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College entrance exam-taking strategies in Georgia

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Abstract

Using administrative data from Georgia, we provide the first study of the full set of college entrance exam-taking strategies, including who takes the ACT and the SAT (or both), when they take the exams, and how many times they take each exam. We have several main findings. First, one-third of exam takers take both the ACT and SAT. Second, we see pronounced disparities in several measures of exam-taking strategy by free- and reduced-price lunch status, even after including a rich set of controls, but not by underrepresented minority status. Third, we find evidence that taking more total exams leads to higher admissions-relevant test scores and a higher likelihood of enrolling in colleges with relatively high graduation rates and earnings. However, these relationships with test scores and college enrollment are smaller for those who take both the ACT and SAT, as opposed to retaking the same exam multiple times.

JEL CLASSIFICATION

I20; I21; I23; I24

1 | INTRODUCTION

The transition from high school to college requires many steps, processes, and procedures, many of which prove to be hurdles for disadvantaged students (see, e.g., Page & Scott-Clayton, 2016). One of these procedures in the United States is taking college entrances exams—namely, the ACT and SAT. A series of papers shows that just getting students to take the ACT or SAT can increase college-going rates, suggesting it is a barrier for some students, even for some who would perform well (Bulman, 2015; Goodman, 2016; Hurwitz et al., 2015; Hyman, 2017; Klasik, 2013). There are also several papers that show the benefits of retaking college entrance exams on exam performance and college enrollment, despite the fact that so few low-income and underrepresented minorities do so (Frisancho et al., 2016; Goodman et al., 2020; Vigdor & Clotfelter, 2003). One study looks at determinants of whether students take both the ACT and SAT in Texas (Thomas, 2004). In the United States, none of the aforementioned papers captures the complete picture of college exam taking.

In this paper, we investigate the comprehensive set of exam-taking strategies, including both the ACT and SAT. We use data on all ACT and SAT exam attempts among public high school students in Georgia between 2009 and 2015. Compared with previous work in the area that focuses on one exam or the other, we are the first to assess high school students' complete exam-taking strategies, disparities in strategies between groups, and potential impacts of these strategies on score performance and college enrollment.

Why might students have different exam-taking strategies from one another?[1] There are institutional reasons, such as the admissions policies of local colleges or the regional and high school test-taking norms and policies that influence students' test taking. There also exist student-centric reasons such as preferences for colleges and risk tolerance. There are also the frequently discussed and important reasons that plague education, such as differential access to adults and resources to help them navigate the transition to college. These disparities have been shown to impact the number of only ACT exams or only SAT exams taken (e.g., Goodman et al., 2020; Hyman, 2017). But it is not clear what is the best strategy given that there are two different exams. The somewhat uninformative first result of a Google search of “Should I take the ACT or SAT?” says both exams are similar and “Different students tend to do better on one test over the other” but it does not say which students.[2] Even after students choose one of the two exams for their first attempt they then have an equally unclear decision on whether to take a second exam and if so, which one? The previous advice suggests that students may do better on the alternative exam but “superscoring” policies—which take the best subsection scores from each exam attempt (only within the same exam type) to make the best score possible—promotes retaking the same exam multiple times (Goodman et al., 2020). On top of that, most colleges consider superscores in the admission process while some colleges simply state that they want to see all exam attempts. In sum, there are varying policies across colleges that would confuse most applicants who are not certain of where they plan to enroll.

Our analysis begins with a simple fact on exam-taking strategies: about one-third of exam takers in Georgia take both the SAT and ACT. This is a bit higher than the 26-30% found in Texas in the 1990s (Thomas, 2004). We also show that lower-income students, as measured by participation in the free- or reduced-price lunch (FRL) program, take fewer exams overall. FRL students are also 5 percentage points less likely to take both the SAT and ACT, and 12 percentage points less likely to retake at least one of the exams relative to non-FRL students. We see similar disparities in the timing of the first exam taken, where relatively advantaged students are more likely to take their first exam in their junior year of high school.

Second, we explore how first exam scores influence students exam-taking choices. A number of studies document how students respond to receiving new information such as by

[1]Collectively, we refer to this as a “strategy,” which we acknowledge is sometimes a passive response to existing practices and policies.

[2]https://www.princetonreview.com/college/sat-act

adjusting the colleges they apply to with unexpectedly high or low first SAT scores (Bond et al., 2018) or updating their beliefs about their ability upon receiving college grades (Arcidiacono et al., 2012; Arcidiacono et al., 2016; Stange, 2012; Stinebrickner & Stinebrickner, 2012, 2013; Zafar, 2011). Similarly, how students fare on their first exam can influence how students make exam-taking choices. We document patterns of exam retaking and switching (i.e., taking the ACT after first taking the SAT) across the full distribution of first exam scores. The evidence suggests scoring relatively poorly on the SAT may discourage some students about their ability to succeed on the SAT, leading them to be more likely to switch to the ACT. Then, we show that where first exam scores fall relative to the minimum admissions requirements at the University System of Georgia, or relative to round number exam scores, influences exam-taking strategies. These analyses replicate and extend upon Goodman et al. (2017) and Goodman et al. (2020) using a different data set and by considering ACT exam taking,[3] and it also serves as a benchmark for the potential responsiveness of students to policy interventions aimed at changing exam-taking strategies.

Using a regression discontinuity design, we find that scoring below the USG admissions thresholds that determine minimum eligibility requirements to the 4-year public university sector in Georgia on either the SAT or ACT induces students to retake the exam. The SAT confirms the results of Goodman et al. (2017) and the ACT is a new but consistent result. Among students who take the SAT first, we also find that scoring below the USG admissions requirement induces some students to switch to the ACT exam. This suggests that students explore their exam options in order to meet the admissions requirements and highlights the demand for the 4-year public university sector for this population of students. Furthermore, and also using a regression discontinuity design, we show that where a student's first scores fall relative to round numbers on the SAT or ACT influences exam taking. Relative to those scoring just above a round number (e.g., 1800 on SAT or 20 on ACT), students scoring just below a round number are more likely to retake the SAT or ACT, suggesting that students set goals that are targeted around these round number scores.

In our third broad result, we use a selection-on-observables approach to analyze how different exam-taking strategies are associated with both admissions-relevant exam scores and college enrollment. We address the endogeneity of the choice of exam-taking strategy by including a rich set of controls including student demographics, high school academics such as GPA, and high school by cohort fixed effects. Without exogenous variation in students' choice of exam-taking strategy, bias arising from unobserved factors associated with strategy choice and college outcomes such as preference for going to college or college selectivity is a concern. However, we present additional analyses that support the reliability of our estimates. For example, our selection-on-observables approach produces nearly identical estimates of the effect of retaking an exam compared with the estimated causal effect of SAT retaking from Goodman et al. (2020) who use a regression discontinuity design.

We find that taking more exams is generally associated with higher scores and better college enrollment outcomes, albeit with diminishing returns. But, conditional on the number of exams taken, the portfolio of exams taken does not make a large difference for college enrollment outcomes or measures of college quality. However, we do find evidence that, relative to taking a mix of SAT and ACT exams, there are greater returns to sticking with a single type of exam in terms of admissions-relevant scores. These results suggest that there are little to no benefits of diversifying the exam portfolio with attempts on both the SAT and ACT compared with sticking with just the SAT or ACT.

[3]ACT scores were unobserved in the data used in these papers.

Lastly, we use our estimates to infer how much of the income-based gap in 4-year college enrollment would be reduced if disparities in strategy take up were eliminated. To do this, we take the summary statistics that show large differences in rates of exam-taking strategy take up between FRL and non-FRL students and multiply them by the estimated impacts of taking each strategy. We calculate that eliminating strategy gaps would reduce the 4-year college enrollment gap by about 20% among exam takers. These calculations ignore any possible general equilibrium effects that initiatives to equalize strategy take up between student groups might have on colleges and other students.

Overall, this paper adds to the literature that studies SAT and ACT exam taking by moving beyond the study of a single exam and providing a more complete picture. Although we focus on a single state, there are many states like Georgia where a substantial fraction of its high school graduates take both the ACT and SAT.[4] This paper also adds to the larger literature on complexities in the transition from high school to college that expand well beyond ACT and SAT taking (see Page & Scott-Clayton, 2016). We show that there are in fact disparities in exam-taking strategies and the strategies may lead to meaningful differences in admission scores and college enrollment. As such, we are contributing to a broader literature on the relationship between educational inequality and the role that colleges can play in economic mobility (e.g., Chetty et al., 2020). Finally, our results provide (somewhat) practical advice for schools, parents, and students on how best to navigate college entrance exams.

2 | BACKGROUND AND DATA

2.1 | College entrance exams

The SAT and ACT are standardized national exams used to measure students' readiness for college. The SAT is administered by the College Board and the ACT is administered by an organization of the same name as its exam. Students typically take these exams during 11th and 12th grade of high school before submitting applications to colleges. There are ~2,000 colleges in the United States that are not open enrollment, among them about 1,600 (79%) require, recommend, or consider SAT or ACT scores for admission but do not state a preference for either.[5] In fact, many colleges (and high school and college counselors) use an ACT-SAT concordance table to compare scores across exams.[6] Many of the remaining colleges will use SAT and ACT scores for placement into coursework. Colleges consider these scores in order to have a standardized measure that puts students' high school academic records—such as coursework, grades, and class rank—into a national perspective.

