Initial College Choice and Degree Completion Rates: Using Admissions Test Score Thresholds to Estimate Undermatch Penalties

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February 2014

ABSTRACT

The growing debate on the impact of initial college choice on student outcomes has suffered from a lack of clear evidence, given the non-random nature of college selection. We remedy this by identifying an exogenous source of variation in college choice, namely college admission minimum test score thresholds. Using the universe of SAT takers in the 2004-08 graduating high school cohorts, we study both Georgia's state university system, whose thresholds are public, and another group of colleges whose use of thresholds is not public but can be detected in our data. A regression discontinuity design comparing the relatively low-skilled students just above and below these thresholds yields two main findings. First, in both settings, missing these thresholds diverts students into two-year colleges or less selective four-year colleges, suggesting that college choices are narrowed by failure to take low cost steps like retesting or applying more widely. Second, missing these thresholds reduces bachelor's degree completion rates, particularly for students from low-income high schools. We argue this is clear evidence of an undermatch penalty, as some students are diverted from four-year colleges from which they are capable of graduating.

*This research reflects the views of the authors and not their corresponding institutions.

1. Introduction

The concept of college undermatch featured prominently in the report summarizing the recent White House summit on college access:

> "Too few low-income students apply to and attend colleges and universities that are the best fit for them, resulting in a high level of academic undermatch – that is, many low-income students choose a college that does not match their academic ability. Students who attend selective institutions, which tend to have more resources available for student supports, have better education outcomes, even after controlling for student ability." (p. 4, White House, 2014)

The last line of that statement highlights the current state of knowledge regarding undermatch. We have clear evidence that students, particularly low-income ones, do not attend the highest quality colleges available to them (Roderick et al., 2008; Bowen et al., 2009; Smith et al., 2013). We also have clear evidence that relatively small interventions can alter these enrollment patterns, at least for high-skilled students (Hoxby and Turner, 2013). We have, however, little clear causal evidence that such undermatch generates longer-run penalties, such as reduced graduation rates. The best studies on this topic use empirical strategies that cannot completely rule out channels other than college quality, such as financial aid (Cohodes and Goodman, 2014) or unobserved abilities (Smith, 2013). The major empirical challenge is to find an exogenous source of variation in initial college choice. Such an instrument has been lacking in the prior literature, especially for students who are not at the top of the academic ability distribution.

We remedy this by taking advantage of the fact that the college application and enrollment process in the United States is complex and costly. The optimal strategy may be particularly unclear for students from low-income families who lack the necessary information and support to navigate the many steps in the process (Avery and Kane, 2004; Dillon and Smith, 2013). Even high-achieving low-income students fail to apply to colleges sufficiently selective to match their academic talents (Hoxby and Avery, 2013). We explore a previously understudied factor that adds another complication to the college application process, namely the use of test score thresholds by colleges during the admissions process. Such thresholds are used by public college systems in a number of states, including California, Florida and Texas, though often in combination with other factors such as GPA. Across the U.S., roughly one in five colleges report using specific scores as a minimum threshold for admission (NACAC, 2009).

We study two settings in which such thresholds are used. The first is Georgia's state university system (GSUS), which publicly announces minimum SAT scores to be used for first-year admission. The second is a group of seven colleges, which we describe further below, whose use of SAT thresholds in the admissions process is not known to the public. We develop an algorithm to identify this latter group of colleges by exploiting our unique dataset, which connects the universe of SAT-takers to college enrollment and completion outcomes. For both these colleges and Georgia's state universities, a regression discontinuity design comparing students just above and below the relevant thresholds yields two main findings.

First, in both settings, missing these thresholds diverts students into two-year colleges or less selective four-year colleges than they would otherwise have attended. That the choice of college is so sensitive to small test score differences suggests students may be failing to take low cost steps that would widen their enrollment options. In Georgia, for example, retaking the SAT would for some marginal students raise their scores sufficiently to grant them potential access to GSUS. In the hidden college thresholds, for example, applying more widely could mitigate these enrollment effects. These findings are consistent with recent research documenting small costs have disproportionate impacts on students' college decisions. For example, students apply more widely and enroll more frequently and in higher quality colleges when they are permitted to send test scores to additional colleges for free (Pallais, 2013), when they are given help filling out financial aid forms (Bettinger et al., 2012), and when they are provided information, application fee waivers and guidance about the application process (Hoxby and Turner, 2013; Carrell and Sacerdote, 2013). We contribute to this literature by documenting a new aspect of the college admissions process, namely SAT thresholds, that have enrollment impacts for students whose retaking and application behavior appear suboptimal.

Second, scoring just below these thresholds decreases the probability of BA completion in the Georgia setting and for low-income students in the hidden threshold setting. Specifically, in Georgia, we find that marginal students just below the threshold are 7 percent less likely to have obtained a bachelor's degree within six years of high school completion. For low-income students who apply to less selective hidden threshold schools and just miss the thresholds, results are even more dramatic. These students experience a 16 percent six-year bachelor's degree penalty. Prior literature has identified the impact of enrolling in a two-year, instead of four-year, college on BA completion using techniques such as propensity score matching and instrumental variables based on geography (Rouse, 1995; Rouse, 1998; Leigh and Gill, 2003; Long and Kurlaender, 2009; Reynolds, 2012). This paper uses test score thresholds as a new source of exogenous variation in college choice and generates results consistent with that prior work.

We argue that these thresholds may harm students by diverting them into less selective colleges than they are qualified to attend, the definition of undermatch,[1] and also prevent some from completing bachelor's degrees. As mentioned, prior work has demonstrated that undermatching is a widespread phenomenon, particularly among low-income students and those who are poorly informed about the college application process (Dillon and Smith, 2013). Though most of this prior research has focused on undermatching at the moment of enrollment, relatively few papers demonstrate convincingly that undermatching can lower graduation rates (Long, 2008; Smith, 2013; Cohodes and Goodman, 2014). We add to this literature a new example of a clearly identified mechanism that generates undermatch and subsequent graduation rate penalties.[2] Our paper has additional contribution of focusing on students near the 20th percentile of the skill distribution, a set of students very different from those studied in recent work focusing on the high end of the distribution (Hoxby and Turner, 2013).

Finally, our work adds to a small but growing literature exploiting test score thresholds as a source of exogenous variation in the type of postsecondary institution that students attend. Van der Klauuw (2002) exploits a single college's use of such thresholds in the financial aid process to estimate the enrollment effects of such aid. Hoekstra (2009) exploits admissions thresholds at a single flagship state university to estimate the labor market return to attending a selective college. In neither case can the author observe college enrollment for those not enrolling in the college of interest. Zimmerman (2014) estimates the labor market return to attending a four-year college by exploiting an admissions threshold for the least selective state university in Florida,

[1] The term "undermatch" was coined in Bowen et al. (2009), where they define undermatched students as "high school seniors who were presumptively qualified to attend strong four-year colleges but did not do so, instead attending less selective four-year colleges, two-year colleges, or no college at all" (p. 88).

[2] The undermatch literature is part of a much larger literature on the returns to college quality, including but not limited to, James et al. (1989), Loury and Garman (1995), Behrman et al. (1996), Daniel et al. (1997), Hoxby (1998), Kane (1998), Brewer et al. (1999), Monks (2000), Dale and Krueger (2002 and 2011), and Long (2008).

where he can observe the enrollment decisions of all students. Though we do not observe labor market outcomes, ours is the first paper in the U.S. context to document the importance of test score thresholds across multiple universities, including an entire state public university system. In this sense, our work resembles recent work exploiting the Chilean national system of college admissions thresholds to estimate the impact of college quality on a variety of labor market and other outcomes (Saavedra, 2008; Hastings et al., 2013; Kauffman et al., 2013; Navarro-Palau et al., 2013).

The structure of the paper is as follows. Section 2 describes the two contexts studied here. Section 3 describes our regression discontinuity methodology. Section 4 describes the data and provides evidence on the validity of our empirical design. Section 5 describes enrollment and completion results and discusses their implications. Section 6 concludes.

2. The Data and Two Contexts

We use student-level data for the graduating high school classes of 2004-08, collected from two sources. The first data set, collected and maintained by the College Board (CB), contains information on the nearly 1.5 million students each year who take the SAT, a test many four-year colleges require for admission. The SAT contains a math and critical reading section, each of which is scored on a scale between 200 and 800 for a maximum composite score of 1600.[3] Students may retake the SAT as often as the testing schedule permits, with each test administration costing roughly $40 during the time period studied here. Fee waivers are available to low income students taking the exam for the first or second time. We use two versions of students' SAT scores, depending on the context. A student's first composite score is, defined as

[3] The writing section was introduced in 2005, making the maximum composite score 2400. For consistency across cohorts, and because colleges typically do not rely on the writing section, we focus here only on the math and critical reading sections.

the total score earned the first time a student takes the SAT, and the maximum composite score, defined as the sum of the maximum math and critical reading scores earned regardless of whether they were earned on the same test date. Colleges frequently rely on this maximum SAT score for admission. The CB data set also identifies colleges to which students send official copies of their SAT scores, which serve as good proxies for actual college applications (Card & Krueger, 2005; Pallais 2013).[4] In addition, the CB data set contains information on student race, gender, parental income and education, and high school attended.

These data are then merged with data from the National Student Clearinghouse (NSC), which collects postsecondary enrollment information on more than 94 percent of students enrolled in U.S. postsecondary institutions.[5] Data from the NSC allow us to track a student's postsecondary trajectory including enrollment, transfer behavior and degree completion. We focus on the 2004-08 cohorts for whom we can observe four-year graduation rates, as well as the 2004-06 cohorts for whom we can observe six-year graduation rates. For simple measures of four-year college quality, we merge to our data each institution's six-year college completion rates and average standardized test scores (ACT and SAT) of incoming students, as reported to the Integrated Postsecondary Education Data System (IPEDS). Our analyses focus on two distinct sub-samples of this data.

2.1. Georgia

The first sub-sample consists of all students residing in the state of Georgia at the time of taking the SAT. We focus on Georgia because its Board of Regents has required that SAT-takers

[4] When registering for the SAT, the student has the option to send his scores to four colleges for free. Scores may also be sent at a later date for a fee of $11 per score send.

[5] A large fraction of non-participating colleges are for-profit institutions.

score at least 430 in critical reading and at least 400 in math in order to be admitted to universities within the Georgia state university system (GSUS).[6] We describe the set of 18 universities governed by this requirement in panel A of Table A.1. These consist of three research universities, two regional universities, and 13 state universities. Columns 8 and 9 show that five of the 18 universities impose higher minimum thresholds than required by the Board of Regents, though only two impose substantially higher thresholds. Georgia's state and technical colleges, all of which are primarily two-year institutions, impose much lower minimum thresholds of 330 in critical reading and 310 in math.

The Georgia context is interesting for three reasons. First, the GSUS minimum admissions thresholds correspond to roughly the 20th-25th percentile of the distribution of scores among Georgia SAT-takers in the years in question. The marginal student here is often choosing between two- and four-year colleges. Much of the most prior best research on college choice and undermatch focus on a much higher point in the skill distribution (Cohodes and Goodman, 2014; Hoxby and Turner, 2013). Second, these thresholds apply to all students applying to four-year public institutions in Georgia. As we show later, over 60% of Georgia students near these thresholds who enroll in four-year colleges do so in these GSUS institutions. These thresholds thus affect the majority of college options for students in this market. Most prior research exploiting admissions thresholds has focused on individual institutions, rather than entire postsecondary systems.

