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Evidence from a Natural Experiment with Low-Achieving Students

Abstract

In several countries, students who fail end-of-high-school high-stakes exams are faced with the choice of retaking them or forgoing postsecondary education. We explore exogenous variation generated by a 2006 policy that imposed a performance threshold for admission into postsecondary education in Greece to estimate the effect of retaking exams on a range of outcomes. Using a fuzzy regression discontinuity design and novel administrative data, we find that low-achieving students who retake national exams improve their performance by half a standard deviation, but do not receive offers from higher quality postsecondary placements. The driving mechanism for these results stems from increased competition.

JEL-Codes: J160, I210, I230.

Keywords: postsecondary education admission, low-achieving students, exogenous policy, fuzzy regression discontinuity design.

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1 Introduction

A growing literature shows that scoring above or below a threshold in high-stakes exams can be a key determinant for lifetime success or failure (Pop-Eleches and Urquiola, 2013; Goodman, Oded and Jonathan, 2020; Machin, McNally and Ruiz-Valenzuela, 2020). Several countries use such exams to select students for a limited number of admissions slots, including China, Chile, Greece, Israel, India, Korea, and Turkey. Success on these exams is a gateway to postsecondary education and better labor market outcomes (Blundell, Dearden, Goodman and Reed, 2000; Belfield, Britton, Buscha, Dearden, Dickson, Van der Erve, Sibieta, Vignoles, Walker and Zhu, 2019). Failure on these high-stakes exams can be *absolute* — when students fail to obtain a place in higher education due to poor performance on the exam — or it can be *relative*, when students fail to get into their postsecondary university or degree of choice.

Failing on the first attempt can be costly for students, since they may have to wait up to an entire year to retake the exam. If students are not in the labor market while preparing to retake the entrance exam, they forgo earnings. Such students devote a significant amount of effort, money, and time to retaking high-stakes exams, while also incurring mental health costs due to the stigma of having to retake (Krishna, Lychagin and Frisancho 2018). Some benefits are associated with retaking, such as increased familiarity with the exam format, learning gains, and improved scores (Vigdor and Clotfelter, 2003; Frisancho, Krishna, Lychagin and Yavas, 2016; Goodman, Oded and Jonathan, 2020).

In this paper, we analyse the impact of retaking high-stakes exams (due to absolute failure) for entry into postsecondary education on students' performance in subsequent attempts and on the quality of their postsecondary placement. Our unique contribution is that we address the potential endogeneity related to who retakes using an exogenous policy that introduced a minimum performance threshold in postsecondary admission. A common concern in the literature is that the decision of a student to retake an exam is likely affected by confounding characteristics, including the lack of motivation, financial hardship for the student's family, a supportive environment at home or school, or the availability of outside options such as studying abroad (Krishna, Lychagin and Frisancho, 2018; Machin, McNally and Ruiz-Valenzuela, 2020; Goodman, Oded and Jonathan, 2020). Existing studies use either a naturally-induced threshold, such as multiples of 100 in the SAT scale in the US or grade C in the GSCE exam in Britain (Machin, McNally and Ruiz-Valenzuela, 2020; Goodman, Oded and Jonathan, 2020) or structural estimation (Krishna, Lychagin and Frisancho, 2018) in an attempt to deal with endogeneity. However, it may be the case that students, teachers or graders may respond to existing and anticipated naturally-induced thresholds to some extend or that not all students view these round number thresholds as real milestones. In this paper, we overcome existing challenges by using an unanticipated policy that imposed a clear performance threshold for postsecondary admission for all applicants in Greece.

Starting in 2006, senior year high school students must achieve a minimum average (across subjects) score of 10,000/20,000 (i.e., 50%) on the postsecondary education admission exams; while previously there was no minimum admission threshold. Students whose performance is below this threshold are now refused access to postsecondary education. The only way for students who failed at their first attempt to access postsecondary education is to retake all exams in the next exam session (1 year later) and score above the required performance threshold. Under the new policy, failing the exam is quasi-randomly assigned among low-achieving students, and thus we control for confounding characteristics of students that might be correlated with the decision to retake the exam. The prospect of *absolute* failure is faced by low-achieving students who obtain scores close to the threshold and who are the focus of this paper. This group is of paramount importance for policy purposes, because they are more likely to give up education. To identify causal effects and account for partial compliance[1], we use a fuzzy regression discontinuity design. Comparing students who just failed the threshold to those students who just passed the threshold eliminates selection bias due to observed and unobserved teacher, class, and school characteristics. We focus on the first cohort that was affected by the policy change (the 2006 cohort), since only for this cohort the policy was unanticipated and we can make sure that students, teachers and graders are unlikely to respond to the unexpected introduction of the minimum performance threshold.

We use new administrative data that we obtained from the Ministry of Education in Greece. The data include detailed student-level records of exam performance and postsecondary placement for the universe of students in Greece. Interestingly, we have access to this information for each time a student retakes the exam. This dataset is also linked to rich information about student postsecondary education preferences and choices, such as a ranked order of students' preferences for college-courses, the type of each college-course (academic university compared to vocational school), the quality of each college-course and information about the offered postsecondary education college-course. To complement our main analysis, we also use a smaller comprehensive dataset which includes additional information on student birthdate and other measures of student-level academic performance.

We find that students who retake the exam improve their performance by around 24%, which is

[1]Due to some affirmative action policies that we explain in Section 3.2.

equivalent to an improvement of half a standard deviation. This is in line with previous work (Goodman, Oded and Jonathan, 2020). We provide evidence that the exam improvement is not explained by: (1) retakers being more mature since they are 1 year older, and (2) teachers inflating students' grades as a response to the policy. In particular, we show that both 17- and 18-year-old students improve their performance similarly upon retaking the exam and that there is no bunching around the performance threshold. We conclude the performance improvement is most likely the effect of learning through studying during the additional year.

We also find that students do not necessarily obtain better postsecondary placements upon retaking. Despite significantly improving their academic performance on the exam, students are not more likely to obtain offers from better-ranked college-courses or have better employment prospects; they are also not more likely to obtain a place in an academic as opposed to a vocational institution.

We identify two possible mechanisms that could explain why students do not improve on their offers despite obtaining higher scores: (1) the strength of the competition that retakers face is now much higher and (2) retakers now change their application strategies in terms of the quality of their choices and their risk-taking behavior. We find evidence in support of the first mechanism only. In particular, we show that upon introduction of the policy in 2006, the pool of applicants changes substantially, since low-performing students are now discouraged from applying. Thus, students who retake the exam in 2007 see no relative improvement in their placement. In a counterfactual exercise, we show that had they competed against their contemporary peers or a cohort that was not affected by the threshold, they would have improved their ranking by 14-18 percentage points in the distribution and would have been able to access places at better-ranking institutions. With regards to the second mechanism, we find no evidence that students become more (or less) ambitious or change their attitudes against risk in the way they list their postsecondary choices in their later attempt compared to their first attempt. In particular, students do not change the way they compile their college-course preference list.

We provide extensive evidence for the validity of our design. If sorting around the threshold were a problem, we would expect to see a discontinuity in the distribution of scores around the threshold value, since a disproportionate number of students would fall just above the threshold relative to the number of students just below the threshold. First, we show that the distribution of students' scores is continuous around the threshold. The institutional setting is also reassuring here. Teachers are practically unable to manipulate the assignment variable in order to influence whether students receive the treatment or not. This is because the performance threshold is a weighted average of a student's average performance across six exams (each exam is marked by two independent examiners), and thus an individual subject teacher is not aware of a student's performance on the other subjects. Second, we show that students who just failed to achieve the required achievement threshold on their first attempt have on average the same observed characteristics, and thus are identical to those students who just achieved the required achievement threshold. Falling just to the right or just to the left of the required threshold seems to be simply a matter of luck. Third, we provide evidence that there is no manipulation of the assignment variable around the threshold using a formal test with robust confidence interval estimators proposed by Calonico, Cattaneo and Titiunik (2014b). Forth, we show that the estimated effects remain similar when we use different measures of performance.

We perform a battery of robustness checks that confirm the validity of our findings. First, we show that the estimated effects are not sensitive to the selection of the bandwidth. We use several alternative bandwidths and the estimated effects remain very similar to the main effects. Second, we estimate placebo regressions in which we pretend that the threshold is at different threshold values instead of the real one and we find no significant effects. The lack of any discernible effects when the pseudo-thresholds are used suggests that the estimated effects do not pick up any effects of unobserved confounders and that there is no misspecification in the relationship between the running and the outcome variable. Third, we eliminate observations that are located very close to the performance threshold (donut method), and this exercise leads to estimated effects that are still similar in magnitude and statistically significant.

Our study moves beyond the existing literature in several important ways. First, we exploit an education system that is highly centralized. This feature makes our setting ideal for the type of questions that we study. In highly centralized systems, such as the Greek one, admission to postsecondary education depends entirely on well-defined measures of performance (mainly externally marked) and students' preferences. In other systems, in contrast, postsecondary placement depends on merit more loosely (i.e., personal statements, reference letters, extracurricular activities, subjective ranking of students or schools). Another feature that makes the Greek setting appealing is that it relies less on a student's socioeconomic background compared with other settings. Postsecondary education is free of tuition fees in Greece, which means that students express their unconstrained preferences in terms of their desired postsecondary college-courses. This allows them to potentially move up the socioeconomic ladder by enrolling to a prestigious college-course although they may come from low-income families.

Second, our paper contributes to a small but growing literature on retaking high-stakes exams (Goodman, Oded and Jonathan, 2020; Landaud and Maurin, 2020; Frisancho, Krishna, Lychagin and Yavas, 2016; Krishna, Lychagin and Frisancho, 2018; Vigdor and Clotfelter, 2003). The closest paper to ours is a recent paper by Goodman, Oded and Jonathan (2020). They study the effect or retaking SATs in the US (exploiting thresholds at multiples of 100) and find a positive effect on test scores among low-achieving students, similar to our main results. We contribute and add to previous work by showing that the mechanism behind performance improvement is not due to retakers being 1 year older, which is a possible confounder in previous studies. Most importantly, the data-generating process that we exploit allows us to evaluate the role of the strength of the competition when retaking the exam. Our study is the first to highlight the role of the strength of the competition in settings where a minimum threshold is imposed and thus the overall skill level in the applicant pool changes. Our work emphasizes the mechanism that explains why although individuals may experience an increase in their absolute performance, they do not necessarily obtain better relative outcomes in these types of high-stakes exams. Selective institutions with limited places, such as degree-granting entities, the civil service, or popular companies, often readjust their selective criteria for entry either to increase the signalling value of accepted individuals or to decrease selection costs. Thus, we highlight the fact that while retaking a high-stakes exam will most likely lead to improved performance, when a limited number of places is at stake the strength of the competition is a relevant factor that should be considered as carefully as the individual student's performance.

We also contribute to the literature that analyzes the effects of passing college admission exams on subsequent outcomes (Avery, Gurantz, Hurwitz and Smith, 2018; Goodman, Hurwitz and Smith, 2017; Zimmerman, 2014). Given our focus on low-achieving students, our study is also related to the literature that focuses on just passing or failing important exams. Clark and Martorell (2014) provide evidence that marginal students do not benefit from marginally passing high school exit exams in the US. Canaan and Mouganie (2018) show that students marginally passing the French high school exit exam are more likely to enroll into STEM degrees and into better quality postsecondary institutions and also earn more in their late 20s, relative to those who marginally failed the exam. Machin, McNally and Ruiz-Valenzuela (2020) present findings that students who just fail the high-stakes national examination taken at the end of compulsory schooling in England have a lower likelihood of entering postsecondary education and are more likely to drop out of education before reaching 18. Martorell, McFarlin and Xue (2015) show that having to take remediation courses does not lead to a drop in college enrollment among students in Texas. Andresen and Løkken (2020) show that low-achieving students who fail an exam are more likely to drop out from school in Norway.

The rest of the paper is structured as follows. Section 2 describes the institutional setting, section 3 presents the data and section 4 discusses the methodology. Section 6 reports the main results, and Section 7 discusses the mechanisms. Section 8 focuses on the robustness checks, and section 9 concludes.

2 Institutional Setting

2.1 Admission to Postsecondary Education in Greece

Most postsecondary institutions in Greece are public and state-funded. Admission to postsecondary education is based on student performance on national high school examinations and is centralized and administered by the Ministry of Education. Students must take these standardized national exams at the end of their final year of senior high school to enter postsecondary education. Each postsecondary education college-course has a specific number of available places every year, and students submit a preference list of their desired postsecondary college-courses in ranked order to the Ministry of Education. These preferences can be over both college-courses in academic universities and vocational schools.

Students are ranked based on their *admissions grade*. The admissions grade is a weighted average grade based on a student's average performance on national and school exams in core and track subjects in the final year of high school.[2] In 2006, the postsecondary education admissions grade was calculated based on a student's national exam performance in six subjects: two core subjects and four track subjects. Students may also take exams in an optional subject.[3]

The admissions score ranges from 0 to 20,000 and is increasing in performance. Core subjects are general education subjects and are compulsory for all students. Students chose a track in the penultimate year of high school. All high schools in Greece offer three tracks. These are classics, science, and exact science. Students take the same subjects within tracks, but subjects differ across tracks. Track subjects are compulsory for students in a given track. All schools that administer these national exams follow the same curriculum and offer courses in core and track subjects in accordance with the material covered on the exam.

Exams in each subject are centrally collected and sent to examiners across the country for scoring; the student's name and school are hidden. Each exam is scored by at least two anonymous independent

[2]National exams take a much higher weight compared with school exams (70% compared with 30%) in the calculation of the admissions grade.

[3]This optional subject is required for entrance to specific fields of study, such as economics, foreign languages, etc.

graders. All students who desire to apply to tertiary education must take the exam at least once.

After exam scores have been finalized and released, students rank their preferences for postsecondary college-courses.[4] In general, all postsecondary college-courses are divided into five broad scientific fields of study.[5] Each student can apply to college-courses that belong to up to two scientific fields of study. Each scientific field includes both academic and vocational courses. Depending on the scientific fields of study students are considering, different high school subjects take different weights in calculating the admissions score. Since students can apply to up to a maximum of two postsecondary education specialisation tracks, they may obtain two different admissions scores which they use in their applications. Thus students may have two slightly different admission scores depending on the scientific field of study they apply to.[6]

Once students have expressed their college-course preferences, they submit their ranked preference list to the Ministry of Education, which assigns students to college-courses using a centralized application system for postsecondary education (Goulas and Megalokonomou, 2019). This algorithm considers college-course rankings in the order of students' admissions scores. It starts with the student with the highest admissions score and places her at her top-ranked college-course. It then assigns the student with the second-highest admissions score to their top-ranked college-course and then it moves down to the student with the third-highest admissions score. Once a college-course runs out of places, a student is placed to the college-course ranked second highest, and so on; thus each student will be offered a unique placement. Since there is no limit in terms of how many college-courses students can include in their preference list, the dominant strategy for each student is to submit rankings for college-course preferences that truthfully reveal their preferences (Chade and Smith, 2006). It should also be noted that the contemporaneous college-course-specific threshold is not known to students when they submit their preference list; however, they can easily check the local performance admission thresholds of previous years.

[4] A college-course includes a university and department configuration.

[5] Those scientific fields of study are determined by the Ministry of Education and include: (1) Humanities, Law and Social Sciences, Theology, Teaching Professions, (2) Hard Sciences, Military Academies, Nautical Academies, Teaching Professions, (3) Medical Schools, Military Medical Schools, (4) Technology and Engineering, Military Academies, Nautical Academies, and (5) Economics and Business, Police Academies, Tourism Academies.

[6] Nevertheless, students' raw average test core in the six subjects in national exams is always the same. Consider a student who is applying for college-courses in the following two scientific fields of study: (a) Technology and Engineering and (b) Economics and Business. Performance in mathematics and physics received a higher weight in the calculation of the admission score for college-courses in technology and engineering, while performance in economics and mathematics receives a higher weight for college-courses in economics and business.

2.2 Decision to Retake the Admissions Exams

Students take the exam in their senior year of high school, hoping to first pass the admissions performance threshold and then to score high enough to meet their desired college-course choices' thresholds. Students who do not pass the admissions performance threshold on their first attempt may retake the national exams 1 year (or more) later if they desire to again reattempt to gain access to a postsecondary college-course.[7] In 2005, 19% of applicants failed to secure a postsecondary place.[8] Students who failed to gain access to tertiary education in their first attempt and desire to try again must retake the exam in all subjects and not only specific subjects. Exam questions are the same for retakers and students who are taking the exam for the first time. The curriculum assessed at the national level is usually the same over time. Students who retake the exam usually do not attend any school, pursue any job, or undertake military service between graduation and the next examination period.[9] There is only one examination period per year, around May-June, and schools do not provide any additional classes for retakers. In other words, retaking is a costly decision, in terms of both opportunity costs and preparation costs faced by students who must prepare and study intensively during the intervening year.[10] Despite this, in 2005, 15% of applicants retook the exam and gained access to postsecondary education.[11]

2.3 The 2006 Performance Admissions Threshold Reform

Before 2006, there was no specific admission performance threshold that students had to achieve to gain access to postsecondary education; each postsecondary college-course had its own local performance admissions threshold, and there was no universal performance threshold for admission. That is, any postsecondary education admissions score could—in theory—guarantee a postsecondary education spot, conditional on availability. Starting from 2006, a universal performance threshold for admissions was imposed, such that students had to obtain an admissions score of at least 10,000/20,000 (equivalent to 50%) to be eligible to apply for a postsecondary college-course.

Amid persistently high youth unemployment, the primary argument for the introduction of the restrictive minimum threshold was to increase the signalling value of a postsecondary education college-

[7]Alternatively, students might decide to study abroad or not study at all. In 2019, 5% of the tertiary student population was enrolled abroad, while 8% of 18-24 year-olds had been in neither employment nor education for the past 12 months (OECD, 2019).

[8]Authors' calculation based on the administrative dataset used in this paper.

[9]Serving in the military is compulsory for men in Greece. The average time they must serve is 12 months. It is not the norm for students to delay their undergraduate studies in order to serve the military.

[10]It should also be noted that preparatory classes in the form of private tutoring are common, with Greece being among countries with the most time spent per week in private after-school classes (OECD, 2018).

[11]Authors' calculation based on the administrative dataset used in this paper.

course for graduates in the labor market.[12] As Figure A1 in Appendix A shows, the law that introduced the minimum threshold for entering higher education was submitted to Parliament on 1/9/2005, debated on 21/22 September 2005, and implemented without a previous notice for the 2006 high school incoming cohort.[13]

The policy was in place for only 4 years, and the admissions threshold was abolished in 2010. During the years the policy was in effect, lower-achieving students were discouraged from applying to postsecondary education. In particular, on average 22% fewer students applied to enter postsecondary education during the years of the reform relative to the two adjacent years before and after the reform, while the grades of the admitted students were 24% higher.[14] The policy was reintroduced in 2020.

3 Data

3.1 Main Study Sample

In this study we use rich administrative data obtained from the Greek Ministry of Education and Religious Affairs for the universe of students who apply to postsecondary education institutions in Greece. The Ministry of Education and Religious Affairs collects annual data on all senior high school students. We focus on the 2006 cohort of students — i.e., students who took the exam for the first time in 2006. We obtain access to students' entire applications for postsecondary education. In particular, we gained access to a variety of variables reported on students' applications, including a unique student identifier, student gender, high school graduation year, name of high school attended, postsecondary education admissions score, the combination of colleges and courses students apply, the order of preference in which students rank their college-course preferences on their applications, whether they obtain an offer and, if so, at which college and course.[15] Importantly, we have access to this information every time a student takes the exam.

To the best of our knowledge, this is the first dataset that contains this detailed information and allows us to track students and observe the postsecondary education admissions score every time a

[12]In August 2005, a leading newspaper published an article that highlighted the record low admissions scores obtained by the outgoing cohort of 2005. The article criticised the government for letting students with such low grades enter higher education. Two days later, the Minister for Education at that time was interviewed by the same newspaper and promised to look into the matter and introduce changes. It is not entirely clear whether it was the newspaper article that prompted the discussion of introducing an admissions performance threshold for low-achieving students or the government was already planning to introduce the minimum threshold.

[13]Law 3404/2005, Article 13 states that students have to achieve at least half of the possible maximum postsecondary education admissions score to gain access to tertiary education. More information can be found in Figure B1 in Appendix B.

[14]Authors' calculations based on the administrative data used in this paper.