There are no limits on the number of times students can take the SAT or ACT, but during our sample period, the exams are each typically offered a maximum of seven times per year.

[4]There are a few clear "SAT states" and a few clear "ACT states" but among the states where students tend to take both exams with relative frequency, Georgia is somewhat typical. See Table A1 for details.

[5]Many colleges have recently relaxed their SAT and ACT score submission requirements to accommodate the circumstances of the COVID-19 pandemic. Also, a superior court judge has recently ruled that the University of California system cannot use SAT and ACT scores as a determinant in admissions.

[6]A current concordance table can be found here: https://collegereadiness.collegeboard.org/pdf/guide-2018-act-sat-concordance.pdf.

Fees for each exam range from $0 for lower-income students who qualify for a fee waiver to $40–$60 for higher-income students.[7] The SAT consists of three sections—math, reading, and writing—each scored on a scale of 200 to 800. Thus, total SAT scores can range from 600 to 2400.[8] The ACT consists of four sections—math, reading, writing, and science—each scored on a scale of 1 to 36. Composite ACT scores are the average of the scores from the four sections, rounded to the nearest integer. For each student we calculate separate SAT and ACT superscores—which are commonly used by college admissions offices—by computing a total SAT and composite ACT score using each student's maximum score in each exam section across all attempts of each exam type, respectively. For example, consider a student who scores a 400 on math, 400 on reading, and an 800 on writing on their first SAT attempt, and scores an 800 on math, 800 on reading, and 400 on writing on their 2nd (and final) SAT attempt. Her SAT superscore would be $800 + 800 + 800 = 2400$. Despite the concordance table, colleges do not superscore across the ACT and SAT, as far as we are aware.

2.2 | Higher education in Georgia

Among public high school graduates in Georgia who attend college immediately after high school, about 63% enroll in an institution in the University System of Georgia (USG), 13% enroll in an institution in the Technical College System of Georgia (TCSG), 9% enroll in a Georgia private institution, and 15% enroll in an out-of-state institution.[9] USG includes 26 institutions, including four research universities, four regional universities, nine state universities, and nine state colleges. The vast majority of degrees awarded by USG institutions during our sample period are bachelor's degrees. TCSG includes 22 institutions which offers certificate, diploma, and associate degree programs.

College entrance exams are particularly important for Georgia students. First, USG employs minimum SAT and ACT requirements to be admitted to the public universities in the state. USG requires at least a 430 in reading and a 400 on the math section of the SAT, or a 17 on both the reading and math sections of the ACT. These admissions requirements apply for 17 of the 26 institutions in USG, excluding only the nine state colleges. Only two of these institutions set SAT and ACT admissions standards significantly higher than the system's minimums. These admissions requirements affect a significant share of Georgia students. Previous work shows that over 60% of Georgia students who score near these thresholds and enroll in 4-year colleges do so in universities within USG (Goodman et al., 2017). We will show that these thresholds influence the portfolio of exams students take.

Second, the ACT and SAT are used for other purposes in Georgia. The exams are used for placement into programs at the TCSG institutions (and some programs at USG). In addition, students who score high enough on the ACT or SAT are eligible for scholarships. Eligibility for the Zell Miller scholarship—a recent addition to the HOPE scholarship—is dependent upon

[7]Fee waivers are available for up to two SAT exams and up to four ACT exams. Students are eligible for such fee waivers if they receive or are eligible for federally subsidized school lunch, receive public assistance, live in federally subsidized public housing, or are homeless.

[8]In 2016, the SAT changed its format to include only two sections—Math and Evidence-Based Reading and Writing—such that total scores range from 400 to 1600.

[9]These numbers are obtained from the High School Graduate Outcomes dashboard of the Govenor's Office of Student Achievement: https://gosa.georgia.gov/dashboards-data-report-card/data-dashboards/hs-grad-outcomes.

SAT or ACT scores.[10] To be eligible for this scholarship that covers 100% of tuition at Georgia public colleges or a significant share of tuition at Georgia private colleges, students must obtain a 3.7 high school GPA and a combined score of at least 1200 on the math and reading sections of the SAT, or a composite ACT score of at least 26.

More students in Georgia take the SAT than the ACT but exam taking is relatively balanced compared with some states. Table A1 shows how exam taking between the SAT and ACT compares across states for high school graduates in 2015. There are about 15 "ACT states" and only one "SAT state" where very few students take the SAT or ACT, respectively. Georgia ranks 19th in terms of the ratio of SAT to ACT takers. Overall, Georgia is not substantially different from many states. Table A1 also displays Google Trends search intensity for the SAT and ACT exams between 2008 and 2015. Here, Georgia is again relatively similar to many other states in terms of searches for the SAT and ACT exams.

2.3 | Data and summary statistics

We use data from Georgia's statewide longitudinal database, Georgia's Academic and Workforce Analysis and Research Data System (GA•AWARDS). GA•AWARDS includes data on all students from Georgia public schools, combining data sources from several government agencies in Georgia. We only have data on all students who completed at least one college entrance exam, not the entire public school population.[11] We observe each exam taker's complete exam-taking history, including scores by subject and exam administration dates for all attempts on both the SAT and the ACT. We also observe information sourced from the Georgia Department of Education about each student's demographics and their high school experience. Finally, we observe college enrollment histories from National Student Clearinghouse records.[12] Our analytic sample consists of all exam takers from Georgia public high school cohorts between 2009 and 2015.

We link a few auxiliary sources of information about colleges and high schools to the GA•AWARDS data. Data on colleges come from the Integrated Postsecondary Education Data System (IPEDS) and the College Scorecard. IPEDS is an annual survey of the universe of colleges in the United States conducted by the National Center for Education Statistics (NCES) at the United States Department of Education. The College Scorecard, also maintained by the United States Department of Education, provides aggregate institution-level data on earnings and student loan repayment sourced from the United States Department of the Treasury and the National Student Loan Data System, respectively. Finally, data on high schools comes from the Common Core of Data (CCD), which is NCES's annual survey of the universe of public K-12 schools and school districts in the United States.

Our main outcomes of interest are college admissions-relevant exam scores and college enrollment. Our measure of college admissions-relevant scores (hereafter referred to as "admissions scores") approximates what college admissions offices typically use. Specifically, we

[10]In 2011, Georgia reduced the generosity of the HOPE scholarship and created the Zell Miller scholarship which requires higher academic requirements to be eligible than the HOPE scholarship.

[11]Previous research has focused on disparities on the extensive margin of taking or not taking an ACT or SAT. The literature consistently shows the disparities in exam taking and scoring, along with the benefits of taking an exam on the probability of enrolling in a 4-year college.

[12]College enrollment data are obtained via GA•AWARDS but is originally sourced from the National Student Clearinghouse, which tracks enrollment for about 94% of U.S. college students.

compute admissions scores as follows: (1) students who only take one type of exam (i.e., only the SAT, or only the ACT) are assigned their appropriate SAT or ACT superscore, where ACT superscores are converted into SAT-equivalent terms using official ACT-SAT concordance tables; (2) students who take both the SAT and ACT are assigned the maximum of their SAT superscore and SAT-equivalent ACT superscore. Notably, we mimic colleges and do not superscore across the ACT and SAT.[13]

For college enrollment outcomes, we use the college enrollment data to identify the first college each student attends after high school. We characterize these colleges by 4-year or 2-year sector, and the graduation rate at the college obtained from IPEDS. As additional measures of college quality, we also use the institution-level data from the College Scorecard on average earnings and student loan default and repayment rates. We use the average earnings of students entering the labor market in 2008, where earnings are measured 6 years after entry. Student loan default and repayment rates are used for students entering repayment in 2013, where rates are measured 3 years after entry.[14] The College Scorecard defines being in "repayment" if individuals are not in default and have loan balances that have declined since entering repayment.

Table 1 shows mean characteristics of the full sample, as well as for several subpopulations of interest: students who took the SAT or ACT first; students who participated in the FRL program, a proxy for students from lower-income families; students who were not FRL eligible; underrepresented minority (URM) students, defined as students indicated as Black, Hispanic, or Native American; and non-URM students. For our full sample of exam takers, 47% are URM and 51% are FRL students.

First exam scores average 1393, where ACT scores are converted into SAT-equivalent terms using official ACT-SAT concordance tables, with maximum exam scores about 44 points higher. Average superscores are 5 to 12 points higher than average maximum scores, and the average of our admissions score measure is 7 to 12 points higher than average superscores. Fifty-one percent of our sample first enrolled in a 4-year college, while 18% first enrolled in a 2-year college. There is a 12 percentage point gap in 4-year college enrollment rates between FRL and non-FRL students. Across the college enrollees in our sample, the average graduation rate at the institutions they enroll is 39%.

3 | DETERMINANTS OF EXAM-TAKING STRATEGIES

In this section, we define and catalogue different exam-taking strategies, as measured by the portfolio of ACT and SAT taking patterns and the timing of the exams, and we also show some factors that are associated with and impact the strategies students take. We show that there are disparities in exam-taking strategies, which is cause for concern because of the potential for these strategies to directly impact college enrollment.