Third, the fact that these thresholds are public knowledge means that students can, in theory, take these thresholds into account when planning their college application process. We explore whether students do, in fact, plan around these thresholds. Because the public nature of the

[6] This requirement has been in effect since 2004, if not earlier. Students can also be admitted on the basis of ACT scores.

thresholds may render score-sending behavior endogenous, we define our sample as all students residing in the state of Georgia, rather than just students sending scores to GSUS institutions.

2.2. Hidden Threshold Colleges

The second sample consists of all students who sent their SAT scores to one of seven colleges we identify as using minimum test score thresholds in the admissions process, even though the existence of such thresholds is not publicly known. We refer to these as “hidden threshold” colleges. We define hidden threshold colleges as those for which students’ matriculation probabilities as a function of the maximum composite SAT show a clear and substantial discontinuity. We now describe the algorithm by which we identified these colleges.

We started with the 2004 cohort of graduating high school seniors and conducted the following procedure for each college in our data. First, we identified all students who sent SAT scores to that college. Second, using those students, we employed a regression discontinuity design to test for the presence of discontinuities in the probability of matriculation as a function of maximum composite SAT scores. To do so, we ran a series of local linear regressions in which we varied the potential location of the discontinuity from a composite score of 600 to a composite score of 1400, testing all possible values in between. Third, we kept only potential discontinuities where the t-statistic on the threshold indicator exceeded three. We also eliminated colleges where the density of score senders changed dramatically around potential discontinuities. Colleges that violated this density condition were those that made public their specific thresholds, making it much less likely that students just above and below the threshold were similar in terms of observable or unobservable characteristics. Fourth, to verify that these discontinuities were not anomalies, we then repeated this search process for the remaining colleges but for each the subsequent 2005-08 cohorts, keeping only colleges that showed clear discontinuities in all five cohorts.

The result of this process was the identification of seven colleges that clearly employ SAT minimum thresholds in the admissions process. Figure A.1 shows the probability that applicants enroll in these seven target colleges as a function of applicants' distance from the threshold we identify as relevant for their cohort. A few points are worth noting. First, extensive internet research revealed no public indication of the use of such thresholds for any of these seven colleges, strongly implying that these colleges keep this aspect of their admission processes hidden from applicants. Because these thresholds are not publicly known, score-sending behavior should not be endogenous with respect to those thresholds. We confirm this empirically below and thus define our sample to include only those who send scores to these colleges, a definition which should not generate any selection bias. Second, the slight variation in the location of each college's threshold over time suggests that colleges may be setting these thresholds based either on the percentiles represented by these composite scores or based on their capacity to read a fixed number of applications each year.

Third, panels B and C of Table A.1 describe these colleges while preserving their anonymity. We divide the seven colleges into two groups, those with low hidden thresholds (composite SAT scores ranging from 754-1028, panels A-D in Figure A.1) and those with high hidden thresholds (composite SAT scores ranging from 1192-1216, panels E-G in Figure A.1). The low threshold colleges have six-year graduation rates in the 40-60 percent range, slightly higher than the average GSUS institution. The high threshold colleges have six-year graduation rates in the 70-80 percent range, substantially higher than the GSUS and low threshold colleges. All seven colleges are located in either the Mid-Atlantic or the Southeast and all seven are public, so we further limit the sample to students who are in-state residents.[7] We include as multiple observations the relatively few students who send scores to multiple hidden threshold colleges. Excluding these students entirely or limiting each to only a single college has no impact on the results below.

3. Methodology

To eliminate selection bias driven by different types of students making different college choices, we exploit the thresholds previously described. We use a regression discontinuity to compare a variety of outcomes between students just above and below these thresholds. We generate estimates by running local linear regressions of the form:

$$Y_{ic} = \beta_0 + \beta_1 Above_{ic} + \beta_2 Distance_{ic} + \beta_3 Above_{ic} * Distance_{ic} + \delta_c + \varepsilon_{ic}$$

Here, *Y* is any one of the outcomes of interest for student *i* in cohort *c*, including measurements of SAT-retaking behavior, initial college enrollment, and four- and six-year graduation rates. *Above* is an indicator for meeting or exceeding the relevant test score threshold and *Distance* measures the number of SAT points each student's score is from the threshold. All regressions include cohort fixed effects. The coefficient of interest, β_1, estimates the effect of being above the relevant admissions threshold on the outcome of interest, because the two sets of students on either side of the threshold are nearly identical in academic skill and other characteristics.

[7] In addition to being consistent with the Georgia analysis, which uses in-state students, students who send scores from out of state are likely unusual in other respects. Out-of-state students may, for example, meet special admissions criteria, such as those for recruited athletes.

We measure distance from the threshold differently in the two contexts studied here. In Georgia, a student must score at least 430 in reading and at least 400 in math. We therefore define distance from the threshold in Georgia as:

$$Distance_{GA} = \min\left(SAT_R - 430, SAT_M - 400\right)$$

This minimum function collapses the two-dimensional threshold into a single dimension, where negative values imply a student has missed at least one threshold and zero or positive values imply a student has met or exceeded both thresholds. This method of collapsing a multi-dimensional boundary into a single dimension is discussed in Reardon and Raudenbush (2009) and has previously been used in papers such as Cohodes and Goodman (2013) and Papay, Murnane, and Willet (2014). For applicants to hidden threshold colleges, we define each student's distance from the threshold as:

$$Distance_{TC} = SAT_R + SAT_M - MINSAT_{TC}$$

where *MINSAT* is the threshold composite score identified by our algorithm for the applicant's target college (*TC)* and cohort.

In the Georgia context, where admissions thresholds are publicly known, we initially define each student's distance from the threshold using that student's first SAT scores. First scores do not suffer from any endogeneity driven by potential retaking of SAT in reaction to failing to meet the thresholds. We will provide evidence that, though there is endogenous retaking of SAT in reaction to the thresholds, the magnitude of that endogeneity and the bias it generates is quite small. As such, we also show regression estimates in which distance has been defined by maximum SAT scores, the measure that is actually employed by colleges in the admissions process.[8] For applicants to hidden threshold colleges, we use only maximum composite SAT scores when defining distance because the hidden nature of the thresholds precludes endogenous retaking of the test, a fact that we confirm empirically.

We run the local linear regression above using a triangular kernel that more heavily weights points near the threshold, as suggested by Porter (2003). We present our primary estimates for each outcome using the optimal bandwidth generated by the procedure described in Imbens and Kalyanaraman (2012), which balances the need for precision against the desire to minimize bias generated by fitting straight lines to data that may become non-linear far from the threshold. These bandwidths thus vary by the sample and outcome examined and we later test the sensitivity of the estimates to different bandwidth choices. We cluster standard errors at the high school level. Regressions involving the hidden threshold colleges also include fixed effects for each target college.

Finally, we disaggregate our estimates by income as measured by the average reported income of SAT-takers at each student's high school. We characterize students by the average income at their high schools for two reasons. First, approximately one-third of SAT-takers failed to report their own income. Using high school average income allows us to assign everyone to an income level. Second, the high school-level income measure is a good proxy for the socioeconomic profile of the peers who may be influencing each student's college choices.

[8] See http://www.usg.edu/academic_affairs_handbook/section3/C660 for the GSUS admissions requirements.

4. Summary Statistics, Test Retaking, and Validity of the Research Design

4.1 Summary Statistics

Table 1 presents summary statistics for the sub-samples examined here, residents of Georgia, applicants to low hidden threshold colleges, and applicants to high hidden threshold colleges. In this table, we limit the sub-samples to students whose maximum SAT scores place them within the IK-estimated optimal bandwidth generated by using on-time four year college enrollment as an outcome. The College Board data provides information on students' gender, race, parental education and income, the last of which we average by high school. Those data also include SAT scores, retakes and score sends. We define indicators for students failing to report gender, race or parental education. The National Student Clearinghouse data allow us to construct indicators for both on-time college enrollment, defined as enrollment within one year of high school graduation, and degree completion within four or six years of high school graduation.

In the Georgia sample, 19 percent had percent who were high school dropouts, 33 percent had percent who were high school graduates, and 38 percent had percent with four-year college degrees or higher. 18 percent attended high schools with an average family income of less than $50,000 a year, 73 percent attended schools where income averaged between $50,000 and $100,000, and 10 percent attended schools where income exceeded $100,000. The average Georgia student in this sample scored 903 on the SAT, took the SAT 1.8 times, and sent scores to 3.6 colleges. One-third enrolled in a GSUS college within one year of graduating high school, while half enrolled in any four-year college. This means that over 60 percent of the students who enrolled in a four-year college did so in the in-state public sector. Only 8 percent completed their B.A. degrees within four years, with 29 percent completing within six years.

The applicants to low hidden threshold colleges are somewhat more advantaged than students in the Georgia sample, with more educated percent and attending high schools with higher average income. The average student in this sample scored 957 on the SAT, took the SAT 2.2 times, and sent their scores to 6.0 colleges. Two-thirds enrolled in a four-year college within one year of high school graduation, with fewer than one-fifth of those enrolling in the target college that warrants their inclusion in the sample. The average four-year college in which these students enroll has a six-year graduation rate of 53 percent, relative to the 41 percent graduation rate for four-year college enrollees in Georgia. 21 percent completed their B.A. degrees within four years, with 47 percent completing within six years.

Applicants to high hidden threshold colleges are much more advantaged than students in the other sub-samples, with 40 percent attending high income high schools. The average student in this sample scored 1209 on the SAT, took the SAT 2.3 times, and sent their scores to 7.6 colleges. Nearly nine-tenths enrolled in a four-year college within one year of high school graduation, and those colleges had an average six-year graduation rate of 73 percent. 52 percent completed their B.A. degrees within four years, with 77 percent completing within six years.

4.2 SAT Retaking Behavior

In order for the regression discontinuity design to estimate causal impacts, we need the thresholds to provide exogenous sources of variation in eligibility to attend the colleges in question. This, in turn, requires that the running variable itself is not subject to manipulation by the student, particularly near the threshold. First SAT scores satisfy this condition but maximum SAT scores may fail to do so if students retake the test in response to their distance from the threshold. This endogenous retaking behavior should be a potential problem only in settings where thresholds are publicly known, such as Georgia.

We explore this issue directly in Table 2, which estimates for the Georgia sample discontinuities in SAT retaking behavior at the GSUS eligibility threshold. Panel A, which includes all students, shows that students whose first SAT scores barely meet the eligibility thresholds are 3.2 percentage points less likely to retake the SAT than those who barely miss the eligibility thresholds. As seen in the first column of Table A.2, this result is quite robust to a variety of bandwidths and does not appear in the neighboring state of North Carolina, suggesting that it is driven by the GSUS-specific nature of the thresholds.[9] Figure 1 shows the graphical version of this relationship between retake probability and distance from the GSUS threshold, with a discontinuity clearly visible at the threshold itself. Meeting the GSUS thresholds decreases the probability of retaking the SAT once, twice, or even three or more times. As a result, those on the threshold retake the SAT 0.055 fewer times than those just below the threshold. We observe no discontinuities in the probability of sending SAT scores to a GSUS institution or in the total number of score sends, perhaps because those induced to retake the SAT by missing the threshold are precisely the students who had already sent their first SAT scores to GSUS institutions. We observe threshold-induced SAT retaking for students of all income levels, with the estimated effect of 3.6 percentages points for low income students larger than but statistically indistinguishable from the 2.5 percentage point effect observed for high income students. Though this discontinuity is fairly similar across income groups, the overall probability of retaking is not. Of those just below the thresholds, 79 percent of high income

[9] We choose North Carolina as a placebo state because it both geographically proximate to Georgia and has students who overwhelmingly take the SAT, rather than the ACT, for college admissions. Other placebo states similarly show no discontinuity in retaking behavior at the GSUS thresholds.

students retake the exam, relative to 58 percent of middle income students and 53 percent of low income students.