[15]Note that we do not observe actual enrollment, only offers.

student takes the exam, as well as the college-course choices a student lists each time they take the exam. In this system, students get an offer from a unique college-course depending on their choices and the course's availability. We have access to the unique college-course students enroll in.[16]

Students in Greece are assigned to public schools through zoning based on their residential address and residential proximity to the school (Goulas, Megalokonomou and Zhang, 2018). Using the student's school address, we deduce whether they reside in an urban or rural area using information on the number of inhabitants per postcode.[17] We also use the postcode level annual average household income (in euro) to define high- (above median) and low- (below median) income neighborhoods. Information on inhabitants and household income[18] is obtained from the National Statistical Authority.

3.2 Sample for Additional Analysis

For a small subsample of the population of schools and students, we have access to additional information. For students in the smaller sample, our data include information on their senior year GPA and birthdate. The senior year GPA includes the average performance on all first- and second- semester school exams in grade 12.[19] These are not standardized exams across the country but are representative of the entire student population in the study schools.[20] This dataset is also used in other studies (Lavy and Megalokonomou, 2019; Dinerstein, Megalokonomou and Yannelis, 2020; Kedagni, Krishna, Megalokonomou and Zhao, 2021; Lavy and Megalokonomou, 2021) and includes comprehensive data from 23 high schools. As shown in those studies, these schools are representative of the school population with respect to several observed variables, are distributed throughout the country, and cover a diverse set of areas (Figure B2). These additional data were obtained by visiting each high school in person, obtaining all student-level records, and digitizing them. We have additional data for the years 2006 and 2007.

3.3 Summary Statistics

Table 1 shows a summary of the novel administrative data used in the main analysis. Column (1) includes the entire student population who took the exam in cohort 2006 in Greece, which is almost

[16]The government indicates that only in very specific cases, a student's enrolled college-course may be different from the one they got an offer from, such as students from families with more than 3 children or students with a major disability. In those cases, students may be allowed to enroll in a college-course in the same field of study as the one they got an offer from, with the only difference being that the enrolled one is closer to their parents' residential address.

[17]Urban areas are those with more than 20,000 inhabitants.

[18]We obtained this information at postcode level and aggregated it at neighborhood level.

[19]Note that the school-level GPA units run from 0-20, while the units for the national exams run from 0-20,000.

[20]Not only students applying to postsecondary education.

70,000 students. Column (2) includes students within a +/-1,500-point bandwidth around the threshold (i.e., admissions scores ranging from 8,500 to 11,500). This sample includes around 14,500 students, and is the sample we use in our main analysis. The sample size in the analysis changes with each optimal bandwidth calculated for each outcome, and thus we present summary statistics within a +/-1,500-point bandwidth from the threshold. This encompasses all bandwidths that are calculated using a linear polynomial of the running variable.[21]

Column 1 of Table 1 includes students in the entire sample of the 2006 cohort — i.e., students who were eligible to take the exam for the first time in 2006. The admissions score tends to be higher for the entire sample, with a mean of 12,344 (column (1)), relative to the sample closer to the threshold with a mean of 10,045 (column (2)). This is expected, since the sample included in the analysis focuses on students who marginally pass or fail the admissions threshold, i.e, lower-achieving students. Since students' admissions score is calculated differently for each of the five knowledge fields, and students choose up to two knowledge fields, each student gets at most two admission scores. Thus, in our main analysis we define the admissions score as the admissions score used for the offer if a student gets an offer on first attempt, or the highest of the two admissions scores if a student does not obtain an offer on the first attempt.[22]

Around 34% of students failed to secure a postsecondary education offer on their first attempt in 2006 (column (1)). Around the threshold, failure rates are significantly larger - around 52% (column 2). We then rank college-courses in terms of quality using the admissions score of the last admitted student in 2005. Forty-two percent of students receive an offer from a college-course above the median quality in the entire sample, while only 6% get offers from high-quality college-courses in the lower-ability sample (column (2)). "Offer from Academic Institution" is a binary indicator that takes the value 1 if the offered postsecondary institution is an academic university and 0 if it is a vocational school or the student is not admitted to any postsecondary institution. In the entire sample, around 51% of students get offers from an academic institution, while only 20% of the lower-ability sample get offers from academic institutions.

We also classify college-courses based on an employability index that relates to the job prospects and job insecurity associated with each college-course. This index reflects the fear of involuntary job loss and is collected from a series of long-term surveys of university graduates in Greece discussed

[21] Certain bandwidths are calculated using a quadratic polynomial, usually $>$1,500.

[22] We show in a robustness exercise that our results remain similar if we use the admissions score that corresponds to the first, second or third choice the student includes on their preference list (Table 7).

by Goulas and Megalokonomou (2019). For each university department, this index indicates whether the employment prospects for students after graduation are good, mediocre, poor, or very poor. More information about how this index is constructed is provided in the note for Figure B3 in Appendix B. We classify each college-course as a high or low employment prospect.[23] In Table 1, there is no statistically significant difference in terms of the college-course employability index between the entire sample (column (1)) and the sample of lower-achieving students (column (2)).

Overall, 21% of students in the entire sample retake the exam at some point after their first attempt, and most (19%) do so in the next consecutive year, i.e., in 2007. Of the sample within the +/-1,500-point bandwidth from the threshold, 43% retake the exam at some point after their first attempt, while 41% retake the exam in the next consecutive year. Moreover, most students who retake tend to do so only once and in the following year after their first attempt. Regarding those who do not fail in absolute terms (but failed in relative terms, which means that they still scored an admissions score $>$10,000), 11% of them retake the exam in the entire sample (column (1)) and 25% of students retake the exam in the +/-1,500-point bandwidth sample (column (2)). The retake rate is much higher among those who fail the exam in absolute terms (admissions score $<$10,000) in both samples.

We then show summary statistics for students' postsecondary applications. Students with admissions scores around the threshold express more college-course choices (around 32 college-course choices) than the entire sample (around 26 college-course choices). For the entire sample, 56% of students opt for academic tracks, 49% choose top college-courses, and 64% choose college-courses with high employment prospects. In the +/-1,500-point bandwidth sample (column (2)), only 24% of students choose academic college-courses and only 12% focus on a high-quality college-course but the majority (68%) choose college-courses with high employment prospects.

A similar proportion of students who apply for a postsecondary college-course have graduated from urban high schools in the two samples (columns (1) and (2)). Students in the +/-1,500-point bandwidth sample are slightly less likely to have graduated from a top-performing school. We measure school-level performance by the average admission score of all applicants in that school the year before (2005). We define as top-performing schools those whose school-level performance is above the median performance. We also notice that students in the low-performing sample have a slightly smaller household income than those in the entire sample, and are slightly less likely to be female; however, these differ-

[23]In particular, we define as college-courses with high employment prospects those that have an initial employability between 1 and 2, or in other words a college-courses degree with good or mediocre employment prospects. Following the same logic, we define as college-courses with low employment prospects those that have an initial employability index between 2 and 3, or in other words a college-course degree with poor or very poor employment prospects.

ences are relatively small and not statistically different from zero.

4 Empirical Strategy

4.1 Baseline Model and Specification

We identify the relationship between retaking the exam and resulting outcomes (Y) by exploiting a regression discontinuity design (RDD). In particular, we rely on the change in the postsecondary education admissions rule that took effect in Greece in 2006. This policy imposed an important threshold at a score of 10,000 out of 20,000. Students gain access to postsecondary education only if they score at least 10,000; in previous years, anyone could get into postsecondary education, subject to vacant slots. This new admission rule generated a discontinuity in the treatment assignment (i.e., receiving a postsecondary education offer) around the threshold. We are interested in establishing the causal effect of passing the performance threshold on later outcomes for similar students who fell on either side of the performance threshold simply because they performed relatively better or worse than the performance threshold.

We note that not everyone below the threshold is refused access to tertiary education, and thus some students below the threshold may not have to retake the exam. This is because the government applies some affirmative action policies, and means that students who do not achieve the required performance threshold might still be admitted to postsecondary education and will not have to retake the exam, simply because they belong to a group that receives beneficial treatment. Since there is only partial compliance around the threshold, the identification strategy we use is a fuzzy RDD (Angrist and Lavy, 1999; Hahn, Todd and der Klaauw, 2001). The imposed postsecondary performance threshold serves as an exogenous source of variation for retaking decisions. In particular, a binary indicator that shows whether a student fails to achieve a score of 10,000/20,000 is used to instrument for whether a student has to retake the exam.

To estimate the effects of retaking the exam a year later[24] on subsequent outcomes, we employ a fuzzy RDD to account for potential confounding factors. In particular, we instrument the probability of retaking the exam in 2007 for student i in school s ($Retake_{is}$) with an indicator for whether the admission score was below 10,000 (T_i):

[24]Our main analysis examines the effects of retaking the exam in 2007, because the vast majority of students retake the exam only once (in 2007). We conduct a robustness check in Section 8 where we focus on students' outcomes in the latest attempt they take the exam.

$$Retake_{is} = \alpha_1 + \alpha_2 T_i + \gamma_1 f(score_i) + \gamma_2 T_i f(score_i) + \mu_{is}, \quad (1)$$

where $f(score_i)$ is a linear or quadratic polynomial of the distance between student $i's$ score and the 10,000 threshold. Our main regression is thus given by

$$Y_{is} = \beta_1 + \beta_2 Retake_{is} + \theta_1 f(score_i) + \theta_2 T_i f(score_i) + e_{is}, \quad (2)$$

where Y_{is} is the outcome of interest for student i in school s. Outcomes of interest include (for example) a student's most recent performance on the exam, the quality of the most recent offer received or an indicator of whether the student received an academic offer or not. The above specifications produce first- and second-stage 2SLS estimates. Standard errors are clustered at the school level to allow for heteroskedasticity and serial correlation at that level, since students who attend the same school may share some error patterns. To further check the robustness of our findings and in addition to the 2SLS estimates, we apply a nonparametric method that relies on local polynomial (fuzzy) regression discontinuity point estimators with robust-bias corrected (RBC) confidence intervals and we call these CCT estimates given that the procedure follows Calonico, Cattaneo and Titiunik (2014a,b).

We use the mean squared error (MSE) optimal bandwidths computed according to the method proposed by Calonico, Cattaneo and Titiunik (2014b).[25] Our nonparametric estimates come from a local polynomial regression that uses a triangular kernel. This procedure assigns higher weights to observations closer to the threshold, following the approach proposed by Calonico, Cattaneo and Titiunik (2014a) and Calonico, Cattaneo, Farrell and Titiunik (2019).

4.2 First-Stage Results

Figure 1 illustrates the first stage. The x-axis describes the distance of the student's score from the threshold of 10,000/20,000 (indicated by the distance from the vertical line at 0); the y-axis describes the probability to retake the exam at different distances from the threshold. The sample is restricted to students who obtain a score in the +/- 1,500-point sample (i.e., student performance between 8,500 and 11,500). First, we see that retaking the exam is quite common, with an average of 40% for the sample in the figure.[26] There is a clear discontinuity in the probability to retake the exam for students around the

[25] According to Calonico, Cattaneo and Titiunik (2014b), when researchers apply the MSE optimal bandwidth, it yields the MSE-optimal regression discontinuity treatment effect estimator, which is invalid for inference. RBC inference methods are valid when using the MSE-optimal bandwidth, but they yield suboptimal confidence intervals in terms of coverage error. In this paper, the authors establish valid coverage error expansions for RBC confidence interval estimators and use these results to establish new inference-optimal bandwidth choices for forming these intervals. Thus, we follow their work and use RBC confidence intervals and MSE optimal bandwidth throughout the paper.

[26] Figure A2 in the Appendix illustrates the first-stage estimates for the entire distribution of scores, and not only for the +/-1,500-point sample. We notice that there is a considerable discontinuity of retake rates around the performance threshold.

threshold. In particular, below-threshold students are on average 50% more likely to retake the exam. Above-threshold students are 10-23 percentage points less likely to retake the exam depending on their distance from the threshold.

As a robustness check, we show that there is no first stage in the years prior to and after the reform. In particular, we use information on 2004 (the year before introduction of the performance threshold) and 2010 and 2011 (2 consecutive years after lifting of the performance threshold). Figure 2 presents the first stage for these placebo years. The x-axis describes the distance of the student's score from the threshold of 10,000/20,000; the y-axis describes the probability to retake the exam at different distances from the threshold. Panel A of Figure 2 presents the first stage for cohort 2004, before introduction of the threshold. Panels B and C present the probability to retake the exam the first year after lifting the threshold (2010) and a year later (2011), respectively. In all these years, we see that the probability of retaking the exam is continuous around the threshold, as expected. Consistent with the institutional setting, this evidence reassures us that we are indeed estimating the effects of the 2006 reform.

Students retake the exam to gain access to postsecondary education. The exclusion restriction is not violated by students taking the exam only to obtain a high school certificate and not to access postsecondary education. The threshold at 10,000 is only relevant for entering postsecondary education and does not affect whether the student obtains a high school degree. Obtaining a high school certificate solely depends on exams that are administered by the local school and graded by the students' school teachers.

5 Validity of the Estimation Strategy

5.1 Manipulation Around the Threshold

Our main identifying assumption in the RDD setting is that the density of treated observations just above the threshold should be approximately similar to the density of control observations just below the threshold. In the context of high-stakes exams, the manipulation of the running variable (admission grade) is a legitimate concern and has been shown to be present in the school system, especially close to important performance thresholds (Diamond and Persson, 2016; Dee, Dobbie, Jacob and Rockoff, 2019). In our setting, one may expect manipulation to be present if graders inflate the scores of students who just fail to pass the newly introduced threshold.

We also notice that for students far to the left of the threshold, the retake rate jumps to almost the frequency of retake rates for students just to the left of the threshold.

Figure 3, Panel A presents a histogram of the running variable around the performance threshold. In Panel B, we follow the approach proposed by Cataneo, Idrobo and Titiunik (2019) and present the actual density estimate with 95% confidence intervals. Both figures provide clear evidence that the density of the admissions score around the threshold displays no systematic differences below and above the performance threshold. Moreover, the overlap of the confidence intervals in Panel B is further supported by the formal test, which yields a p-value of 0.241 for the null that there is no difference in the density of treated and control observations at the threshold. This is not surprising, given that these are standardized exams that are graded by different professional graders under specific rules and in anonymity. The names of the student and the school are also blinded in these exams. Two or more graders (in different geographical areas) grade each exam script and the overall grade is the average of the graders' scores. Additionally, a student's admissions score is made up of an average of six or seven separate subjects. Manipulating the admissions score would require cooperation among several graders in a systematic manner, which is not feasible in this institutional setting.

5.2 Balancing Tests on Observables Around the Admissions Threshold

Another key assumption required in a RDD setting is that the treated and control observations are similar on average around the threshold in terms of observable predetermined characteristics. Figure 4 provides graphical evidence regarding the validity of this assumption. Our results show that students just above and below the newly imposed performance threshold are equally likely to be girls (Panel A), are equally likely to be attending a top-performing high school (Panel B), are equally likely to be attending an urban high school (Panel C) and are equally likely to be located in a high income area (Panel D). These figures provide evidence that students are randomly distributed around the threshold with respect to their observed characteristics.

6 Results

6.1 Effect of Retaking on Subsequent Academic Performance

Table 2 shows the estimates of retaking[27] the exam on students' subsequent academic performance on the exam. Each column corresponds to a different bandwidth and polynomial specification of the running variable. We report 2SLS estimates (columns (1)-(5)), as well as robust CCT estimates (columns (6) and (7)) obtained following Calonico, Cattaneo and Titiunik (2014a) and Calonico, Cattaneo, Farrell

[27]We consider retaking a year after because almost everyone retakes the exam in the subsequent year.

and Titiunik (2019). The optimal bandwidth in columns (4)-(7) is obtained following Calonico, Cattaneo and Titiunik (2014b). We use either a linear (columns (1)-(4) and (6)) or a quadratic (columns (5) and (7)) polynomial of the running variable whose slope is allowed to change at the performance threshold. The top row shows our first-stage estimates across all columns. Students who just fail to pass the performance threshold are 8-12% more likely to retake the exam. The instrument is strong in all 2SLS specifications, with the Kleinbergen-Paap Wald F-statistic being consistently greater than 10. The magnitude of the coefficient of the first stage is, as expected, not so large, since retaking the exam is common throughout the entire distribution of scores. Nevertheless, all first-stage estimates are positive and statistically different from zero, suggesting that there is a clear causal positive impact of missing the threshold on the probability to retake the entrance exams.

Columns (1)-(3) of Table 2 show 2SLS estimates when the distance from the performance threshold increases from +/-1,000 (column (1)), to +/-1,500 (column (2)) and +/-2,000 (column (3)). Our preferred specifications are those in columns (4) and (6) and use the optimal bandwidth, as defined by Calonico, Cattaneo and Titiunik (2014a) and a linear polynomial of the running variable. The second row presents the effects of retaking the exam in 2007 on student academic performance on the exam. The estimated effects are positive and statistically significant across all specifications. Our preferred specifications indicate that retaking the exam leads to improved performance for students of 2,282-2,588 points.[28] This corresponds to about half standard deviation increase in their admissions score. This level is similar to what Goodman, Oded and Jonathan (2020) find using retaking the SAT in the US. We report robust confidence intervals in all remaining tables instead of standard error as this is preferred for inference (Calonico, Cattaneo, Farrell and Titiunik, 2019).

6.2 Mechanisms Behind Improved Performance

6.2.1 Grade Inflation

The results reported above show that students improve their academic performance when they retake the exam. In this section, we examine a few mechanisms through which students may perform better.

[28]We also estimate the main specification for different sub-groups: (a) by income, namely for students who reside in regions with a postcode-level average household above and below the median, separately, in Table A1, (b) by gender, in Table A2, (c) by high school quality, in Table A3 and (d) by type of high school, namely for students who attend public and private school, separately, in Table A4. We find that, if anything, the effects are slightly more pronounced and precise for students attending schools in high income regions, boys, high quality high schools and private schools. However, in most of those cases we fail to reject equality of the parameters between the different subgroups or the value of the Kleinbergen-Paap Wald F-statistic takes values below 10, indicating that we cannot draw strong or general conclusions about our heterogeneity exercises.

We use the additional comprehensive dataset for the smaller sample of schools and students we describe in Section 3.2.[29] We focus on whether the improved performance is a result of grade inflation, being a year older, or learning.

One could worry that teachers responded to the minimum performance threshold by inflating scores of students in an attempt to help them pass the threshold. This is more likely to happen in 2007 when the minimum performance threshold is anticipated and teachers know this in advance of reporting students' first and second semester grades compared with 2006 when the policy was unanticipated. To address this concern, we focus on the distribution of students' high school GPA instead of the admission scores. The reason is that we want to include all students in this exercise and not only those who desire to gain access to tertiary education and thus take the national exams. We present the GPA distribution of lower-achieving students to obtain a picture of whether teachers are likely to inflate the grades of students in 2007 compared with 2006. Figure 5 shows the distributions of GPA for 2006 and 2007 for lower achieving students, i.e., with a GPA below 15/20. There is no evidence that teachers inflated student grades between 2006 and 2007, since the GPA distributions are almost identical for the low-achieving students with the p-value of the Kolmogorov-Smirnov test being equal to 0.947.

6.2.2 Students Being 1 Year Older

Next, we study whether students improve their grades as a result of being a year older. We use the additional comprehensive sample of schools to produce Table 3. This table shows the main estimated effects for 18-year-old students (Panel A) and for 17-year-olds (Panel B). Older students constitute the majority of the student sample. Administrative rules that assign early-age students to a cohort based on their birthdate result in many fewer 17-year-old students than 18-year-old students in the same cohort. We present both 2SLS (column (1)) and CCT (column (2)) estimates. Both 18- and 17-year-old students improve their performance substantially upon retaking the exam.

Overall, we show that neither grade inflation nor the student's age is the driving mechanism behind students' observed improvement in their admissions score from retaking. We conclude that it is reasonable to assume that the observed improvement in performance is the result of additional study and learning.

[29]We replicate the main estimation in the smaller sample and the estimated effects are shown in Table A5. These effects are almost the same as the ones using the entire sample. In particular, the main effect of retaking on academic performance is 2,282 scores in the entire sample and 2,396 scores in the small sample using the 2SLS estimation (under the preferred specification), with very similar confidence intervals. The main estimate is 2,589 scores in the entire sample and 2,864 scores in the small sample using the CCT estimation (under the preferred specification), with very similar confidence intervals.

