly what the (limited) available data on the careers of GE graduates suggest. Until 2002, the French Labor Force survey (LFS) made it possible to distinguish between graduates of first-tier GE programs (called *Très Grandes Écoles* in the survey) and graduates of less prestigious GE programs. Using LFS conducted between 1991 and 2002, we looked at hourly wages earned in the years after graduation, and found that the impact on these wages of graduating from a first-tier GE program rather than from a less prestigious GE program is just as significant for women as for men (the hourly wage premium is about 15%, regression results available on request).[23]

Another explanation for women's lower sensitivity to prestige could be that they do not want to appear too career-oriented in the eyes of male students (which is consistent with Bursztyn, Fujiwara and Pallais, 2017). As discussed below, however, the repetition gap between male and female students is also seen in nonscientific preparatory classes, where female students make up a very large majority of the students, and where the influence of males is likely much more diluted than in scientific preparatory classes.

6.2 Competition Aversion

Another plausible reason for the lower perseverance of female students is that repeating a year in the highly competitive environment of science preparatory classes represents a much more costly decision for them than for male students (especially for the higher income ones).

The hypothesis of a higher aversion of women to competitive environments has already been tested and verified in several experimental settings (see, e.g., Bertrand, 2011; Niederle and Vesterlund, 2011). This hypothesis also helps to explain why female students are, to begin with, much less likely to apply to enter a scientific preparatory class.[24] Among science high school students who graduate with the highest honors, the proportion who apply to scientific preparatory class is on average about half for girls as for boys, namely 39% vs. 60% in the high-income group and 27% vs. 59% in the low-income group (see Buisson-Fenet, 2017). Our results are also consistent with studies that show that female students tend to become discouraged more quickly when they fail (Buser and Yuan, 2019; Ellison and Swanson, 2018; Cai et al., 2019), and that boys are less put off from preferred educational paths by negative feedback (see, e.g., Owen, 2010; Rask and Tiefenthaler, 2008).

[23]If we look at the executive committees of the 40 largest French companies (i.e., the CAC40), the vast majority of their members are graduates of first-tier GE programs and 20% of them are women, which is precisely the proportion of women in first-tier programs (Ferrary, 2021). These facts are in line with the idea that the impact of attending a first-tier program on the probability of joining the executive committee of a large company is as high for women as for men.

[24]Goodman, Gurantz and Smith (2020) find no significant gender differences in the likelihood of retaking the SAT in the United States, but retaking the SAT does not imply spending an extra year in an ultra-competitive environment.

6.3 Risk Aversion

Another possible explanation for female students' lower repetition rate could be that they are at greater risk of doing less well the second time. As it happens, our data show that repetition has positive effects on a very large majority of repeaters, but the probability of doing less well after repeating a year tends indeed to be somewhat higher for female students.

An additional explanation could be that female students are less inclined than males to take the risk of doing less well at the second attempt, regardless of the actual magnitude of this risk. Female students admitted to a second-tier GE program would be less likely to repeat a year (with the hope of being admitted to a first-tier program the following year), not because they believe they have a greater likelihood of losing everything, but because they are more risk averse (see, e.g., Bertrand, 2011; Niederle and Vesterlund, 2011 for a review of experimental findings on gender differences in risk aversion).

To further test this assumption, it is possible to compare the behavior of female and male students in another category of preparatory classes, namely those that prepare students for the literary competitive exams of the ENS.[25] The principle of these classes is similar to that of the science preparatory classes: a great deal of hard work to prepare for highly selective competitive exams, with the same possibility of repeating a year if the first attempt is unsuccessful. An important difference, however, is that most students in literary classes prepare for one competitive exam only (that of the ENS), and the seats offered in this exam represent barely 5% of students enrolled in literary preparatory classes.[26] In this context, the overwhelming majority of first-time participants are not admitted to any selective program, so that repeating a year does not generally imply the same risks as in science preparatory classes.[27]

Nevertheless, using the same administrative data as mentioned above, it can be shown that in these preparatory classes, male students also repeat more often than female students (Table A6 in the Online Appendix). The gap between female and male students is even greater in these literary classes, where the risk is almost nonexistent, than in science classes, where the risk is very real. These results are not consistent with the assumption that the gap in repetition rates between female and male students is a consequence of female students' greater risk aversion.

[25]Successfully passing this competitive exam allows one to prepare for a career as a professor and researcher in humanities with the status and salary of a civil servant. Many of the most influential French intellectuals of the nineteenth and twentieth century attended this institution (Durkheim, Sartre, Bourdieu).

[26]Since 2011, some business and political science programs also have been recruiting from the literary competitive exams organized by the ENS, but even taking these programs into account, the seats offered do not exceed 20% of enrollments.

[27]At the end of their preparatory years, students in these literary classes are considered to have completed two years of undergraduate studies in humanities and can complete their undergraduate studies at a regular university (those who have repeated a year and spent three years in preparatory classes can even apply directly for a graduate program at a regular university).

6.4 The Cost of Repetition

A final possible explanation is that an extra year in preparatory classes would represent a greater financial burden for female than for male students, perhaps because they would more often come from low-income families or because they would have more difficulties in accessing cheap student accommodations. However, these assumptions are not really consistent with available data: the proportion of students eligible for income-based scholarships is about the same for female and male students (20%), as is the proportion of students in boarding schools (30%).

7 Concluding Remarks

In this paper, we compare the performance of groups of students defined by their gender and social background in the highly competitive environment of French GE preparatory classes, the most prestigious and selective higher education institutions of the country. We rely on a unique database tracing the performance and repetition decisions of several cohorts of students. We show that, ceteris paribus, female students tend to repeat a year and retake entrance exams much less often than males, especially high-income ones, even though repeating a year almost systematically improves students' performance and their probability of access to the most selective GEs.

The lower repetition rate of female students reflects in part that they are less sensitive to differences in prestige between GEs. It is also consistent with the idea that female students are more inclined to turn away from highly competitive environments. At the end of the day, the differences in persistence alone explain a significant fraction of the differences in access to the most prestigious GEs between gender and social groups.

In most countries, as in France, female students (and males from disadvantaged backgrounds) are largely underrepresented in elite scientific institutions of higher education, even when recruitment is done through standardized competitive examinations. Advocates of such competitive procedures generally argue that the problem is not with the principle of competitive examinations, but with the fact that too few women and too few students from disadvantaged backgrounds survive school selection long enough to be able to start preparing for these difficult examinations. Our research suggests that there is also a problem with the competitive entrance exams themselves and the intense and long preparation they require. As it happens, they foster the emergence of a predominantly high-income male elite, selected not only for their particular mathematical skills but also for their ability to cope longer with the stress of preparation and competition. Further research is needed to better understand the policies that could actually contribute to reducing these perseverance gaps and, consequently, reducing access gaps to elite positions.

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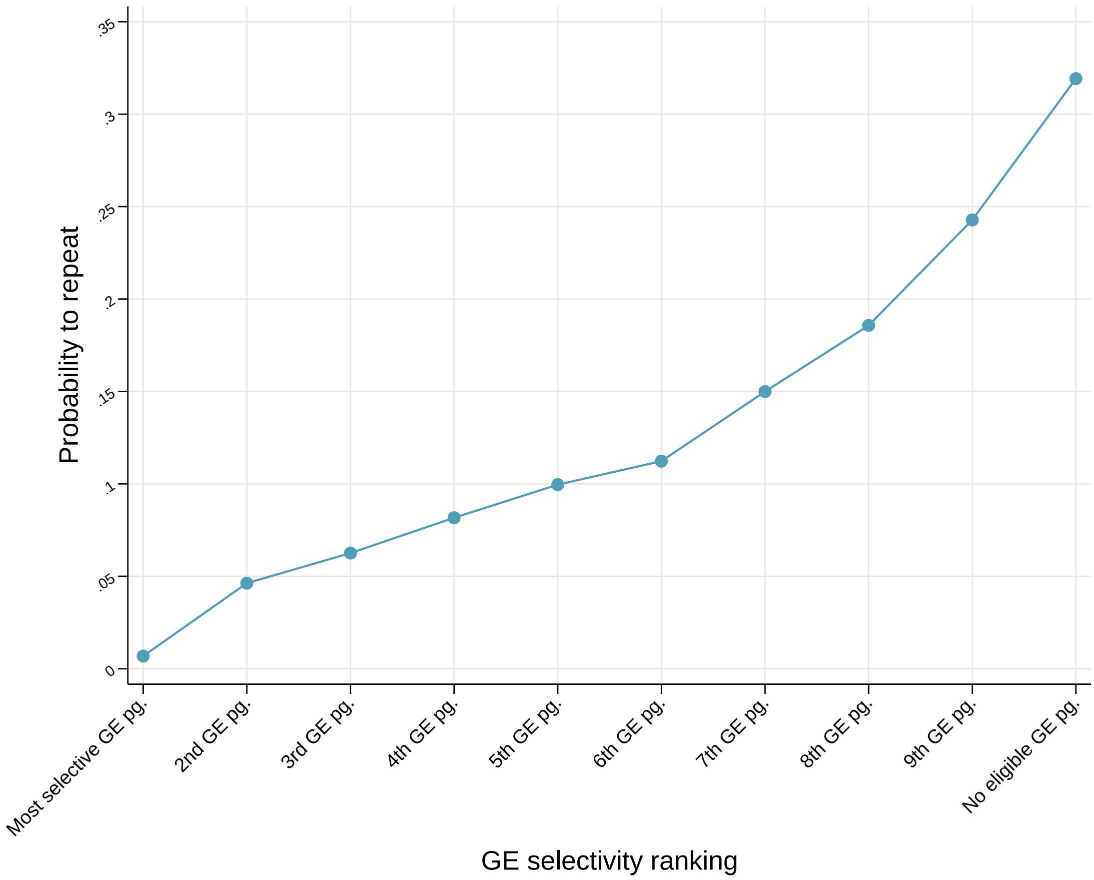


Figure 1 – Repetition Decisions by Level of Performance at First Attempt

Notes: The figure refers to the sample of participants who for the first-time attempted the CCMP exams (MP and PSI tracks) between 2012 and 2016. The figure shows the variation in the proportion who chose to repeat a year across groups defined by the level of selectivity of the best program to which they were eligible for admission at their first attempt (ENSAE is excluded, as this program is specific to the MP track).
Reading: Among first-time participants whose best first-time opportunity is to join the seventh most selective program, about 15% choose to repeat a year.