[13]A majority of colleges who consider SAT scores say that they superscore (College Board, 2015). We are not aware of any college that publicly states that they superscore across the SAT and ACT. Some institutions even explicitly say they do not superscore across exams. For instance, the University of Georgia states on their admissions website: "We do not mix scores between the tests, so we will not select highest SAT Math + highest ACT English to calculate a superscore."

[14]The college scorecard excludes individuals who are enrolled in school or in the military in their calculations.

TABLE 1 Summary statistics

	All takers (1)	SAT-first takers (2)	ACT-first takers (3)	FRL takers (4)	Non-FRL takers (5)	URM takers (6)	Non-URM takers (7)
Panel A. Demographics							
Female	0.55	0.55	0.55	0.57	0.54	0.57	0.54
White	0.58	0.59	0.54	0.38	0.79	0.19	0.92
Black	0.39	0.37	0.45	0.59	0.18	0.84	0.00
Asian	0.06	0.07	0.04	0.06	0.07	0.02	0.10
Native American	0.04	0.04	0.04	0.06	0.02	0.09	0.00
Two or more races	0.05	0.05	0.05	0.06	0.05	0.09	0.02
Other race	0.11	0.11	0.11	0.15	0.08	0.19	0.04
Hispanic	0.08	0.08	0.08	0.11	0.05	0.18	0.00
URM	0.47	0.45	0.51	0.69	0.23	1.00	0.00
FRL	0.51	0.49	0.56	1.00	0.00	0.76	0.30
Panel B. Exam taking							
Took SAT	0.79	1.00	0.27	0.80	0.83	0.80	0.84
Took ACT	0.54	0.37	1.00	0.54	0.55	0.57	0.52
SAT attempts	1.35	1.73	0.39	1.25	1.53	1.32	1.47
ACT attempts	0.64	0.41	1.21	0.63	0.66	0.66	0.61
Total attempts	1.99	2.14	1.61	1.88	2.19	1.98	2.08
Panel C. Exam scores							
First exam score	1393	1399	1376	1283	1509	1272	1497
Maximum SAT score	1437	1442	1394	1319	1558	1313	1547
Maximum ACT score	1438	1490	1390	1315	1569	1307	1561
SAT superscore	1449	1454	1403	1330	1572	1324	1559
ACT superscore	1442	1493	1395	1319	1573	1311	1565
Admissions score	1456	1475	1407	1338	1585	1332	1568
Panel D. College enrollment							
Four-year college	0.51	0.53	0.45	0.48	0.60	0.53	0.54
Two-year college	0.18	0.18	0.20	0.23	0.15	0.21	0.18
College's graduation rate	0.39	0.40	0.36	0.32	0.45	0.34	0.44
College's mean earnings (000 s)	34.3	34.8	33.1	31.6	36.8	32.2	36.0
College's default rate	0.11	0.11	0.12	0.13	0.09	0.13	0.10
College's repayment rate	0.45	0.45	0.43	0.38	0.51	0.39	0.50
Test takers	484,956	348,032	136,924	229,422	222,703	212,443	238,709

Note: Listed above are mean values of key variables. Column (1) consists of all exam takers in the Georgia public high school classes of 2009–2015. Columns (2) and (3) consists of the subset of students who took the SAT and ACT first, respectively. Column (4) consists of the subset of students classified as FRL. Column (5) consists of the subset of students from an underrepresented race/ethnicity (Black, Hispanic, and Native American). Race and ethnicity variables are not mutually exclusive. Mean earnings are from the 2008 college graduating cohort, observed 6 years after entering the labor market. Student loan default and repayment rates are from the 2013 college graduating cohort, and are observed 3 years after entering repayment. The college scorecard defines students as being in "repayment" if they are not in default and have loan balances that have declined since entering repayment, while excluding currently enrolled and military deferment from the calculation.

3.1 | Defining and cataloging exam-taking strategies

In Georgia, the SAT is taken more frequently than the ACT. Seventy-nine percent of exam-takers take the SAT in our sample, but 54% take the ACT, and about one-third of exam-takers take both the SAT and ACT. Overall, exam takers average 1.35 SAT attempts and 0.64 ACT attempts. This facilitates our study of exam-taking strategies that combine taking both the SAT and ACT.

We define seven mutually exclusive exam-taking strategies to be studied in this paper, particularly when we analyze the impacts of these strategies on test scores and college enrollment outcomes. These strategies are:

- Took only the SAT and only once.
- Took only the ACT and only once.
- Took only the SAT and took it twice.
- Took only the ACT and took it twice or more.[15]
- Took both the SAT and ACT and took both each once.
- Took only the SAT and took it three or more times.
- Took both the SAT and ACT and retook at least one exam.

In some analyses, we also consider strategies that are not mutually exclusive of each other. For instance, among students who take the SAT first, we will consider strategies such as retaking the SAT and whether they ever took the ACT. Likewise, among students who take the ACT first, we will consider ACT retaking and whether the student ever took the SAT.

Figure 1 shows the distribution of the mutually exclusive exam-taking strategies among the full sample, as well as separately by FRL status and race/ethnicity. Among all takers, 46% only take the SAT, with 25% taking it only once, 16% taking it twice, and 5% taking it at least three times. Twenty-one percent of all takers only take the ACT, with 18% taking it only once and 3% taking it multiple times. Finally, 34% of all takers take some combination of the SAT and ACT, with 11% taking each exam only once and 23% retaking at least one of the exams.

Figure 1 also demonstrates the disparities in exam-taking strategies between students who have participated in FRL and those who have not as well as between URM and non-URM students. Forty-seven percent of FRL students take just one exam versus only 34% for non-FRL students. Also, 40% of FRL students retake either the SAT or the ACT compared with 56% of non-FRL students. Strategy disparities are much smaller between URM and non-URM students in our sample of exam takers. URM students have 3 percentage points higher rates of taking just one exam and 3 percentage points lower exam retaking rates compared with non-URM students.

An important determinant of exam-taking strategies is the timing in which students take their first exam. The later in high school students take their first exam, the less time they have to retake or switch to the other exam before college applications are due, something that proves consequential in Goodman et al. (2020). Figure 2 shows the distribution and disparities of first exam timing. In the full sample, 53% take their first exam in their junior year, while 47% take their first exam during their senior year. FRL and URM students are much more likely to

[15]We do not split the "took only the ACT and took it twice or more" category into taking it twice or three or more, like we do with the SAT, since this category already represents a fairly small share of exam takers.

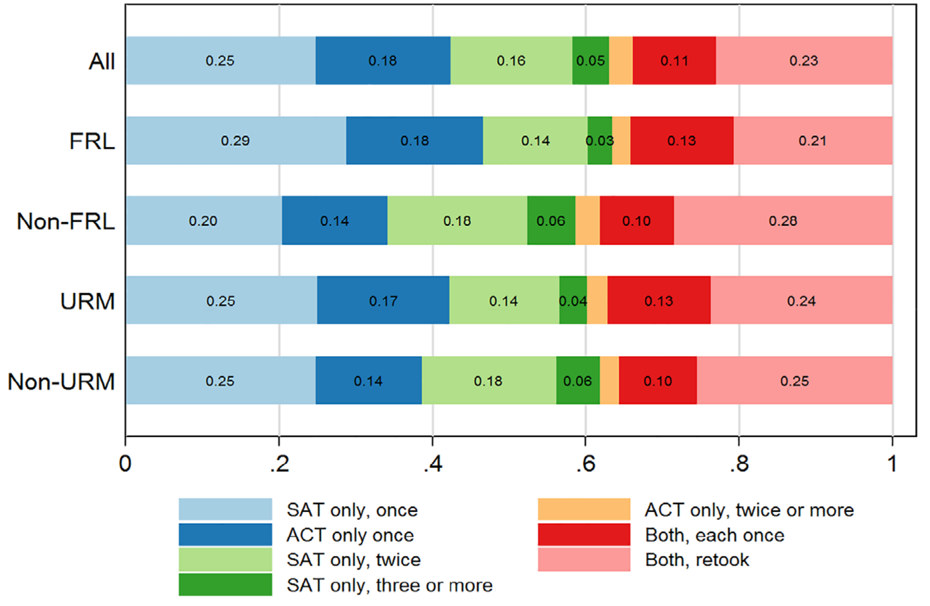

FIGURE 1 Distribution and disparities of exam-taking strategies. This figure shows the distribution of the mutually exclusive exam-taking strategies across various populations. The sample consists of all exam takers in the Georgia public high school classes of 2009–2015. FRL refers to students who participated in the free- or reduced-price lunch program. URM refers to students from an underrepresented race/ethnicity (Black, Hispanic, and Native American) [Color figure can be viewed at wileyonlinelibrary.com]