6.3 Effect of Retaking on Offers

Table 4 presents the estimated effects of retaking on students' quality of subsequent offers. We measure the quality of an offer using three measurements: whether the average college-course quality is above or below the median[30], whether it is an offer from an academic institution or a vocational one, and whether the course has high employment prospects. Columns (1)-(5) show 2SLS estimates, while columns (6) and (7) show CCT estimates. Our preferred estimates are in columns (4) and (6), in which linear polynomials of the running variable are used. Panel A shows the results of the effect of retaking the exam on whether the offer is from a college-course with quality above the median. The estimates range from 0.101 to 0.154, but are relatively imprecise. This suggests the lack of sufficient evidence for an effect. This pattern is robust across different bandwidths (+/-1,000, +/-1,500, +/-2,000, and optimal), across different estimations (2SLS and CCT), and when using a quadratic instead of a lineal polynomial of the running variable (columns (5) and (7)).

Panel B in Table 4 shows the effect of retaking the exam on whether the student is more likely to obtain an academic as opposed to a vocational offer. On average, college-courses from academic institutions require higher grades and are more prestigious. The outcome variable here is a binary indicator that takes the value of 1 if the student obtains an offer from an academic college-course and 0 if they obtain an offer from a vocational college-course or no offer. Our preferred specifications (columns (4)-(6)) show that there is a positive but not very precisely estimated impact of retaking on the students' probability to obtain an academic offer. The estimated coefficient is imprecise across different bandwidths, estimations, and polynomials, and is occasionally significant. Thus, we conclude that students are not necessarily more likely to obtain an academic offer.

Panel C of Table 4 shows the impact of retaking the exam on obtaining an offer from a college-course with better employment prospects. Consistent with previous panels, we do not find that students are more likely to obtain an offer from a college-course with better employment prospects. Our preferred specifications (columns (4) and (6)) show a negative and statistically insignificant coefficient that is imprecisely estimated. Thus, there is a lack of evidence to show that students clearly improve their future employment prospects upon retaking the exam.

Overall, we notice that despite the significant improvement in their exam performance due to retaking, the evidence on whether students manage to receive offers from highly ranked college-courses is

[30] We use a standardized index of quality that is measured based on the 2005 admission thresholds for each college-course.

inconclusive.[31] Retakers do not appear to automatically obtain offers from better-ranked college-courses and they are also not more likely to obtain offers from college-courses with better employability. We next study the mechanisms behind these results.

7 Mechanisms

7.1 Changes in the Overall Skill Level of the Applicant Pool

We propose the change in the skill level of the pool of applicants as a potential mechanism behind the improved performance of retakers, which does not translate into an improved postsecondary placement. Figure 6 shows the distribution of admissions scores before, during, and after lifting the minimum threshold.[32] Panel A shows the distribution of scores for the pre-reform years, i.e., 2004 and 2005. We notice that the two distributions are very similar. Panel B in Figure 6 shows the distribution of admissions scores for years before (2004, 2005) and while the reform was in place (2006-2009). We notice that the distribution of admissions scores shifts to the right during the years of the reform, relative to before, which indicates the presence of fewer low-achieving applicants. Panel C in Figure 6 shows the distribution of admissions scores for years in which the minimum threshold policy was in place (2006-2009) and after it was lifted (2010-2012). We notice that after lifting the minimum threshold, the distribution of scores slowly shifts to the left, close to what it was before the introduction of the policy. Overall, this pattern indicates that retakers who took the exam for the first time in 2006 and are retaking in 2007 are now faced with a different pool of competitors. Their competitors are now students who are taking the exam for the first time in 2007. As shown in Figure 6, the distribution of admissions scores shifts to the right for the 2007 applicant cohort.

We then examine the effects of the change in the competitors' pool on a series of counterfactual

[31] In Appendix A, we also show the impact of retaking on students' field of study offers and choices. We categorize the college-courses into fields of study and use the following groups: Health, Engineering, Science, Humanities and Business. Results are presented in Appendix A in Table A6. Panel A shows that while there are no statistically significant effects of retaking the exam on the probability to get an offer for a college-course in a health-, engineering-, sciences-, or humanities-related college-course, there is a large drop in the likelihood to get an offer from a business-related college-course. Panel B indicates that there are no statistically significant effects of retaking on the probability for a student to report at least 50% of their college-courses choices in a health-, engineering-, sciences-, or humanities-related college-courses. However, students are less likely to report at least 50% of their college-course choices on a business-related college-course. Although there seems to be a drop in the likelihood of a business-related offer and choices, we are unable to draw strong conclusions about any systematic pattern in preferences for college-courses from retaking.

[32] We observe a significant drop in the number of applicants during the 4 years the policy was in place compared with the years pre- and post-policy. Figure A3 in Appendix A shows the drop in the number of applicants over the years. The policy of the minimum performance threshold is introduced in 2006 and is in place until (and including) 2009. The drop is moderate in 2006, but becomes more pronounced in years 2007 to 2009. The first year the reform is lifted, the number of applicants jumps again close to the pre-reform number of applicants. The reform only targets low-achieving students and thus discourages them from applying.

possible outcomes for retakers in Table 5. We divide students into 100 bins based on their exam score and examine potential changes in their position upon retaking. Panel A in Table 5 shows the counterfactual change in the students' rank had they retaken the exam competing against their own cohort — i.e., the 2006 cohort.[33] All estimated effects are positive and statistically different from zero. Columns (4) and (6) show our preferred estimates — namely, the linear 2SLS and CCT estimates using optimal bandwidths according to Calonico, Cattaneo and Titiunik (2014a). The estimates indicate that students would have improved their rank position by 11 to 14 percentage points. The improvement in student performance is stable across the different specifications. The F-statistic for the instrument remains above 10 across all specifications.

Panel B of Table 5 shows the actual change in the rank of the retakers in the year they retook the exam, i.e., in 2007.[34] Students from 2006 who retook for the first time in 2007 are competing against the 2007 student cohort. The estimated effects are small and imprecise, which indicates no improvement in their rank when they are considered relative to their actual competitors. This suggests that despite significantly improving their exam performance, students' relative position in the distribution does not change, possibly due to an increase in the overall skill level of their competitors.

Finally, Panel C in Table 5 shows the counterfactual change in students' rank had they been competing with the 2011 cohort — i.e., the first cohort after the minimum threshold is lifted. We use the 2011 cohort because the skill level of the applicant pool changes in 2011 (as we saw in Figure 6) and becomes similar to the 2006 cohort, which means that the applicant pool again includes students with lower scores. In Panel C, we notice that all estimates are positive and statistically different from zero, similar to Panel A. Based on our preferred specifications, in columns (4) and (6), retakers would have improved their position by 15-18 percentage points, similar to Panel A.

The findings in Table 5 suggest that students do not obtain better postsecondary admission offers even though they improve their exam performance, because the competition the year they retake the exam changes (as a response to introduction of the minimum performance threshold). In particular, there are fewer low-achieving students now, and thus the competition to gain access to postsecondary education becomes more intense. Retakers are therefore not in a relatively better position with respect to other first-attempt applicants, and thus they do not obtain better offers. Retakers would most likely have improved the quality of their postsecondary offers if they had retaken the exam in a year in which

[33]For this we use students' exam performance in 2007 and calculate what their relative rank would be in 2006 with their 2007 exam performance.

[34]For this we use students exam performance in 2007 and calculate what their relative rank would be in 2007.

the minimum threshold to enter postsecondary education was not in place.

7.2 Changes in Students' Application Choices

Changes in students' application choices could explain the improved performance of retakers that does not translate to an improved postsecondary placement. It could be that retaking students become overly ambitious and optimistic in their application forms, and list college-courses that are not achievable given their exam scores. That would explain why retakers do not finally obtain better postsecondary offers. In Table 6, we examine the effects of retaking on a series of outcomes related to student college-course choices: the number of choices students list on their application form (Panel A),[35] whether students report more than 50% of their college-course choices being above median quality (Panel B), whether more than 50% of their choices are academic compared with vocational (Panel C), and whether more than 50% of their choices are for college-courses with high employment prospects (Panel D).

Table 6, Panel A presents estimated effects which are small and statistically insignificant. This indicates that students do not change the number of college-courses they list on their preference list upon retaking the exam. The intuition behind looking at the number of choices is that the more choices a student lists, the more risk-averse they may be. The structure of the table is similar to the one in the main results, with the only difference being the use of different outcome variables. Panel B of Table 6 shows that students do not report more top college-courses upon retaking. This indicates that students do not become more ambitious when resubmitting their college-course choices upon retaking. The estimated effects are small and not statistically different from zero across all specifications.

Academic college-courses on average require higher exam performance than vocational courses and are perceived to be more prestigious. Since students obtain a higher score upon retaking, we then examine whether students are more likely to apply to academic college-courses. In Table 6, Panel C does not provide any evidence that students list more academic than vocational choices on their preference lists, since all estimates are close to zero and statistically insignificant. Finally, in Panel D we examine whether retakers consider the future employability of their college-courses, having just forgone an additional year of employment to retake the exam. We do not find evidence that students take into consideration the future prospects of their college-courses when retaking the exam.

These estimates clearly suggest that a change in student application choices is not associated with the lack of better offers for students upon retaking. Retakers do not seem to change their application

[35] There is no limit on the number of choices students can list on their application forms in the Greek application system.

choices to become more (or less) ambitious compared with their first-attempt applications.

8 Robustness Checks

8.1 Alternative Bandwidths

We then examine the robustness of our main results. In this subsection, we show the sensitivity of our results to using different bandwidths. In our main specification, we use the MSE optimal bandwidth, which we also present here as a benchmark.

In Figure 7, we change the bandwidth used for local polynomial estimation, and we show results using four bandwidths suggested by Cataneo, Idrobo and Titiunik (2019): the MSE optimal bandwidth (used in main results), the double of the MSE bandwidth, the coverage error (CER) optimal bandwidth, and the double of the CER optimal bandwidth. We show results for the four main outcome variables that we used in Tables 2 and 4 while using these different bandwidths. The figure notes detail which numbers corresponds to each bandwidth for each of the four different outcomes.

Panel A in Figure 7 shows that the estimated coefficients on academic performance remain stable when changing the bandwidth. As expected, smaller bandwidths are less precisely estimated. In Panel B, we present the estimates of obtaining an offer from a college-course above the median quality. We find that our main (and imprecise) results change little if we use different bandwidths, although, as expected, they do become more precise when we use larger than optimal bandwidths. Panel C shows the effect of retaking on the likelihood of obtaining an academic as opposed to a vocational offer. The coefficient remains stable, and as we restrict the bandwidth the estimates become less precise. Finally, Panel D shows the effect of retaking on the likelihood to obtain an offer from a college-course that has high employment prospects. The results indicate a similar coefficient when changing the bandwidth.[36]

8.2 Pseudo-Thresholds

Figure 8 presents robustness exercises based on placebo measures of treatment—namely, when we replace the true minimum performance threshold with pseudo-minimum performance thresholds (Crost, Felter and Johnston, 2014; Dahl, Løken and Mogstad, 2014). In particular, we use pseudo-thresholds

[36]In Figure A4 in Appendix A we repeat this exercise; the outcomes are the different measures of application choices that we used in Table 6. In particular, the outcomes are: (A) the number of choices students list on their preference form, (B) whether a student reports at least 50% of their college-course choices being above median quality, (C) whether at least 50% of student choices are academic compared with vocational and (D) whether at least 50% of student choices are for courses with high employment prospects. We notice that the estimated effects remain similar when using the alternative bandwidths.

equal to 9,000, 9,500, 10,500, and 11,000 instead of the 10,000, which is the real one. We show the estimated effects for our main four outcomes in the different panels. All estimates using the pseudo-thresholds are small, have inconsistent signs, and are statistically insignificant. Notable are the differences between the estimates from the placebo regressions and from those obtained when the true minimum performance threshold is used, especially for the outcome that was positive and statistically significant before – i.e., academic performance (Panel A). The remaining outcomes are less precisely estimated, with large confidence intervals, and have different signs than the true effects (Panels B, C, and D). These patterns are confirmed by Table A7 in Appendix A, which shows all the estimates reported in Figure 8. The third row in each panel corresponds to the true performance threshold, while all other rows correspond to pseudo-thresholds as reported in column (1). The lack of any discernible effects when the pseudo-thresholds are used suggests that the estimated treatment effects are not spuriously picking up any effects of unobserved confounders and that there is no misspecification in the relationship between the running variable and the outcome (Crost, Felter and Johnston, 2014).[37]

8.3 Eliminating Observations

One could be concerned that our results may be sensitive to observations that are located very close to the minimum performance threshold. This could be an issue, especially if there is systematic manipulation of the admissions scores around the threshold (Scott-Clayton and Zafar, 2019; Arnold and Freier, 2013; Dahl, Løken and Mogstad, 2014). Figure 9 presents further evidence that our main results remain stable when we eliminate observations around the threshold. As before, we show results for all four main outcome variables. We eliminate observations for students with admission scores within +/-100 and +/-200 points from the threshold. By doing so, we expect our coefficients to remain stable but the precision of the estimates to decrease. In all four figures, as we move to eliminate up to 200 observations around the threshold, we see that the point estimates are quite stable. We notice that as the confidence intervals gradually increase the estimates become less precise, as expected.[38] These findings are also confirmed by Table A8. The radius of 0—first row in each panel—corresponds to the main estimated effects when the threshold is 10,000. The second and third row in each panel corresponds to when we eliminate +/-100 and +/-200 scores around the threshold, respectively. The estimated effects remain very similar when we eliminate those observations around the threshold, while the confidence intervals

[37]Figure A5 in Appendix A shows that the effect of retaking on the measures of choices used in Section 7 are also robust to using placebo thresholds.

[38]Figure A6 in Appendix A shows that the effect of retaking on the measures of choices used in section 7 are also robust to eliminating observations around the threshold.

slightly increase.

8.4 Different Admissions Scores

We conduct two robustness exercises in which we use different admissions scores to check the sensitivity of our estimates. First, as we mention above students obtain different admissions scores depending on the scientific field they apply to. Students who obtain offers are assigned an admissions score that corresponds to the offered college-course and we use this in all tables. It is not straightforward which admissions score to assign to students who do not obtain an offer, simply because they do not have an offered college-course. In the main analysis, we assigned to them the highest admissions score based on the knowledge fields they listed in their preference list.

For students who do not receive any offer, we now assign the admissions scores that correspond to their top (Panel A), second (Panel B), and third (Panel C) choice in their application list and results are shown in Table 7. The estimates slightly increase in magnitude in almost all cases, but the pattern remain similar and clearly indicate a positive effect of retaking on subsequent academic performance.[39]

Second, in the main analysis we focus on the effect of retaking the exam in 2007, which is the first time students retake the exam.[40] We conduct another robustness exercise in which we use the admissions score from a student's latest attempt of retaking the exam. These results are presented in Table A9. The estimates remain positive and slightly drop in magnitude by 5-10%, although they are not statistically different from the ones used in the main analysis. These results suggest that our main results are very robust to using different admissions scores.

9 Conclusion

This is the first paper that measures the causal effect of retaking a high-stakes admissions exam on student subsequent outcomes using an exogenous unexpected policy that introduced a minimum performance threshold for postsecondary admission. We focus on low-achieving students due to the nature of the policy. The policy was unexpected the first year it was implemented in 2006 and changed the decision rule related to obtaining access to tertiary education in Greece. In particular, students who

[39]Note that the number of observations for the alternative admissions scores are slightly fewer than the observations in the main analysis of Table 2. This is a result of a small number of students making mistakes in their applications list and choosing college-courses that they are actually not eligible to apply to since they did not take an additional examination required for certain college-courses. In such cases, the student obtains a missing value next to the college-course that they are not eligible for.

[40]The reason is that the vast majority retakes the exam only once.

fail to obtain 10,000/20,000 scores (i.e., 50%) on the postsecondary admission exam at the end of high school fail to gain access to tertiary education. The only way for these students to access postsecondary education is to retake the exam and pass the required performance threshold in a subsequent period. Students who pass the critical threshold were allowed to compile a list of preferences of postsecondary college-courses.

We estimate the impact of retaking the exam on exam performance and quality of postsecondary placement. We use rich new administrative data for the universe of students, which we obtained from the Ministry of Education in Greece. We rely on detailed student records on exam performance, postsecondary applications, and admission for each time a student retakes. We also have access to an additional comprehensive sample for a smaller number of schools and students that we use for some additional analyses. Since there is only partial compliance, we use a fuzzy regression discontinuity design. Comparing students who just failed the performance threshold to those students who just passed the performance threshold eliminates any selection bias due to observed and unobserved teacher, class, and school characteristics. We support this identification approach with evidence that clearly indicates that students who just failed to pass the critical threshold are identical in terms of their observed characteristics to students who just passed the critical threshold, and can thus serve as a proper counterfactual group.

The results suggest that students who retake the exams improve their performance by one-half a standard deviation. The underlying mechanism is through learning and studying, while we provide evidence that the exam improvement is not explained by: (1) students being more mature since they are 1 year older, and (2) teachers inflating students' grades as a response to the policy. We also find that retakers are not necessarily more likely to obtain an offer from a college-course of higher quality. We highlight two mechanisms that could potentially drive these results: (i) the strength of the competition that retakers face is now much higher and (ii) retakers now change their application strategies in terms of the quality of their choices and their risk-taking behavior. We find evidence in support of the first mechanism only.

This is the first study that highlights the role of the strength of the competition in settings where a minimum threshold is imposed and thus the overall skill level in the applicant pool changes. Although retakers experience an increase in their performance, they do not find themselves in a better relative position to obtain a more prestigious postsecondary placement. The main objective of the policy was not to allow students with particularly low performance to enter postsecondary education. However, retakers are now disadvantaged, despite them substantially improving their academic performance. The results presented above suggest that one must carefully assess the costs and benefits of retaking the exam and of minimum threshold policies (Jacob and Lefgren, 2009). In doing so, one should consider the trade-offs between potential benefits — absolute and relative — and potential costs. Understanding how these policies affect students' current and subsequent outcomes is important when designing those policies. Policy makers should not ignore that restricting access to postsecondary education may introduce selection with respect to applicants' characteristics.

The method we use to study the effects of the introduction of a minimum threshold is general and could be applied in other contexts. Any context in which rules or laws create thresholds in the implementation of events, policies and programs — such as competitive exams, merit scholarships, participation programs and poverty programs — could profit from our approach of using detailed individual records to compare those who are just affected by the rule with those who are just not affected by the rule and uncover the mechanisms behind those effects. The benefits of combining exogenous variation with rich administrative data for the universe of students to study retaking decisions are that (1) we focus on low-achieving students who are very likely to give up education, (2) we rely on a setting that depends on student merit, (3) we are able to evaluate the strength of the competition related to the applicant pool, and (4) we are able to rule out alternative mechanisms which are common threads in the literature such as the age of retakers as a potential driver of the effects of interest.