This paper is, to our knowledge, the first to document exam retaking in response to publicly known admission thresholds. Prior research on SAT-taking behavior has shown that some students retake the SAT in order to achieve round-numbered scores like 1000 or 1100 (Pope and Simonsohn, 2011). Others retake the SAT to increase their maximum scores (Vigdor and Clotfelter, 2003), which are an important factor in an increasingly competitive admissions process (Bound et al., 2009). Theoretical models of admissions systems based on maximum SAT scores suggest that such systems have the potential to elicit accurate information about student ability, particularly when the alternatives to retaking are test preparation services (Leeds, 2012). These prior empirical and theoretical works explore retaking behavior when admissions processes are private, in that students know only that higher scores increase their odds of admission. Given that that the GSUS thresholds have no significance outside of Georgia, we interpret our results as clear evidence of demand for access to this particular set of universities. In other words, the only reason that students just below the threshold should retake the SAT at higher rates than those just above it is to gain admission to GSUS institutions.

Though we have shown that retaking behavior reacts endogenously to distance from the threshold, the magnitude of this endogeneity is not particularly large. Only three percent of students' scores are affected by this endogenous retaking. Calculated differently, because nearly 60 percent of students just below the eligibility threshold retake the SAT. only one twentieth of those retakes are endogenous reactions to the threshold. Simply put, the vast majority of SAT retaking has nothing to do with the thresholds itself. We therefore present estimates in the Georgia sample using both first SAT scores and maximum SAT scores as the running variable, given that the latter differ from the former largely for reasons having nothing to do with the thresholds themselves. We provide two further pieces of evidence in favor of taking seriously the results from using the maximum SAT score as the running variable in the Georgia context. First, we will show that students on either side of the threshold as defined by maximum SAT scores look quite similar in terms of observable characteristics. Second, we show that controlling for such observables, including the number of retakes, has little impact on our estimated coefficients.

4.3 McCrary and Covariate Balancing Tests

Before turning to our main results concerning college enrollment and completion, we first perform two checks of the validity of our regression discontinuity design. The key assumption underlying the identification strategy is that students on either side of the threshold be quite similar in terms of observable and unobservable characteristics, so that eligibility for admission is the only factor that differs between them. We confirm this as best as the data allow in Table 3, where panels A and B examine the Georgia sample, respectively using the first and maximum SAT scores as the running variable, and panels C and D examine the low and high hidden threshold colleges, using maximum SAT score as the running variable. Here we use across all specifications within a panel the IK-estimated optimal bandwidth for on-time four-year college enrollment.

The first column of Table 3 performs a version of the test suggested by McCrary (2008), in which we collapse the data into observation counts by discrete value of the running variable, then check for discontinuities in that density. In none of the samples do we observe any practically or statistically significant discontinuity in the number of observations. There is thus little evidence of students managing to redistribute themselves across the threshold in any way. This is unsurprising for panel A, where students have no scope to manipulate their first SAT score, and for panels C and D, where the hidden nature of the thresholds also prevents such deliberate manipulation through retaking. That panel B also shows no discontinuity in the density confirms our previous claim that the extent of retaking in response to the threshold is sufficiently low as to have little impact on the distribution of students around the threshold. We see no evidence of substantial numbers of students deliberately moving themselves from one side of the threshold to the other, both because relatively few students endogenously retake the SAT and because those that do have limited ability to control where their subsequent scores fall in relation to the threshold.

The remaining columns in Table 3 test for discontinuities in observable covariates such as gender, race, parental education and high school-level income. Panel A shows no discontinuities in gender, race or high school income, and only a small imbalance in the parental education levels of those just above and below the threshold. Panels C and D show no evidence of covariate imbalance, with even first SAT scores and the number of SAT attempts similar across students just above and below the relevant thresholds. That all three of these panels show little or no covariate imbalance is expected, given no scope for manipulation of first SAT scores in panel A and no knowledge of the relevant thresholds in panels C and D.

More interesting is that panel B shows no statistically significant discontinuities in race, parental education or high school income when the maximum SAT score is used as the running variable in Georgia. This suggests that the small amount of retaking does not cause systematic differences in these characteristics across the threshold. That students' first SAT scores are also balanced across the threshold implies that this empirical design compares students of similar academic skill as measured by their first exam result. Gender is the only covariate that shows clear imbalance in this specification, with those just above the threshold two percentage points more likely to be female than those just below. Overall, we see little evidence that use of the maximum SAT score as the running variable in the Georgia context generates substantial bias. As a further check on this, we later show that our results on college enrollment and completion are quite robust to inclusion of all of these observables in the regression specification.

5. College Enrollment and Completion

5.1 College Enrollment

We now turn to the question of how these admissions thresholds affected students' college enrollment decisions. The first seven columns of Table 4 estimate the discontinuities in various college enrollment measures at the relevant thresholds. Columns 1-4 use as outcomes indicators for enrolling within one year of high school graduation at a GSUS (in panels A and B) or hidden threshold college (in panels C and D); at any four-year college; at any two-year college; and at any four- or two-year college. The outcome in column 5 indicates whether the student has ever enrolled in a four-year college in the data available to us, which runs through the summer of 2012.

In panel A, which uses Georgia students' first SAT scores to define distance to the threshold, meeting the admissions thresholds increases the proportion of students who enroll on time in a GSUS college by a statistically significant 1.6 percentage points. The proportion who enroll in any four-year college increases by a nearly identical 1.4 percentage points while enrollment in two-year colleges drops by 0.9 percentage points. This suggests that most of the students who enroll in GSUS colleges only because they have met the admissions thresholds would otherwise have enrolled in two-year colleges. Few would have found other four-year colleges to attend. These estimates are robust to a variety of alternative specifications, as seen in Table A.2, panel A.

Because GSUS colleges use maximum SAT scores as the relevant admissions criteria, panel A's estimates are downward-biased by extensive measurement error induced by the fact that nearly 60 percent of students retake the SAT near the threshold. Panel B removes this measurement error by employing maximum SAT scores as the running variable. This comes at a cost of introducing bias due to the endogeneity of the retake decision but, as we have previously shown, endogenous retaking accounts for only 5 percent or so of the retaking near the threshold. We therefore believe that the coefficients in panel B are much closer to causal estimates than are those in panel A.

The story in panel B is thus quite similar to that in panel A but with much larger point estimates. Meeting the thresholds increases the probability of enrolling in a GSUS college by a large and highly statistically significant 6.8 percentage points. The graphical version of this can be seen in Figure 2, panel A, which plots the probability of enrollment in a GSUS college as a function of distance from the threshold and shows a clear discontinuity at that threshold. Figure 2, panel B, which plots the probability of enrollment in the four- and two-year college sectors, also shows clear discontinuities. Four-year college enrollment rates rise by 4.8 percentage points, implying that over two-thirds of the students who enroll in GSUS colleges because of meeting these thresholds would not otherwise have enrolled in any four-year college. Meeting the thresholds reduces two-year college enrollment rates by 3.2 percentage points, so that overall college enrollment is 1.6 percentage points higher for such students. These effects persist beyond the first after high school graduation. The proportion of students who ever enroll in a four-year college is 2.3 percentage points higher among those eligible for access to GSUS colleges, suggesting that only half of those diverted in the short-run from the four-year sector eventually enroll in that sector.[10]

Meeting these thresholds alters not only the sector of college that students attend but also the quality of the four-year colleges attended. Conditional on enrolling on-time in a four-year college, those who meet the GSUS thresholds attend institutions where the average student's SAT score is 10.5 points higher and the six-year graduation rate is 1.1 percentage points higher, relative to students who fail to meet those thresholds.[11] All of these estimates are robust to a variety of alternative specifications, as seen in Table A.3, panel A. Two particular checks are worth noting. First, controlling for observable covariates, including gender and first SAT scores, has relatively little impact on the estimates, increasing them slightly in some cases. This is further evidence that the endogeneity introduced by the use of maximum SAT scores is likely quite small. Second, a placebo test replicating these regressions on students in North Carolina generates estimates extremely close to zero, suggesting the impact of these thresholds is quite specific to Georgia.

In summary, qualifying for access to GSUS colleges on the basis of SAT scores affects three different types of marginal students, those who enroll in GSUS as a result of the thresholds. First, roughly half of those marginal students enroll in GSUS instead of in the two-year sector. Second, roughly a quarter of those marginal students enroll in GSUS instead of no college at all.

[10] Though it is not possible to completely purge estimates derived from maximum SAT scores of all bias, it is possible to put an upper-bound on exactly how much bias is introduced from this choice of forcing variable. In Table 3, we show that about 3.2 percent of students who just miss the GSUS thresholds on the first SAT are endogenous responders to the thresholds. About three-quarters of students just below the GSUS thresholds who retake the SAT cross over the threshold, and of these, about half first attend a GSUS institution on time. Using these two numbers, we estimate a bias from endogenous responders of only about 1.2 percentage points.

[11] Given that the standard deviation of SAT scores is roughly 100 points, this represents a roughly 0.1 standard deviation increase in average peer quality.

Third, for those who would have enrolled in the four-year college sector anyway, access to GSUS substantially improves the quality of the institution they attend, at least as measured by peer skill and graduation rates.

Panel C shows similar results for applicants to low hidden threshold colleges. Meeting the relevant admissions thresholds increases the proportion enrolling in their target college by a large and highly statistically significant 9.1 percentage points. The graphical version of this can be seen in Figure 3, panel A, which plots the probability of enrollment in a low hidden threshold college as a function of distance from the threshold and shows a clear discontinuity at that threshold. Figure 3, panel B, which plots the probability of enrollment in the four- and two-year college sectors, also shows clear discontinuities. The proportion enrolling in any four-year college increases by 4.3 percentage points, implying that roughly half of the marginal students here would not have attended a four-year college on time if they had failed to qualify for admission. Two-year college enrollment rates decrease by a nearly identical 3.6 percentage points, implying that nearly all of those who would not have attended a four-year college would have instead attended a two-year college. As a result, meeting the thresholds has no effect on overall enrollment rates. As in Georgia, meeting the thresholds increases the proportion who ever enroll in a four-year college by 2.3 percentage points, implying that roughly half of those diverted from that sector by these thresholds never ultimately enroll.

For those enrolling in the four-year sector, access to their target colleges improves by 8.2 points the average SAT scores of the peers to whom they are exposed, though there is little discernible impact on the graduation rate of the institution they enroll in. All of these estimates are robust to a variety of alternative specifications, as seen in Table A.4, panel A. In summary, qualifying for access to low hidden threshold colleges shifts a substantial fraction of students from two-year to four-year colleges, as well as shifting some from four-year colleges with lower quality peers.