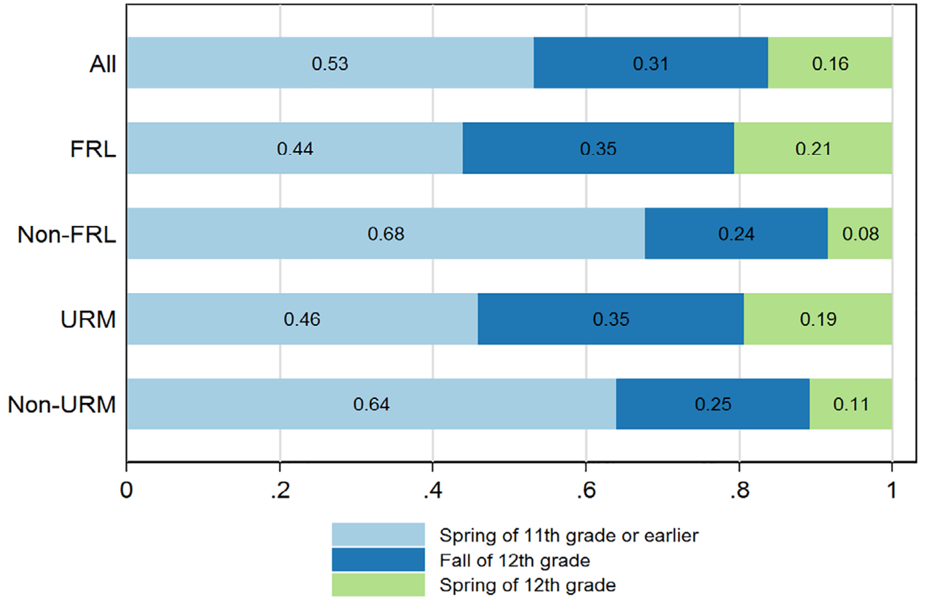

FIGURE 2 Distribution and disparities of first exam timing. This figure shows the distribution of the timing of first exam students' take across various populations. The sample consists of all exam takers in the Georgia public high school classes of 2009–2015. FRL refers to students who participated in the free- or reduced-price lunch program. URM refers to students from an underrepresented race/ethnicity (Black, Hispanic, and Native American) [Color figure can be viewed at wileyonlinelibrary.com]

take their first exam later than the fall of the senior year compared with their non-FRL and non-URM counterparts. Twenty-one percent of FRL students and 19% of URM students take their first exam late in their senior year, versus 8% and 11% of non-FRL and non-URM students, respectively.

3.2 | Student and high school characteristics

Table 2 shows predictors of exam taking from regressions of characteristics of students' exam taking on various individual- and high school-level covariates. Contrary to raw summary statistics, these regressions account for any associations between observed covariates. FRL students take 0.25 fewer exams overall and are 5 percentage points less likely to take the SAT first. They also are 5 percentage points less likely to take both the SAT and ACT, and are 12 percentage points less likely to retake at least one of the exams. These smaller exam portfolios are correlated with the timing with which students using FRL take their first exam, which is 1.6 months later than students not using FRL. In our sample, URM students have 0.24 fewer months to take more exams compared with non-URM students, but they end up taking 0.18 more exams and are more likely to diversify their exam portfolio. Female students tend to take more exams and are more likely to take a mix of SAT and ACT exams than male students, despite no difference in first exam timing. Finally, higher-achieving students in high school are much more likely to take the SAT first, take more exams, and to start taking them early. Each additional high school grade point is associated with 4 percentage points higher probability of taking the SAT first, 0.3 more exams, 13 percentage points higher probability of retaking, and taking the first exam 1.5 months earlier.

Figure 3 takes a deeper look at the relationship between exam-taking strategies and high school GPA. Both figures in Panel A and B group students within bins of 0.05 GPA points and plots the share of students within each bin that choose a given strategy. Panel A shows that students with higher high school GPAs are more likely to take the SAT as their first exam. It also shows that there are very little differences in these patterns between URM and FRL students. Panel B shows that high school GPA is strongly related to the portfolio of mutually exclusive exam-taking strategies. Consistent with the results in Table 2, students with higher GPAs are more likely to take both the SAT and ACT and more likely to retake either of the exams. Notably, Panel B shows that the relationships between exam-taking strategies and GPA are strikingly linear.

High school characteristics also represent important predictors of exam taking and exam timing, particularly in terms of the school's composition of family income. Students in schools that are 75% FRL eligible take 0.4 fewer exams, are 15 percentage points less like to retake an exam, and take their first exam 1.9 months later than students in schools that are 25% FRL eligible. Larger schools and schools in districts with higher expenditures per student have small but positive associations with the number and the early timing of exams taken.

3.3 | First exam scores

In this section, we explore how first exam scores influence how students make exam choices. Bond et al. (2018) show that students respond to scoring unexpectedly well or poorly on their first exam by making modest updates to the quality of colleges they apply to. Similarly, students could

TABLE 2 Predictors of exam taking and timing

	SAT exams (#) (1)	ACT exams (#) (2)	Took SAT first (3)	Took SAT (4)	Took ACT (5)	Took both (6)	Retook (7)	First exam month (#) (8)
Individual characteristics								
FRL	−0.23***	−0.02***	−0.050***	−0.039***	−0.009**	−0.048***	−0.117***	−1.60***
	(0.01)	(0.01)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.04)
URM	0.055***	0.123***	−0.038***	−0.021***	0.094***	0.073***	0.065***	−0.24***
	(0.008)	(0.008)	(0.004)	(0.003)	(0.006)	(0.005)	(0.004)	(0.05)
Asian	0.358***	−0.020	0.039***	0.022***	−0.026**	−0.003	0.144***	0.92***
	(0.013)	(0.014)	(0.004)	(0.003)	(0.010)	(0.010)	(0.005)	(0.06)
Female	0.013***	0.032***	−0.004**	−0.000	0.024***	0.024***	0.016***	0.01
	(0.004)	(0.003)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.02)
Gifted	0.109***	−0.035***	0.051***	0.048***	−0.025***	0.023***	0.046***	1.99***
	(0.009)	(0.005)	(0.004)	(0.003)	(0.004)	(0.003)	(0.004)	(0.05)
Dual enroll	0.096***	0.051***	0.007	0.015**	0.022**	0.037***	0.044***	2.66***
	(0.015)	(0.014)	(0.007)	(0.006)	(0.009)	(0.007)	(0.006)	(0.11)
HS GPA (out of 4)	0.231***	0.068***	0.041***	0.053***	0.045***	0.098***	0.128***	1.50***
	(0.005)	(0.004)	(0.003)	(0.003)	(0.004)	(0.002)	(0.002)	(0.04)
School characteristics								
Cohort size (00s)	0.016*	0.004	0.006	0.006*	0.003	0.010***	0.009***	−0.008
	(0.008)	(0.007)	(0.007)	(0.004)	(0.005)	(0.003)	(0.003)	(0.035)
Fraction FRL	−0.620***	−0.173***	−0.144***	−0.165***	−0.100**	−0.265***	−0.311***	−3.722***
	(0.092)	(0.065)	(0.051)	(0.044)	(0.050)	(0.028)	(0.029)	(0.360)
Student-teacher ratio	0.003	−0.001	0.002	0.001	−0.001	0.000	0.001	0.003
	(0.003)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.011)
Expenditures per student (00s)	0.000	0.002***	−0.001*	−0.001*	0.001***	0.001***	0.001**	0.011***
	(0.001)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.003)
R-squared	0.180	0.084	0.116	0.169	0.053	0.119	0.134	0.233

Note: Each column reports coefficients from a separate regression. Fraction FRL is measured from 0 to 1. Other school-level characteristics are included in the regressions, but their coefficients are not shown. These include the share of 12th grade enrollment in various demographic categories. The sample consists of all exam takers in the Georgia public high school classes of 2009–2015.

$^{*}p < .10$, $^{**}p < .05$, $^{***}p < .01$.

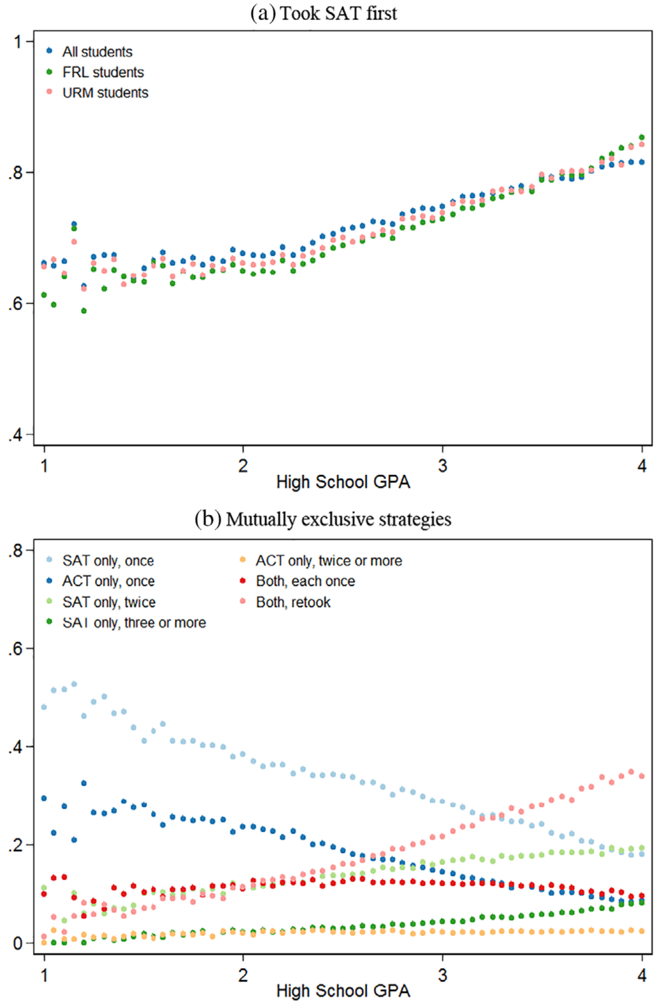

FIGURE 3 **Exam-taking by high school GPA**. (a) Took SAT first (b) Mutually exclusive strategies. In both Panel A and Panel B, plotted on the horizontal axis are students high school GPAs put into bins of 0.05 GPA points. In Panel A, the vertical axis plots the share of students in each GPA bin that took the SAT as their first exam. In Panel B, the vertical axis plots the share of students in each GPA bin that choose the different mutually exclusive exam-taking strategies [Color figure can be viewed at wileyonlinelibrary.com]