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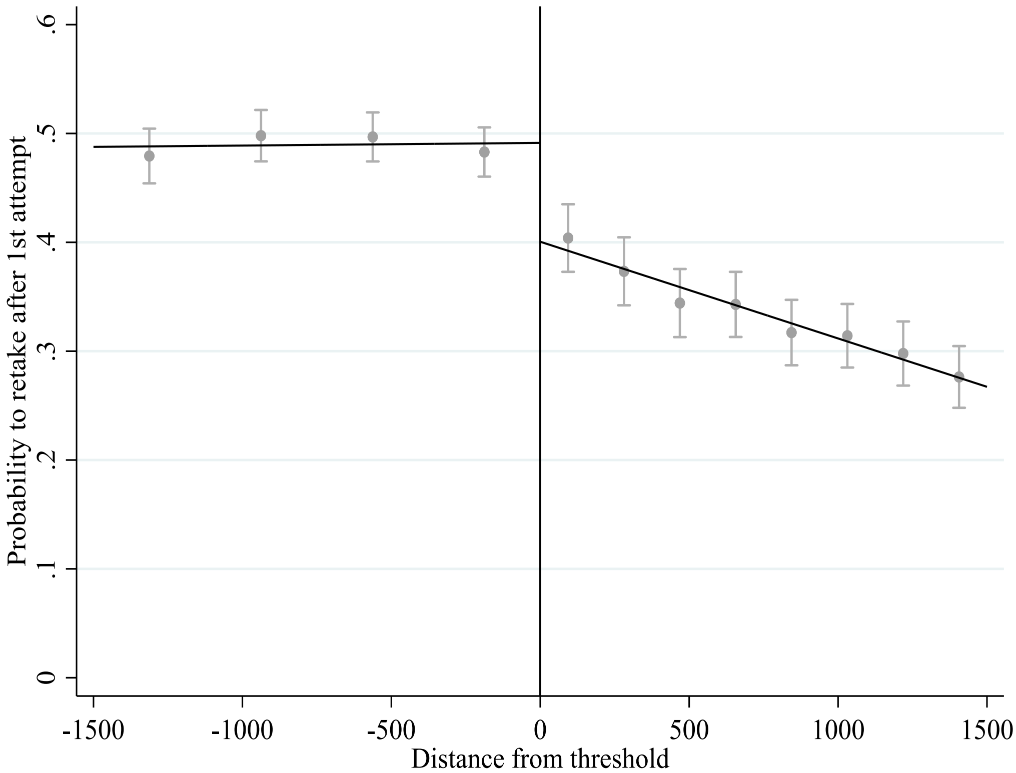
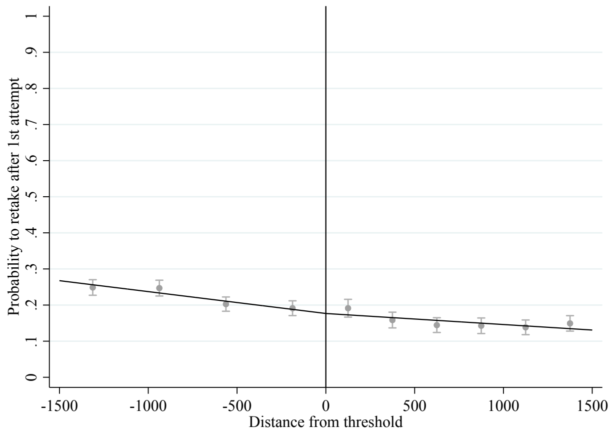
Figure 1: FIRST STAGE: PROBABILITY TO RETAKE IN 2007

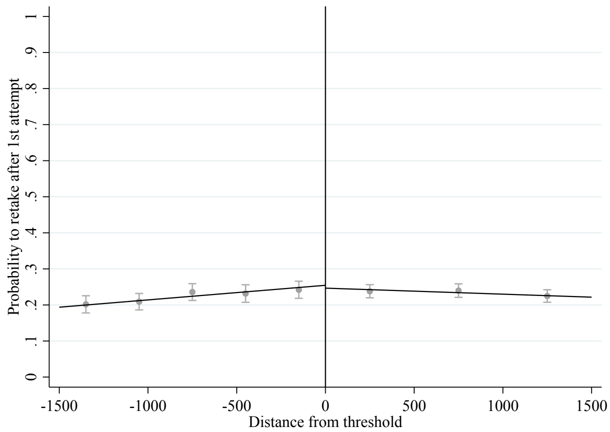


Notes: The figure illustrates the first stage result, namely the likelihood of retaking the exam in the subsequent year after students' 1st attempt, namely in 2007, for students with admissions scores within +/-1,500 from the threshold of 10,000. The sample is based on 2006 cohort students. We estimate local linear effects using evenly spaced bins, and the lines illustrate the 95% confidence intervals.

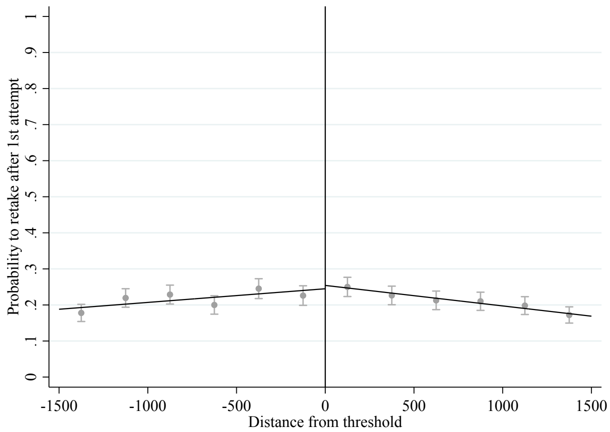
Figure 2: FALSIFICATION EXERCISE FOR FIRST STAGE USING PLACEBO COHORTS INSTEAD OF TREATED COHORT



(A) Cohort 2004



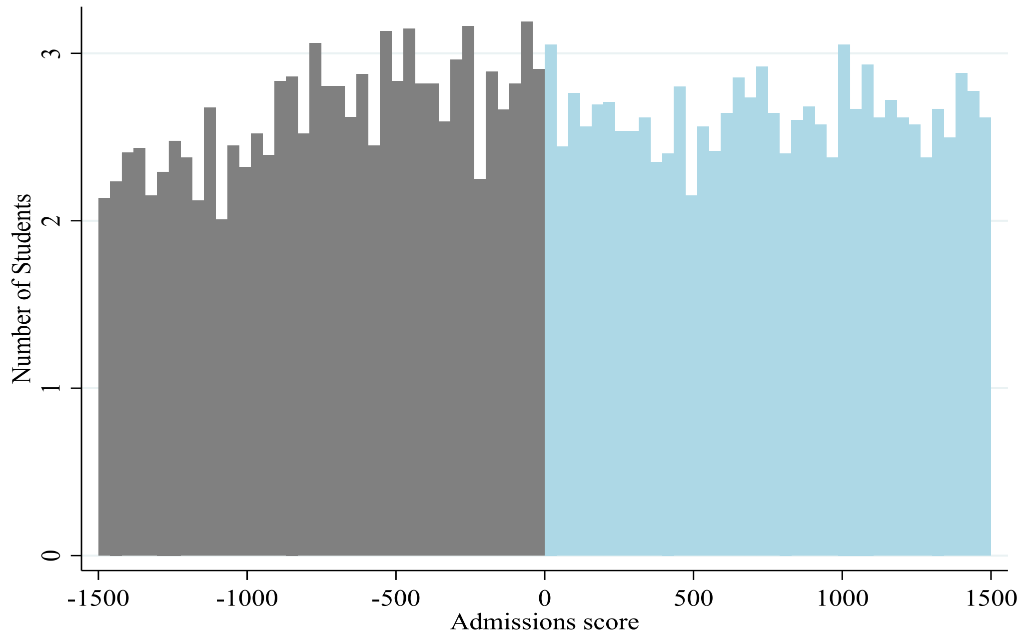
(B) Cohort 2010



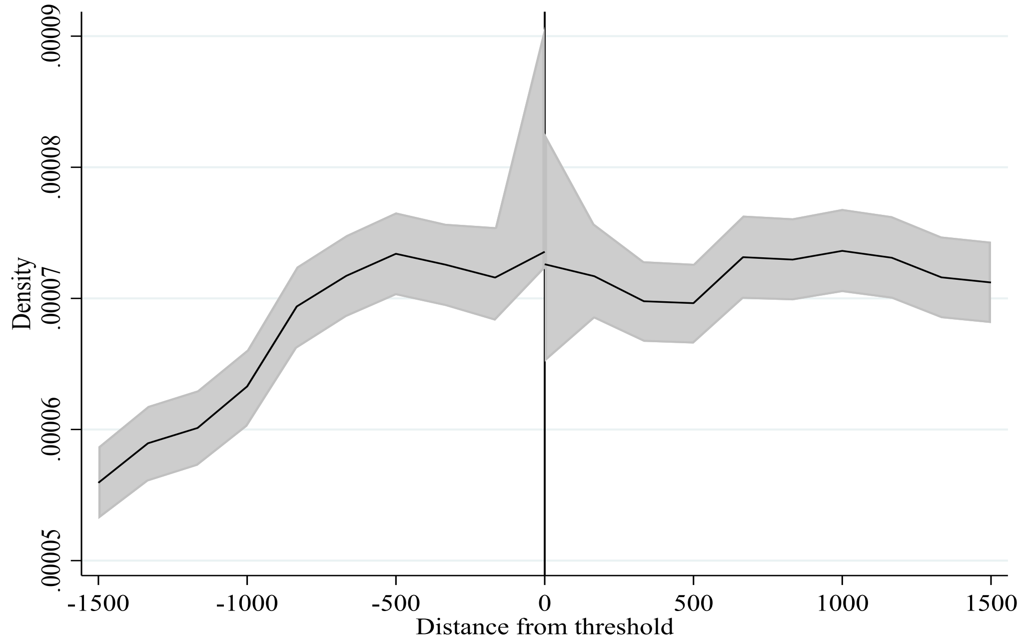
(C) Cohort 2011

Notes: The figure illustrates how the likelihood of retaking the exam in the subsequent year for placebo cohorts instead of the treated cohort. Those placebo cohorts are: 2004 (a year before the introduction of the minimum performance threshold), and 2010-2011 (the first two years after the minimum performance threshold was lifted). Panel A refers to the 2004 cohort, Panel B to the 2010 cohort, and Panel C to the 2011 cohort. In those placebo cohorts there is no minimum performance threshold for students to gain access to tertiary education. Each panel refers to a different cohort and the sample is based on the students who obtained scores within +/-1,500 from the threshold of 10,000. We estimate local linear effects using evenly spaced bins, and the lines illustrate the 95% confidence intervals.

Figure 3: HISTOGRAM AND DENSITY OF THE ADMISSIONS SCORE



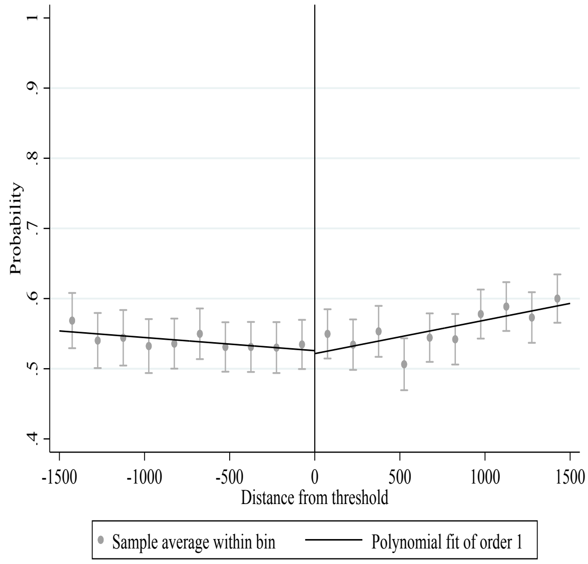
(A) Histogram of the Admissions Score



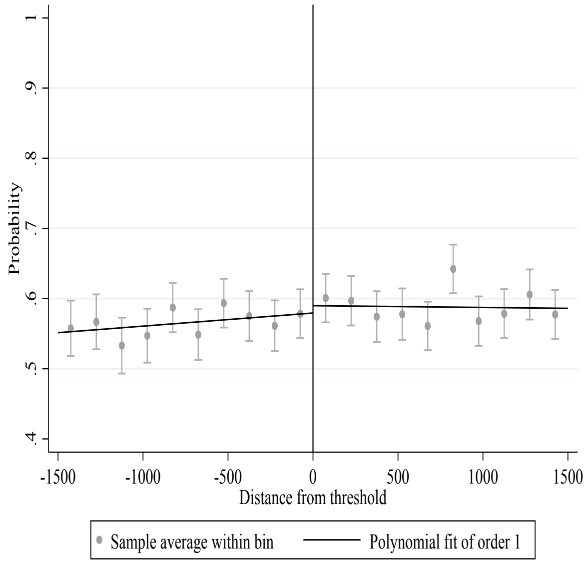
(B) Density of the Admissions Score

Notes: Panel A shows the distribution of admissions score for students with admission scores within +/-1,500 points from the threshold of 10,000. Panel B shows the density of the admissions scores around the 10,000 threshold, for those with scores within +/-1,500 points from the threshold. The density and 95% confidence intervals on each side of the threshold displayed in Panel B are estimated following the approach in Cataneo, Idrobo and Titiunik (2019). We fail to reject the null hypothesis that the density of the running variable is continuous at the threshold of 10,000 scores as proposed by Cataneo, Idrobo and Titiunik (2019) with a p-value equal to 0.241. Overall, there is no statistical evidence of manipulation around the threshold, which provides additional evidence supporting the validity of the RD design.

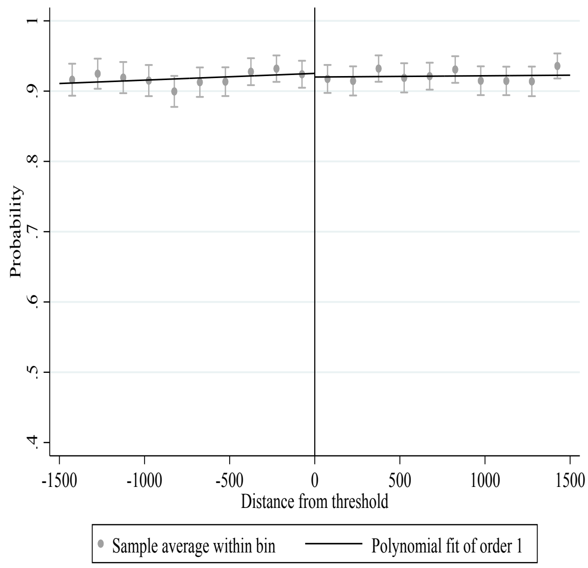
Figure 4: BALANCING TESTS OF PREDETERMINED CHARACTERISTICS



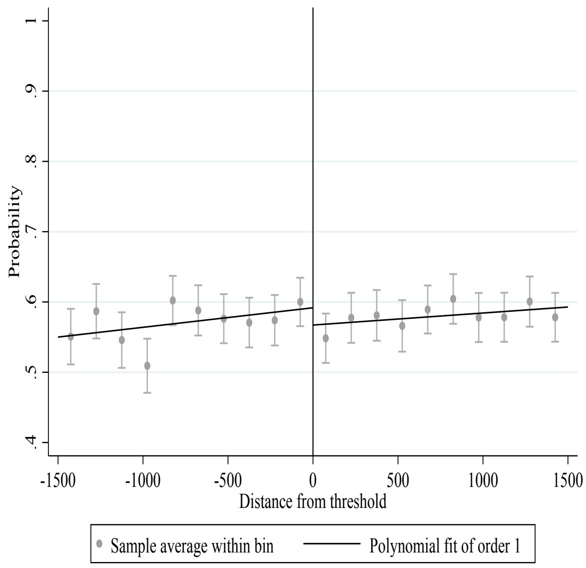
(A) Girl



(B) Attend a Top-Performing High School



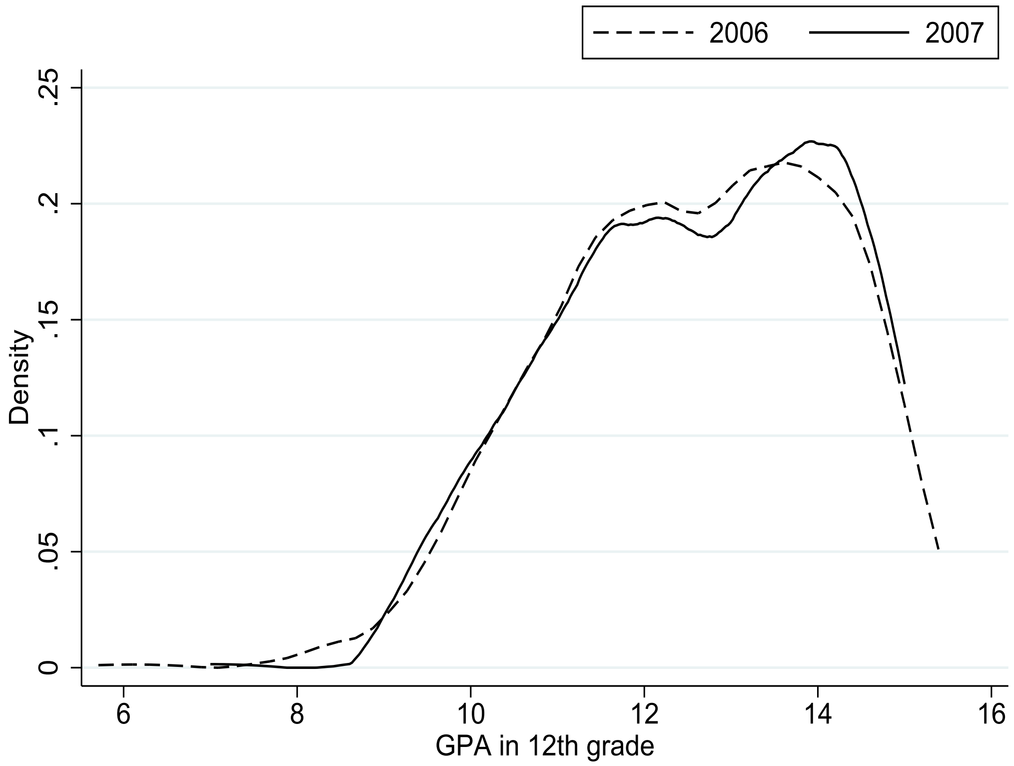
(C) Attend a High School in an Urban Area



(D) Reside in a High-Income Neighborhood

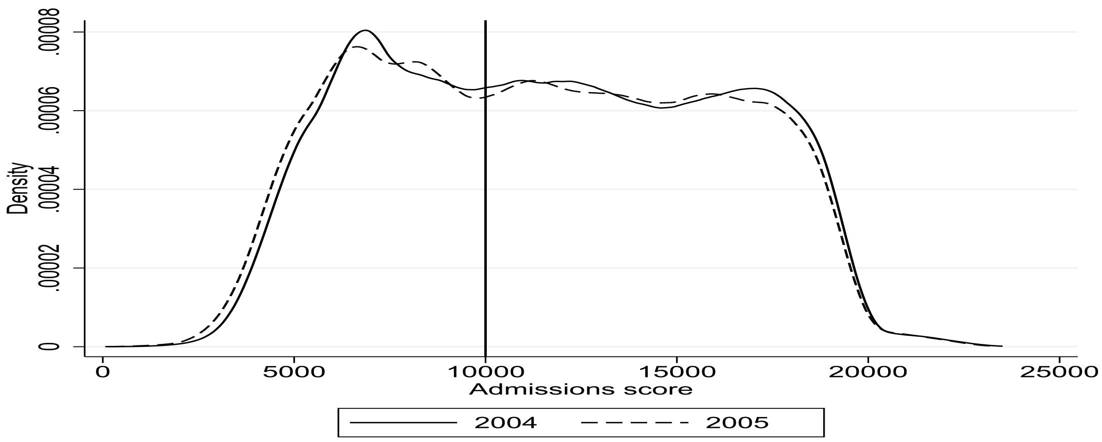
Notes: Each panel shows balancing tests for different predetermined characteristic, for individuals with admissions scores within +/-1,500 points from the threshold of 10,000. Panel A shows the likelihood that a student is a girl, Panel B shows the likelihood that a student attends a top-performing high school, Panel C shows the likelihood that a student attends an urban high school, and Panel D shows the likelihood that a student resides in a high-income neighborhood. The x-axis shows students' admissions scores as a distance from the admission threshold of 10,000. The lines illustrate the 95% confidence intervals. We estimate local linear effects using evenly spaced bins; the optimal MSE bandwidth is different for each variable and calculated following the approach in Cataneo, Idrobo and Titiunik (2019).

Figure 5: Distribution of High School GPA in the First and Second Years after the Introduction of the Minimum Performance Threshold

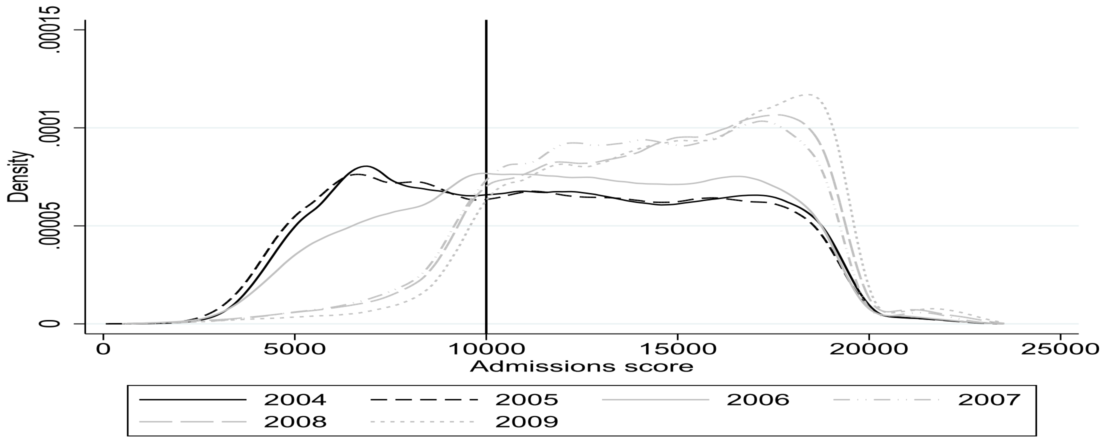


Notes: The figure illustrates the distribution of high school GPA the year the reform was introduced (2006), and the following year (2007). The GPA is the grade the student obtains as the average performance on all first- and second-term examinations in the senior year of high school. The GPA is different from the scores obtained on the entrance exam. All students obtain a GPA at the end of high school. The sample is restricted to students with a GPA below 15/20. We use the smaller sample of 23 schools to derive these distributions since we have information on students' GPA only in the smaller comprehensive sample that we use for additional analysis.