Panel D shows a different story for applicants to high hidden threshold colleges. As with Georgia students and applicants to low hidden threshold colleges, meeting the relevant thresholds increases by a large and highly statistically significant 7.1 percentage points the proportion of students attending their target college. Unlike in the previous two contexts, this has little impact on the college sector such students attend. The estimates in columns 2 and 3 suggest that only about 1.0 percent of students switch from the two-year into the four-year sector as a result of such eligibility. This is roughly one-fourth the proportion in the other two contexts. There is no discernible impact on overall on-time enrollment rates or on the proportion of students who ever enroll in a four-year college. Access to high hidden threshold colleges does, however, substantially improve the quality of the four-year college students attend, increasing peer quality by 16.3 SAT points and six-year graduation rates by 1.5 percentage points, both highly statistically significant. In brief, meeting the thresholds for high hidden threshold colleges has nearly no effect on the sector of college that students attend but does induce students to attend higher quality four-year colleges than they otherwise would have.

5.2 College Completion

Having shown that these admissions thresholds generate large and clear impacts on students' initial college choices, we turn now toward estimating the impacts of those thresholds on college completion. The final three columns of Table 4 use as outcomes indicators for earning a four-year college degree within four years, earning a four-year degree within six years, and earning either a four- or a two-year degree within six years of high school graduation. That first outcome is observed for the 2004-08 cohorts, while the last two are observed only for the 2004-06 cohorts.

The estimates in panel A suggest that students whose first SAT scores meet the GSUS threshold are 0.8 percentage points more likely to earn their BAs within four years. This represents roughly half of the marginal students induced into the four-year sector by these thresholds. That graduation effect disappears, however, over a six year timeframe.

The estimates in panel B suggest that students whose maximum SAT scores meet the GSUS thresholds are no more likely to earn their BAs within four years. They are, however, 1.8 percentage points more likely earn their BAs within six years, an effect that is statistically significant. This estimate is one-fourth the magnitude of the 6.8% of students induced to attend a GSUS institution, or one-third the magnitude of the 4.8% of students induced to attend any four-year college. Most of this additional BA completion does not come at the expense of earning an AA, as overall degree completion rates rise by a similar and marginally significant 1.3 percentage points.

In panel C, applicants to low hidden threshold colleges who meet the threshold have a 1.2 percentage point higher rate of BA completion, an effect that is statistically insignificant. This estimate is one-eighth the magnitude of the 9.1% of students induced to attend a target college, or one-fourth the magnitude of the 4.3% of students induced to attend any four-year college. In panel D, applicants to high hidden threshold colleges appear to suffer no BA completion benefit as a result of meeting the relevant threshold, with a point estimate indistinguishable from zero.

Table 5 estimates these enrollment and completion effects by income level. In the first three columns of panel A, there appears to be little heterogeneity by income in these on-time enrollment effects. At the extensive margin, access to GSUS institutions increases four-year college enrollment rates, at the expense of two-year college enrollment, for all income levels. There is, however, evidence, of heterogeneity on the intensive margin, with lower income students attending higher quality four-year colleges than they would otherwise have if not for access to GSUS. This may explain why low income students see a statistically significant 1.2 percentage point increase in the four-year BA completion rate while the other income groups see no significant increase. Six-year BA completion rates are positive and statistically indistinguishable across income groups, though the magnitude of the effect is, if anything, larger for higher income students.

For applicants to low hidden threshold colleges, shown in panel B, there is even clearer heterogeneity by income. First, effects on the extensive margin of four- and two-year college enrollment are larger in magnitude for higher income students. Second, intensive margin effects are larger for lower income students, for whom access to their target college improves the quality of the four-year institution they attend. Third, and most importantly, meeting the relevant threshold substantially increases the four- and six-year BA completion rates for low income students, whereas we observe no such effect for middle and high income students.

5.3 Discussion

With Georgia residents and with applicants to low hidden threshold colleges, we document substantial enrollment and completion effects generated by the use of SAT score thresholds in the relevant admissions processes. We note a few important implications. First, the fact that small differences in test scores can generate such large differences in initial college choice is itself remarkable. This suggests that students are not applying to a continuum of colleges, or that in some postsecondary markets such a continuum does not exist.

Second, the observed BA completion effects suggest that initial college choice matters. We have previously noted three margins affected by these thresholds. Failing to meet these thresholds pushes some students toward lower quality four-year colleges, toward two-year colleges or, to a lesser extent, toward no college at all. Though we cannot isolate which of these margins is driving the BA completion results, the overall implication is that enrolling in a less selective institution appears to have meaningful long-run consequences.

We also cannot rule out a fourth margin, namely the importance of unobserved college match quality. If missing these thresholds pushes students away from their target college and to another college of similar observed quality, there may still be long-run consequences. If, for example, the target college was closer to home, or less expensive, than the alternative, this may decrease completion rates.

In the Georgia context, we see graduation effects across the income distribution. For applicants to low hidden threshold colleges, only the lowest income students see substantial graduation effects. This may be because middle and high income students diverted into less selective institutions nonetheless have the academic and financial resources to succeed in those institutions. That low income students' long-run outcomes are most sensitive to initial college choice seems unsurprising.

Finally, that applicants to high hidden threshold colleges see little change in their choice of college sector and their completion rates is likely due to the fact that such high-achieving students are sophisticated college applicants. They apply to a larger number of schools, so that failing to gain admission to any single school does not alter their probability of attending a four-year college. As such, their enrollment rates are unaffected.

6. Conclusion

In two settings where test score thresholds play an important role in the college admissions process, we find clear evidence of students whose college trajectories are strongly affected by seemingly small test score differences. We thus identify a new aspect of the college admissions process that generates undermatch and demonstrate that, for some students, such undermatch reduces ultimate BA completion rates.

We believe our results have three implications for education policy. First our findings are consistent with the two-year penalty literature (Long and Kurlaender, 2009; Smith, 2013) in that starting at a two-year college may reduce their probability of earning a BA degree. We cannot, however, entirely rule out that college quality within the four-year sector also contributes to the reduced BA degree attainment rates.

Second, students should make test-taking and application choices that prevent test score thresholds, some of which they may not even be aware of, from severely restricting their available postsecondary options. In settings where such thresholds are publicly known, this implies that students falling below but close to those thresholds should be encouraged to retake the relevant exam, either through information campaigns or reductions in the costs of retaking. More generally though, students should be encouraged to expand their college application portfolios in order to secure admission to well-matched colleges.

Finally, further research is needed to determine which aspects of college quality are responsible for these graduation effects. Our work highlights the importance of initial college choice. The precise mechanism through which this operates warrants more work.

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Tables and Figures

Table 1: Summary Statistics

	(1)	(2)	(3)	(4)	(5)	(6)
	SAT Takers Residing in Georgia		Low Hidden Threshold College Applicants		High Hidden Threshold College Applicants	
	Mean	N	Mean	N	Mean	N
(A) Demographics						
Male	0.426	92,245	0.41	35,848	0.53	65,534
Female	0.573	92,245	0.59	35,848	0.47	65,533
Missing gender	0.001	92,245	0.00	35,848	0.00	65,534
White	0.485	92,245	0.60	35,848	0.67	65,534
Black	0.337	92,245	0.20	35,848	0.08	65,534
Hispanic	0.038	92,245	0.04	35,848	0.04	65,534
Asian	0.038	92,245	0.07	35,848	0.09	65,534
Missing race/ethnicity	0.071	92,245	0.10	35,848	0.12	65,534
Parental education - HS dropout	0.193	92,245	0.15	35,848	0.05	65,534
Parental education - HS graduate	0.325	92,245	0.27	35,848	0.14	65,534
Parental education - BA or higher	0.376	92,245	0.47	35,848	0.67	65,534
Missing parental education	0.106	92,245	0.10	35,848	0.14	65,534
Low income high school (< $50,000)	0.179	92,245	0.12	35,848	0.04	65,534
Middle income high school ($50,000-$100,000)	0.726	92,245	0.69	35,848	0.55	65,534
High income high school (> $100,000)	0.095	92,245	0.20	35,848	0.40	65,534
(B) Test scores						
Maximum SAT score (M+CR)	903	92,245	956.54	35,848	1208.51	65,534
Maximum SAT exceeds relevant threshold	0.629	92,245	0.60	35,848	0.56	65,534
Number of SAT takes	1.773	92,245	2.15	35,848	2.34	65,534
Number of score sends	3.581	92,245	6.03	35,848	7.59	65,534
(C) College outcomes						
Enrolled on time, GSUS or target college	0.328	92,245	0.12	35,848	0.13	65,534
Enrolled on time, four-year college	0.504	92,245	0.65	35,848	0.88	65,534
Enrolled on time, two-year college	0.288	92,245	0.25	35,848	0.05	65,534
Avg. SAT of first four-year college	1,014	43,838	1,066	22,495	1,195	57,091
Six-year grad. rate of first four-year college	0.413	46,414	0.53	23,149	0.73	57,959
Completed BA within four years	0.081	92,245	0.21	35,848	0.52	65,534
Completed BA within six years	0.286	53,290	0.47	20,381	0.77	37,889
Completed AA within four years	0.059	92,245	0.04	35,848	0.01	65,534
Completed AA within six years	0.091	53,290	0.06	20,381	0.01	37,889

Note: The sample consists of SAT takers from the 2004-08 graduating high school cohorts whose maximum SAT scores place them within the IK-estimated optimal bandwidth for on-time four-year college enrollment. This bandwidth is 43.6 points from either the math or critical reading thresholds for Georgia residents, and 145.2 and 126.0 composite (math + critical reading) points for applicants to the low and high hidden threshold colleges. Columns 1 and 2 include students who resided in Georgia at the time of taking the SAT. Columns 3 and 4 include students who sent SAT scores to one of the low hidden threshold colleges. Columns 5 and 6 include students who sent SAT scores to one of the high hidden threshold colleges. Self-reported income is aggregated at the high school level and applied to all students from that high school. On-time enrollment is defined as enrollment within one year of high school graduation. Average SAT and college-level completion data are obtained from IPEDS 2011 and are calculated only among on-time four-year college enrollees.