make adjustments to their exam-taking strategies based on the results of their first exam. For instance, students who score poorly on their first exam could become discouraged about their ability to perform well on that exam type, potentially making them more likely to switch to the other exam. Also, Goodman et al. (2017) and Goodman et al. (2020) show using College Board data that students scoring below the minimum SAT score requirements for admission into USG and scoring just below round number SAT scores both induce students to retake the SAT. Here, we examine how exam-taking patterns vary across the distribution of first exam scores, and replicate (using a different data set) and extend upon Goodman et al. (2017) and Goodman et al. (2020) by considering ACT-first takers and exam-switching behavior.

Panel A of Figure 4 plots the share of SAT-first takers who retake the SAT and who ever take the ACT for each possible first score. A couple of patterns emerge. First, except among very

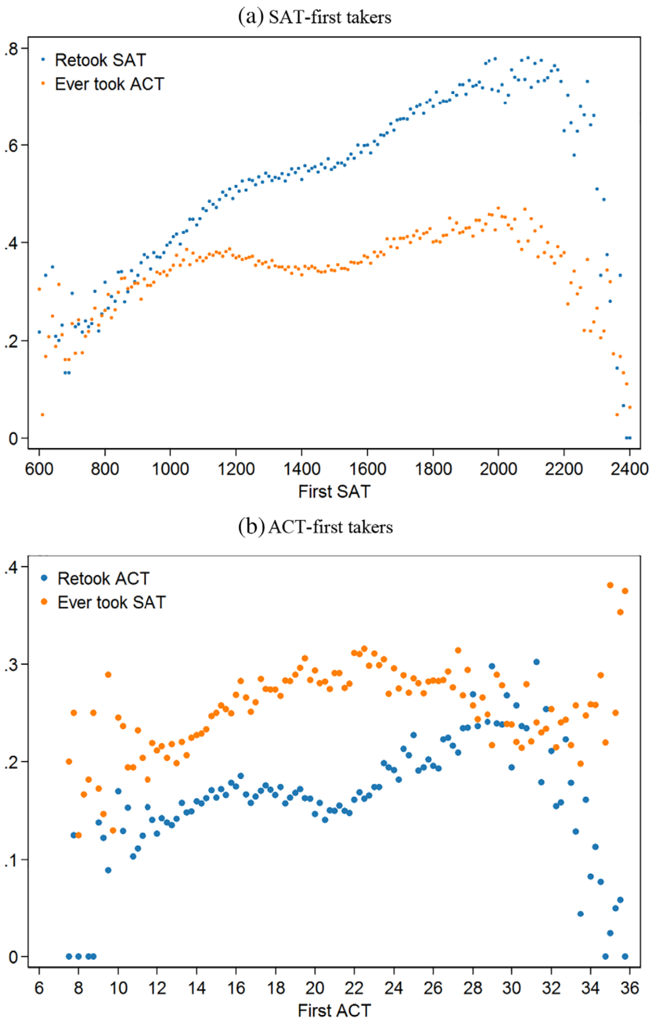

FIGURE 4 **Retaking and switching exams by first exam score**. (a) SAT-first takers (b) ACT-first takers. The figures above plot students first exam scores on the horizontal axis. Panel A shows the share of SAT-first takers who retake the SAT and switch to the ACT for each possible first SAT score. Panel B shows the share of ACT-first takers who retake the ACT and switch to the SAT for each possible (unrounded) first ACT score [Color figure can be viewed at wileyonlinelibrary.com]

high scorers, SAT retaking rates increase relatively linearly over the distribution of first SAT scores. Second, there is a bimodal relationship between first SAT scores and switching to the ACT. Switching rates increase among very low scorers until reaching its first peak around 1200 before beginning to drop slightly to a low point around 1500. Switching rates then increase again, reaching its second peak around 2000 before dropping off among very high scorers. This pattern possibly supports the hypothesis that a low initial SAT score may discourage some students and induce them to switch to the ACT. Panel B of Figure 4 plots retaking and switching rates among ACT-first takers for each possible (unrounded) ACT score. Interestingly, and in contrast to SAT-first takers, switching exams is common among very high ACT scorers.

We next explore how Georgia's college admissions policy context—namely, USG's minimum admissions thresholds—influences students' exam-taking choices. These SAT and ACT score thresholds are publicly known, so students who fail to meet the requirements on their first attempt may alter their exam-taking strategies in order to gain access to the in-state 4-year public sector in Georgia. We use a regression discontinuity specification following Goodman et al. (2017) to estimate how students respond to failing to meet USG's minimum SAT and ACT score requirements. See Appendix B for details on this specification.

We report our estimates of the effects of scoring below USG's minimum admissions thresholds on exam retaking and switching in Panel A of Table 3 and the graphical relationships in Figures 5 and 6.[16] First, we confirm Goodman et al. (2017) with our estimate that scoring below USG's SAT minimum increases SAT retaking rates by 4.4 percentage points.[17] Second, we show that this retaking effect holds among ACT-first takers by showing that scoring below USG's ACT minimum increases ACT retaking by 2.7 percentage points. Third, we estimate that scoring below USG's minimum SAT threshold increases the probability of ever taking the ACT by 2.2 percentage points. This suggests that failing to meet USG's requirements on their first SAT attempt induces students to switch to the ACT in order to explore exam options to meet USG's requirements. However, unlike students who first take the SAT, we do not find that students who fail to meet USG's ACT threshold influences exam switching.[18]

Lastly, we consider behavioral responses to whether first exam scores that fall near round numbers influences the SAT and ACT exam portfolio students take. We estimate the influence of scoring below round numbers on exam-taking strategies using an RD specification similar to Goodman et al. (2020) that "stacks" each of the round number thresholds in one regression to obtain a single estimate that represents the average effect of scoring below a round number threshold. See Appendix B for details on this specification. We report our estimates in Panel B of Table 3 and the graphical relationships in Figures 7 and 8.[19]

First, we replicate Goodman et al. (2020)'s finding that scoring below a round number threshold on the SAT increases the probability of retaking by 0.9 percentage points when we focus on students who take their first SAT relatively early.[20] Second, we show that this retaking effect holds for ACT-first takers by estimating that scoring below a 20 or 30 on the ACT increases the probability of retaking the ACT by 1.5 percentage points. Finally, we conclude that scoring below a round number on either the SAT or ACT does not induce students to switch to the other exam.[21] Although we show a statistically significant estimate for scoring below an ACT round number, we consider the graphical evidence—which shows no clear discontinuity—as more reliable.

[16]We report estimates of the heterogeneity in these effects by student characteristics in Table A2.

[17]Our estimated effect is larger than the effect estimated by Goodman et al. (2017). This is likely explained by the slightly different sample, as Goodman et al. (2017) uses different cohorts and includes private school students. The larger effect that we estimate emphasizes the significant demand for access to Georgia's 4-year public sector among Georgia's public high school students.

[18]We cannot determine why USG's thresholds would influence exam-switching among SAT-takers but not ACT-takers but one potential reason is the differences between students who choose to take the SAT first versus students who choose to take the ACT first.

[19]We report estimates of the heterogeneity in these effects by student characteristics in Table A2.

[20]Specifically, we subset our sample for students who first took the SAT before the end of 11th grade and thus have ample time to take more exams. This is a similar sample restriction carried out by Goodman et al. (2020).

[21]One hypothesis for why we find that scoring below USG's admissions threshold induces switching to the ACT but scoring below an SAT round number does not, is that failing to meet USG's standards causes some students to be discouraged about their prospects on the SAT, but just falling short of a round number target score does not have a similar discouraging effect.