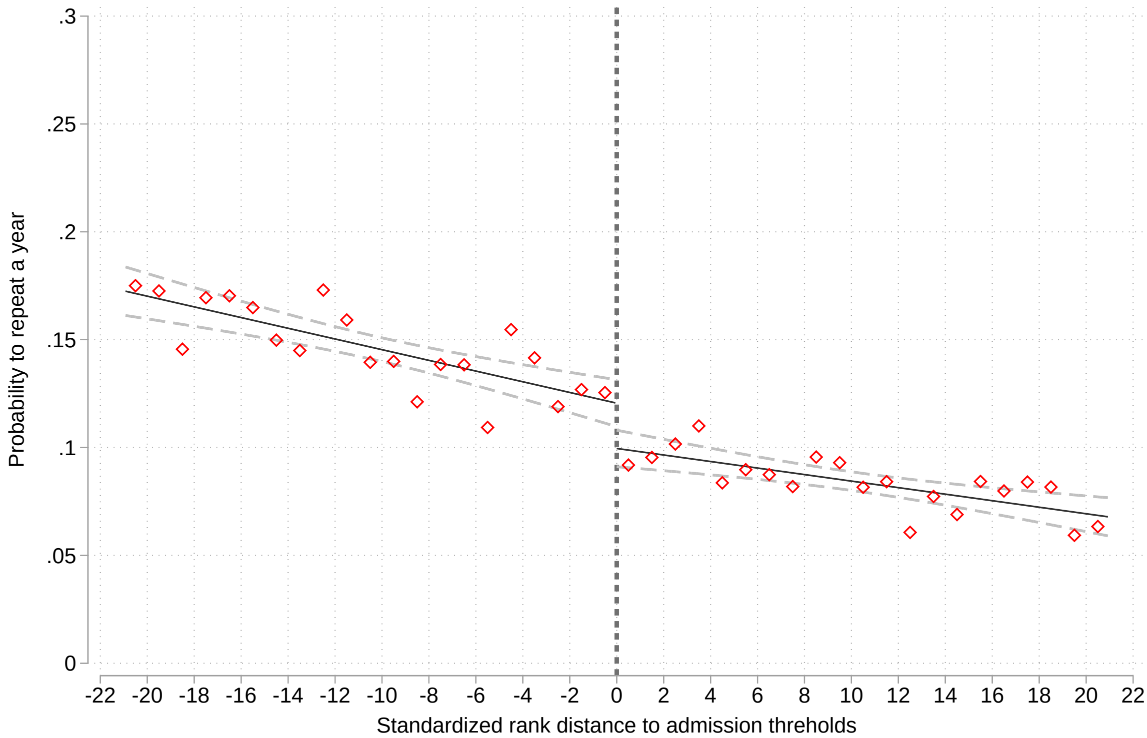


Figure 2 – Distance to Threshold and Probability of Repeating a Year

Notes: The figure refers to the sample of students who for the first-time attempted the CCMP exams between 2012 and 2016. We focus on those whose standardized score at their first attempt fell either just below or just above the admission threshold of a CCMP program, and we show the proportion who chose to repeat a year, plotted against the standardized distance to the threshold. The bandwidth is computed following Sebastian Calonico, Matias D. Cattaneo and Rocio Titiunik (2014).

Reading: The proportion of first-time participants who chose to repeat a year is about 12% just below the threshold, and 10% just above.

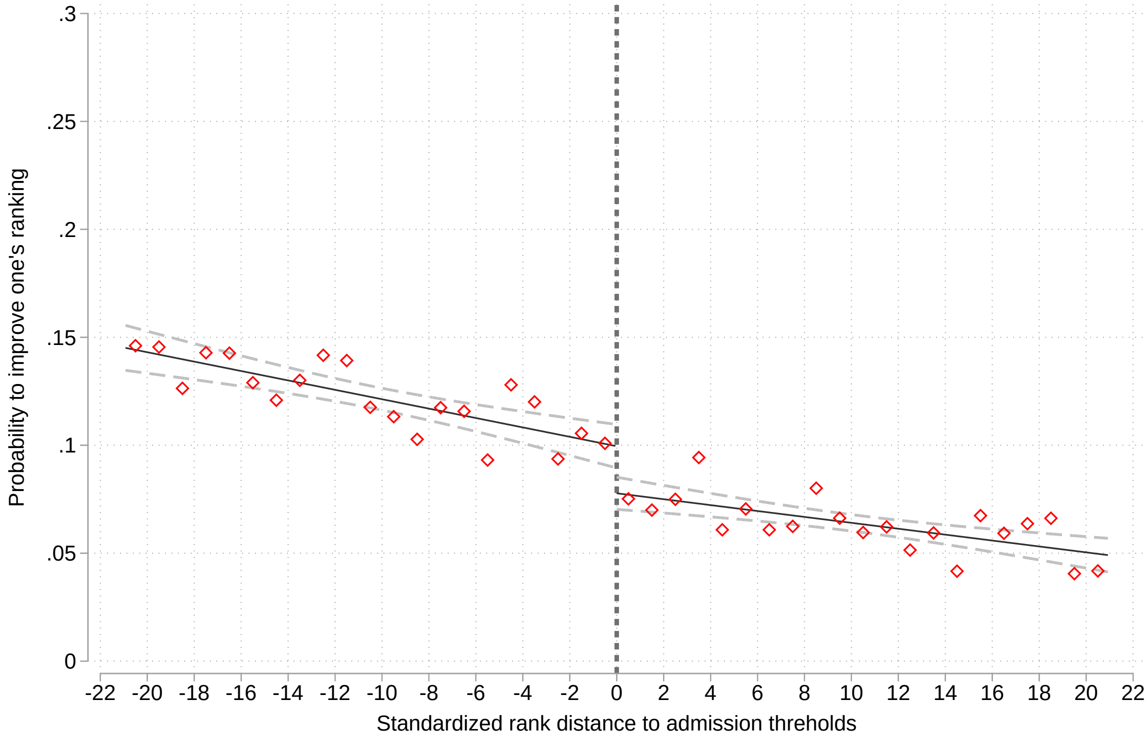


Figure 3 – Distance to Threshold and Joint Probability of Repeating a Year and Improving One's Ranking

Notes: Same RD sample as Figure 2. The figure shows the proportion of students who managed to improve their initial ranking, that is, who repeated a year and obtained a strictly better standardized ranking at their second attempt (plotted against the initial standardized distance to the threshold).
Reading: The proportion of first-time participants who repeated a year and obtained a better ranking at their second attempt is about 10% just below the threshold and 8% just above.