Table 2: SAT Retaking and Score Sending Behavior in Georgia

	(1) Retook SAT	(2) Retook once	(3) Retook twice	(4) Retook 3+ times	(5) Number of takes	(6) Sent score to GSUS	(7) Score sends
(A) All students							
Above threshold	-0.032***	-0.008**	-0.015***	-0.005***	-0.055***	0.001	-0.044
	(0.005)	(0.004)	(0.003)	(0.002)	(0.009)	(0.005)	(0.032)
Mean below threshold	0.594	0.379	0.164	0.051	1.872	0.674	3.676
Bandwidth	103.8	157.2	113.6	148.7	119.8	80.1	94.2
N	205,943	255,676	218,593	247,980	218,593	176,238	191,497
(B) Low income							
Above threshold	-0.036***	-0.016*	-0.016***	-0.004	-0.060***	0.004	-0.117*
	(0.011)	(0.009)	(0.005)	(0.004)	(0.016)	(0.007)	(0.061)
Mean below threshold	0.527	0.365	0.128	0.035	1.732	0.733	4.300
Bandwidth	167.9	205.4	188.7	188.3	176.6	199.9	175.2
N	37,812	39,932	38,932	38,932	38,397	39,311	38,397
(C) Middle income							
Above threshold	-0.034***	-0.012***	-0.015***	-0.006***	-0.058***	-0.004	-0.055*
	(0.006)	(0.004)	(0.004)	(0.002)	(0.011)	(0.006)	(0.031)
Mean below threshold	0.579	0.379	0.153	0.046	1.837	0.661	3.472
Bandwidth	90.1	156.7	116.1	181.5	124.7	77.8	125.7
N	137,111	180,072	155,642	191,263	162,965	115,155	162,965
(D) High income							
Above threshold	-0.025**	0.017*	-0.033***	-0.010	-0.082***	-0.007	0.013
	(0.012)	(0.009)	(0.011)	(0.008)	(0.027)	(0.018)	(0.097)
Mean below threshold	0.792	0.399	0.286	0.107	2.315	0.672	4.071
Bandwidth	160.7	244.3	141.6	145.9	162.5	91.1	131.7
N	40,067	48,819	36,699	36,699	40,067	25,462	34,649

Note: Heteroskedasticity robust standard errors clustered by high school are in parentheses (* p<.10 ** p<.05 *** p<.01). All estimates come from a local linear regression of the listed outcome on an indicator for being above the relevant threshold, using a triangular kernel and IK-estimated optimal bandwidth. Distance to the threshold is defined here by each student's first SAT score. The sample consists of the 2004-08 graduating high school cohorts residing in Georgia the time of taking the SAT. Each regression includes cohort fixed effects. Also listed is the mean value of the outcome for students with SAT scores 10 points below the threshold.

Table 3: McCrary and Covariate Balance Tests

	(1) Number of obs.	(2) Male	(3) Black	(4) Hispanic	(5) Asian	(6) Parent HS dropout	(7) Parent HS graduate	(8) Parent BA or more	(9) Low income	(10) Middle income	(11) High income	(12) First SAT	(13) SAT attempts
(A) Georgia - First SAT (BW=48.4)													
Above threshold	-17.5	-0.010	0.005	0.001	-0.001	0.011**	0.003	-0.014*	0.002	-0.003	0.001		
	(185.3)	(0.007)	(0.007)	(0.003)	(0.003)	(0.006)	(0.007)	(0.007)	(0.006)	(0.007)	(0.005)		
Mean below threshold	2,228	0.424	0.314	0.039	0.039	0.177	0.313	0.402	0.167	0.722	0.110		
N	45	102,441	102,441	102,441	102,441	102,441	102,441	102,441	102,441	102,441	102,441		
(B) Georgia - Maximum SAT (BW=43.8)													
Above threshold	75.0	-0.021***	-0.007	0.005	-0.005	0.005	0.005	-0.002	-0.011*	0.007	0.005	1.045	
	(206.3)	(0.008)	(0.008)	(0.003)	(0.004)	(0.007)	(0.008)	(0.008)	(0.006)	(0.007)	(0.004)	(1.107)	
Mean below threshold	1,915	0.431	0.382	0.038	0.040	0.206	0.332	0.353	0.203	0.720	0.076	842	
N	45	92,245	92,245	92,245	92,245	92,245	92,245	92,245	92,245	92,245	92,245	92,245	
(C) Low threshold colleges (BW=145.2)													
Above threshold	13.2	0.007	0.007	0.002	0.004	-0.012	0.007	0.009	-0.003	-0.002	0.005	-1.466	0.008
	(10.6)	(0.010)	(0.008)	(0.004)	(0.005)	(0.008)	(0.008)	(0.010)	(0.006)	(0.009)	(0.007)	(1.189)	(0.019)
Mean below threshold	489	0.404	0.223	0.036	0.071	0.165	0.282	0.441	0.146	0.701	0.152	901	2.096
N	145	49,737	49,737	49,737	49,737	49,737	49,737	49,737	49,737	49,737	49,737	49,737	49,737
(D) High threshold colleges (BW=126.0)													
Above threshold	15.2	-0.008	-0.003	0.002	0.001	0.003	0.007	-0.008	0.004	0.010	-0.014	0.589	-0.007
	(17.4)	(0.008)	(0.005)	(0.004)	(0.006)	(0.004)	(0.007)	(0.008)	(0.005)	(0.009)	(0.009)	(1.026)	(0.016)
Mean below threshold	1,190	0.496	0.074	0.041	0.084	0.062	0.162	0.641	0.047	0.621	0.332	1,140	2.300
N	125	59,370	59,370	59,370	59,370	59,370	59,370	59,370	59,370	59,370	59,370	59,370	59,370

Note: Heteroskedasticity robust standard errors clustered by high school are in parentheses (* p<.10 ** p<.05 *** p<.01). All estimates come from a local linear regression of the listed outcome on an indicator for being above the relevant threshold, using a triangular kernel of IK-estimated optimal bandwidth for on-time four-year college enrollment. Distance to the threshold is defined using first SAT scores in panel A and maximum SAT scores in the remaining panels. The sample consists of the 2004-08 graduating high school cohorts. Panels A and B include students who resided in Georgia at the time of taking the SAT. Panels C and D include students who sent SAT scores to one of the low or high hidden threshold colleges. Each regression includes cohort fixed effects, as well as target college fixed effects in panels C and D. Also listed is the mean value of the outcome for students with SAT scores 10 points below the threshold.

Table 4: Initial College Enrollment and Degree Completion

	(1) Enrolled on time, GSUS/target college	(2) Enrolled on time, 4-year college	(3) Enrolled on time, 2-year college	(4) Enrolled on time, any college	(5) Ever enrolled, 4-year college	(6) Average SAT, 4-year college	(7) 6-year grad. rate, 4-year college	(8) Earned BA within 4 years	(9) Earned BA within 6 years	(10) Earned BA or AA within 6 years
(A) Georgia - First SAT scores										
Above threshold	0.016**	0.014**	-0.009	0.002	0.003	-0.444	0.003	0.008***	-0.001	-0.004
	(0.007)	(0.007)	(0.006)	(0.004)	(0.006)	(1.906)	(0.002)	(0.003)	(0.007)	(0.007)
Mean below threshold	0.347	0.527	0.273	0.800	0.701	1026	0.427	0.091	0.317	0.410
Bandwidth	41.7	48.4	45.2	107.7	55.3	59.6	90.5	112.7	66.7	76.2
N	102,441	102,441	102,441	205,943	123,083	66,904	109,989	112.7	83,632	93,549
(B) Georgia - Maximum SAT scores										
Above threshold	0.068***	0.048***	-0.032***	0.016***	0.023***	10.490***	0.011***	-0.001	0.018**	0.013*
	(0.008)	(0.008)	(0.007)	(0.005)	(0.007)	(2.436)	(0.002)	(0.002)	(0.008)	(0.007)
Mean below threshold	0.244	0.429	0.339	0.769	0.635	988	0.386	0.069	0.242	0.344
Bandwidth	36.0	43.6	43.3	82.7	48.7	62.4	93.2	118.0	61.1	68.2
N	73,193	92,245	92,245	161,047	92,245	63,000	93,199	202,414	75,245	75,245
(C) Low threshold colleges										
Above threshold	0.091***	0.043***	-0.036***	0.005	0.023***	8.209***	-0.005	0.009	0.012	0.009
	(0.008)	(0.009)	(0.009)	(0.005)	(0.006)	(2.036)	(0.003)	(0.007)	(0.011)	(0.010)
Mean below threshold	0.062	0.580	0.291	0.871	0.765	1054.530	0.501	0.170	0.414	0.480
Bandwidth	94.6	145.2	123.6	196.7	279.0	173.7	195.1	195.4	181.0	229.0
N	34,133	49,737	43,752	63,016	79,448	36,054	40,276	63,016	35,420	40,855
(D) High threshold colleges										
Above threshold	0.071***	0.010*	-0.007*	0.004	0.005	16.255***	0.015***	0.002	0.000	0.001
	(0.007)	(0.006)	(0.004)	(0.004)	(0.005)	(1.785)	(0.003)	(0.007)	(0.009)	(0.008)
Mean below threshold	0.137	0.853	0.079	0.933	0.936	1172	0.688	0.475	0.717	0.736
Bandwidth	81.9	129.9	159.1	142.6	103	139.9	145.9	183.7	185.7	179.4
N	42,179	59,367	70,692	67,107	51,076	53,890	58,006	80,505	47,470	45,587

Note: Heteroskedasticity robust standard errors clustered by high school are in parentheses (* p<.10 ** p<.05 *** p<.01). All estimates come from a local linear regression of the listed outcome on an indicator for being above the relevant threshold, using a triangular kernel with an IK-estimated optimal bandwidth. Distance to the threshold is defined using first SAT scores in panel A and maximum SAT scores in the remaining panels. The sample consists of the 2004-08 graduating high school cohorts in columns 1-8 and the 2004-06 cohorts in columbs 9 and 10. Panels A and B include students who resided in Georgia at the time of taking the SAT. Panels C and D include students who sent SAT scores to one of the low or high hidden threshold colleges. Each regression includes cohort fixed effects, as well as target college fixed effects in panels C and D. Also listed is the mean value of the outcome for students with SAT scores 10 points below the threshold. In columns 1-4, the outcomes are defined as first-time enrollment within one year of high school graduation. Column 5 considers enrollment through the summer of 2012. Institution-level SAT scores and graduation rates in columns 6 and 7 are obtained from IPEDS 2011 and are calculated only among on-time four-year college enrollees. Columns 8-10 indicate whether the student has earned his BA (or AA) within four or six years of high school graduation.