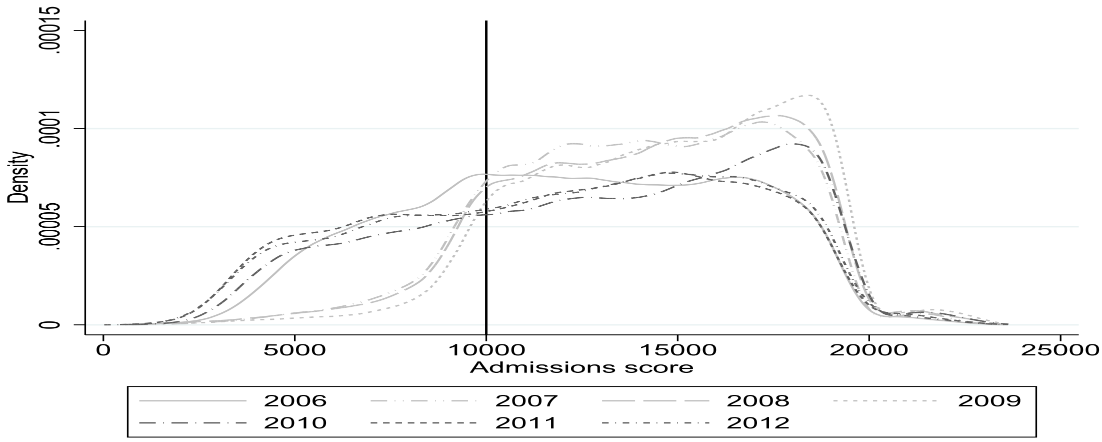
Figure 6: DISTRIBUTION OF ADMISSIONS SCORES BEFORE, DURING, AND AFTER THE REFORM YEARS



(A) Distribution of Admissions Scores Pre-reform



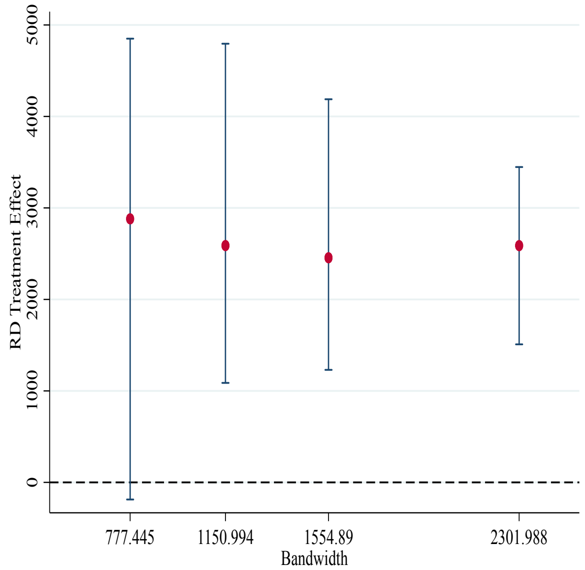
(B) Distribution of Admissions Scores Pre- and During reform



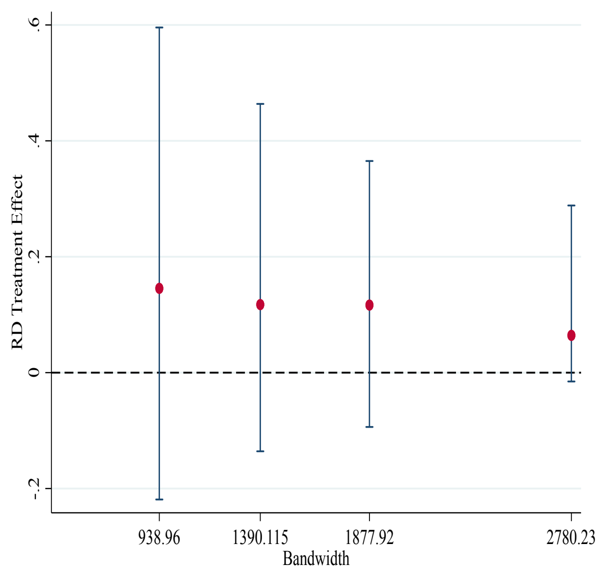
(C) Distribution of Admissions Scores During and Post-reform

Notes: The figure shows the distribution of admissions scores of applicants to postsecondary education in Greece between 2004 and 2012. Panel A shows the distribution of admissions scores before the minimum performance policy was introduced (2004 and 2005). Panel B shows the distribution of admissions scores for the years that the minimum performance policy was in place (2004-2009). Panel C shows the distribution of admissions score for some of the years the minimum performance policy was in place (2006-2009) and after it was lifted (2010-2012).

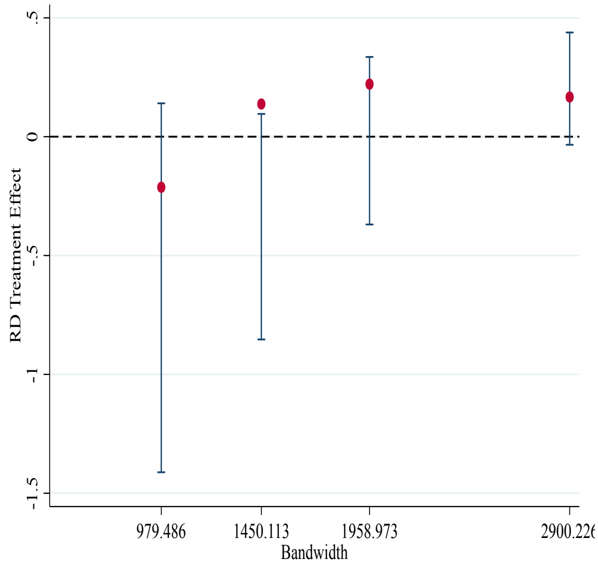
Figure 7: ROBUSTNESS EXERCISE: ALTERNATIVE BANDWIDTHS



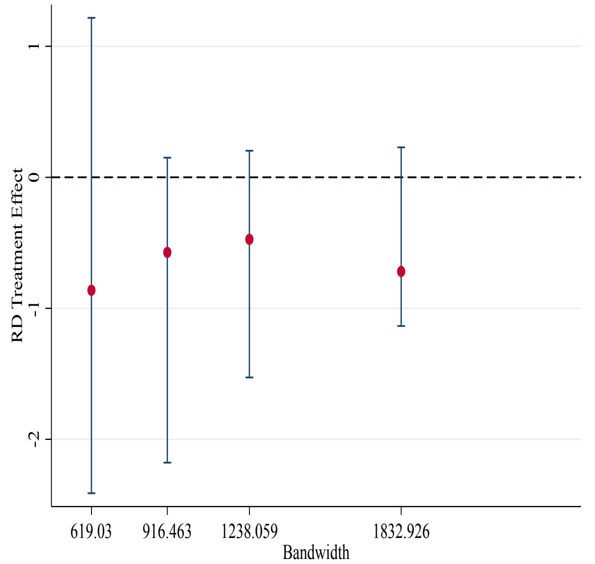
(A) Academic Performance



(B) Offer From Top 50% College-course



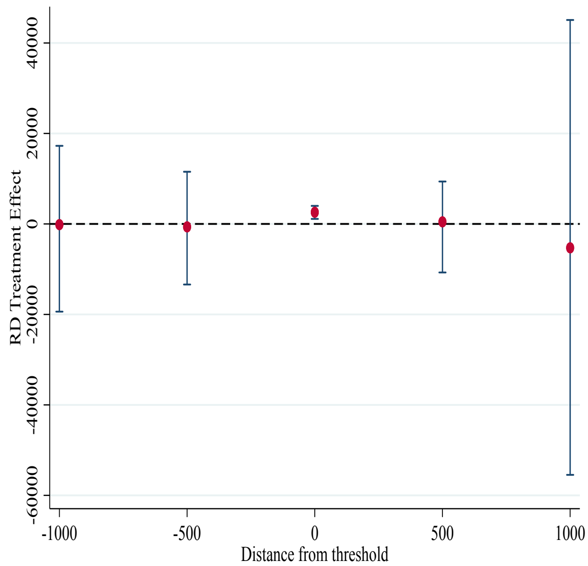
(C) Offer From Academic College-course



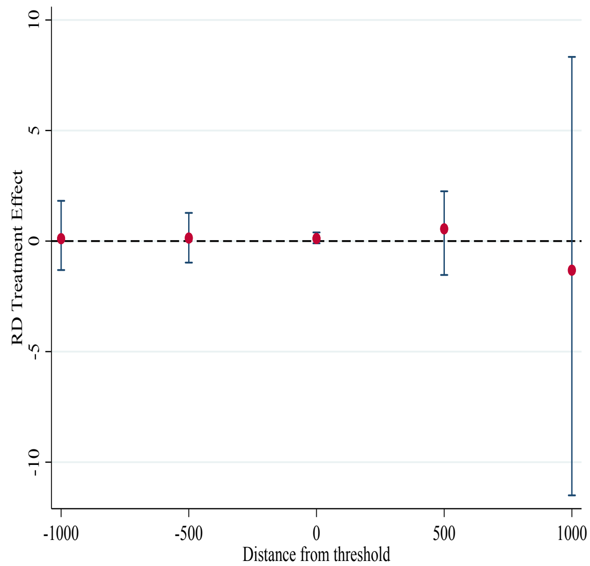
(D) Offer From College-course with High Employment Prospects

Notes: The figure shows the estimates of retaking the exam on a set of outcomes. These outcomes are: academic performance (Panel A), the likelihood to obtain an offer from a college-course that is above the median quality (Panel B), the likelihood of obtaining an academic offer compared with an offer from a vocational school (Panel C), and the likelihood of obtaining an offer from a college-course with high employment prospects (Panel D). We show estimated effects using four different bandwidths in each panel, as suggested by Cataneo, Idrobo and Titiunik (2019). These bandwidths are: the MSE optimal bandwidth (the one we use in the main specification as a benchmark), the double of the MSE optimal bandwidth, the CER optimal bandwidth and the double of the CER optimal bandwidth. In Panel A, the MSE and CER optimal bandwidths are 1,150.994, and 777.445, respectively. In Panel B, the MSE and CER optimal bandwidths are 1,390.115, and 938.96, respectively. In Panel C, the MSE and CER optimal bandwidths are 1,450.113, and 979.486, respectively. In Panel D, the MSE and CER optimal bandwidths are 916.463, and 619.03, respectively. Dots represent the estimated coefficients and lines represent the 95% confidence intervals.

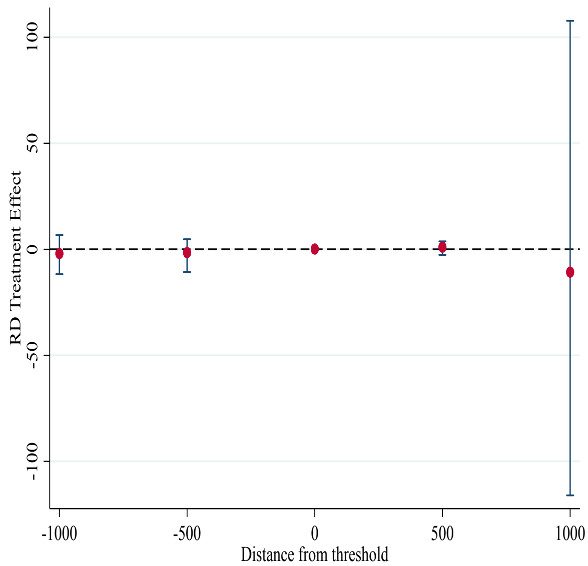
Figure 8: ROBUSTNESS EXERCISE: PSEUDO-THRESHOLDS



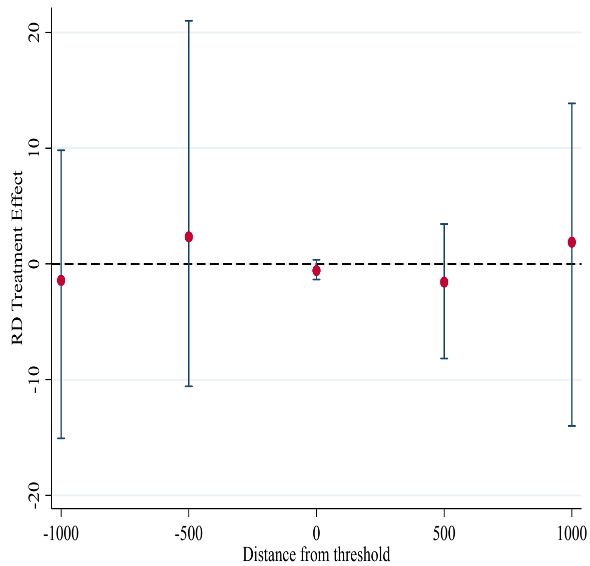
(A) Academic Performance



(B) Offer From Top 50% College-course



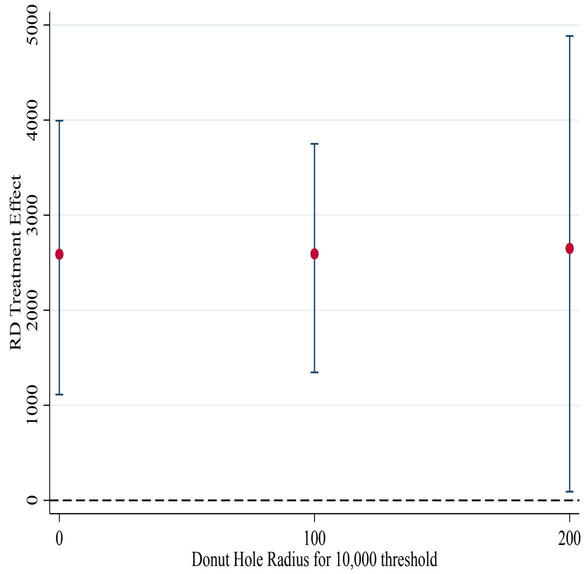
(C) Offer From Academic College-course



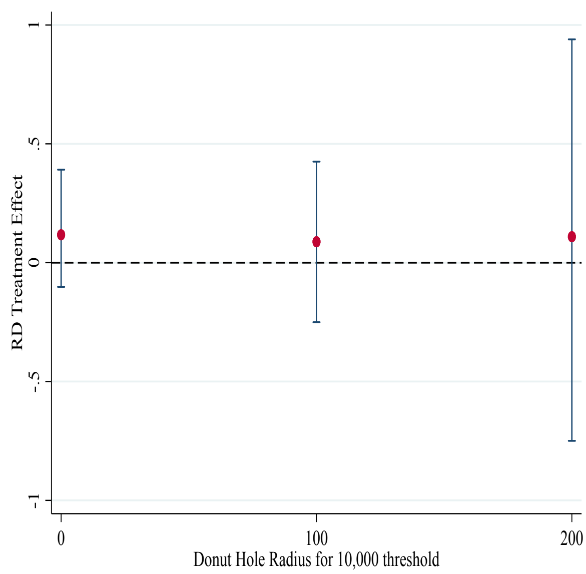
(D) Offer From College-course with High Employment Prospects

Notes: This figure shows the impact of retaking the exam on four different outcomes: academic performance (Panel A), the likelihood to obtain an offer from college-course that is above the median quality (Panel B), the likelihood of obtaining an academic offer compared to vocational offer (Panel C) and the likelihood of obtaining an offer from a college-course with high employment prospects (Panel D). The estimated effects on those outcomes are presented for various fake thresholds. The horizontal axis measures the difference from the true threshold (10,000), with the main estimate presented at 0. For each estimation, the optimal bandwidth is calculated using a local linear polynomial following Cataneo, Idrobo and Titiunik (2019). Dots represent the estimated effects obtained when using different thresholds and lines represent the 95% confidence intervals.

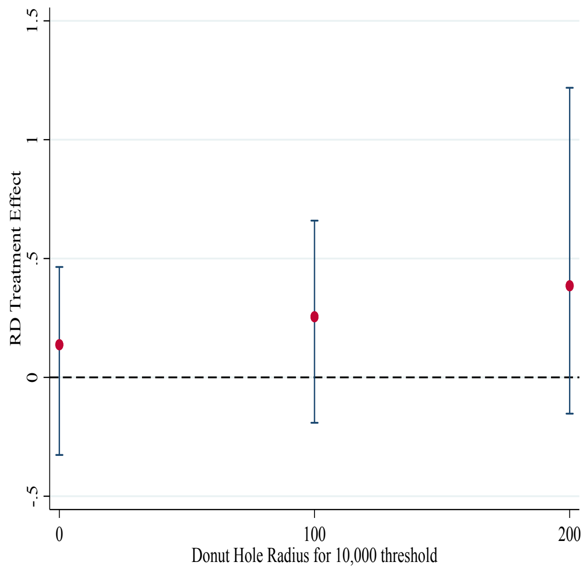
Figure 9: ROBUSTNESS EXERCISE: ELIMINATING OBSERVATIONS AROUND THE THRESHOLD



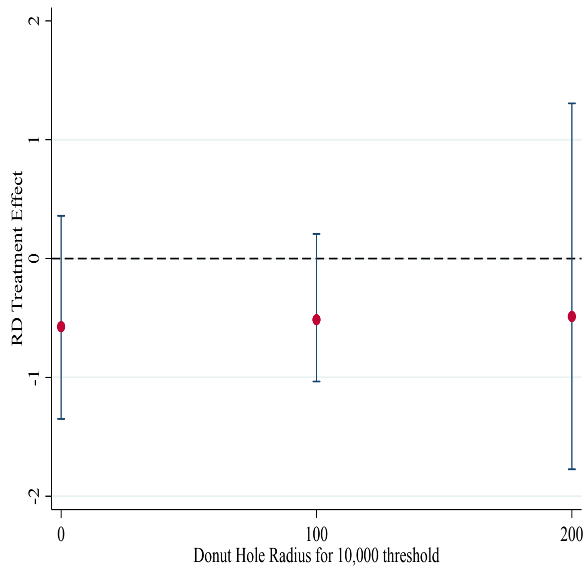
(A) Academic Performance



(B) Offer From Top 50% College-course



(C) Offer From Academic College-course



(D) Offer From College-course with High Employment Prospects

Notes: The figure shows the impact of retaking the exam on four different outcomes, when eliminating observations around the threshold. The outcomes are: academic performance (Panel A), the likelihood to obtain an offer from college-course that is above the median quality (Panel B), the likelihood of obtaining an academic offer compared to vocational offer (Panel C) and the likelihood of obtaining an offer from a college-course with high employment prospects (Panel D). The horizontal axis measures the donut hole radius, with the main estimate represented at 0. For each estimation the optimal bandwidth is calculated using a local linear polynomial following Cataneo, Idrobo and Titiunik (2019). Dots represent the estimated coefficients for different donut radius and lines represent 95% confidence intervals.