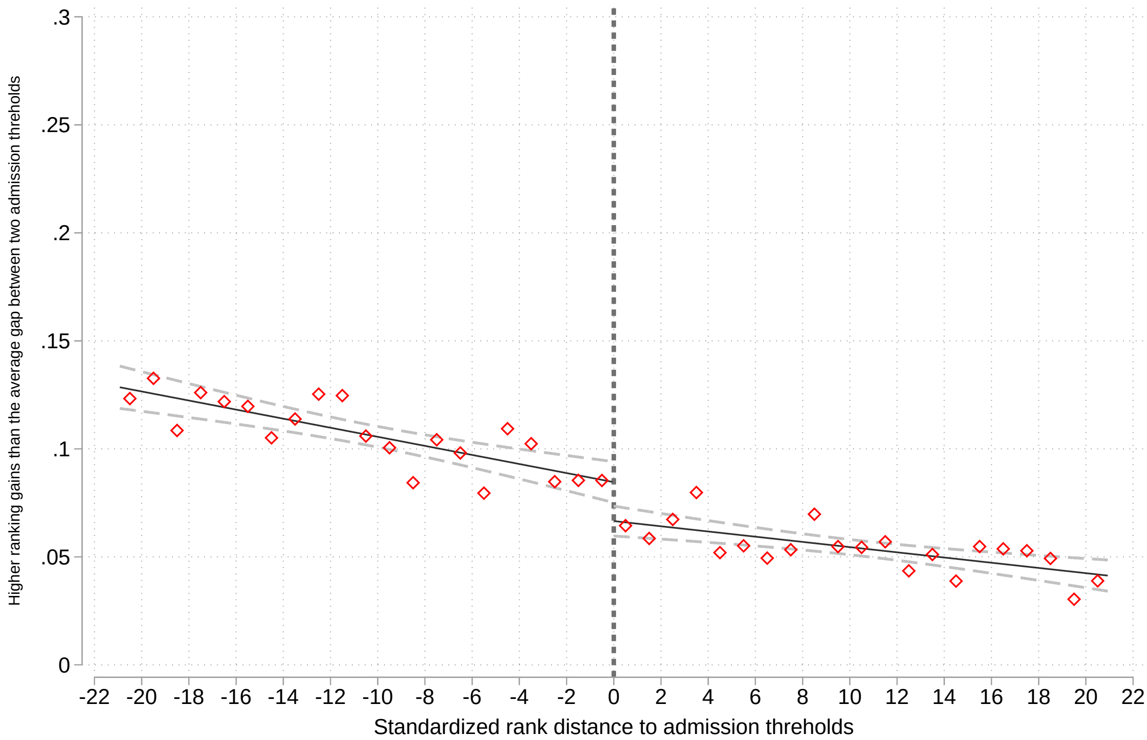
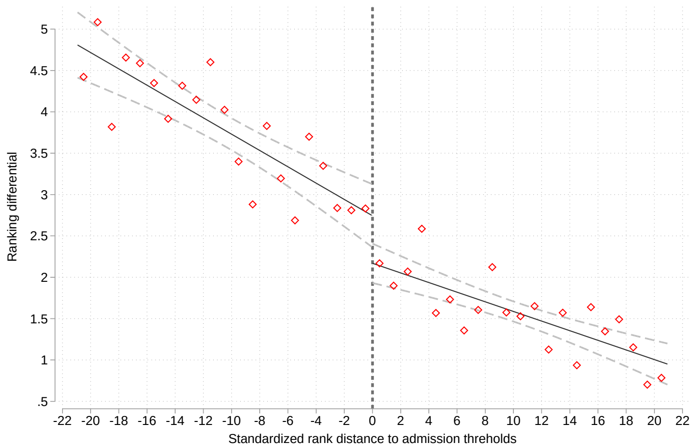


Figure 4 – Distance to Threshold and Joint Probability of Repeating a Year and Improving One's Ranking by More Than the Average Gap between Two Admission Thresholds

Notes: Same RD sample as Figure 2. On average, the standardized distance between two admission thresholds in the CCMP competition is 10.2 percentile ranks. The figure shows the proportion of students who managed to improve their initial ranking by more than the average gap between two admission thresholds, that is, who repeated a year and obtained higher standardized ranking at their final attempt than that at their first attempt by at least 10.2 percentiles (plotted against the initial standardized distance to the threshold).
Reading: The proportion of first-time participants who repeated a year and managed to improve their ranking by more than the average gap between two admission thresholds is about 8.5% just below the threshold and 6.5% just above.

(a) Nonadjusted for First-time Bonuses



(b) Adjusted for First-time Bonuses

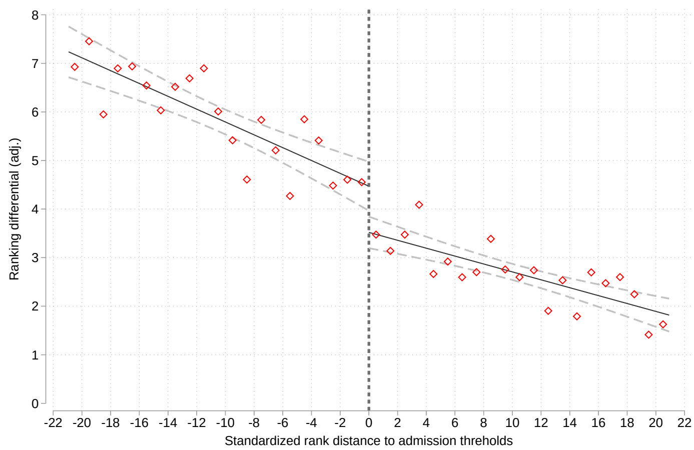


Figure 5 – Distance to Threshold and Ranking Improvement between First and Last Attempts

Notes: Same RD sample as Figure 2 (excluding repeaters who are not ranked on their second attempt). (a) shows the average difference in standardized rankings between first and last attempts, plotted against the initial standardized distance to the threshold. (b) shows similar results where standardized rankings are adjusted for first-time bonuses. Note that the difference in rankings between first and last attempts can be nonzero for repeaters only.
Reading: The average improvement between first and last (unadjusted) ranking is about 2.7 percentile points below the threshold, but only 2.2 percentile points above the threshold.

Table 1 – Descriptive Statistics on Repetition Rates and Performance of Repeaters at Second Attempt

	Not eligible in Y1		Eligible for at least one pg. in Y1		Eligible for a second-tier GE pg. in Y1		Eligible for a first-tier GE pg. in Y1	
	Repetition	Eligibility in Y2	Repetition	Better ranking in Y2	Repetition	Better ranking in Y2	Repetition	Better ranking in Y2
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: All	0.316	0.253	0.115	0.814	0.182	0.860	0.047	0.638
	[0.465]	[0.435]	[0.319]	[0.389]	[0.386]	[0.348]	[0.212]	[0.482]
Panel B: Girls	0.260	0.225	0.071	0.757	0.123	0.744	0.026	0.810
	[0.439]	[0.418]	[0.257]	[0.431]	[0.329]	[0.439]	[0.159]	[0.402]
Panel C: Boys	0.333	0.260	0.124	0.821	0.193	0.873	0.052	0.620
	[0.471]	[0.439]	[0.329]	[0.384]	[0.395]	[0.333]	[0.222]	[0.487]
High-income boys	0.337	0.316	0.123	0.820	0.199	0.869	0.049	0.624
	[0.473]	[0.465]	[0.329]	[0.385]	[0.399]	[0.338]	[0.217]	[0.486]
Low-income boys	0.325	0.166	0.125	0.826	0.172	0.888	0.064	0.605
	[0.468]	[0.372]	[0.331]	[0.380]	[0.378]	[0.316]	[0.245]	[0.495]

Notes: The table refers to the sample of students who for the first-time attempted CCMP exams between 2012 and 2016. Column 1 refers to the subsample who are not eligible for any CCMP program on their first attempt, and column 2 is restricted to those who repeated a year. Column 3 refers to the subsample who are eligible to enter at least one CCMP program on their first attempt, and column 4 is restricted to those who repeated a year. Column 5 refers to the subsample of eligible students whose best opportunity (at their first attempt) is to join a second-tier CCMP program, and column 6 is restricted to those who repeated a year. Eventually, column 7 refers to the subsample of eligible students whose best opportunity (on their first attempt) is to join a first-tier CCMP program, and column 8 is further restricted to those who repeated a year. Each panel corresponds to a specific group of applicants, namely the full sample of applicants (Panel A), the subsample of female applicants (Panel B), and the subsample of male applicants (Panel C). Panel C is further divided into two subgroups: male applicants not eligible for means-tested financial assistance (row 4), and male applicants eligible for means-tested financial assistance (row 5). For each group, columns 1, 3, 5, and 7 report the probability of year repetition. For each group of applicants who are not eligible for any CCMP program after their first attempt, column 2 reports the probability that those who repeat will eventually qualify for at least one CCMP program after one repetition. Finally, columns 4, 6, and 8 report the probability that those who repeat a year will improve their standardized ranking for all subsamples of applicants who are eligible for at least one CCMP program on their first attempt. Standard deviations are given in brackets.

Table 2 – Repetition Decisions and Gains in Student Achievement: A RD Approach

	Repetition (1)	Exam Retaking (2)	Ranking gain (3)	Ranking gain > 10.2 pc. (4)	Ranking diff. (5)	Ranking diff. (adj.) (6)
Panel A: All						
Above	-0.016**	-0.016**	-0.019***	-0.015**	-0.396*	-0.630**
	(0.007)	(0.007)	(0.007)	(0.006)	(0.235)	(0.308)
Mean at the thresholds	.133	.129	.109	.0933	3.1	4.97
Observations	31664	31664	31664	31664	31379	31379
Panel B: Girls						
Above	-0.005	-0.002	-0.010	-0.002	-0.132	-0.073
	(0.014)	(0.013)	(0.012)	(0.011)	(0.381)	(0.510)
Mean at the thresholds	.068	.0609	.051	.0425	1.31	2.08
Observations	5419	5419	5419	5419	5372	5372
Panel C: Boys						
Above	-0.020**	-0.020**	-0.021***	-0.018**	-0.476*	-0.822**
	(0.008)	(0.008)	(0.007)	(0.007)	(0.270)	(0.357)
Mean at the thresholds	.148	.145	.122	.105	3.49	5.61
Observations	26245	26245	26245	26245	26007	26007
High-income boys						
Above	-0.029***	-0.030***	-0.030***	-0.026***	-0.824***	-1.229***
	(0.009)	(0.009)	(0.008)	(0.008)	(0.306)	(0.403)
Mean at the thresholds	.152	.148	.126	.106	3.56	5.73
Observations	20781	20781	20781	20781	20606	20606
Low-income boys						
Above	-0.001	-0.003	-0.002	-0.002	0.346	0.051
	(0.018)	(0.018)	(0.016)	(0.016)	(0.572)	(0.772)
Mean at the thresholds	.131	.131	.109	.0987	3.26	5.17
Observations	5464	5464	5464	5464	5401	5401