Table 5: Heterogeneity by Income

	(1) Enrolled on time, GSUS/target college	(2) Enrolled on time, 4-year college	(3) Enrolled on time, 2-year college	(4) Avg. SAT 4-year college	(5) Six-year grad. rate, 4-year college	(6) Earned BA within 4 years	(7) Earned BA within 6 years
(A) Georgia - Maximum SAT							
Low income	0.091***	0.051***	-0.028*	18.232***	0.017***	0.012**	0.014
	(0.016)	(0.016)	(0.015)	(3.657)	(0.004)	(0.005)	(0.016)
Mean below threshold	0.327	0.508	0.248	957.4	0.364	0.066	0.247
Bandwidth	53.5	60.3	59.5	87.5	106.2	145.9	78.9
N	19,791	22,782	19,791	13,590	16,424	36,448	15,118
Middle income	0.069***	0.048***	-0.033***	9.594***	0.009***	-0.002	0.018**
	(0.009)	(0.008)	(0.008)	(2.872)	(0.003)	(0.003)	(0.009)
Mean below threshold	0.225	0.404	0.365	992.1	0.381	0.066	0.233
Bandwidth	38.8	45.0	45.4	72.9	103.1	110.5	65.5
N	53,116	66,985	66,985	49,581	70,667	145,100	54,459
High income	0.091***	0.064***	-0.068***	2.288	-0.010	-0.013	0.046*
	(0.016)	(0.019)	(0.022)	(4.047)	(0.008)	(0.009)	(0.025)
Mean below threshold	0.207	0.457	0.345	1045.8	0.486	0.098	0.309
Bandwidth	83.4	76.4	73.5	101.3	88.0	123.2	95.8
N	17,258	15,143	15,143	14,794	11,177	26,295	10,724
(B) Low threshold colleges							
Low income	0.068***	0.037**	-0.016	12.049**	0.005	0.033***	0.046**
	(0.015)	(0.017)	(0.017)	(6.076)	(0.009)	(0.012)	(0.020)
Mean below threshold	0.053	0.538	0.237	1,003.368	0.440	0.111	0.240
Bandwidth	162.4	350.6	250.8	227.7	250.3	377.8	355.6
N	6,960	10,232	9,126	4,594	5,157	10,356	5,994
Middle income	0.091***	0.033***	-0.032***	7.694***	-0.006	0.003	0.004
	(0.009)	(0.011)	(0.011)	(2.217)	(0.004)	(0.008)	(0.012)
Mean below threshold	0.065	0.575	0.306	1,055.838	0.499	0.165	0.429
Bandwidth	115.3	149.6	139.1	212.2	211.1	184.8	215.0
N	28,433	34,657	32,625	28,876	29,519	41,936	27,842
High income	0.160***	0.066***	-0.062***	4.914	-0.013*	0.006	-0.014
	(0.015)	(0.022)	(0.020)	(3.538)	(0.007)	(0.016)	(0.029)
Mean below threshold	0.055	0.641	0.275	1,088.950	0.558	0.249	0.547
Bandwidth	230.2	170.8	157.6	350.6	254.6	189.0	260.6
N	13,776	10,531	9,371	13,884	10,903	11,068	8,179

Note: Heteroskedasticity robust standard errors clustered by high school are in parentheses (* p<.10 ** p<.05 *** p<.01). All estimates come from a local linear regression of the listed outcome on an indicator for being above the relevant threshold, using a triangular kernel with an IK-estimated optimal bandwidth. Distance to the threshold is defined using maximum SAT scores. The sample consists of the 2004-08 graduating high school cohorts in columns 1-6 and the 2004-06 cohorts in column 7. Panel A includes students who resided in Georgia at the time of taking the SAT. Panel B includes students who sent SAT scores to one of the low hidden threshold colleges. Each panel divides students by the income level of their high school, as described in the text. Each regression includes cohort fixed effects, as well as target college fixed effects in panels B. Also listed is the mean value of the outcome for students with SAT scores 10 points below the threshold.

Table A.1: Characteristics of USG and Hidden Threshold Colleges

	(1) Location	(2) FTE students	(3) Tuition and fees	(4) Median SAT score	(5) Percent admitted	(6) Instr. spending per FTE	(7) Six-year grad. rate	(8) SAT verbal threshold	(9) SAT math threshold	(10) SAT total threshold
(A) GSUS universities										
I. Research universities										
Georgia Institute of Technology	Georgia	15,789	4,076	1325	70	8,988	72	430	400	
Georgia State U.	Georgia	21,437	3,920	1090	56	5,161	41	430	400	900
U. of Georgia	Georgia	30,388	4,078	1205	75	6,057	72	430	400	
II. Regional universities										
Georgia Southern U.	Georgia	14,374	2,912	1050	54	4,130	38	430	400	960
Valdosta State U.	Georgia	8,854	2,860	1005	68	4,361	38	440	410	
III. State universities										
Albany State U.	Georgia	3,129	2,774	920	84	5,211	40	430	400	
Armstrong Atlantic State U.	Georgia	5,138	2,602	1020	84	4,370	18	460	430	
Augusta State U.	Georgia	4,884	2,592	970	66	3,761	19	430	400	
Clayton State U.	Georgia	4,208	2,670	995	71	3,525	14	430	400	
Columbus State U.	Georgia	5,541	2,676	980	62	4,048	27	440	410	
Fort Valley State U.	Georgia	2,283	2,782	930	44	6,106	30	430	400	
Georgia Coll. & State U.	Georgia	4,762	3,596	1120	44	5,205	37	430	400	
Georgia Southwestern State U.	Georgia	1,902	2,798	965	75	4,901	32	430	400	
Kennesaw State U.	Georgia	13,854	2,724	1065	61	3,789	31	490	460	
North Georgia Coll. & State U.	Georgia	3,836	2,808	1075	36	4,488	50	430	400	
Savannah State U.	Georgia	2,415	2,830	880	49	4,737	31	430	400	
Southern Polytechnic State U.	Georgia	2,857	2,754	1135	62	5,340	23	500	500	
U. of West Georgia	Georgia	8,399	2,774	1000	61	3,911	30	430	400	
IV. Other Georgia public colleges										
State colleges (primarily two-year)	Georgia	2,503	1,575	887	73	3,324		330	310	
Technical colleges (two-year)	Georgia	1,776	1,127			3,097		330	310	
(B) Low hidden threshold colleges										
College A	Mid-Atlantic	5,000	5,000	1000	70	5,000	50			754
College B	Southeast	6,000	5,000	1050	70	4,000	40			898
College C	Southeast	5,000	4,000	1200	40	5,000	40			980
College D	Mid-Atlantic	10,000	7,000	1200	70	8,000	60			1028
(C) High hidden threshold colleges										
College E	Southeast	16,000	4,000	1400	70	9,000	70			1192
College F	Mid-Atlantic	31,000	7,000	1250	50	10,000	70			1210
College G	Mid-Atlantic	5,000	5,000	1300	40	5,000	80			1216

Notes: Figures in columns 2-7 are taken from the 2004 Integrated Postsecondary Education Data System. Median SAT scores are computed as the sum of the mean of the 25th and 75th percentile math and verbal SAT scores. In panels B and C, columns 2, 3 and 6 are rounded to the nearest thousand, column 4 is rounded to the nearest 50, and columns 5 and 7 are rounded to the nearest ten. The SAT thresholds listed in columns 8 and 9 are taken from academic handbooks from 2004. The SAT thresholds listed in column 10 are the mean of the five college-specific thresholds identified for each year from 2004 through 2008.

Table A.2: Robustness Checks - Georgia Students, Using First SAT Scores

	(1) Retook SAT	(2) Enrolled on time, GSUS college	(3) Enrolled on time, 4-year college	(4) Enrolled on time, 2-year college	(5) Average SAT of first college	(6) 6-year grad. rate of first college	(7) Earned BA, within 4 years	(8) Earned BA, within 6 years
(A) All students								
IK optimal bandwidth	103.8	41.7	48.4	45.2	59.6	90.5	112.7	66.7
Bandwidth = IK	-0.032***	0.016**	0.014**	-0.009	-0.444	0.003	0.008***	-0.001
	(0.005)	(0.007)	(0.007)	(0.006)	(1.906)	(0.002)	(0.003)	(0.007)
Bandwidth = IK, controls	-0.032***	0.017**	0.017**	-0.010	0.758	0.005**	0.007**	0.002
	(0.005)	(0.007)	(0.007)	(0.006)	(1.635)	(0.002)	(0.003)	(0.007)
Bandwidth = 50	-0.032***	0.015**	0.014**	-0.009	-0.049	0.004	0.010**	0.002
	(0.007)	(0.007)	(0.007)	(0.006)	(2.057)	(0.003)	(0.004)	(0.009)
Bandwidth = 100	-0.032***	0.026***	0.021***	-0.019***	1.407	0.003*	0.008***	0.002
	(0.005)	(0.004)	(0.005)	(0.005)	(1.423)	(0.002)	(0.003)	(0.006)
Bandwidth = 150	-0.031***	0.043***	0.033***	-0.031***	2.514**	0.003	0.007***	0.009*
	(0.004)	(0.004)	(0.004)	(0.004)	(1.219)	(0.002)	(0.002)	(0.005)
Bandwidth = 100, North Carolina	0.001	-0.000	-0.000	0.003	0.260	0.001	0.002	-0.001
	(0.005)	(0.000)	(0.005)	(0.005)	(1.536)	(0.002)	(0.004)	(0.007)
(B) Low income students								
IK optimal bandwidth	167.9	65.1	82.2	68.3	68.4	86.9	193.6	97.9
Bandwidth = IK	-0.036***	0.045***	0.037***	-0.018	8.214*	0.009*	0.020***	0.013
	(0.011)	(0.011)	(0.012)	(0.012)	(4.239)	(0.005)	(0.005)	(0.014)
Bandwidth = IK, controls	-0.039***	0.047***	0.040***	-0.021*	8.504**	0.010**	0.018***	0.010
	(0.010)	(0.011)	(0.011)	(0.011)	(3.993)	(0.005)	(0.005)	(0.012)
Bandwidth = 50	-0.015	0.041***	0.037**	-0.017	10.164*	0.016**	0.021**	0.013
	(0.017)	(0.014)	(0.017)	(0.015)	(5.265)	(0.006)	(0.009)	(0.022)
Bandwidth = 100	-0.035***	0.052***	0.037***	-0.023**	7.200**	0.009*	0.020***	0.014
	(0.012)	(0.010)	(0.011)	(0.010)	(3.497)	(0.005)	(0.007)	(0.014)
Bandwidth = 150	-0.036***	0.066***	0.042***	-0.031***	9.447***	0.010**	0.020***	0.023**
	(0.011)	(0.008)	(0.009)	(0.008)	(2.932)	(0.004)	(0.006)	(0.011)
Bandwidth = 100, North Carolina	-0.003	-0.000	-0.021*	0.014	-4.412	-0.005	0.005	-0.011
	(0.013)	(0.000)	(0.012)	(0.010)	(3.659)	(0.004)	(0.009)	(0.016)

Note: Heteroskedasticity robust standard errors clustered by high school are in parentheses (* p<.10 ** p<.05 *** p<.01). All estimates come from a local linear regression of the listed outcome on an indicator for being above the GSUS admissions threshold, using a triangular kernel with the listed bandwidth. Distance to the threshold is defined as the minimum of the distance of each student's first math or critical reading score from the relevant admissions minimum. The sample consists of the 2004-08 graduating high school cohorts residing in Georgia, except for column 6, which includes only the 2004-06 cohorts. Each regression includes cohort fixed effects. Panel A includes all students and panel B includes only low income students. Columns 2-4 define enrollment as within one year of high school graduation. Average SAT and college-level completion data in columns 7 and 8 are obtained from IPEDS 2011 and are calculated only among on-time four-year college enrollees.