Table 1: SUMMARY STATISTICS

	Entire Sample (1)	Sample within +/- 1,500 Bandwidth (2)
Admissions Score	12,343.965	10,044.902
	(4,275.356)	(850.357)
Offer Statistics		
No Offers in 2006	0.336	0.521
	(0.472)	(0.500)
Offer From College-course Above Median	0.423	0.063
	(0.494)	(0.242)
Offer From Academic Institution	0.514	0.200
	(0.500)	(0.400)
Offer From College-course With High Empl. Prospects	0.461	0.473
	(0.498)	(0.499)
Retake Statistics		
Retake	0.209	0.427
	(0.407)	(0.495)
Retake in 2007	0.193	0.409
	(0.394)	(0.492)
Retake Once	0.196	0.403
	(0.397)	(0.490)
Retake | Fail=0	0.116	0.248
	(0.320)	(0.432)
Retake | Fail=1	0.344	0.557
	(0.475)	(0.497)
Application Statistics		
No. of Choices in 2006	26.327	31.514
	(23.096)	(25.778)
$\geq 50\%$ Choices Academic	0.566	0.242
	(0.496)	(0.428)
$\geq 50\%$ Choices Top College-course	0.491	0.120
	(0.500)	(0.325)
$\geq 50\%$ Choices High Empl. Prospects	0.640	0.675
	(0.480)	(0.468)
High School Statistics		
Urban	0.931	0.920
	(0.253)	(0.271)
Top-performing High School (in 2005)	0.624	0.577
	(0.484)	(0.494)
Demographics		
Average Annual Household Income (euro)	21,962.711	21,025.748
	(10,027.646)	(7,851.361)
Girl	0.561	0.549
	(0.496)	(0.498)
Observations	69,345	14,558

Notes: The sample consists of the student cohort of 2006. The application statistics are from the year 2006, i.e., the first time cohort 2006 takes the exam. Column (1) includes the entire sample of students who take the postsecondary admission exam for the first time in 2006. Column (2) restricts the sample to students who obtained an admissions score within a +/- 1,500 bandwidth around the 10,000 performance cutoff. Application statistics are reported based on the application forms of students' first attempt. The top-performing high schools are the ones with average scores above the median in 2005. Household income is measured in euro and is aggregated at the school postcode level. Standard deviations in parentheses.

Table 2: EFFECT OF RETAKING ON ACADEMIC PERFORMANCE

	2SLS					CCT	
	+/-1,000	+/-1,500	+/-2,000	Optimal	Optimal	Optimal	Optimal
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
First Stage	0.081***	0.091***	0.117***	0.084***	0.079***	0.074***	0.074***
	(0.020)	(0.017)	(0.014)	(0.018)	(0.017)	(0.020)	(0.018)
Retake in 2007	2,336.404***	2,463.050***	2,657.051***	2,282.469***	2,469.717***	2,588.643***	2,461.655***
	[1,165.105;3,507.702]	[1,642.594;3,283.507]	[2,105.925;3,208.177]	[1,201.463;3,363.475]	[1,501.841;3,437.593]	[1,112.68;3,993.072]	[1,149.744;3,776.778]
Observations	9,948	14,558	18,932	11,378	28,082	11,378	28,082
Kleinbergen-Paap Wald F-stat	16.970	30.110	65.380	19.070	22.250		
Pre-policy outcome mean	10,008.759	10,018.128	10,017.101	10,020.025	10,018.085	10,017.163	10,008.090
Linear polynomial	✓	✓	✓	✓		✓	
Quadratic polynomial					✓		✓

Notes: The table presents the estimated effects of retaking the exam on performance on the entrance exam. The first row shows the estimates from the first stage for different bandwidths. Columns (1) to (5) show estimates from a 2SLS estimation, columns (5) and (6) use the robust nonparametric approach of Calonico, Cattaneo and Titiunik (2014a). The bandwidth for the linear polynomial of the running variable is 1,150.99 (columns (4) and (6)) and for the quadratic polynomial of the running variable it is 3,043.9 (columns (5) and (7)). The pre-policy outcome mean refers to cohort 2004. We do not include individuals who retake more than once in this table, since the majority of students retake only once. Standard errors are clustered at school level in parentheses and 95% robust confidence intervals are in square brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table 3: EFFECT OF RETAKING ON PERFORMANCE - BY AGE

	2SLS	**CCT**
	(1)	(2)
Panel A: 18-year-old		
Retake	2,510.235***	2,857.931***
	[960.916;4,059.555]	[1,208.345;4,507.516]
Observations	315	1,077
Kleinbergen-Paap Wald F-stat	10.280	.
Panel B: 17-year-old		
Retake	1,935.918*	2,752.977**
	[-108.860;3,980.696]	[294.704;5,211.251]
Observations	331	823
Kleinbergen-Paap Wald F-stat	6.500	.
Linear polynomial	✓	✓

Notes: The table presents the estimated effects of retaking the exam on exam performance by age. Panel A shows the effects for students who are 18 years old, while Panel B shows the effects for students who are 17 years old. Each coefficient comes from a different regression. Column (1) shows results from a 2SLS estimation and column (2) applies the robust nonparametric (CCT) approach of Calonico, Cattaneo and Titiunik (2014a). In Panel A the optimal bandwidth for the linear polynomial is 3,183.65. and in Panel B is 2,263.41 Optimal bandwidths are calculated following Calonico, Cattaneo and Titiunik (2014a). We do not include individuals who retake more than once in this table, since the majority of students retake only once. Standard errors are clustered at school level and 95% robust confidence intervals are in square brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table 4: EFFECT OF RETAKING ON QUALITY OF OFFERS

	2SLS					CCT	
	+/-1,000	+/-1,500	+/-2,000	Optimal	Optimal	Optimal	Optimal
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Offer from Top College-course							
Retake in 2007	0.114	0.123	0.101*	0.110	0.154	0.117	0.140
	[-0.101;0.328]	[-0.037;0.282]	[-0.008;0.209]	[-0.055;0.275]	[-0.174;0.483]	[-0.102;0.391]	[-0.251;0.501]
Observations	9,948	14,558	18,932	13,562	17,258	13,562	17,258
Kleinbergen-Paap Wald F-stat	16.970	30.110	65.380	26.730	6.970		
Panel B: Offer From Academic College-course							
Retake in 2007	-0.018	0.273**	0.219**	0.271**	0.335**	0.138	0.234
	[-0.392;0.355]	[0.017;0.529]	[0.042;0.397]	[0.002;0.540]	[0.017;0.653]	[-0.326;0.464]	[-0.225;0.608]
Observations	9,948	14,558	18,932	14,109	27,377	14,109	27,377
Kleinbergen-Paap Wald F-stat	16.970	30.110	65.380	28.440	21.550		
Panel C: Offer from College-course with High Employment Prospects							
Retake in 2007	-0.248	-0.787***	-0.827***	-0.239	-0.538*	-0.573	-0.445
	[-0.765;0.270]	[-1.261;-0.314]	[-1.155;-0.499]	[-0.826;0.348]	[-1.132;0.056]	[-1.349;0.360]	[-1.061;0.356]
Observations	9,948	14,558	18,932	9,168	22,860	9,168	22,860
Kleinbergen-Paap Wald F-stat	16.970	30.110	65.380	13.440	15.490		
Linear polynomial	✓	✓	✓	✓		✓	
Quadratic polynomial					✓		✓

Notes: The table presents the estimated effects of retaking the exam on a set of outcomes–each panel refers to a different outcome. Each coefficient comes from a different regression. Columns (1) to (5) show estimates from a 2SLS estimation, columns (6) and (7) use the robust nonparametric approach of Calonico, Cattaneo and Titiunik (2014a). In Panel A, the optimal bandwidth for the linear polynomial is 1,150.99 (columns(6) and (8)) and for the quadratic it is 3,043.9 (columns (7) and (9)). In Panel B, the bandwidths are 1,119.39 (columns (6) and (8)) and 2,954.94 (columns (7) and (9)). In Panel C, the bandwidth is 1,114.41 (columns (6) and (8)) and 3,081.72 (columns (7) and (9)). We do not include individuals who retake more than once in this table, since the majority of students retake only once. Standard errors are clustered at school level and 95% robust confidence intervals are in square brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table 5: EFFECT OF RETAKING ON STUDENT RELATIVE PERFORMANCE

	2SLS					CCT	
	+/-1,000	+/-1,500	+/-2,000	Optimal	Optimal	Optimal	Optimal
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Counterfactual Relative Rank among 2006 Test-Takers							
Retake in 2007	11.656**	11.719***	12.243***	11.619**	13.633***	13.894**	14.212***
	[2.212;21.100]	[5.037;18.400]	[7.739;16.748]	[2.648;20.590]	[5.618;21.648]	[2.673;26.237]	[3.794;25.326]
Observations	9,948	14,558	18,932	11,090	27,282	11,090	27,282
Kleinbergen-Paap Wald F-stat	16.970	30.110	65.380	17.880	20.760		
Panel B: Relative Rank among 2007 Test-Takers							
Retake in 2007	0.176	0.437	0.839	-0.248	3.692	2.903	3.648
	[-10.320;10.671]	[-6.993;7.868]	[-4.177;5.854]	[-10.259;9.763]	[-4.785;12.168]	[-9.469;16.733]	[-7.245;15.514]
Observations	9,948	14,558	18,932	11,034	28,414	11,034	28,414
Kleinbergen-Paap Wald F-stat	16.970	30.110	65.380	18.080	22.290		
Panel C: Counterfactual Relative Rank among 2011 Test-Takers							
Retake in 2007	15.924***	16.206***	16.769***	15.770***	18.353***	18.189***	18.308***
	[7.039;24.809]	[9.930;22.483]	[12.549;20.989]	[7.374;24.167]	[10.785;25.920]	[7.628;29.721]	[8.261;28.990]
Observations	9,948	14,558	18,932	11,124	26,603	11,124	26,603
Kleinbergen-Paap Wald F-stat	16.970	30.110	65.380	18.120	20.290		
Linear polynomial	✓	✓	✓	✓		✓	
Quadratic polynomial					✓		✓

Notes: The table presents the estimated effects of retaking the exam on a set of outcomes – each panel refers to a different outcome. Each coefficient comes from a different regression. Columns (1) to (5) show estimates from a 2SLS estimation, columns (6) and (7) use the robust non-parametric approach of Calonico, Cattaneo and Titiunik (2014a). Columns (1)-(3) respectively use bandwidths of 1,000, 1,500 and 2,000 marks away from the cutoff. In Panel A, the optimal bandwidth for the linear polynomial is 1,150.99 (columns(4) and (6)) and for the quadratic polynomial it is 3,043.9 (columns (5) and (7)). In Panel B, the bandwidths are 1,119.39 (columns (4) and (6)) and 2,954.94 (columns (5) and (7)). In Panel C, the bandwidths are 1,114.41 (columns (4) and (6)) and 3,081.72 (columns (5) and (7)). We do not include individuals who retake more than once in this table, since the majority of students retake only once. Standard errors are clustered at school level and 95% robust confidence intervals are in square brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table 6: EFFECT OF RETAKING ON APPLICATION CHOICES

	2SLS					CCT	
	+/-1,000	+/-1,500	+/-2,000	Optimal	Optimal	Optimal	Optimal
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Number of Choices							
Retake in 2007	0.236	-2.755	2.048	1.870	-5.757	3.991	-4.342
	[-22.648;23.119]	[-20.256;14.745]	[-9.934;14.029]	[-18.757;22.497]	[-25.020;13.507]	[-23.789;33.503]	[-29.825;20.983]
Observations	9,948	14,558	18,932	12,173	29,603	12,173	29,603
Kleinbergen-Paap Wald F-stat	16.970	30.110	65.380	21.380	24.050		
Panel B: At Least 50% Top College-course Choices							
Retake in 2007	-0.125	0.026	0.002	0.002	0.017	-0.051	-0.003
	[-0.505;0.255]	[-0.236;0.289]	[-0.173;0.176]	[-0.280;0.283]	[-0.347;0.380]	[-0.494;0.348]	[-0.464;0.518]
Observations	9,948	14,558	18,932	13,374	22,914	13,374	22,914
Kleinbergen-Paap Wald F-stat	16.970	30.110	65.380	25.960	15.640		
Panel C: At Least 50% of College-course Choices Academic							
Retake in 2007	-0.224	-0.076	-0.003	-0.051	0.072	-0.125	-0.051
	[-0.698;0.249]	[-0.405;0.253]	[-0.217;0.211]	[-0.396;0.295]	[-0.305;0.449]	[-0.713;0.329]	[-0.597;0.469]
Observations	9,948	14,558	18,932	13,687	27,532	13,687	27,532
Kleinbergen-Paap Wald F-stat 16.970	30.110	65.380	26.390	22.060			
Panel D: At Least 50% of College-courses with High Employment Prospects							
Retake in 2007	0.197	-0.008	0.035	0.021	-0.010	0.130	0.015
	[-0.290;0.684]	[-0.335;0.318]	[-0.186;0.256]	[-0.390;0.432]	[-0.444;0.424]	[-0.423;0.745]	[-0.539;0.622]
Observations	9,948	14,558	18,932	11,857	25,747	11,857	25,747
Kleinbergen-Paap Wald F-stat	16.970	30.110	65.380	20.400	18.190		
Linear polynomial	✓	✓	✓	✓		✓	
Quadratic polynomial					✓		✓

Notes: The table presents the estimated effects of retaking the exam on application choices – each panel refers to a different outcome. Each coefficient comes from a different regression. Columns (1) to (5) show results from a 2SLS estimation, while columns (6) and (7) use the robust nonparametric approach of Calonico, Cattaneo and Titiunik (2014a). Columns (1)-(3) use bandwidths of 1,000, 1,500 and 2,000 marks away from the cutoff, respectively. In Panel A, the optimal bandwidth for the linear polynomial is 1,237.03 (columns (4) and (6)) and 3,171.57 (columns (5) and (7)). In Panel B, the bandwidths are 1,513.86 (columns (4) and (6)) and 3,043.87 (columns (5) and (7)). In Panel C, the bandwidths are 1,193.64 (columns (4) and (6)) and 3,268.14 (columns (5) and (7)). Panel D, the bandwidths are 1,496.85 (columns (4) and (6)) and 2,816.00 (columns (5) and (7)). We do not include individuals who retake more than once in this table, since the majority of students retake only once. Standard errors are clustered at school level and 95% robust confidence intervals are in square brackets. *** p<0.01, ** p<0.05, * p<0.1.

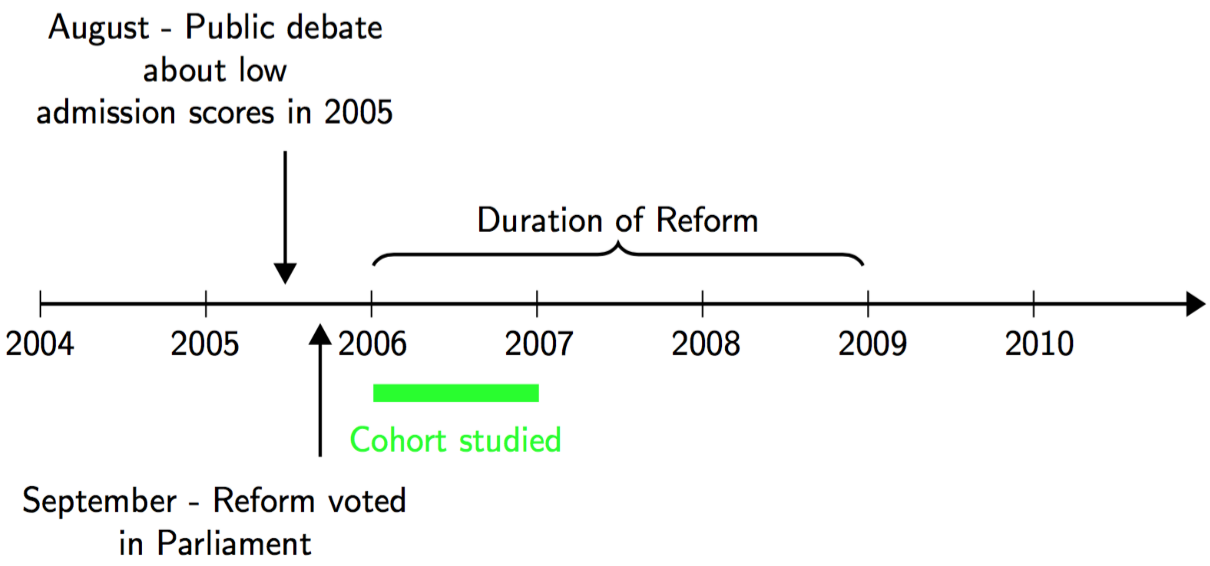
Table 7: ROBUSTNESS EXERCISE: EFFECT OF RETAKING ON ACADEMIC PERFORMANCE USING ALTERNATIVE ADMISSION SCORES

	+/-1,000	+/-1,500	+/-2,000	Optimal	Optimal
	(1)	(2)	(3)	(4)	(5)
Panel A: Admission Score based on 1st Choice					
Retake	2,335.270**	2,781.590***	3,021.003***	2,367.902**	3,148.914**
	[75.471;4,595.069]	[1,708.785;3,854.394]	[2,409.713;3,632.294]	[162.461;4,573.344]	[94.527;6,203.301]
Observations	9,156	13,574	17,899	9,180	9,180
Kleinbergen-Paap Wald F-stat	4.320	16.930	53.380	4.520	.
Panel B: Admission Score based on 2nd Choice					
Retake in 2007	2,248.115*	2,829.746***	2,950.593***	2,728.003**	3,227.053**
	[-216.552;4,712.783]	[1,572.768;4,086.725]	[2,290.922;3,610.264]	[405.358;5,050.648]	[50.486;6,403.620]
Observations	9,165	13,584	17,913	8,882	8,882
Kleinbergen-Paap Wald F-stat	3.910	13.100	47.810	4.200	.
Panel C: Admission Score based on 3rd Choice					
Retake in 2007	1,843.448	2,471.592***	2,720.756***	1,868.825	2,889.283**
	[-447.160;4,134.056]	[1,301.500;3,641.684]	[2,062.014;3,379.498]	[-466.380;4,204.029]	[667.295;5,111.270]
Observations	8,969	13,326	17,535	9,232	9,232
Kleinbergen-Paap Wald F-stat	5.260	15.340	48.370	5.030	.
Optimal Bandwidth Linear 2SLS	✓	✓	✓	✓	
Optimal Bandwidth Linear CCT					✓

Notes: The table presents the estimated effects of retaking the exam on academic performance in the exam. For students with offers, the admissions score corresponds to the admissions score for the offered college-course. For those students without any offer, different admissions scores are used: Panel A uses the admissions score corresponding to students' top choice in their application list, Panel B uses the admission score corresponding to students' 2nd choice in their application list and Panel C uses the admission score corresponding to students' 3rd choice in their application list. Columns (1)-(4) show estimates from a 2SLS estimation and columns (5) uses the robust nonparametric approach of Calonico, Cattaneo and Titiunik (2014a). A linear polynomial of the running variable is used in all estimations. The bandwidth for the (1), (2) and (3) column are +/-1,000, +/-1,500, +/-2,000, as indicated in the top row. Columns (4) and (5) use the optimal bandwidth from the CCT estimation, in Panel A it is 1,003.69 in Panel B it is 969.93 and in Panel C it is 1,028.63. We do not include individuals who retake more than once in this table, since the majority of students retake only once. Standard errors are clustered at school level and 95% robust confidence intervals are in square brackets. *** p<0.01, ** p<0.05, * p<0.1.