Notes: The same RD sample as Figure 2. Panel A refers to the full sample, Panel B refers to the subsample of female applicants, and Panel C refers to the subsample of male applicants. Panel C is further divided into two subsamples: male applicants not eligible for means-tested financial assistance (row 4), and male applicants eligible for means-tested financial assistance (row 5). Each column corresponds to a specific dependent variable, namely a dummy indicating year repetition (column 1), a dummy indicating retaking CCMP exam (column 2), a dummy indicating an improvement in standardized ranking between first and last attempts (column 3), a dummy indicating that the difference in standardized ranking between first and last attempts is higher than 10.2 percentile ranks (which is the average difference between two admission thresholds) (column 4), the difference in standardized rankings between first and last attempts (column 5), and the difference in standardized rankings between last and first attempts using rankings adjusted for the bonus granted to first-time participants (column 6). For columns 5 and 6, the samples exclude the students who were not ranked on their last attempt. For each dependent variable and each sample, the table shows the estimated impact of falling just above the admission threshold. Standard errors clustered at the individual level are given in parenthesis. Each cell corresponds to a specific regression. All regressions include controls selected by double-lasso procedure among student's preparatory school, type of class attended, age, gender, low-income status, and high school graduation results; as well as a triangular kernel centered around admission cutoffs; a full set of cutoff dummies; and a first-order spline function of the running variable with cutoff-specific trends.
* significant at 10%. ** significant at 5%. *** significant at 1%.

Table 3 – Causal Effects of Repetition on Performance for Repeaters and Compliers

	Ranking gain		***Ranking gain > 10.2 pc.***		***Ranking diff.***		***Ranking diff. (adj.)***	
	Repeaters	Compliers	Repeaters	Compliers	Repeaters	Compliers	Repeaters	Compliers
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: All	0.779***	1.065***	0.668***	0.818***	23.591***	20.454**	38.575***	35.131***
	(0.021)	(0.236)	(0.024)	(0.224)	(1.038)	(8.479)	(0.930)	(8.525)
N	389	31664	389	31664	349	31379	349	31379
Panel B: Girls	0.667***	n. s.	0.641***	n. s.	17.913***	n. s.	32.121***	n. s.
	(0.076)		(0.078)		(3.675)		(3.415)	
N	39		39		36		36	
Panel C: Boys	0.791***	1.007***	0.671***	0.846***	24.244***	18.971**	39.317***	33.428***
	(0.022)	(0.212)	(0.025)	(0.224)	(1.073)	(7.683)	(0.953)	(7.155)
N	350	26245	350	26245	313	26007	313	26007
High-income boys	0.795***	0.967***	0.665***	0.836***	22.979***	25.114***	38.214***	38.925***
	(0.025)	(0.154)	(0.029)	(0.177)	(1.228)	(6.804)	(1.089)	(6.298)
N	263	20781	263	20781	238	20606	238	20606
Low-income boys	0.782***	n. s.	0.690***	n. s.	28.258***	n. s.	42.817***	n. s.
	(0.045)		(0.050)		(2.156)		(1.924)	
N	87		87		75		75	

Notes: Columns 2, 4, 6, and 8 refer to the same RD sample as in Table 2. Columns 1, 3, 5, and 7 are restricted to repeaters whose standardized ranking on their first attempt fell just above an admission cutoff point (i.e., between a cutoff and 5 percentiles above). Panel A refers to the full sample, Panel B refers to the subsample of female applicants, and Panel C refers to the subsample of male applicants. Panel C is further divided into two subsamples: male applicants not eligible for means-tested financial assistance (row 4), and male applicants eligible for means-tested financial assistance (row 5). Each column corresponds to a specific dependent variable, namely a variable indicating that the student repeated a year and achieved a better ranking on their last attempt (columns 1 and 2), a variable indicating that the student repeated a year and achieved a higher ranking on their last attempt than their initial ranking by at least 10.2 percentiles (columns 3 and 4), the difference in standardized rankings between the last and first attempts (columns 5 and 6), and the difference in standardized rankings between the last and first attempts using rankings adjusted for first-time bonuses (columns 7 and 8). For columns 5–8, we exclude the few repeaters who failed to achieve a ranking. For each dependent variable and each sample, columns 2, 4, 6, and 8 report the RD estimates of the impact of year repetition. Standard errors clustered at the individual level are in parenthesis. All regressions include the same control variables and use the same specification as in Table 2. In addition, columns 1, 3, 5, and 7 report the mean of each dependent variable for the sample of repeaters whose initial standardized ranking fell just above an admission cutoff point (i.e., between the cutoff and 5 percentiles above).
n.s. nonsignificant at 10%. * significant at 10%. ** significant at 5%. *** significant at 1%.

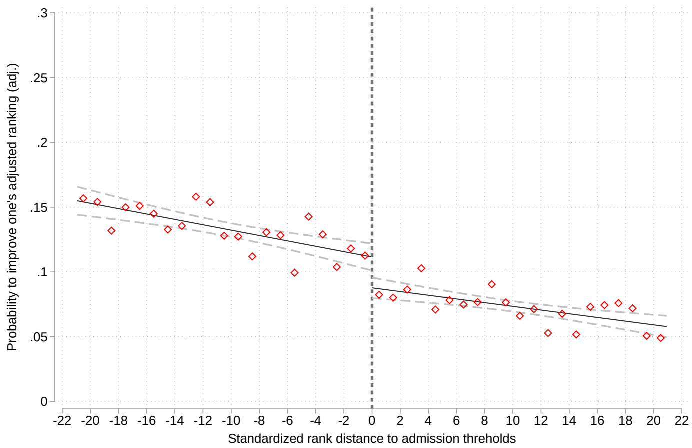
Table 4 – Repetition Decisions and Access Gaps in Elite Science Graduate Programs

	Girls (all) (1)	Boys (all) (2)	Boys (high-inc.) (3)	Boys (low-inc.) (4)
Tier 1 at first attempt	0.130	0.160	0.194	0.090
	(0.004)	(0.002)	(0.003)	(0.003)
Tier 1 at last attempt (nonadj.)	0.148	0.189	0.228	0.107
	(0.005)	(0.003)	(0.003)	(0.004)
Tier 1 at last attempt (adj.)	0.147	0.191	0.230	0.111
	(0.004)	(0.003)	(0.003)	(0.004)
Observations	6214	22992	15502	7490

Notes: The table refers to the sample of students who for the first-time attempted the CCMP exams between 2012 and 2016. Column 1 refers to the subsample of female applicants, and columns 2–4 refer to the subsample of male applicants. Within the subsample of male applicants, column 2 refers to the full sample of male applicants, while column 3 refers to the subset of male applicants not eligible for means-tested financial assistance, and column 4 refers to the subset of male applicants eligible for means-tested financial assistance. For each subsample of applicants, the first row shows the proportion of students initially eligible for a first-tier CCMP program. Row 2 shows the proportion of repeaters plus non-repeaters eligible for a first-tier program for each subsample. Row 3 shows similar results as row 5 using rankings adjusted for first-time bonuses. Standard errors are in parenthesis.

Appendix A

(a) Joint Probability of Repeating a Year and Improving One's Adjusted Ranking



(b) Joint Probability of Repeating a Year and Improving One's Adjusted Ranking by More Than the Average Gap between Two Admission Thresholds

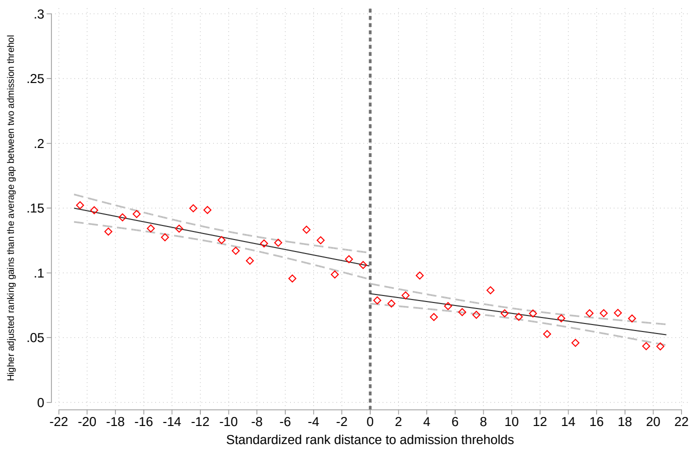


Figure A1 – Distance to Threshold and Joint Probability of Repeating a Year and Improving One's Adjusted Ranking

Notes: Same RD sample as Figure 2. (a) shows similar results as Figure 3, and (b) shows similar results as Figure 4 using standardized rankings adjusted for first-time bonuses.