Table A.3: Robustness Checks - Georgia Students, Using Maximum SAT Scores

	(1) Enrolled on time, GSUS college	(2) Enrolled on time, 4-year college	(3) Enrolled on time, 2-year college	(4) Average SAT of first college	(5) 6-year grad. rate of first college	(6) Earned BA, within 4 years	(7) Earned BA, within 6 years
(A) All students							
IK optimal bandwidth	36.0	43.6	43.3	62.4	93.2	118.0	61.1
Bandwidth = IK	0.068***	0.048***	-0.032***	10.490***	0.011***	-0.001	0.018**
	(0.008)	(0.008)	(0.007)	(2.436)	(0.002)	(0.002)	(0.008)
Bandwidth = IK, controls	0.078***	0.059***	-0.038***	10.209***	0.011***	0.000	0.023***
	(0.008)	(0.007)	(0.007)	(2.245)	(0.002)	(0.002)	(0.008)
Bandwidth = 50	0.073***	0.048***	-0.033***	19.276***	0.020***	-0.008**	0.018*
	(0.007)	(0.007)	(0.007)	(3.475)	(0.004)	(0.004)	(0.009)
Bandwidth = 100	0.099***	0.068***	-0.051***	12.804***	0.010***	-0.001	0.020***
	(0.006)	(0.005)	(0.005)	(1.971)	(0.002)	(0.003)	(0.006)
Bandwidth = 150	0.126***	0.086***	-0.068***	15.094***	0.016***	-0.000	0.030***
	(0.006)	(0.005)	(0.005)	(5.263)	(0.006)	(0.002)	(0.005)
Bandwidth = 100, North Carolina	0.000	-0.005	0.011**	0.682	0.002	-0.001	-0.003
	(0.000)	(0.006)	(0.005)	(1.533)	(0.002)	(0.004)	(0.007)
(B) Low income students							
IK optimal bandwidth	53.5	60.3	59.5	87.5	106.2	145.9	78.9
Bandwidth = IK	0.091***	0.051***	-0.028*	18.232***	0.017***	0.012**	0.014
	(0.016)	(0.016)	(0.015)	(3.657)	(0.004)	(0.005)	(0.016)
Bandwidth = IK, controls	0.100***	0.064***	-0.033**	19.113***	0.019***	0.014***	0.019
	(0.015)	(0.015)	(0.014)	(3.660)	(0.004)	(0.005)	(0.015)
Bandwidth = 50	0.087***	0.048***	-0.028*	9.510***	0.011***	0.003	0.012
	(0.017)	(0.017)	(0.016)	(2.692)	(0.003)	(0.009)	(0.022)
Bandwidth = 100	0.119***	0.065***	-0.042***	18.570***	0.017***	0.009	0.018
	(0.013)	(0.013)	(0.011)	(3.458)	(0.004)	(0.006)	(0.014)
Bandwidth = 150	0.149***	0.084***	-0.060***	14.830***	0.008***	0.013**	0.031***
	(0.012)	(0.011)	(0.010)	(1.716)	(0.002)	(0.005)	(0.011)
Bandwidth = 100, North Carolina	-0.000	-0.034**	0.027**	1.039	0.001	-0.006	0.004
	(0.000)	(0.013)	(0.011)	(3.176)	(0.003)	(0.010)	(0.019)

Note: Heteroskedasticity robust standard errors clustered by high school are in parentheses (* p<.10 ** p<.05 *** p<.01). All estimates come from a local linear regression of the listed outcome on an indicator for being above the GSUS admissions threshold, using a triangular kernel with the listed bandwidth. Distance to the threshold is defined as the minimum of the distance of each student's maximum math or critical reading score from the relevant admissions minimum. The sample consists of the 2004-08 graduating high school cohorts residing in Georgia, except for column 6, which includes only the 2004-06 cohorts. Each regression includes cohort fixed effects. Panel A includes all students and panel B includes only low income students. Columns 2-4 define enrollment as within one year of high school graduation. Average SAT and college-level completion data in columns 7 and 8 are obtained from IPEDS 2011 and are calculated only among on-time four-year college enrollees.

Table A.4: Robustness Checks - Applicants to Colleges with Low, Hidden Thresholds

	(1) Retook SAT	(2) Enrolled in target college	(3) Enrolled in 4-year college	(4) Enrolled in 2-year college	(5) Average SAT of first college	(6) 6-year grad. rate of first college	(7) Earned BA, within 4 years	(8) Earned BA, within 6 years
(A) All students								
IK optimal bandwidth	247.9	94.6	145.2	123.6	173.7	195.1	195.4	181
Bandwidth = IK	0.002	0.091***	0.043***	-0.036***	8.209***	-0.005	0.009	0.012
	(0.007)	(0.008)	(0.009)	(0.009)	-2.036	(0.003)	(0.007)	(0.011)
Bandwidth = IK, controls	-0.001	0.090***	0.040***	-0.034***	7.819***	-0.005	0.008	0.008
	(0.007)	(0.008)	(0.009)	(0.009)	-1.961	(0.003)	(0.006)	(0.011)
Bandwidth = 100	0.017	0.091***	0.046***	-0.035***	7.921***	-0.002	0.009	0.011
	(0.011)	(0.008)	(0.011)	(0.010)	-2.701	(0.004)	(0.009)	(0.015)
Bandwidth = 200	0.005	0.107***	0.045***	-0.040***	8.218***	-0.005	0.009	0.013
	(0.008)	(0.006)	(0.008)	(0.008)	-1.904	(0.003)	(0.007)	(0.011)
Bandwidth = 300	0.001	0.126***	0.050***	-0.047***	6.572***	-0.007**	0.008	0.011
	(0.007)	(0.006)	(0.007)	(0.007)	-1.708	(0.003)	(0.006)	(0.009)
(B) Low income students								
IK optimal bandwidth	672.2	162.4	350.6	250.8	227.7	250.3	377.8	355.6
Bandwidth = IK	-0.012	0.068***	0.037**	-0.016	12.049**	0.005	0.033***	0.046**
	(0.013)	(0.015)	(0.017)	(0.017)	(6.076)	(0.009)	(0.012)	(0.020)
Bandwidth = IK, controls	-0.016	0.068***	0.034**	-0.013	10.644*	0.002	0.030***	0.044**
	(0.012)	(0.015)	(0.017)	(0.017)	(5.920)	(0.009)	(0.011)	(0.019)
Bandwidth = 100	0.046	0.068***	0.076**	-0.034	20.547**	0.020	0.039*	0.079**
	(0.029)	(0.018)	(0.030)	(0.025)	(9.759)	(0.014)	(0.021)	(0.037)
Bandwidth = 200	0.001	0.074***	0.052***	-0.020	12.718**	0.008	0.042***	0.061**
	(0.021)	(0.014)	(0.020)	(0.018)	(6.438)	(0.010)	(0.016)	(0.024)
Bandwidth = 300	-0.012	0.094***	0.042**	-0.014	10.876*	0.003	0.038***	0.048**
	(0.016)	(0.013)	(0.018)	(0.016)	(5.543)	(0.008)	(0.013)	(0.021)

Note: Heteroskedasticity robust standard errors clustered by high school are in parentheses (* p<.10 ** p<.05 *** p<.01). All estimates come from a local linear regression of the listed outcome on an indicator for being above the target college admissions threshold, using a triangular kernel with the listed bandwidth. Distance to the threshold is defined as the minimum of the distance of each student's first math or critical reading score from the relevant admissions minimum. The sample consists of the 2004-08 graduating high school cohorts, except for column 6, which includes only the 2004-06 cohorts. Each regression includes cohort fixed effects. Panel A includes all students and panel B includes only low income students. Columns 2-4 define enrollment as within one year of high school graduation. Average SAT and college-level completion data in columns 7 and 8 are obtained from IPEDS 2011 and are calculated only among on-time four-year college enrollees.

Figure 1

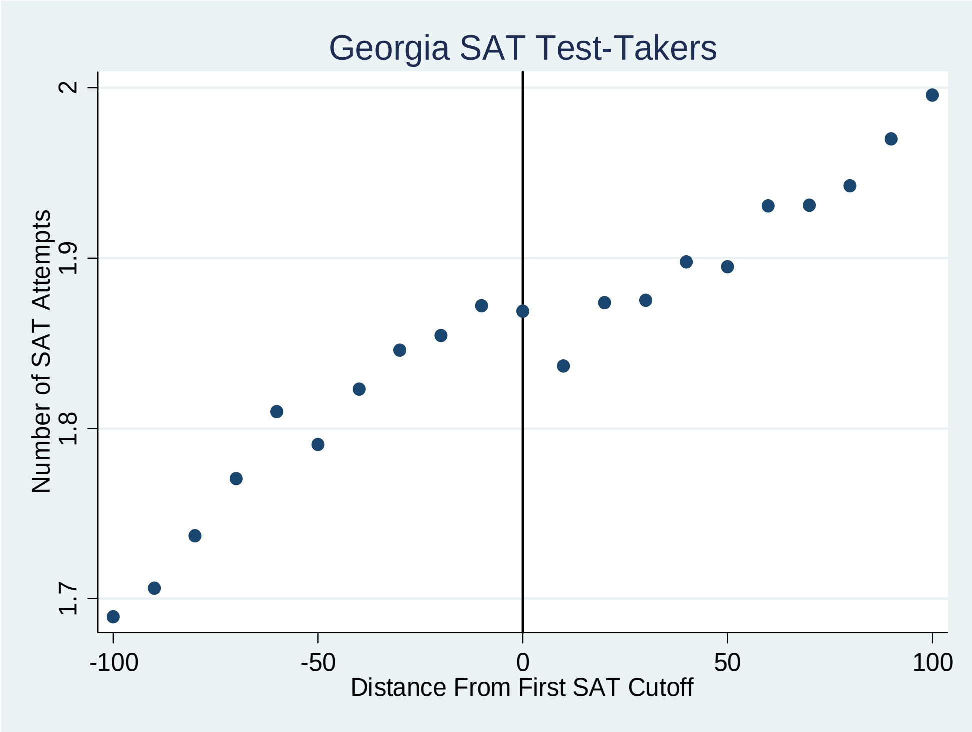
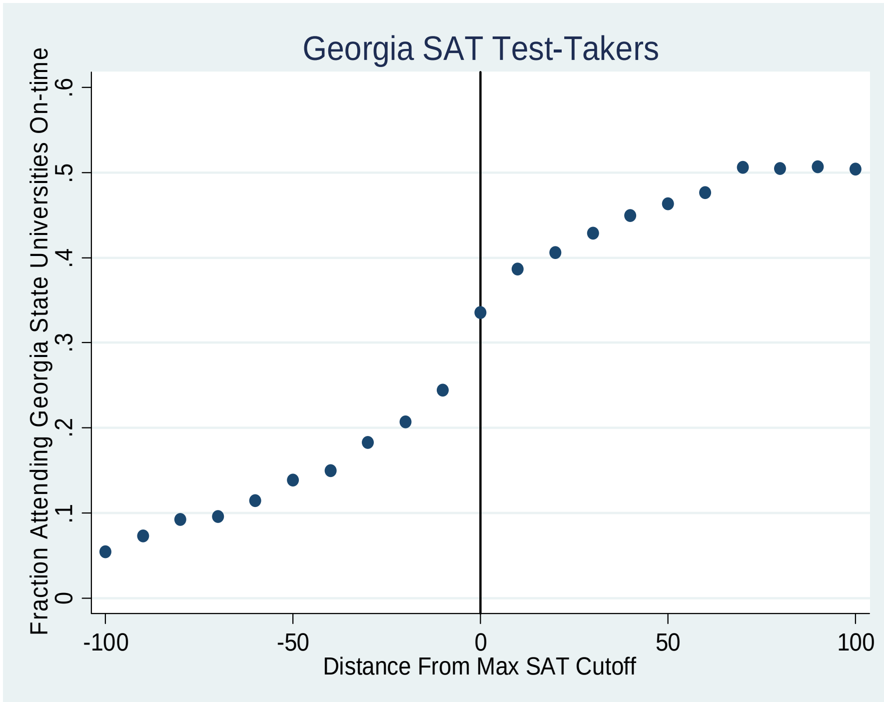
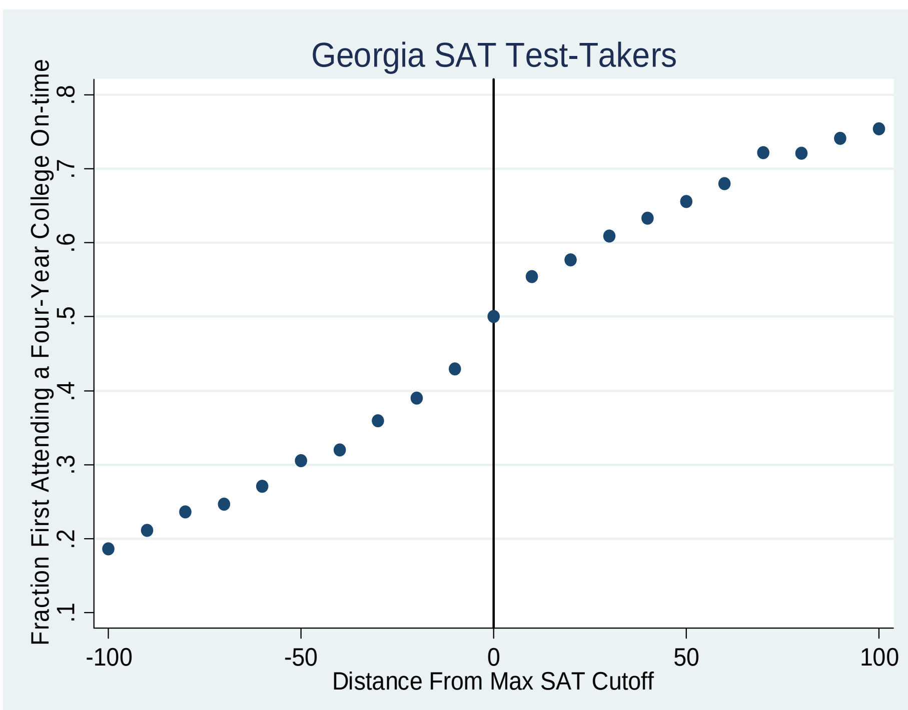