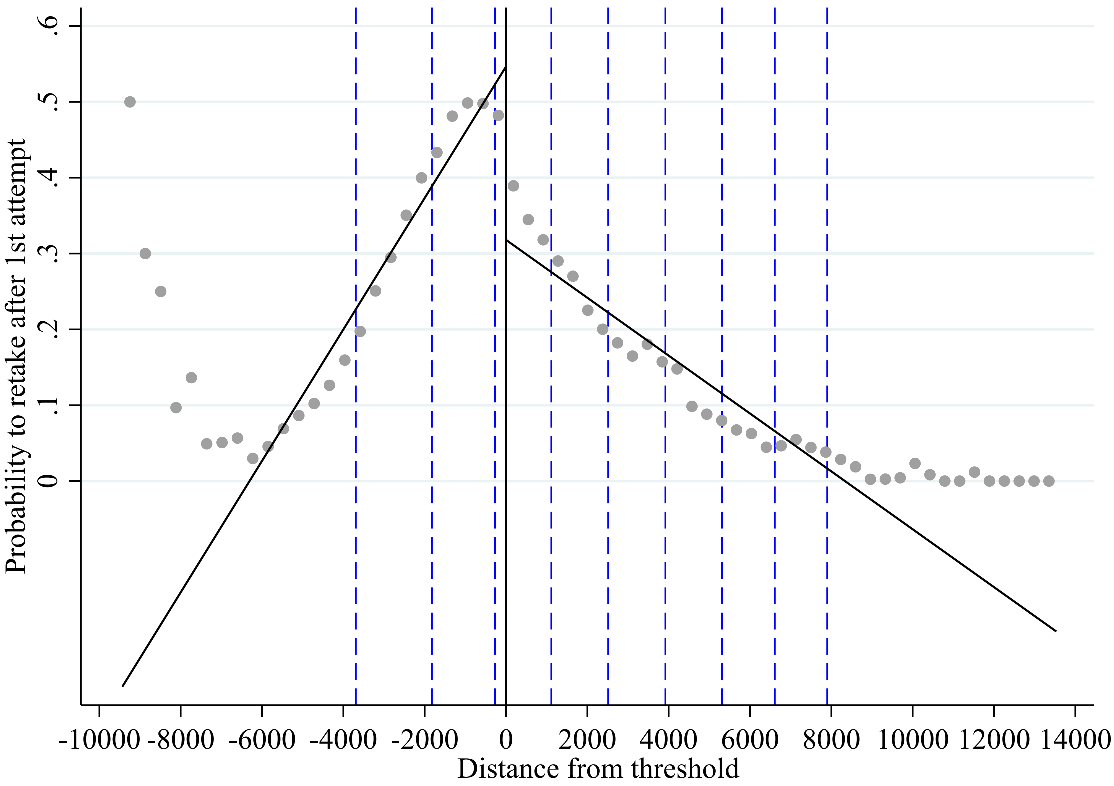
A Appendix

Figure A1: TIMELINE OF THE REFORM



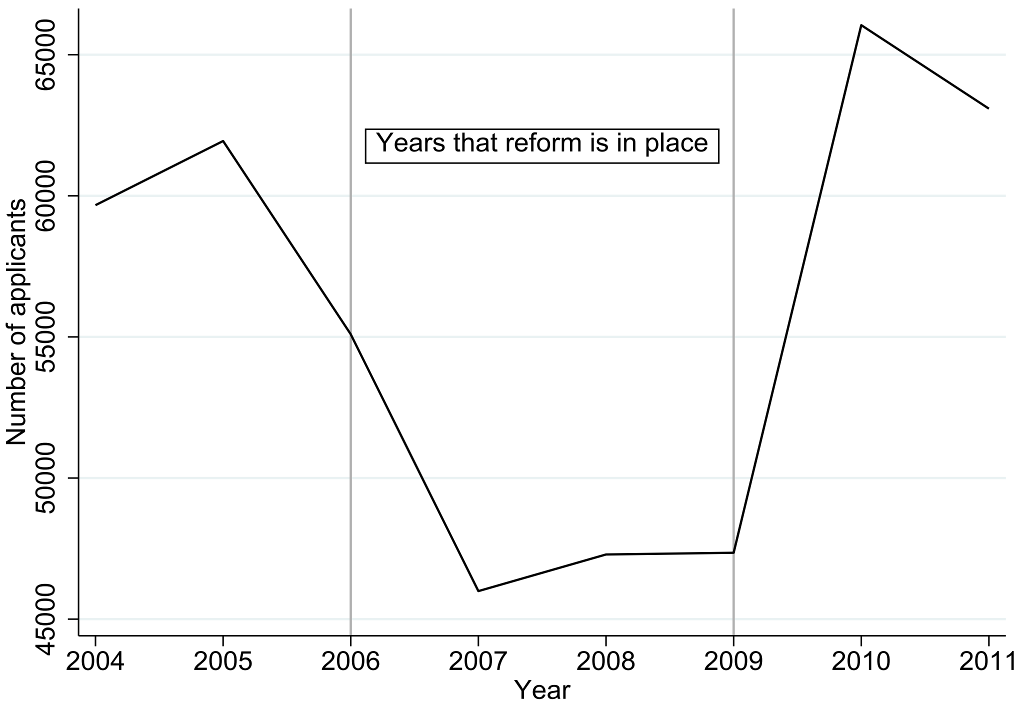
Notes: This figure shows the timing of the reform. In August 2005, there was a public debate and concern that students with very low postsecondary education admissions scores can still get admitted to tertiary education institutions. In September 2005, the reform was voted in Parliament but there was still substantial debate on whether this would be implemented. There were also protests against the implementation of the reform. The first affected cohort is the 2006 cohort, which we use in our main analysis. For this cohort, the reform was unanticipated to a large extent.

Figure A2: FIRST STAGE: PROBABILITY TO RETAKE IN 2007



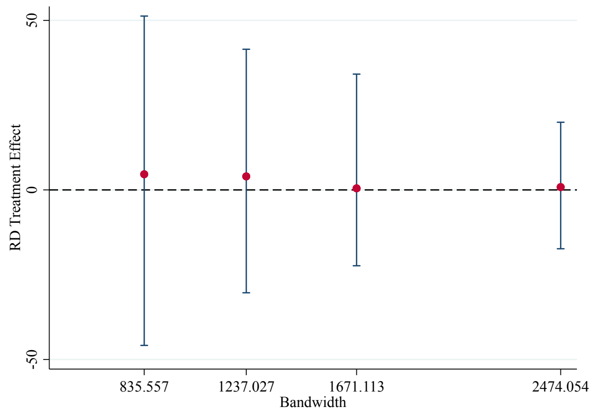
Notes: This figure illustrates how the likelihood of retaking the exam once after the first attempt changes around the score threshold (first-stage estimates). We instrument the probability to retake the exam in 2007 with an indicator of obtaining an admissions score below the 10,000 threshold for all students. Vertical dashed blue lines identify the 10th, 20th, 30th, 40th, 50th, 60th, 70th, 80th, and 90th percentiles of the admissions score.

Figure A3: NUMBER OF FIRST TIME APPLICANTS OVER TIME

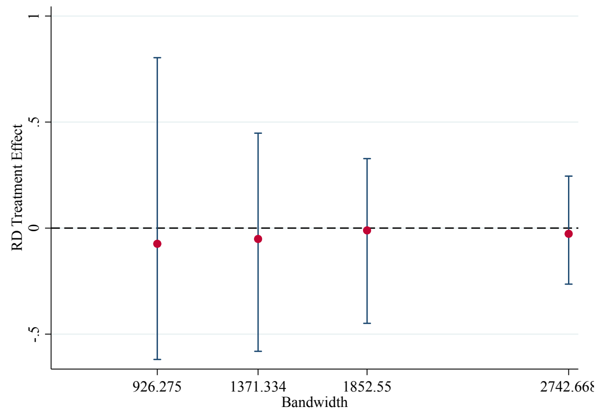


Notes: The figure shows the number of first-time applicants for admission into postsecondary education in Greece from 2005 to 2011. The period within the grey lines indicates the years when the minimum performance threshold for entering postsecondary education was in place.

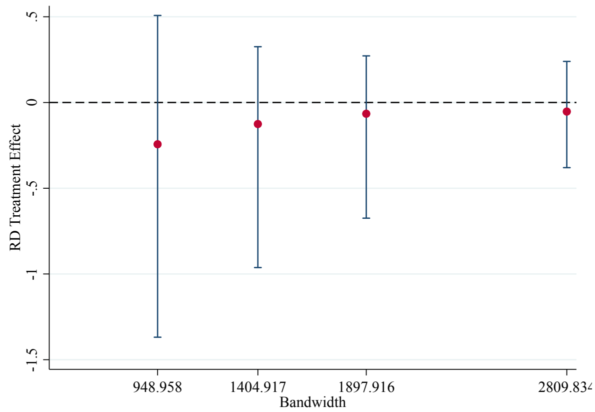
Figure A4: ROBUSTNESS EXERCISE: ALTERNATIVE BANDWIDTHS



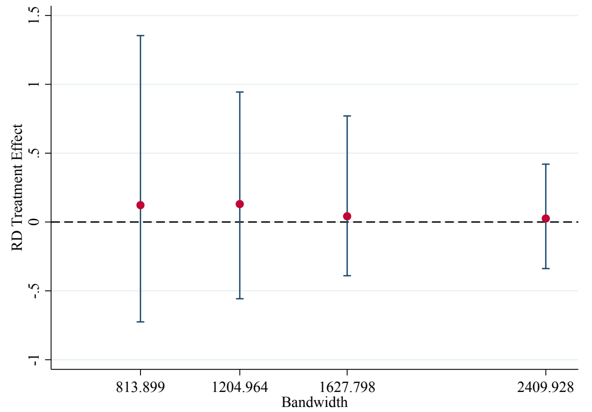
(A) Number of Choices



(B) At Least 50% Top College-course Choices



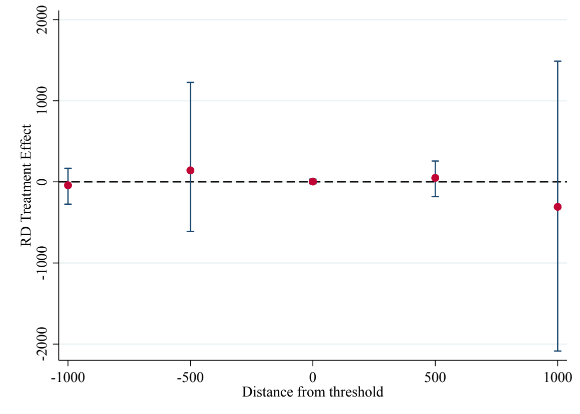
(C) At Least 50% of College-course Choices Academic



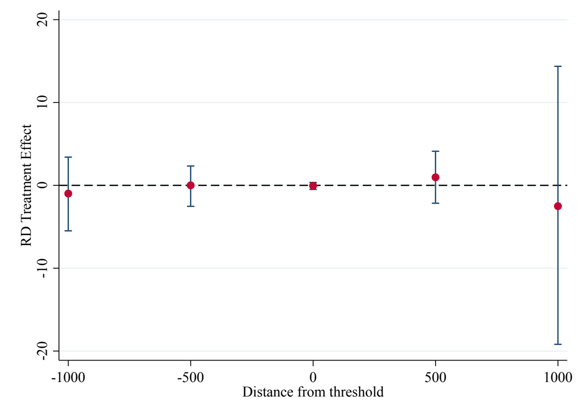
(D) At Least 50% of College-courses with High Employment Prospects

Notes: The figure shows the impact of retaking the exam on four outcomes using alternative bandwidths. In Panel A the outcome is number of choices; in Panel B the outcome is the likelihood that at least 50% of the choices are for college-courses ranked above the median; in Panel C the outcome is the likelihood that at least 50% of the choices are for academic college-courses; in Panel D the outcome is the likelihood that at least 50% of the choices are for college-courses with high employment prospects. In Panel A the MSE and CER optimal bandwidths are 1,237.027, and 835.557, respectively. In Panel B the MSE and CER optimal bandwidths are 1,371.334, and 926.275, respectively. In Panel C the MSE and CER optimal bandwidths are 1,404.917, and 948.958 respectively. In Panel D the MSE and CER optimal bandwidths are 1,204.964, and 813.899, respectively. Dots represent the estimated coefficients, and lines represent the 95% confidence intervals.

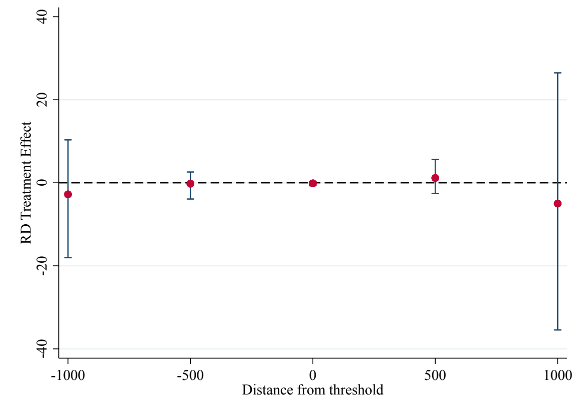
Figure A5: ROBUSTNESS EXERCISE: PSEUDO-THRESHOLDS



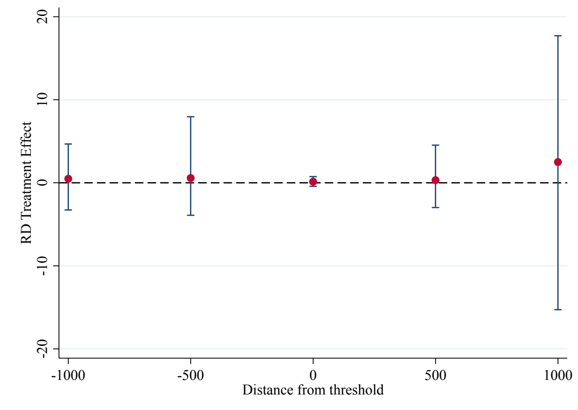
(A) Number of Choices



(B) At Least 50% Top College-course Choices



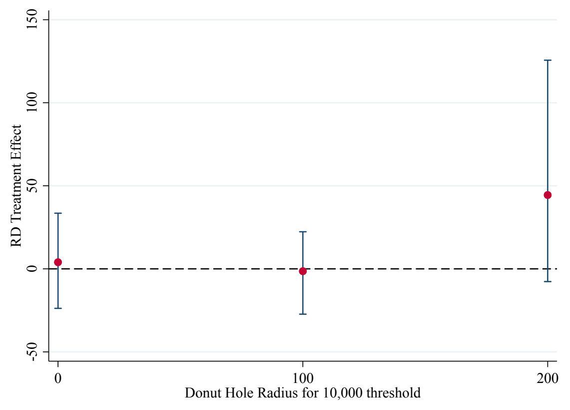
(C) At Least 50% of College-course Choices Academic



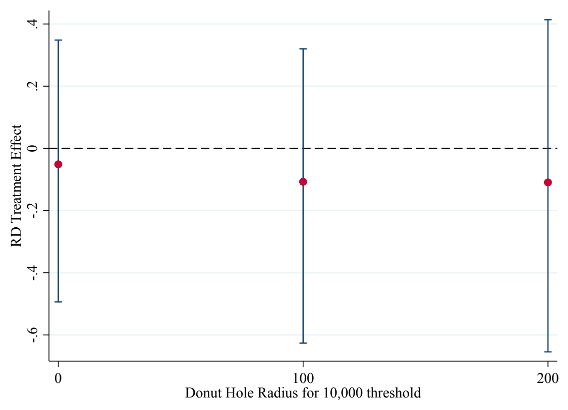
(D) At Least 50% of College-courses with High Employment Prospects

Notes: The figure shows the impact of retaking the national exam using alternative thresholds for four outcomes. In Panel A the outcome is number of choices; in Panel B the outcome is the likelihood that at least 50% of the choices are for college-courses ranked above the median in 2005; in Panel C the outcome is the likelihood that at least 50% of the choices are for academic college-courses; in Panel D the outcome is the likelihood that at least 50% of the choices are for college-courses with high employment prospects. The horizontal axis measures the difference from the true threshold (10,000), with the main estimate represented at 0. For each estimation the optimal bandwidth is calculated using a local linear polynomial following Cataneo, Idrobo and Titiunik (2019). Dots represent the estimated coefficients and lines represent the 95% confidence intervals.

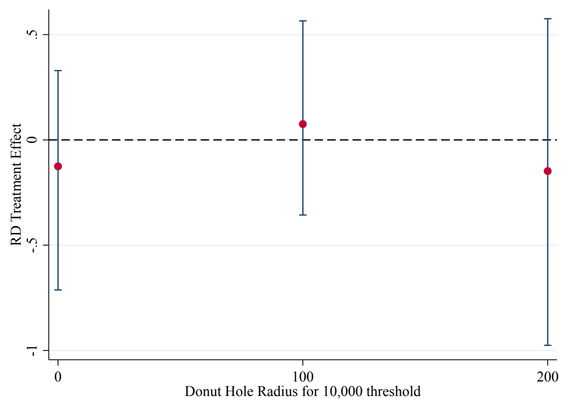
Figure A6: Robustness Exercise: Eliminating Observations around the Threshold



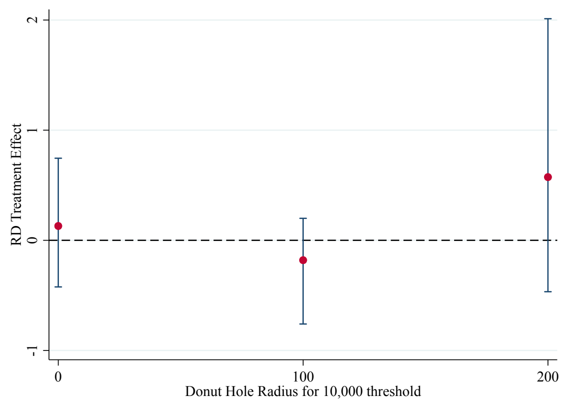
(A) Number of Choices



(B) At Least 50% Top College-course Choices



(C) At Least 50% of College-course Choices Academic



(D) At Least 50% of College-course High Employment Prospects

Notes: The figure shows the impact of retaking the exam when eliminating observations around the threshold for four outcomes. In Panel A the outcome is the number of choices; in Panel B the outcome is the likelihood that at least 50% of the choices are for college-courses ranked above the median; in Panel C the outcome is the likelihood that at least 50% of the choices are for academic college-courses compared to vocational; in Panel D the outcome is the likelihood that at least 50% of the choices are for college-courses with high employment prospects. The horizontal axis measures the donut hole radius, with the main estimate represented at 0. For each estimation the optimal bandwidth is calculated using a local linear polynomial following Cataneo, Idrobo and Titiunik (2019). Dots represent the estimated coefficients and lines represent the 95% confidence intervals.

Table A1: Effect of Retaking on Subsequent Performance Outcomes: by Income

	Academic Performance		Offer from Top College-course		Academic Offer		Offer from High Employment	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: High Income								
Retake in 2007	2,769.337***	3,215.619***	0.054	0.133	0.239*	0.154	-0.789**	-0.748*
	[1,630.035;3,908.639]	[1,720.473;4,962.029]	[-0.186;0.294]	[-0.154;0.501]	[-0.040;0.519]	[-0.279;0.603]	[-1.539;-0.038]	[-1.660;0.297]
Observations	7,775	7,775	7,019	7,019	9,999	9,999	6,566	6,566
Kleibergen-Paap Wald F-stat	16.420	.	14.380	.	27.450	.	13.400	.
Panel B: Low Income								
Retake in 2007	1,872.993***	1,358.814	0.207*	0.141	0.301**	0.290	0.057	0.102
	[520.159;3,225.828]	[-1,260.945;3,210.196]	[-0.016;0.431]	[-0.165;0.536]	[0.008;0.593]	[-0.136;0.787]	[-0.731;0.844]	[-0.636;1.311]
Observations	5,946	5,946	6,253	6,253	7,089	7,089	4,564	4,564
Kleibergen-Paap Wald F-stat	12.450	.	14.450	.	22.370	.	6.500	.
Optimal bandwidth Linear 2SLS	✓		✓		✓		✓	
Optimal bandwidth Linear CCT		✓		✓		✓		✓

Notes: The table presents the estimated effects of retaking the exam on four different outcomes (columns) separately by students from household above the median in terms of income (Panel A) and by students from household below the median (Panel B). Odd columns show estimates using a 2SLS estimation, while in even columns we use the robust non-parametric approach of Calonico, Cattaneo and Titiunik (2014a). We show the impact of retaking the exam on: 1) academic performance in columns (1)-(2), 2) the likelihood the student received an offer from a college-course that is above the median quality in columns (3)-(4), 3) the likelihood the student received an offer from an academic compared to a vocational institution or no offer and 4) the likelihood the student received an offer from a college-course with high employment prospects. Optimal bandwidths are calculated separately for each outcome and for each sub-group (low and high income postcodes). We do not include the results of individuals who retake more than once in this table, the results do not change when we do. Standard errors are clustered at school level and 95% robust CIs are in square brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table A2: EFFECT OF RETAKING ON SUBSEQUENT PERFORMANCE OUTCOMES: BY GENDER

	Academic Performance		Offer from Top College-course		Academic Offer		Offer from High Employment	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Girls								
Retake in 2007	2,693.482***	2,204.675	-0.033	-0.141	0.104	0.036	-0.964	-0.858
	[774.937;4,612.026]	[-1,542.353;5,223.381]	[-0.358;0.292]	[-0.789;0.352]	[-0.425;0.633]	[-0.753;0.942]	[-2.969;1.042]	[-2.915;1.551]
Observations	7,515	7,515	8,858	8,858	8,612	8,612	5,793	5,793
Kleibergen-Paap Wald F-stat	5.840	.	8.260	.	7.660	.	1.940	.
Panel B: Boys								
Retake in 2007	2,332.275***	2,599.699***	0.228**	0.257**	0.386***	0.218	-0.374*	-0.317
	[1,414.245;3,250.304]	[1,433.187;3,830.068]	[0.038,0.417]	[0.027,0.551]	[0.114,0.658]	[-0.195,0.532]	[-0.806,0.058]	[-0.785,0.257]
Observations	6,016	6,016	5,670	5,670	6,902	6,902	5,850	5,850
Kleibergen-Paap Wald F-stat	25.620	.	22.600	.	28.470	.	24.300	.
Optimal bandwidth Linear 2SLS	✓		✓		✓		✓	
Optimal bandwidth Linear CCT		✓		✓		✓		✓