TABLE 3 First exam scores and exam-taking strategies

	SAT-first takers		ACT-first takers	
	Retook SAT (1)	Ever took ACT (2)	Retook ACT (3)	Ever took SAT (4)
Panel A: USG's minimum admission thresholds				
All takers	0.044***	0.022***	0.027***	−0.001
	(0.004)	(0.004)	(0.004)	(0.003)
	[175,648]	[175,648]	[116,736]	[116,736]
Panel B: Round number thresholds				
All takers	0.004	0.001	0.015***	0.008**
	(0.003)	(0.003)	(0.005)	(0.003)
	[347,825]	[347,825]	[116,288]	[116,288]
Early takers	0.009***	0.002	0.022**	0.017***
	(0.004)	(0.003)	(0.009)	(0.005)
	[216,863]	[216,863]	[36,356]	[36,356]

Notess: In Panel A, each coefficient is from a separate regression representing the impact of scoring below the USG minimum admission threshold on exam taking. Bandwidths are [−60, 60] for SAT scores and [−6, 6] for ACT scores. "All takers" consists of the full sample of all exam takers in the high school classes of 2009–2015. In Panel B, the sample in columns (1) and (2) consist of all SAT-first takers from the high school classes of 2009–2015 within a 50-point bandwidth of a multiple of 100 between 700 and 2300. Each coefficient is an estimate of the impact of scoring below a multiple of 100 on exam taking strategies. The sample in columns (3) and (4) consist of all ACT-first takers from the same cohorts within a five-point bandwidth of a 20 or 30 score. Each coefficient is an estimate of the impact of scoring below a 20 or 30 on exam taking strategies. Panel A includes the full sample of SAT-first or ACT-first takers. "Early takers" represents students who took their first exam in their junior year of high school. Heteroskedasticity robust *SE* clustered by the relevant first exam score are in parentheses.
$^{*}p < .10$, $^{**}p < .05$, $^{***}p < .01$.

4 | IMPACTS OF EXAM-TAKING STRATEGIES

In this section, we consider the potential impacts of different exam portfolios on students' exam performance and college enrollment outcomes. We plot the unconditional relationships between exam-taking strategies and admissions score improvements between the first and final exam taken in Figure 9 and 4-year college enrollment rates in Figure 10.[22] In each figure, Panel A includes students who first took the SAT while Panel B includes students who first took the ACT. By default, students who take only one exam do not improve upon their scores from their first exam, which exactly equal their final admissions score. Students who take strategies involving more than one exam experience substantial score improvements. Admissions score improvements for most SAT-first takers average about 100 points for strategies with two exams and 150 points for strategies with three or more exams. Average admissions score improvements are larger for lower scores and smaller for higher scorers. Finally, conditional on the number of exams taken, these averages show only small

[22]See Figures A1 through A5 for similar figures of other college enrollment outcomes.

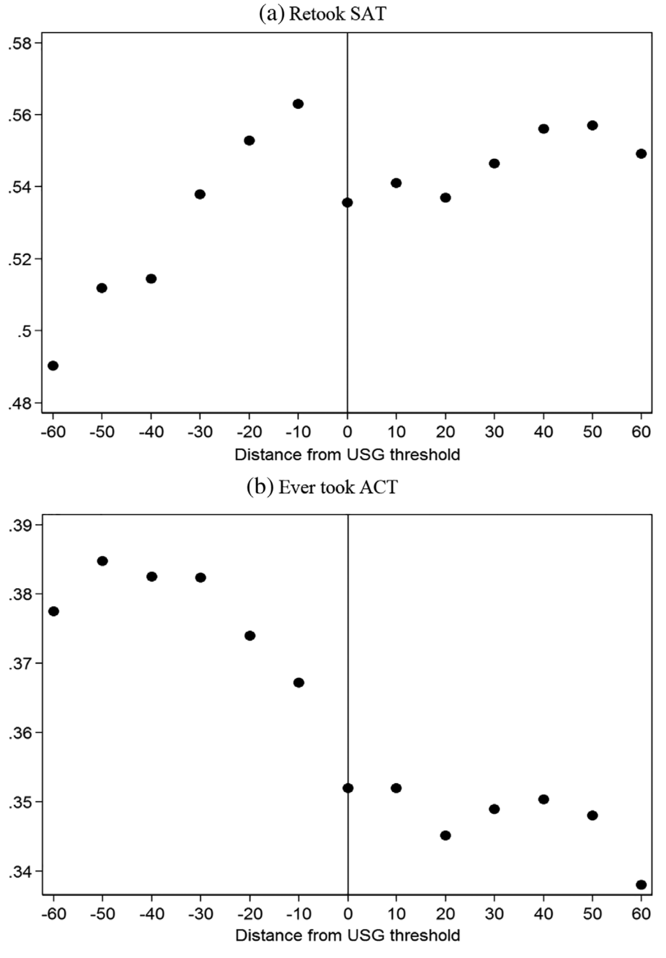

FIGURE 5 USG's SAT minimum admissions thresholds and exam taking. (a) Retook SAT (b) Ever took ACT. Shown above are average SAT retaking rates (Panel A) and the fraction ever taking the ACT (Panel B) as a function of students' first SAT score distance from USG's minimum SAT score threshold. The sample consists of all students who took the SAT first from Georgia public high school classes of 2009–2015

differences in score improvements between exam portfolios, except for very high initial scorers.

Similar patterns are observed with 4-year college enrollment rates. Strategies that involve taking more exams are associated with higher rates of 4-year college enrollment, with a large gap between taking only one exam (either SAT or ACT) and all other strategies. Four-year college enrollment gaps between strategies of more than one exam exist but are generally much smaller.

Our goal with this analysis is to determine to what extent the higher admissions scores and four-year college enrollment rates associated with these exam-taking strategies can be attributed solely to the strategies. Since the exam-taking strategy that a student chooses is not exogenously determined, we must attempt to account for this endogeneity in our empirical strategy. We use a selection-on-observables approach and, in a few analyses, explore using the round numbers and USG admission thresholds as instruments, noting that there are weaknesses to the

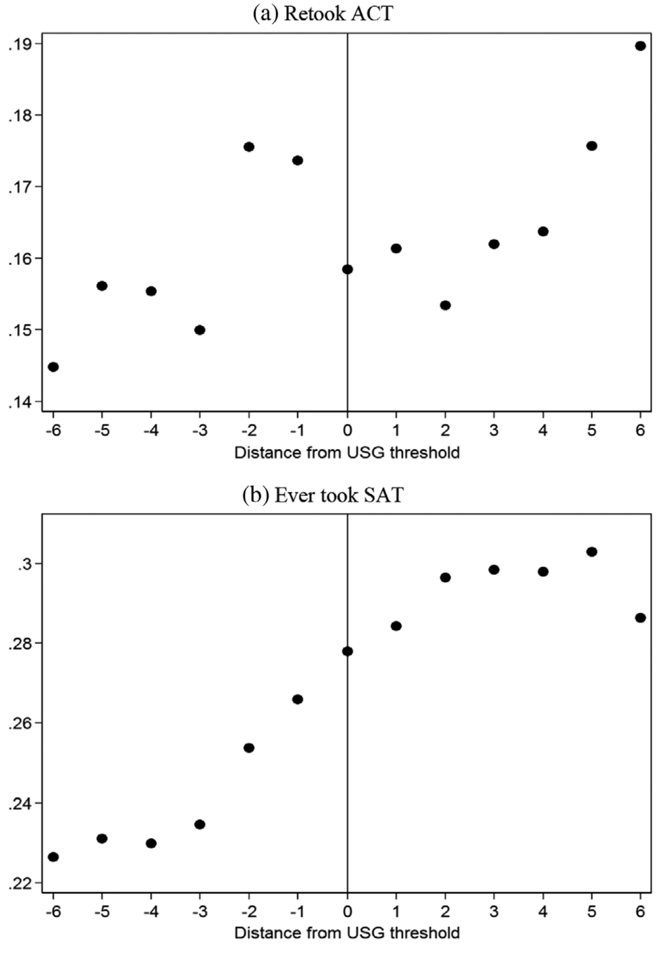

FIGURE 6 USG's ACT minimum admissions thresholds and exam taking. (a) Retook ACT (b) Ever took SAT. Shown above are average ACT retaking rates (Panel A) and the fraction ever taking the SAT (Panel B) as a function of students' first ACT score distance from USG's minimum ACT score threshold. The sample consists of all students who took the ACT first from Georgia public high school classes of 2009–2015

instruments.[23] We regress our outcomes on indicators for a mutually exclusive set of exam-taking strategies, while controlling for student demographics, high school academics, and high school by cohort fixed effects. Specifically, we estimate the following equation:

$$Y_{ijc} = \sum_{s} \beta^{s} Strategy_{ijc}^{s} + \gamma X_{i} + \delta_{jc} + \varepsilon_{ijc} \tag{1}$$

Where Y is an admissions score or college enrollment outcome for student i in high school j and cohort c. The term inside the summation is a vector of indicators for the set of mutually exclusive exam-taking strategies. The vector X includes our controls for student

[23]Ideally, we would have a valid instrument for each strategy. The round numbers could be a valid instrument but lacks statistical power. USG's minimum admissions thresholds violate the exclusion restriction when the outcome is college enrollment (but not admissions scores). We explore their validity in a few analyses.