Georgia SAT Test-Takers
Number of SAT Attempts
2
1.9
1.8
1.7
-100
-50
0
50
100
Distance From First SAT Cutoff

Figure 2

Panel A:



Panel B:



Panel C:

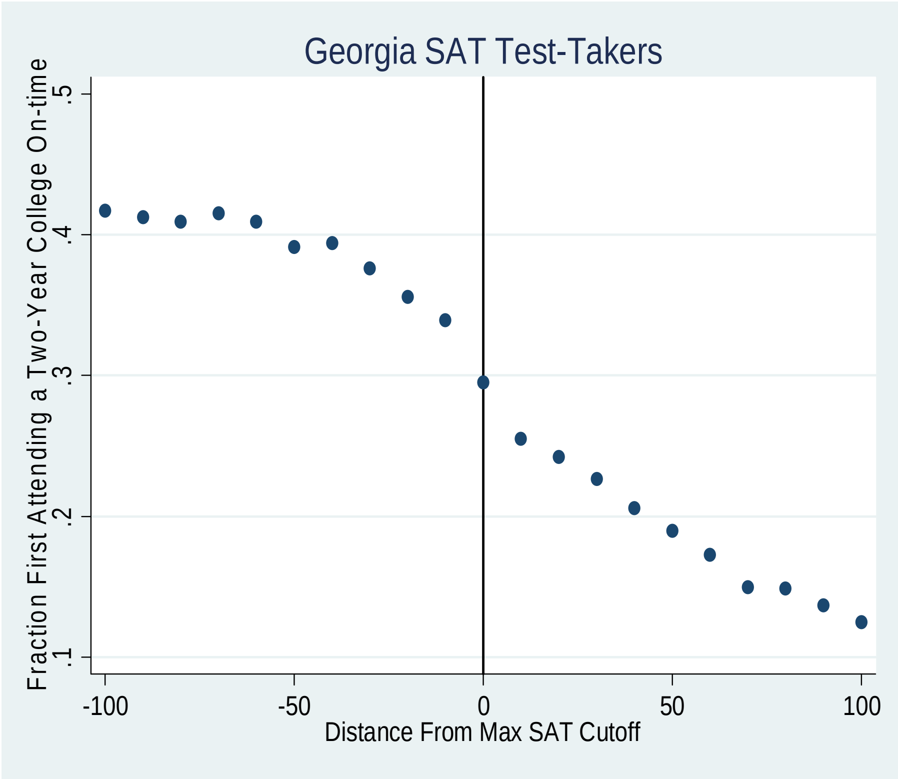

Georgia SAT Test-Takers
Fraction First Attending a Two-Year College On-time
.1
.2
.3
.4
.5
-100
-50
0
50
100
Distance From Max SAT Cutoff

Figure 3

Panel A:

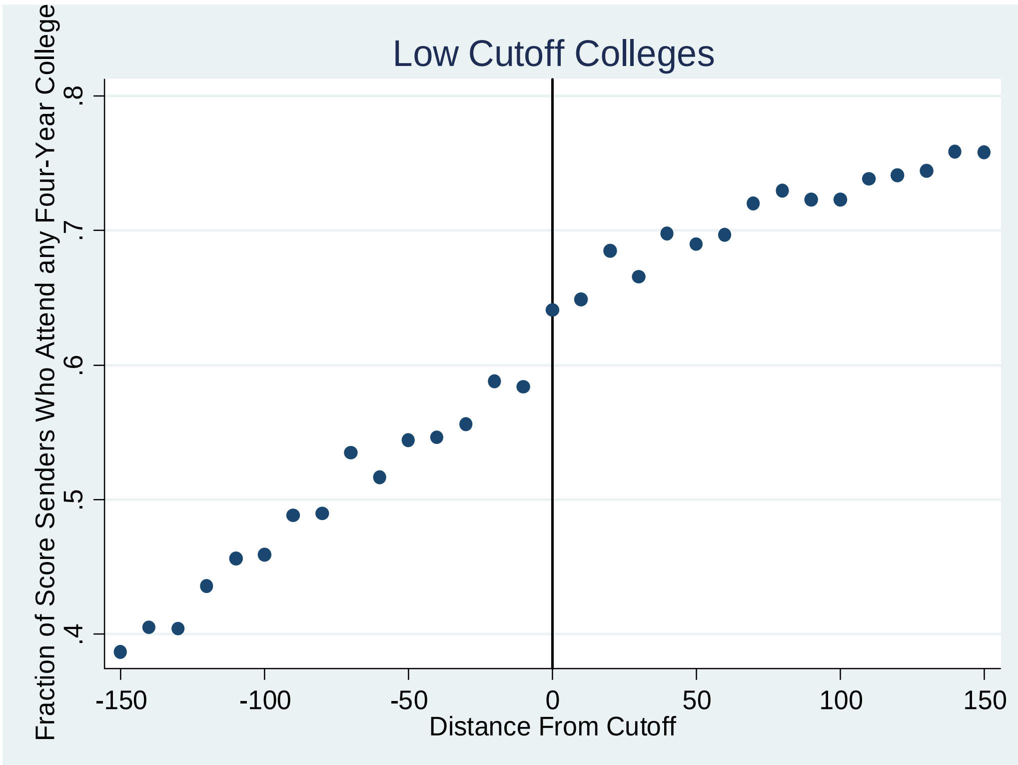
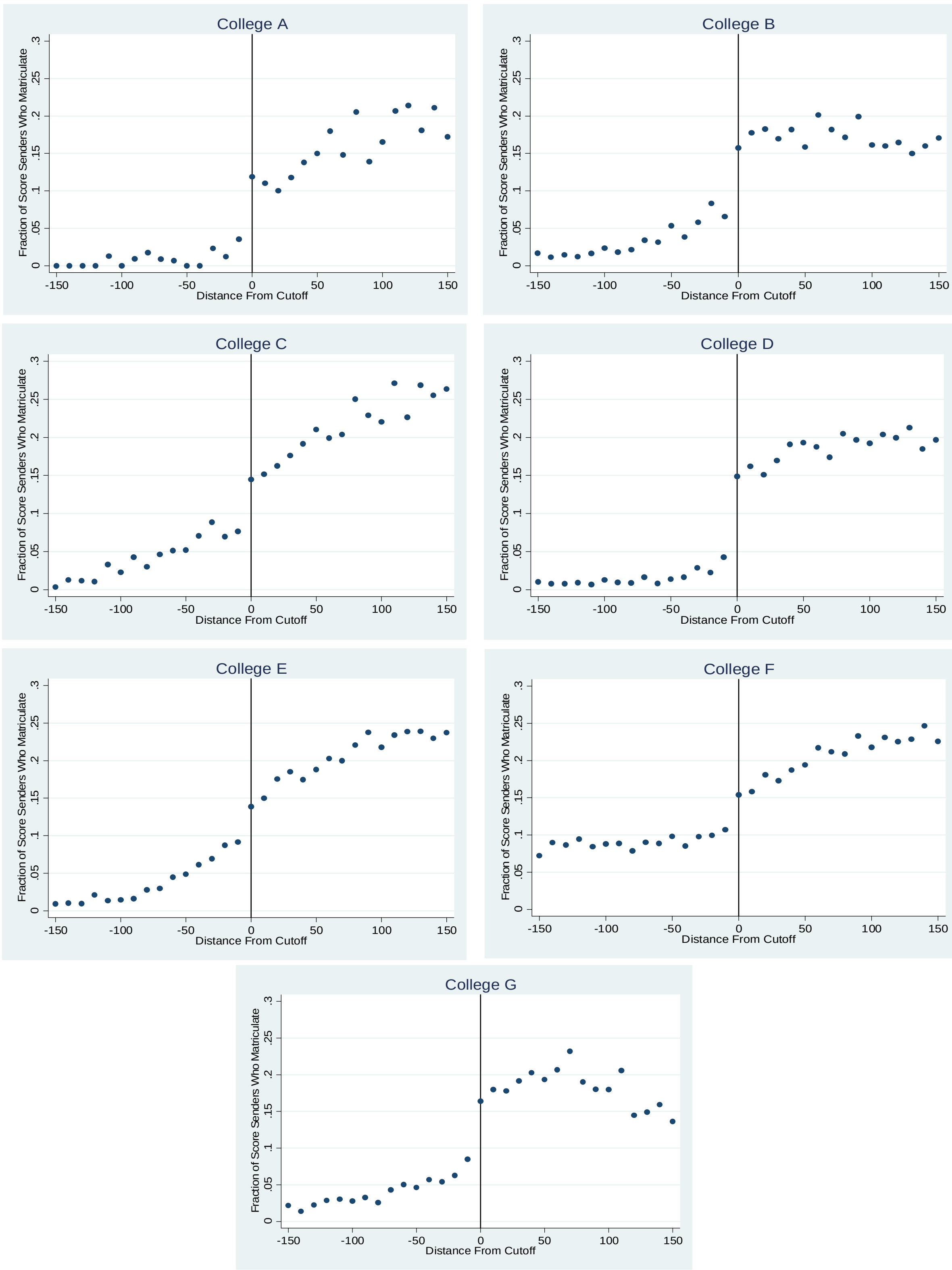


Figure A.1



College A
College B
College C
College D
College E
College F
College G
Fraction of Score Senders Who Matriculate
Distance From Cutoff
0
.05
.1
.15
.2
.25
.3
-150
-100
-50
0
50
100
150