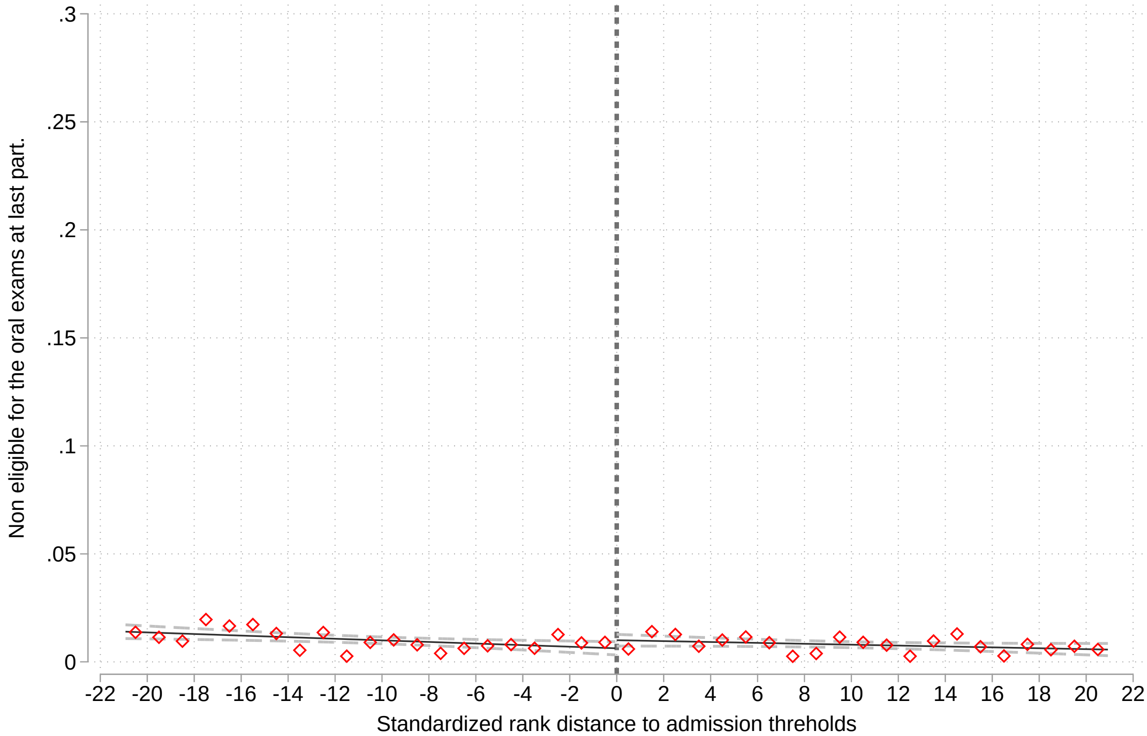
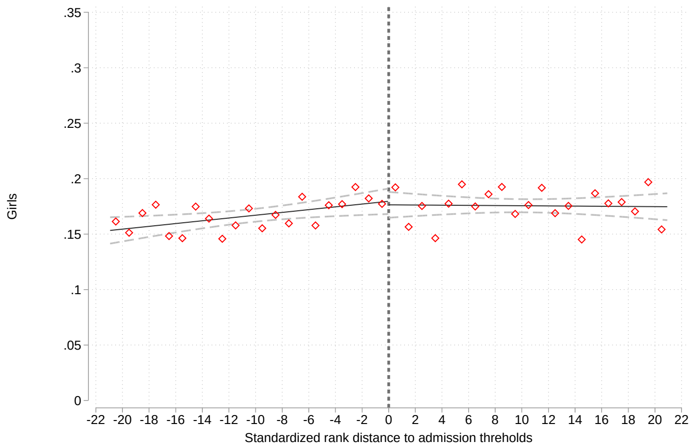


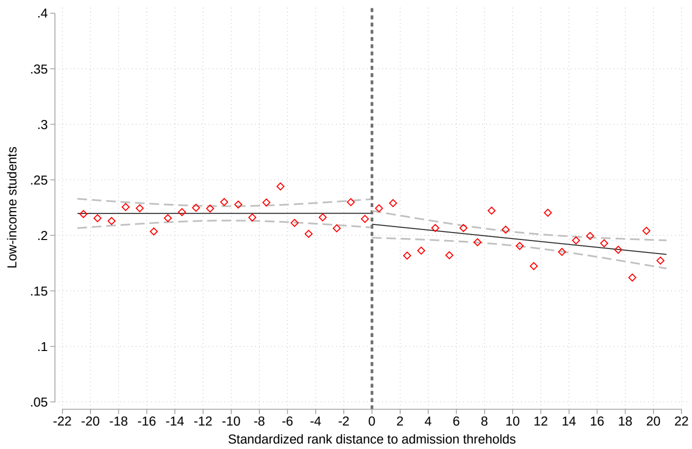
Figure A2 – Distance to Threshold and Joint Probability of Repeating a Year and Failing to Pass the Written Exams the Following Year

Notes: Same RD sample as Figure 2. The figure shows the proportion of students who repeated a year but failed to qualify for the oral examinations on their last attempt (plotted against the initial standardized distance to the threshold).

(a)



(b)



(c)

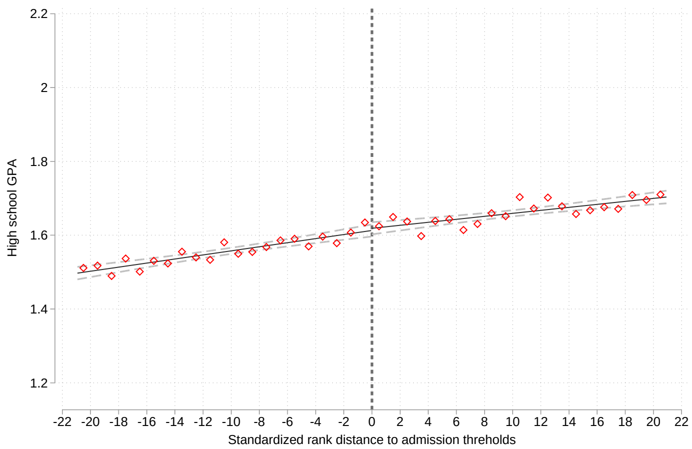
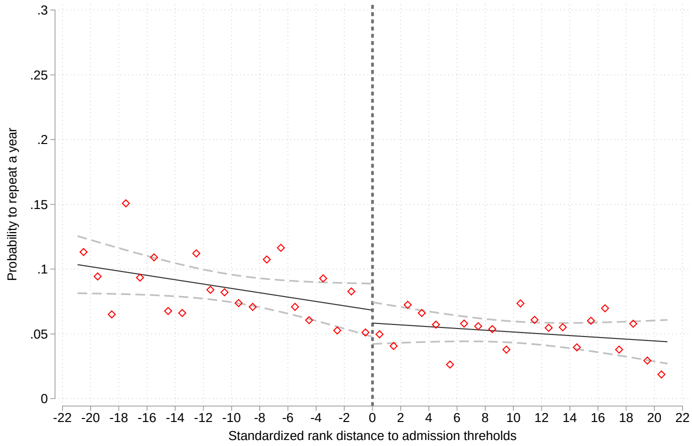


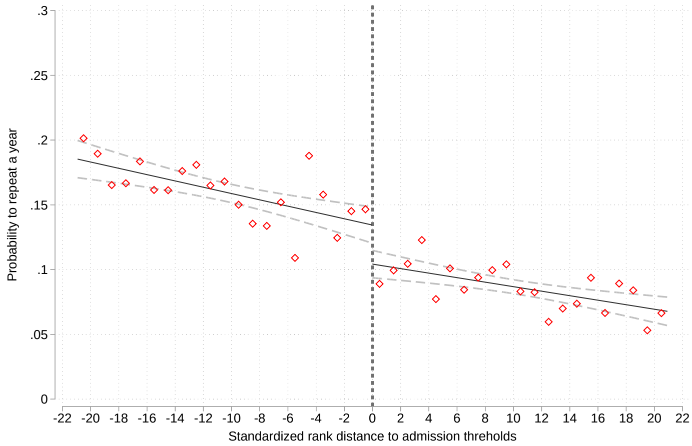
Figure A3 – Distance to Threshold and Students' Baseline Characteristics

Notes: Same RD sample as Figure 2. The figure shows students' baseline characteristics, plotted against the standardized distance to the threshold.