Notes: The table presents the estimated effects of retaking the exam on four different outcomes (shown in columns) separately by girls (Panel A) and boys (Panel B). Odd columns show estimates using a 2SLS estimation, while in even columns we use the robust non-parametric approach of Calonico, Cattaneo and Titiunik (2014a). We show the impact of retaking the exam on: 1) academic performance in columns (1)-(2), 2) the likelihood the student received an offer from a college-course that is above the median quality in columns (3)-(4), 3) the likelihood the student received an offer from an academic compared to a vocational institution or no offer and 4) the likelihood the student received an offer from a college-course with high employment prospects. Optimal bandwidths are calculated separately for each outcome and for each sub-group (boys and girls). We do not include the results of individuals who retake more than once in this table, the results do not change when we do. Standard errors are clustered at school level and 95% robust CIs are in square brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table A3: EFFECT OF RETAKING ON SUBSEQUENT PERFORMANCE OUTCOMES: BY HIGH SCHOOL QUALITY

	Academic Performance		Offer from Top College-Course		Academic Offer		Offer from High Employment	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: High Quality								
Retake in 2007	2,747.150***	2,774.624***	0.094	0.150	0.322	0.175	-0.798*	-0.747
	[1,444.146;4,050.153]	[968.812;4,572.550]	[-0.165,0.353]	[-0.233,0.578]	[-0.071,0.715]	[-0.378,0.711]	[-1.639,0.043]	[-1.791,0.351]
Observations	7,669	7,669	6,742	6,742	8,849	8,849	6,758	6,758
Kleibergen-Paap Wald F-stat	12.490	.	11.000	.	12.860	.	10.190	.
Panel B: Low Quality								
Retake in 2007	2,150.289***	2,149.606***	0.107	0.099	0.276*	0.186	-0.250	-0.065
	[1,129.373;3,171.206]	[424.044;3,660.989]	[-0.108;0.321]	[-0.168;0.439]	[-0.044;0.596]	[-0.300;0.63]	[-0.970;0.470]	[-0.719;0.981]
Observations	6,275	6,275	6,513	6,513	6,733	6,733	4,562	4,562
Kleibergen-Paap Wald F-stat	19.450	.	21.360	.	20.990	.	8.020	.
Optimal bandwidth Linear 2SLS	✓		✓		✓		✓	
Optimal bandwidth Linear CCT		✓		✓		✓		✓

Notes: The table presents the estimated effects of retaking the exam on four different outcomes (shown in columns) separately by students from high schools above the median in terms of performance (Panel A) and by students from high schools below the median (Panel B). Odd columns show estimates using a 2SLS estimation, while in even columns we use the robust non-parametric approach of Calonico, Cattaneo and Titiunik (2014a). We show the impact of retaking the exam on: 1) academic performance in columns (1)-(2), 2) the likelihood the student received an offer from a college-course that is above the median quality in columns (3)-(4), 3) the likelihood the student received an offer from an academic compared to a vocational institution or no offer and 4) the likelihood the student received an offer from a college-course with high employment prospects. Optimal bandwidths are calculated separately for each outcome and for each sub-group (high quality schools and low quality schools). We do not include the results of individuals who retake more than once in this table, the results do not change when we do. Standard errors are clustered at school level and 95% robust CIs are in square brackets. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table A4: EFFECT OF RETAKING ON SUBSEQUENT PERFORMANCE OUTCOMES: BY TYPE OF SCHOOL

	Academic Performance		Offer From Top College		Academic Offer		Offer from High Employment	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Public Schools								
Retake in 2007	2,133.631***	2,341.909***	0.079	0.094	0.224	0.115	-0.217	-0.535
	[838.817;3,428.445]	[823.293;3,860.526]	[-0.140;0.298]	[-0.165;0.354]	[-0.048;0.496]	[-0.241;0.470]	[-0.852;0.418]	[-1.420;0.350]
Observations	10,798	10,798	11,855	11,855	14,403	14,403	9,039	9,039
Kleibergen-Paap Wald F-stat	13.630	.	15.840	.	27.000	.	11.410	.
Panel B: Private Schools								
Retake in 2007	3,927.108***	3,845.046***	0.237	0.257	0.179	0.340	-0.978**	-0.773*
	[1,884.743;5,969.473]	[2,064.794;5,625.299]	[-0.158,0.632]	[-0.101,0.615]	[-0.300,0.659]	[-0.104,0.784]	[-1.863,-0.092]	[-1.611,0.064]
Observations	678	678	702	702	1,138	1,138	1,041	1,041
Kleibergen-Paap Wald F-stat	7.040	.	8.720	.	11.150	.	11.950	.
Optimal bandwidth Linear 2SLS	✓		✓		✓		✓	
Optimal bandwidth Linear CCT		✓		✓		✓		✓

Notes: The table presents the estimated effects of retaking the exam on four different outcomes (shown in columns) separately for public (Panel A) and private schools (Panel B). Odd columns show estimates using a 2SLS estimation, and even columns show robust nonparametric estimates using Calonico, Cattaneo and Titiunik (2014a). We show the impact of retaking the exam on: 1) academic performance in columns (1)-(2), 2) the likelihood a student received an offer from a college-course that is above the median quality in columns (3)-(4), 3) the likelihood a student received an offer from an academic compared with a vocational institution or no offer and 4) the likelihood a student received an offer from a college-course with high employment prospects. Optimal bandwidths are calculated separately for each outcome and for each sub-group (public and private schools). We do not include the results of individuals who retake more than once in this table, the results do not change when we do so. Standard errors are clustered at school level and 95% robust confidence intervals are in square brackets. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table A5: EFFECT OF RETAKING ON SUBSEQUENT ACADEMIC PERFORMANCE - RESULTS FROM SMALLER SAMPLE

	(1)	(2)
Retake	2,395.777***	2,863.705***
	[962.484;3,829.069]	[1,213.367;4,514.044]
Observations	312.000	1,077.000
Kleibergen-Paap Wald F-stat	11.170	.
Optimal Bandwidth 2SLS	✓	
Optimal Bandwidth CCT		✓

Notes: The table presents the estimated effects of retaking the exam on academic performance using only schools and students in the smaller sample. The sample used in this table is used to obtain Table 3. The first column shows estimates using a 2SLS estimation, and the second column uses the robust nonparametric approach of Calonico, Cattaneo and Titiunik (2014a). Optimal bandwidths are the same for columns (1) and (2). Standard errors are clustered at school level and 95% robust confidence intervals are in square brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table A6: EFFECT OF RETAKING ON SUBSEQUENT OFFERS AND CHOICES: BY FIELD OF STUDY

	Health		Engineering		Sciences		Humanities		Business	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel A: Offers										
Retake in 2007	0.298**	0.203	0.234	0.149	0.013	-0.007	-0.047	-0.088	-0.902***	-0.837**
	[0.059;0.536]	[-0.021;0.565]	[-0.152;0.621]	[-0.335;0.705]	[-0.058;0.085]	[-0.100;0.120]	[-0.271;0.176]	[-0.399;0.244]	[-1.456;-0.348]	[-1.625;-0.157]
Observations	9,654	9,654	12,050	12,050	12,768	12,768	12,018	12,018	11,441	11,441
Kleinbergen-Paap Wald F-stat	16.780		21.120		25.720		21.390		19.800	
Panel B: Choices										
Retake in 2007	0.094	0.121	0.278	0.284	-0.036	-0.056	0.072	0.024	-0.480***	-0.361*
	[-0.120;0.307]	[-0.207;0.428]	[-0.110;0.665]	[-0.157;0.900]	[-0.087;0.015]	[-0.163;0.007]	[-0.099;0.243]	[-0.272;0.266]	[-0.841;-0.119]	[-0.863;0.103]
Observations	15,521	15,521	11,540	11,540	14,154	14,154	16,229	16,229	12,560	12,560
Kleinbergen-Paap Wald F-stat	32.860		20.450		29.060		38.830		23.610	
Optimal Bandwidth Linear 2SLS	✓		✓		✓		✓		✓	
Optimal Bandwidth Linear CCT		✓		✓		✓		✓		✓

Notes: The table presents the estimated effects of retaking the exam on a set of outcomes. Panel A refers to offers: in columns (1) and (2) the outcome is the probability to get an offer from a health-related college-course; in columns (3) and (4) the outcome is the probability to get an offer from an engineering-related college-course; in columns (5) and (6) the outcome is the probability to get an offer from a science-related college-course; in columns (7) and (8) the outcome is the probability to get an offer from a humanities-related college-course; in columns (9) and (10) the outcome is the probability to get an offer from a business-related college-course. Panel B refers to choices: in columns (1) and (2) the outcome is the probability to make at least 50% of the choices for a health-related college-course; in columns (3) and (4) the outcome is the probability to make at least 50% of the choices for a engineering-related college-course; in columns (5) and (6) the outcome is the probability to make at least 50% of the choices for a science-related college-course; in columns (7) and (8) the outcome is the probability to make at least 50% of the choices for a humanities-related college-course; in columns (9) and (10) the outcome is the probability to make at least 50% of the choices for a business-related college-course. Odd columns show estimates from a 2SLS estimation and even columns use the robust nonparametric approach of Calonico, Cattaneo and Titiunik (2014a). Optimal bandwidths estimated using the CCT approach are used in all columns. Standard errors are clustered at school level and 95% robust confidence intervals are in square brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table A7: EFFECT OF RETAKING: PSEUDO-THRESHOLDS

Alternative Distance from Threshold	MSE Optimal Bandwidth	RD Estimator	p-value	95% Robust CI	Number Observations Left	Right
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Academic Performance						
-1,000	330.324	-146.748	0.910	[-19,387.410;17,262.110]	1,364	1,598
-500	400.455	-641.542	0.884	[-13,387.880;11,537.740]	1,997	2,002
0	1,150.994	2,588.643	0.001	[1,112.680;3,993.072]	5,597	5,781
500	318.109	466.800	0.896	[-10,724.850;9,379.879]	1,538	1,612
1,000	317.713	-5,280.261	0.840	[-55,468.060;45,085.740]	1,601	1,622
Panel B: Offer From Top College-course						
-1,000	343.129	0.108	0.750	[-1.311;1.820]	1,413	1,654
-500	408.860	0.137	0.793	[-0.974;1.274]	2,035	2,043
0	1,390.115	0.117	0.249	[-0.102;0.391]	6,595	6,967
500	303.722	0.553	0.709	[-1.533;2.252]	1,456	1,549
1,000	285.068	-1.316	0.754	[-11.502;,8.329]	1,431	1,455
Panel C: Academic Offer						
-1,000	358.503	-2.004	0.596	[-11.736;6.744]	1,484	1,725
-500	303.684	-1.559	0.450	[-10.715;4.750]	1,520	1,530
0	1,450.113	0.138	0.732	[-0.326;0.464]	6,836	7,273
500	349.439	1.033	0.733	[-2.628;3.738]	1,687	1,776
1,000	383.305	-10.765	0.942	[-116.040;107.769]	1,950	1,945
Panel D: Offer From College-course with High Employment Prospects						
-1,000	264.037	-1.422	0.678	[-15.074;9.811]	1,102	1,266
-500	249.400	2.337	0.518	[-10.580;21.008]	1,240	1,296
0	916.463	-0.573	0.257	[-1.349;0.360]	4,593	4,575
500	473.418	-1.575	0.426	[-8.173;3.448]	2,307	2,373
1,000	263.614	1.876	0.992	[-14.008;13.866]	1,298	1,364

Notes: Each panel refers to a different outcome. These outcomes are: academic performance (Panel A), the likelihood to obtain an offer from a college-course that is above the median quality (Panel B), the likelihood of obtaining an academic offer compared to an offer from a vocational school (Panel C) and the likelihood of obtaining an offer from a college-course with high employment prospects (Panel D). Each row corresponds to a different threshold. The true threshold (10,000) corresponds to 0 and the estimated effects when the true threshold is used are shown in column 6 in Tables 2 and 4. Results are obtained following the approach of Cataneo, Idrobo and Titiunik (2019).

Table A8: EFFECT OF RETAKING: ELIMINATING OBSERVATIONS AROUND THE THRESHOLD

Donut Hole Radius	MSE Optimal Bandwidth	RD Estimator	p-value	95% Robust CI	Number Observations	Number Observations Excluded Left	Right
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Academic Performance							
0	1,150.994	2,588.643	0.001	[1,112.680;3,993.072]	11,378	0	0
100	1,294.914	2,592.571	0.000	[1,346.185;3,749.882]	11,614	529	532
200	1,011.195	2,649.969	0.042	[91.366;4,884.497]	8,008	1,019	1,023
Panel B: Offer From Top College-course							
0	1,390.115	0.117	0.249	[-0.102;0.391]	13,562	0	0
100	848.731	0.088	0.612	[-0.250;0.425]	7,451	529	532
200	761.186	0.109	0.825	[-0.750;0.940]	5,604	1,019	1,023
Panel C: Academic Offer							
0	1,450.113	0.138	0.732	[-0.326;0.464]	14,109	0	0
100	1,196.320	0.255	0.280	[-0.191;0.660]	10,720	529	532
200	1,028.580	0.386	0.128	[-0.153;1.218]	8,175	1,019	1,023
Panel D: Offer From College-course With High Employment Prospects							
0	916.463	-0.573	0.257	[-1.349;0.360]	9,168	0	0
100	1,098.268	-0.514	0.191	[-1.035;0.207]	9,819	529	532
200	862.484	-0.488	0.766	[-1.774;1.306]	6,600	1,019	1,023

Notes: Each panel refers to a different outcome.These outcomes are: academic performance (Panel A), the likelihood to obtain an offer from a college-course that is above the median quality (Panel B), the likelihood of obtaining an academic offer compared to an offer from a vocational school (Panel C) and the likelihood of obtaining an offer from a college-course with high employment prospects (Panel D). Each row corresponds to a different donut hole radius. The radius of 0 corresponds to the main estimated effects (threshold at 10,000) reported in column 6 in Tables 3 and 4. We also present estimates when we eliminate +/-100 and +/-200 scores around the threshold. Results are obtained following the approach of Cataneo, Idrobo and Titiunik (2019).

Table A9: Effect of Retaking on Academic Performance Using Alternative Admissions Scores for Those who Retake More Than Once

	+/-1,000	+/-1,500	+/-2,000	Optimal	Optimal
	(1)	(2)	(3)	(4)	(5)
Retake	2,112.036***	2,412.980***	2,627.979***	2,195.038***	2,395.353***
	[838.859;3,385.214]	[1,522.164;3,303.796]	[2,033.190;3,222.768]	[1,043.760;3,346.316]	[1,016.601;3,774.105]
Observations	9,948	14,558	18,932	11,422	11,422
Kleinbergen-Paap Wald F-stat	16.970	30.110	65.380	19.330	.
Optimal Bandwidth Linear 2SLS	✓	✓	✓	✓	
Optimal Bandwidth Linear CCT					✓

Notes: The table presents the estimated effects of retaking the exam on academic performance in the exam. In this table we include students who retake the exam more than once. For students who retake the exam more than once, we use their most updated admissions grade and we take into account up to three retakes. Columns (1)-(4) show estimates from a 2SLS estimation and column (5) uses the robust nonparametric approach of Calonico, Cattaneo and Titiunik (2014a). A linear polynomial of the running variable is used in all estimations. The bandwidth for the (1), (2) and (3) column are +/-1,000, +/-1,500, +/-2,000, as indicated in the top row. Columns (4) and (5) use the optimal bandwidth from the CCT estimation. Standard errors are clustered at school level and 95% robust CIs are in square brackets. *** p<0.01, ** p<0.05, * p<0.1.

B Appendix

Figure B1: EXTRACT FROM THE REFORM'S LAW

ΚΕΦΑΛΑΙΟ Γ΄

ΘΕΜΑΤΑ ΕΙΣΑΓΩΓΗΣ, ΜΕΤΕΓΓΡΑΦΩΝ
ΚΑΙ ΚΑΤΑΤΑΞΕΩΝ
ΣΤΗΝ ΤΡΙΤΟΒΑΘΜΙΑ ΕΚΠΑΙΔΕΥΣΗ

Άρθρο 13

Εισαγωγή στην τριτοβάθμια εκπαίδευση

1. Στο ν. 2525/1997 (ΦΕΚ 188 Α΄) μετά το άρθρο 2 προστίθεται άρθρο 2Α ως εξής:

«Άρθρο 2Α

1. Ως προϋπόθεση συμμετοχής του υποψηφίου στη διαδικασία επιλογής των εισαγομένων στα Πανεπιστήμια, στα Τ.Ε.Ι., στην Α.Σ.ΠΑΙ.Τ.Ε., στις Ανώτερες Σχολές Τουριστικής Εκπαίδευσης (Α.Σ.Τ.Ε.) των Σχολών Τουριστικών Επαγγελμάτων του Υπουργείου Τουριστικής Ανάπτυξης, στα Ανώτατα Στρατιωτικά Εκπαιδευτικά Ιδρύματα και τις Σχολές Υπαξιωματικών των Ενόπλων Δυνάμεων, στις Ακαδημίες Εμπορικού Ναυτικού του Υπουργείου Εμπορικής Ναυτιλίας, στις Σχολές Αστυνομικής Ακαδημίας του Υπουργείου Δημόσιας Τάξης και στη Σχολή Ανθυποπυραγών της Πυροσβεστικής Ακαδημίας του Υπουργείου Δημόσιας Τάξης ορίζεται η επίτευξη από τον υποψήφιο γενικού βαθμού πρόσβασης τουλάχιστον ίσου με το μισό του μέγιστου δυνατού βαθμού πρόσβασης. Ειδικά, υποψήφιος που δεν πληροί την προϋπόθεση αυτή συμμετέχει στη διαδικασία επιλογής των εισαγομένων στα ανωτέρω ιδρύματα εφόσον συγκεντρώνει σύνολο μορίων τουλάχιστον ίσο με το μισό του μέγιστου δυνατού αριθμού μορίων.

Notes: This comes from Law 3404/2005, Article 13 and describes the new requirements for gaining access to tertiary education. In particular, it states that new applicants should obtain an admission score that is equal to at least 50%. The federal document can be accessed here: http://www.pi-schools.gr/special_education_new/ftp/nomoi/Ekp_Themata/N.%203404%20-2005%20-%20FEK.%20260%20-A-%2017-10-2005.pdf

Figure B2: COUNTIES CONTAINING SCHOOLS IN THE SMALLER DATASET

Notes: This figure shows the counties with schools for which we have GPA scores and student birthdate.

Figure B3: DEFINITION OF THE EMPLOYMENT PROSPECTS INDEX

Insecurity index: >= 1 and < 1.5	>= 1.5 and <= 2	> 2 and <= 2.5	> 2.5 and 3
Employment prospects are			
Good	Mediocre	Poor	Very Poor
Economics	Mathematics and Statistics	Education, Greek,	Agriculture and Forestry
Engineering and Computer Science	Business and Management	Foreign Languages and P.E.	Liberal Art and Humanities
Biology	Physics and Earth Science	Social, Political, and European Studies	Home Economics
Nursing and Other Health	Psychology	Other	
Medicine	Law	Journalism	
Pharmacy			
Naval Academies			
Police and Military			
Veterinary Science			

Notes: This table comes from Goulas and Megalokonomou (2019). For each university department, the index takes a value between 1 and 3, and indicates how good the employment prospects are for graduates of those university departments. In particular, if the index is between 1 and 1.5 the employment prospects are good, if the index is between 1.5 and 2 the employment prospects are mediocre, if the index is between 2 and 2.5 the employment prospects are poor, and if the index is between 2.5 and 3 the employment prospects are very poor. As discussed in that paper, the job insecurity index is the result of the amalgamation of information from the career offices of all universities in Greece, the Hellenic Bureau of Statistics, the employment observatory, and various labor unions. The index is intended to represent differences in structural and frictional unemployment among those with available university degrees and time-specific labor market conditions. This index refers to students who apply to university departments in 2006.