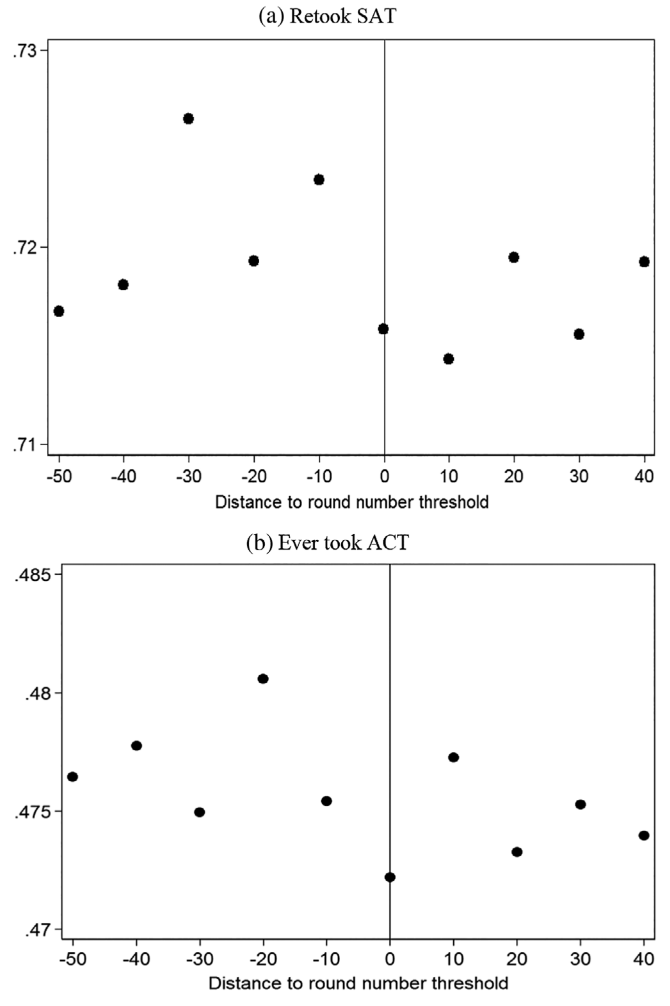

FIGURE 7 **SAT round numbers and exam taking (early takers)**. (a) Retook SAT (b) Ever took ACT. Shown above are the average SAT retaking rates (Panel A) and the fraction ever taking the ACT (Panel B) as a function of students' first SAT score distance from the nearest multiple of 100. The sample consists of all students who took the SAT first in their Junior year from Georgia public high school classes of 2009–2015

demographics and high school academics, which include gender, race, ethnicity, FRL status, fixed effects for high school GPA in bins of 0.25 points, and indicators for participation in gifted and dual enrollment coursework. Finally, we flexibly control for the influence high schools have on the choice of strategy by including high school by cohort fixed effects (δ_{jc}).

Since we lack exogenous variation in choices of exam-taking strategies, it is important to consider possible sources of omitted variable bias. First, while we use high school performance measures to attempt to capture a student's underlying ability, these measures likely do not capture this perfectly. Second, we can control for whether a student was FRL eligible, but this is a particularly crude measure of family income which can obscure important variation in household resources at both the top and bottom of the income distribution (Michelmore & Dynarski, 2017). Finally, another important factor we cannot account for is a student's preference for attending college or attending a particularly selective college that

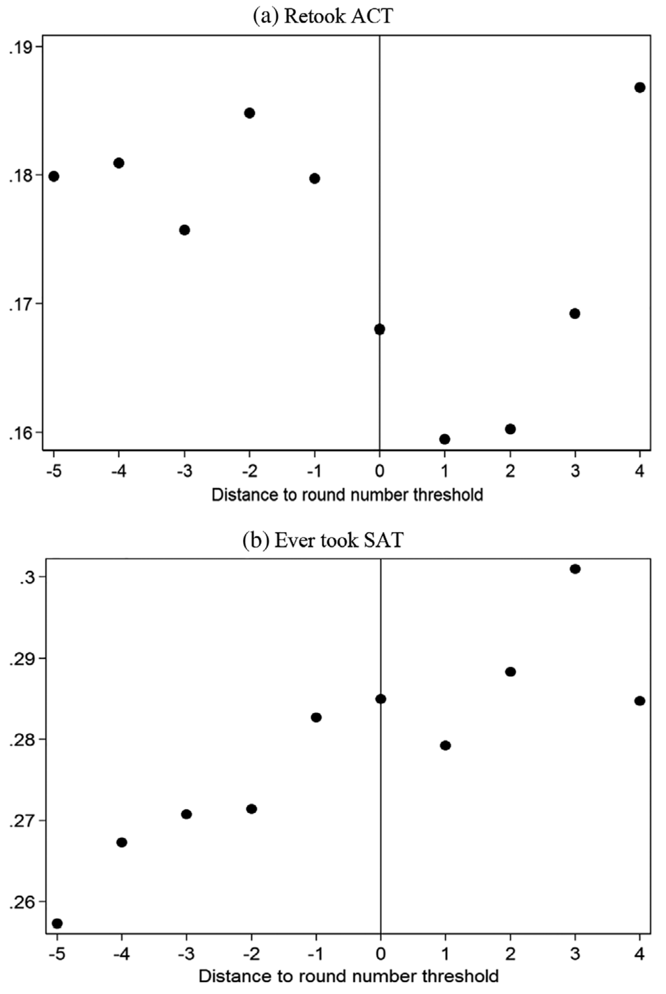

FIGURE 8 **ACT round numbers and exam taking**. (a) Retook ACT (b) Ever took SAT. Shown above are average ACT retaking rates (Panel A) and the fraction ever taking the SAT (Panel B) as a function of students' first ACT score distance from nearest multiple of 10. The sample consists of all students who took the ACT first from Georgia public high school classes of 2009–2015

is independent of our high school academic controls. Without the ability to control for covariates that are positively correlated with both choice of exam-taking strategy and college enrollment, our estimates would overstate the true causal relationship. We later assess and discuss the plausibility of our estimates, noting that our estimates of the impact of strategies on college enrollment outcomes align very closely to the causal local average treatment effect estimates from Goodman et al. (2020), which gives us some confidence in our empirical approach.

4.1 | Admissions-relevant scores

Column (1) of Table 4 presents our estimates from Equation (1) using the full sample of exam takers. The omitted category in the vector of mutually exclusive strategies is "SAT only, once."

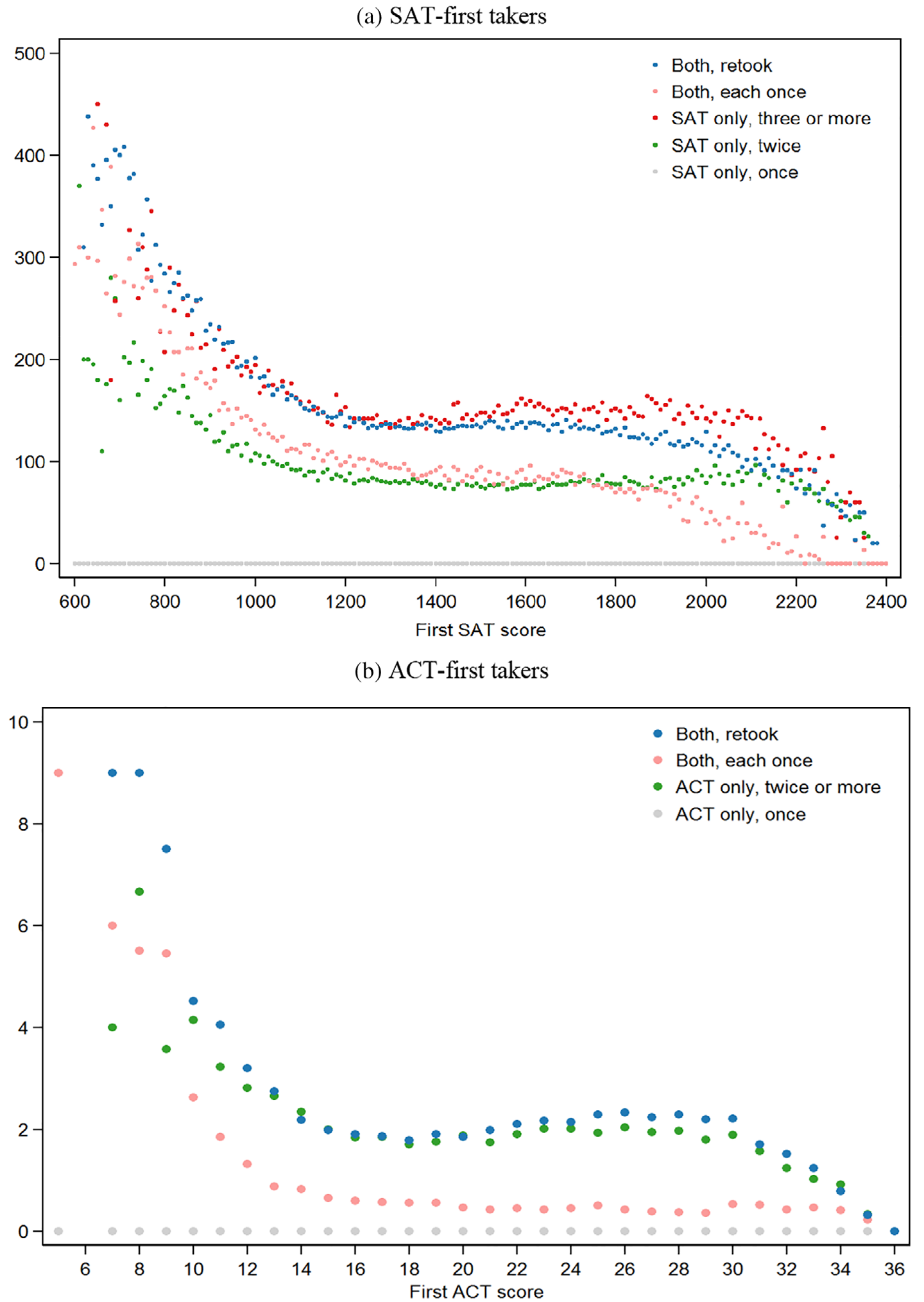

FIGURE 9 **Difference between final admissions score and first exam score, by strategy**. (a) SAT-first takers (b) ACT-first takers. Shown above are the average admissions score improvements between students' first exam and their final exam as a function of their first score. Panel A shows students who first took the SAT and Panel B shows students who first took the ACT. The sample consists of all exam takers from the Georgia public high school classes of 2009–2015 [Color figure can be viewed at wileyonlinelibrary.com]