(a) Girls



(b) High-income boys



(c) Low-income boys

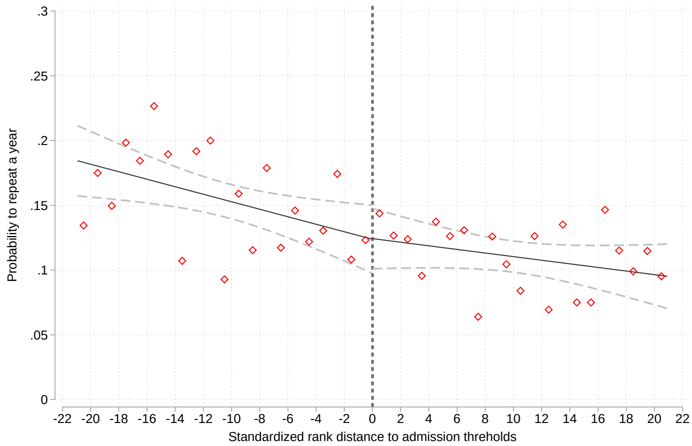
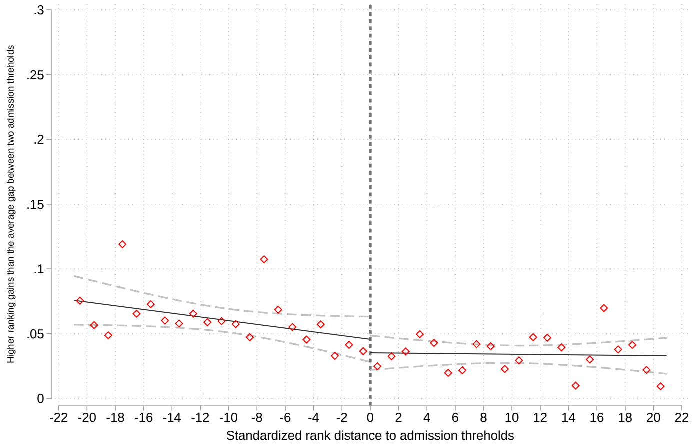


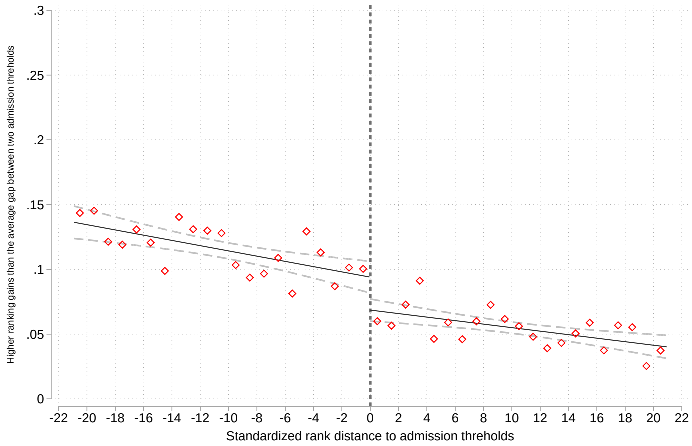
Figure A4 – Distance to Thresholds and Probability of Repeating a Year by Gender and Low-Income Status

Notes: Same RD sample as Figure 2. The figure shows similar results as Figure 2 for three subsamples of applicants: female applicants (a), male applicants not eligible for means-tested financial assistance (b), and male applicants eligible for means-tested financial assistance (c).

(a) Girls



(b) High-income boys



(c) Low-income boys

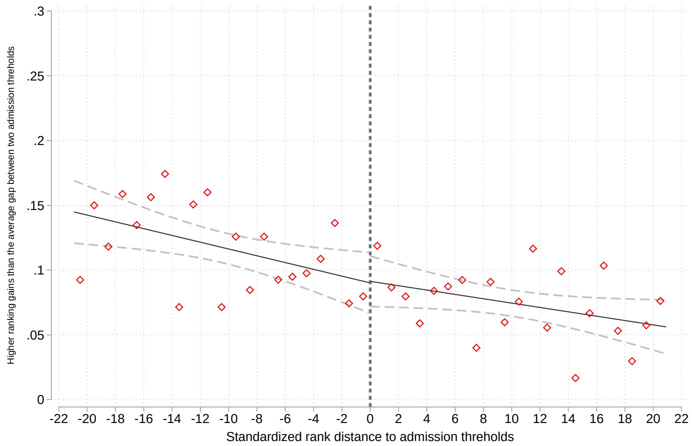


Figure A5 – Distance to Threshold and Joint Probability of Repeating a Year and Improving One's Ranking by More than the Average Gap between Two Admission Thresholds

Notes: Same RD sample as Figure 2. The figure shows similar results as Figure 4 for three subsamples of applicants: female applicants (a), male applicants not eligible for means-tested financial assistance (b), and male applicants eligible for means-tested financial assistance (c).

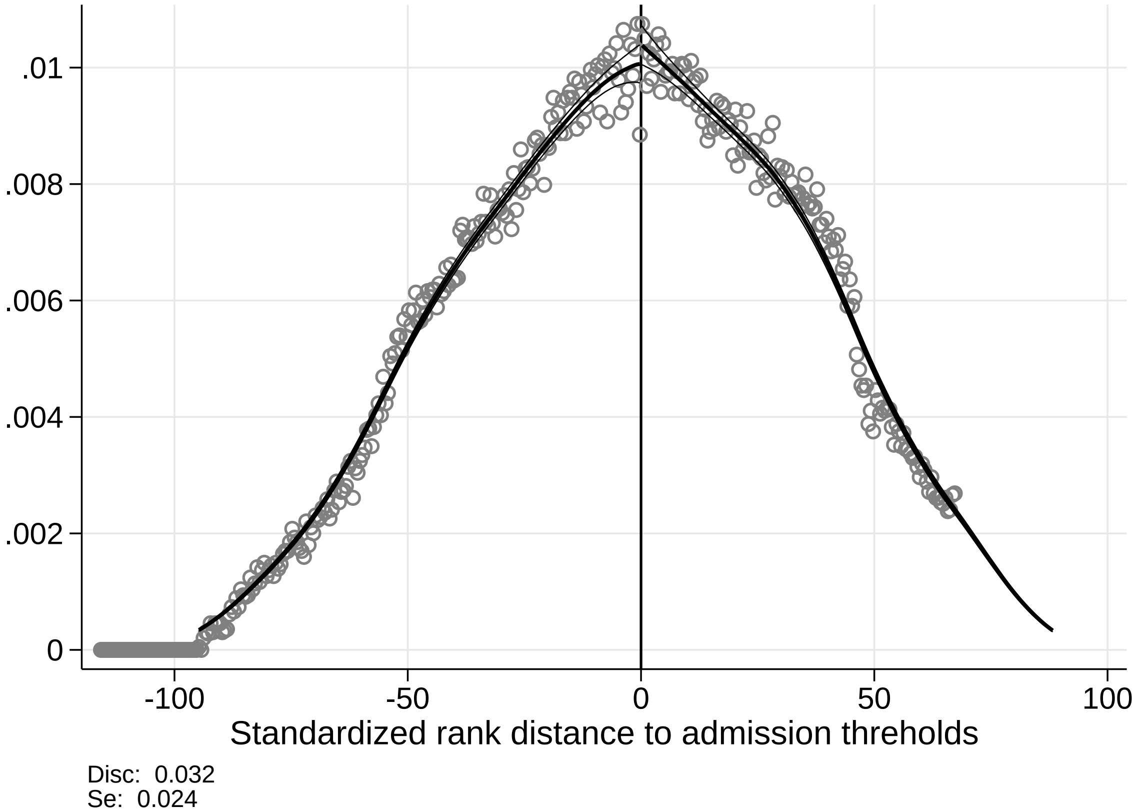
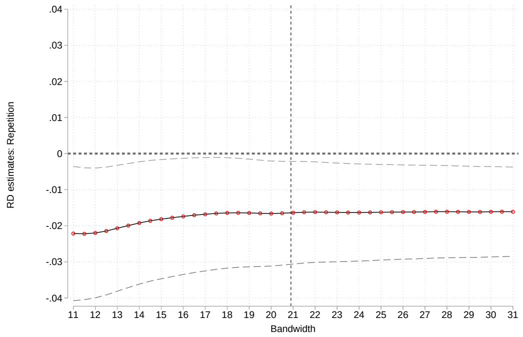


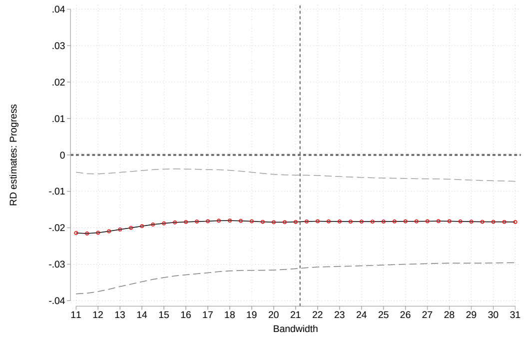
Figure A6 – Density of Observations around Admission Cutoffs

Notes: The figure refers to the sample of students who for the first-time attempted CCMP exams between 2012 and 2016. The figure presents nonparametric estimates of the density of observations on either side of the admission thresholds following McCrary (2008). Each circle shows the average frequency of students per bin of the running variable. The solid lines represent estimated density functions, and the dashed lines represent the corresponding 95% confidence intervals. The bottom left of the figure reports the estimated discontinuity for the density at the cutoff with its standard errors.

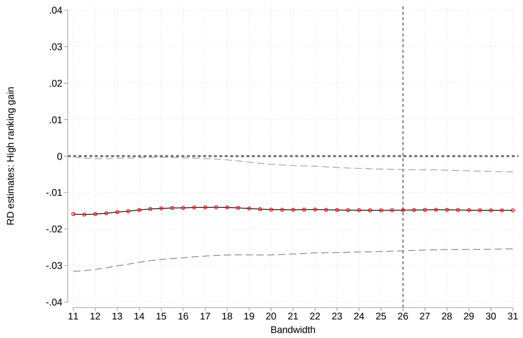
(a) Probability of Repeating a Year



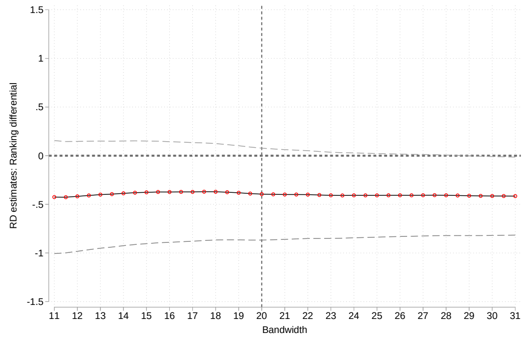
(b) Probability of Improving One's Ranking



(c) Probability of Improving One's Ranking by More than 10.2 pc.



(d) Ranking Differential



(e) Ranking Differential Adjusted for First-time Bonuses

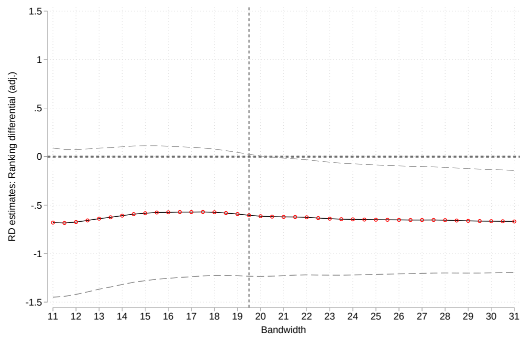


Figure A7 – Robustness to Bandwidth Selection

Notes: The figure refers to the sample of students who for the first-time attempted the CCMP exams between 2012 and 2016. The figure reports the estimated effect of falling just above the admission threshold of a CCMP program on five different outcomes with varying bandwidths. (a) presents the estimated effect of falling just above the admission threshold on the probability of year repetition; (b) presents the estimated effect on the probability of obtaining a strictly better standardized ranking after repeating; (c) presents the estimated effect on the probability that students' final standardized ranking is higher than their first attempt by at least 10.2 percentiles; (d) reports the estimated effect on the average standardized ranking difference between the last and first attempts; (e) reports similar results as (d) accounting for first-time bonuses. The solid red line represents the point estimates from a linear specification with triangular weights using the same specification and control variables as in Table 2. The vertical line shows the optimal bandwidth. The dashed lines represent 95% confidence intervals (standard errors are clustered at the individual level).

Table A1 – Descriptive Statistics on Repetition Rates and Detailed Performance of Repeaters at Second Attempt

	Eligible for at least one pg. in Y1				Eligible for a second-tier GE pg. in Y1				Eligible for a first-tier GE pg. in Y1			
	Not eligible in Y2 (1)	Worse GE pg. in Y2 (2)	Same GE pg. in Y2 (3)	Better GE pg. in Y2 (4)	Not eligible in Y2 (5)	Worse GE pg. in Y2 (6)	Same GE pg. in Y2 (7)	Better GE pg. in Y2 (8)	Not eligible in Y2 (9)	Worse GE pg. in Y2 (10)	Same GE pg. in Y2 (11)	Better GE pg. in Y2 (12)
Panel A: All	0.087	0.050	0.127	0.736	0.079	0.029	0.114	0.778	0.117	0.131	0.178	0.573
	[0.281]	[0.218]	[0.333]	[0.441]	[0.269]	[0.168]	[0.318]	[0.416]	[0.323]	[0.339]	[0.384]	[0.496]
Panel B: Girls	0.131	0.084	0.093	0.692	0.140	0.081	0.093	0.686	0.095	0.095	0.095	0.714
	[0.339]	[0.279]	[0.292]	[0.464]	[0.349]	[0.275]	[0.292]	[0.467]	[0.301]	[0.301]	[0.301]	[0.463]
Panel C: Boys	0.082	0.046	0.131	0.741	0.072	0.023	0.116	0.789	0.120	0.135	0.188	0.557
	[0.274]	[0.210]	[0.337]	[0.438]	[0.258]	[0.150]	[0.321]	[0.408]	[0.326]	[0.343]	[0.391]	[0.498]
High-income boys	0.081	0.052	0.128	0.739	0.077	0.026	0.112	0.786	0.101	0.154	0.188	0.557
	[0.274]	[0.221]	[0.334]	[0.439]	[0.266]	[0.158]	[0.316]	[0.411]	[0.302]	[0.363]	[0.392]	[0.498]
Low-income boys	0.082	0.026	0.144	0.749	0.053	0.013	0.132	0.803	0.186	0.070	0.186	0.558
	[0.275]	[0.158]	[0.352]	[0.435]	[0.224]	[0.114]	[0.339]	[0.399]	[0.394]	[0.258]	[0.394]	[0.502]

Notes: The table refers to the same sample as Table 1 restricted to applicants who were initially eligible for at least one CCMP program and decided to repeat a year. Columns 1, 2, and 3 refer to the full subsample of students who were initially eligible for at least one CCMP program; columns 4, 5, and 6 refer to the subsample of students whose initial best opportunity is to join a second-tier CCMP program; columns 7, 8, and 9 refer to the subsample of students whose initial best opportunity is to join a first-tier CCMP program. Each panel corresponds to a specific sample of applicants, namely the full sample of applicants (Panel A), the subsample of female applicants (Panel B), and the subsample of male applicants (Panel C). Panel C is further divided into two subsamples: male applicants not eligible for means-tested financial assistance (row 4), and male applicants eligible for means-tested financial assistance (row 5). For each subsamples of applicants, columns 1, 5, and 9 show the proportion of applicants who failed to enter in any CCMP program after repeating; columns 2, 6, and 10 report the proportion of applicants who were eligible for a worse CCMP program after repeating compared with their first attempt; columns 3, 7, and 11 report the proportion of applicants whose eligibility for a similar CCMP program did not change after repeating; columns 4, 8, and 12 report the proportion of applicants who were eligible for a better CCMP program after repeating. Standard deviations are in brackets.

Table A2 – Balancing Tests

	Girls	Low-income students	Age < 20	HS graduation with honors	High school GPA	High school Math GPA	Parisian prep. school	Star class
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: All								
Above	-0.003	-0.004	-0.011	-0.001	-0.009	0.011	-0.008	-0.006
	(0.009)	(0.009)	(0.011)	(0.007)	(0.008)	(0.007)	(0.011)	(0.009)
Mean at the thresholds	.181	.214	.324	.733	1.6	1.57	.319	.765
Observations	31664	31664	31664	31664	31664	31664	31664	31664
Panel B: Girls								
Above	0.000	-0.002	-0.022	0.007	-0.028	0.013	0.012	0.021
	(0.000)	(0.023)	(0.027)	(0.013)	(0.019)	(0.015)	(0.026)	(0.023)
Mean at the thresholds	1	.22	.361	.803	1.78	1.58	.319	.728
Observations	5419	5419	5419	5419	5419	5419	5419	5419
Panel C: Boys								
Above	0.000	-0.003	-0.002	-0.003	-0.006	0.010	-0.015	-0.006
	(.)	(0.010)	(0.012)	(0.008)	(0.009)	(0.008)	(0.012)	(0.010)
Mean at the thresholds	0	.213	.31	.718	1.56	1.57	.325	.773
Observations	26245	26245	26245	26245	26245	26245	26245	26245
Low-income boys								
Above	0.000	0.000	0.002	-0.030*	-0.017	0.025	-0.035	-0.018
	(.)	(0.000)	(0.025)	(0.017)	(0.020)	(0.017)	(0.023)	(0.023)
Mean at the thresholds	0	1	.308	.789	1.65	1.62	.252	.766
Observations	5464	5464	5464	5464	5464	5464	5464	5464
High-income boys								
Above	0.000	0.000	-0.003	0.001	-0.004	0.007	-0.008	-0.005
	(.)	(.)	(0.013)	(0.009)	(0.010)	(0.009)	(0.013)	(0.011)
Mean at the thresholds	0	0	.31	.699	1.53	1.56	.345	.775
Observations	20781	20781	20781	20781	20781	20781	20781	20781

Notes: Same sample of students as in Table 2. Panel A refers to the full sample, Panel B refers to the subsample of female applicants, and Panel C refers to the subsample of male applicants. Panel C is further divided into two subsamples: male applicants not eligible for means-tested financial assistance (row 4), and male applicants eligible for means-tested financial assistance (row 5). Each column corresponds to a specific dependent variable. Columns 1–3 describe students' baseline demographic characteristics, that is, whether they are female students (column 1), whether they are eligible for means-tested financial assistance (column 2), and whether they are younger than 20 years on first entering the CCMP competition. Columns 4–6 correspond to variables describing students' baseline academic level at the end of high school, namely whether they graduated with honors (column 4), their standardized average mark for all subjects as assessed at the national exams for high school graduation (column 5), and their standardized average mark in Mathematics at the national exam for high school graduation (column 6). Columns 7 and 8 describe the type of preparatory school and class in which students are enrolled, that is, whether they are enrolled in a preparatory school located in Paris (column 7), and whether they attended a high ability ("star") class (column 8). For each dependent variable and each sample, the table shows the impact of falling just above the admission threshold. Standard errors clustered at the individual level are given in parenthesis. All regressions include the same control variables and use the same specification as in Table 2.
* significant at 10%. ** significant at 5%. *** significant at 1%.

Table A3 – RD Analysis on Change in Performance among First-time Participants

	Ranking gain (1)	Ranking gain > 10.2 pc. (2)	Ranking diff. (3)	Ranking diff. (adj.) (4)
Panel A: All				
Above	-0.016**	-0.014**	-0.304	-0.513**
	(0.006)	(0.006)	(0.196)	(0.252)
Mean at the thresholds	.1	.0836	2.25	3.92
Observations	31664	31664	31379	31379
Panel B: Girls				
Above	-0.007	-0.003	-0.188	-0.140
	(0.011)	(0.011)	(0.327)	(0.415)
Mean at the thresholds	.0467	.0397	.989	1.63
Observations	5419	5419	5372	5372
Panel C: Boys				
Above	-0.019**	-0.017**	-0.335	-0.606**
	(0.007)	(0.007)	(0.226)	(0.291)
Mean at the thresholds	.112	.0933	2.53	4.42
Observations	26245	26245	26007	26007
High-income boys				
Above	-0.027***	-0.026***	-0.639**	-0.960***
	(0.008)	(0.008)	(0.258)	(0.330)
Mean at the thresholds	.114	.0958	2.56	4.52
Observations	20781	20781	20606	20606
Low-income boys				
Above	-0.003	0.003	0.376	0.079
	(0.016)	(0.015)	(0.469)	(0.617)
Mean at the thresholds	.106	.0839	2.39	4.07
Observations	5464	5464	5401	5401

Notes: The table shows the same analysis as in Table 2, columns 3–6. The only difference is that rankings at both attempts are defined among the subset of first-time applicants, rather than among all applicants.
* significant at 10%. ** significant at 5%. *** significant at 1%.

Table A4 – Causal Effects of Repetition on Performance among First-time Applicants for Repeaters and Compliers

	Ranking gain		***Ranking gain > 10.2 pc.***		***Ranking diff.***		***Ranking diff. (adj.)***	
	Repeaters	Compliers	Repeaters	Compliers	Repeaters	Compliers	Repeaters	Compliers
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: All	0.720***	0.927***	0.594***	0.768***	17.210***	15.179**	30.170***	27.078***
	(0.023)	(0.233)	(0.025)	(0.234)	(0.982)	(7.656)	(0.836)	(7.300)
N	389	31664	389	31664	349	31379	349	31379
Panel B: Girls	0.667***	n. s.	0.615***	n. s.	12.404***	n. s.	24.659***	n. s.
	(0.076)		(0.079)		(3.647)		(3.231)	
N	39		39		36		36	
Panel C: Boys	0.726***	0.907***	0.591***	0.797***	17.763***	13.064*	30.804***	25.261***
	(0.024)	(0.223)	(0.026)	(0.231)	(1.009)	(7.179)	(0.850)	(6.642)
N	350	26245	350	26245	313	26007	313	26007
High-income boys	0.722***	0.872***	0.582***	0.831***	16.592***	18.867***	29.857***	30.386***
	(0.028)	(0.170)	(0.030)	(0.185)	(1.161)	(6.184)	(0.973)	(5.681)
N	263	20781	263	20781	238	20606	238	20606
Low-income boys	0.722***	n. s.	0.582***	n. s.	16.592***	n. s.	29.857***	n. s.
	(0.028)		(0.030)		(1.161)		(0.973)	
N	263		263		238		238	

Notes: The table shows the same analysis as in Table 3. The only difference is that rankings at first and last attempts are defined among the subset of first-time applicants, rather than among all applicants.
* significant at 10%. ** significant at 5%. *** significant at 1%.

Table A5 – Robustness to the Choice of Control Variables and Functional Forms

	Repetition		Ranking gain		Ranking gain > 10.2 pc.		Ranking diff.		Ranking diff. (adj.)	
Panel A: Robustness to control variables										
	No controls	All controls	No controls	All controls	No controls	All controls	No controls	All controls	No controls	All controls
Above	-0.019***	-0.017**	-0.020***	-0.018***	-0.016**	-0.013**	-0.446*	-0.346	-0.752**	-0.623**
	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)	(0.006)	(0.237)	(0.231)	(0.315)	(0.306)
Observations	31664	31664	31664	31664	31664	31664	31379	31379	31379	31379
Panel B: Robustness to functional forms										
	Optimal poly.	Local linear	Optimal poly.	Local linear	Optimal poly.	Local linear	Optimal poly.	Local linear	Optimal poly.	Local linear
Above	-0.016**	-0.016*	-0.018***	-0.017**	-0.014**	-0.013*	-0.388*	-0.331	-0.620**	-0.563
	(0.007)	(0.008)	(0.007)	(0.008)	(0.006)	(0.007)	(0.235)	(0.263)	(0.310)	(0.352)
Degree of opt. poly.	1		1		1		1		1	
Observations	31664	31664	31664	31664	31664	31664	31379	31379	31379	31379

Notes: Same working sample as in Table 2 Panel A. Each column corresponds to a specific dependent variable, namely year repetition (columns 1 and 2), obtaining a strictly better standardized ranking for the last attempt compared with the first attempt (columns 3 and 4), obtaining a higher standardized ranking at their last attempt than that at the initial attempt by at least 10.2 percentiles (columns 5 and 6), the difference in standardized rankings between the last and first (columns 7 and 8), and the difference in standardized rankings between the last and first using rankings adjusted for first-time bonuses (columns 9 and 10). For columns 7–10, the sample excludes students who failed to be ranked after repeating. For each dependent variable, the first row replicates the analysis in Table 2 Panel A with different sets of control variables, namely without any control variable for students' baseline characteristics (columns 1, 3, 5, 7, and 9), or with control variables for all available students' baseline characteristics (columns 2, 4, 6, 8, and 10). The second row replicates the analysis in Table 2 Panel A with alternative functional forms; that is, columns 1, 3, 5, 7, and 9 report the results of falling above the admission threshold using a polynomial function of the running variable whose optimal order is obtained by a bins test; and columns 2, 4, 6, 8, and 10 report the results using local linear estimations. All estimates include triangular weights, and standard errors clustered at the individual level are given in parenthesis.
* significant at 10%. ** significant at 5%. *** significant at 1%.

Table A6 – Gender Gaps in Repetition by CPGE Field of Study

	Scientific CPGE	Business CPGE	Humanity CPGE
Girls–boys repetition gap	-0.041***	-0.050***	-0.121***
	(0.003)	(0.003)	(0.007)
Mean repetition for boys	.277	.129	.331
Observations	80313	30009	21244

Notes: The table refers to the sample of students who enrolled for the first time in the second year of either a scientific CPGE (column 1), a business CPGE (column 2), or a humanity CPGE (column 3) between 2011 and 2015. For each column, the table shows the proportion of male students who repeated a year as well as the gender gap in repetition rates (as estimated by the regression of a dummy variable indicating student's repetition decision on a female dummy while controlling for student's high school graduation results as well as for year/school/track/star class fixed effects). Standard errors are given in parenthesis.
* significant at 10%. ** significant at 5%. *** significant at 1%.

Appendix B

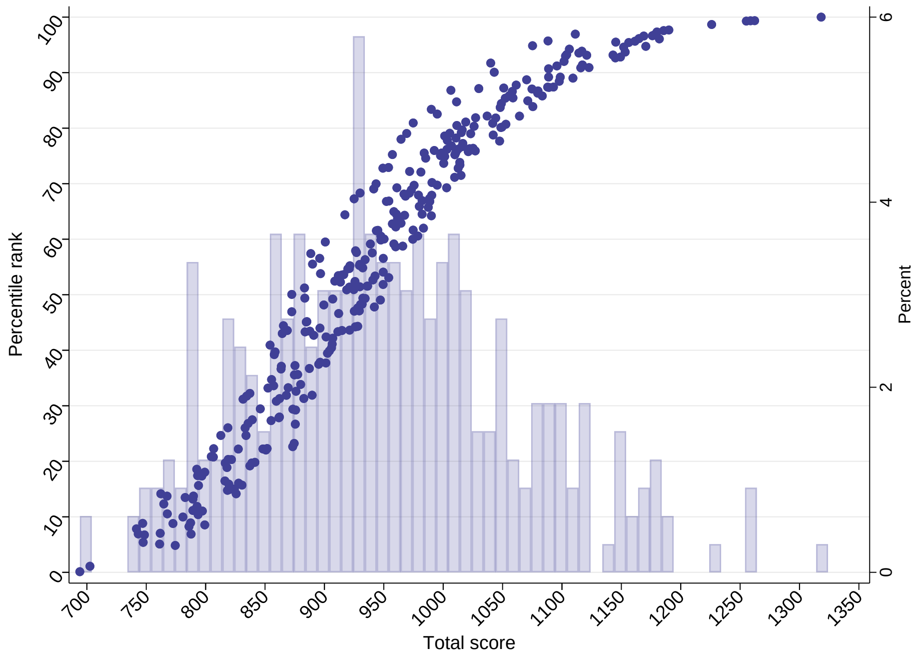


Figure B1 – Correspondence between CCMP Scores and CCMP Rankings

Notes: The figure refers to a specific Parisian CPGE program for which we have full information on both student's CCMP scores and student's CCMP (standardized) rankings between 2012 and 2017. For the different observed scores, the dots report student's standardized rankings. In addition, the histogram shows the density of observed scores. We first used this correspondence between scores and rankings to infer the scores of all CCMP applicants based on their standardized rankings. We were then able to adjust scores for the bonus points granted to first-time applicants and to re-rank students based on their adjusted scores. We used these adjusted rankings to define outcomes corrected for bonus points.