Comparing strategies that involve taking only one exam, we detect no significant admissions score difference between taking the SAT or the ACT, though the estimates are imprecise. Next, we note that, in general, exam-taking strategies that involve more exams produce higher

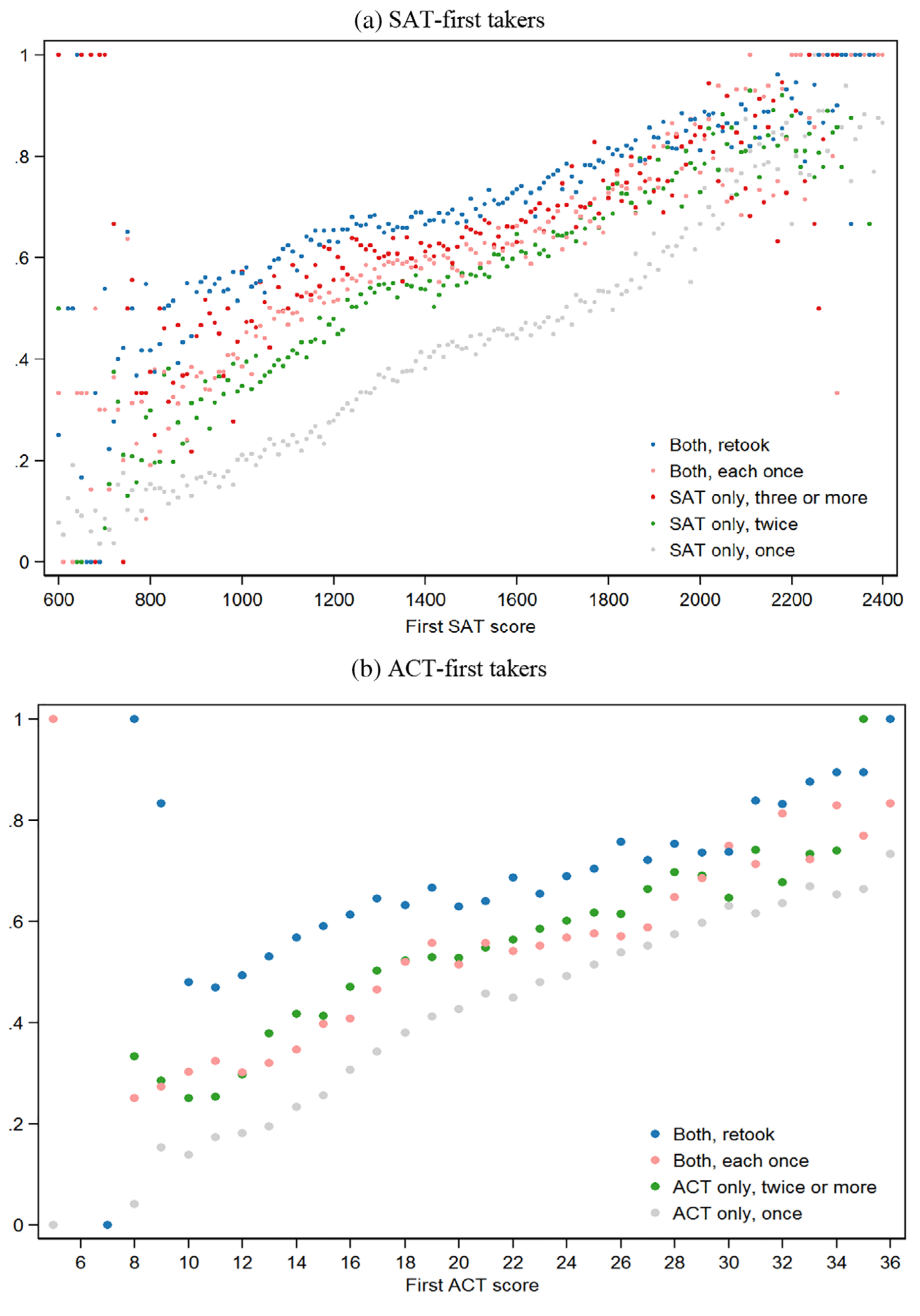

FIGURE 10 **Four-year college enrollment rates, by strategy**. (a) SAT-first takers (b) ACT-first takers. Shown above are the 4-year college enrollment rates as a function of their first score. Panel A shows students who first took the SAT and Panel B shows students who first took the ACT. The sample consists of all exam takers from the Georgia public high school classes of 2009–2015 [Color figure can be viewed at wileyonlinelibrary.com]

admissions scores. Relative to taking only one exam, our estimates imply that taking a second and third exam is associated with 48–73 and 73–100 points higher admissions scores, respectively. This is an unsurprising result given that admissions scores can only increase with each

TABLE 4 Exam-taking strategies and admissions-relevant scores

	All takers (1)	SAT-first takers (2)	ACT-first takers (3)
SAT only, once	(omitted)	(omitted)	
ACT only, once	10.3		(omitted)
	(26.0)		
SAT only, twice	67.3***	66.4***	
	(3.8)	(2.6)	
ACT only, twice or more	73.3***		64.2***
	(19.5)		(6.5)
Both, each once	48.4***	41.1***	52.7***
	(9.3)	(3.5)	(5.2)
SAT only, three or more	100.8***	99.2***	
	(4.6)	(2.8)	
Both, three or more exams	72.9***	70.7***	68.4***
	(5.8)	(2.9)	(5.8)
Demographic controls	X	X	X
HS academic controls	X	X	X
HS by cohort fixed effects	X	X	X
Observations	483,273	347,757	135,403

Note: Each column is a regression of a college admissions-relevant score on mutually exclusive exam-taking strategies. If students only take the SAT (ACT), the admissions-relevant score is their SAT (ACT) superscore. If students take both the SAT and ACT, the admissions-relevant score is the maximum of their SAT and ACT superscores, where the ACT superscore is concorded into SAT-equivalent terms. Column (1) consists of all exam takers in the Georgia public high school classes of 2009–2015. Columns (2) and (3) consist of the subset of students who took the SAT and ACT first, respectively. Heteroskedasticity robust *SE* clustered at first exam scores are in parentheses.
$^{*}p < .10$, $^{**}p < .05$, $^{***}p < .01$.

additional exam attempt. However, these estimates imply a diminishing return to taking additional exams. The marginal score increase is higher for a second exam than it is for a third exam.

Conditional on the number of exams taken there are higher admissions score returns to sticking with either the SAT or ACT compared with diversifying the exam portfolio with attempts on both the SAT and ACT. For instance, relative to taking the SAT only once, taking the SAT twice is associated with 67 points higher admissions scores than only taking the SAT once, whereas taking both the SAT and ACT each once is associated with only 48 points higher admissions scores (a 19-point gap). Additionally, taking the SAT three or more times is associated with about 28 points higher admissions scores than taking three or more exams with a mix of SAT and ACT attempts. For each of these comparisons, F-tests reject the null hypothesis that the coefficients are equal.

Finally, there appears to be very little difference in the admissions score returns to two-exam strategies that involve either only the SAT or only the ACT compared with three-exam strategies that involve a mix of both the SAT and ACT. For example, the estimated admissions score returns to taking three or more exams with a mix of both the SAT and ACT is only about one point higher than taking the SAT twice. Columns (2) and (3) of Table 4 run the same regressions separately for students who took the SAT and ACT first, respectively. Among ACT-first takers, the benefit of sticking with the ACT through two exams rather than switching to the SAT is somewhat less than when using the full sample. Otherwise, the results are consistent with all the findings from the full sample analysis.

We also replicate this analysis using maximum scores as opposed to our admissions scores in Table A3. Maximum scores are defined as a student's highest total/composite score across all attempts. If students take both the SAT and ACT, we use the higher of their SAT and ACT maximum scores, where the ACT maximum score is in SAT-equivalent terms. By default, maximum score returns for strategies involving only one attempt on either the SAT, ACT, or both are identical to admissions scores returns. The estimated score returns for strategies that involve retaking an exam are naturally smaller than when using admissions scores. However, score increases from taking more exams are still large, illustrating that the estimated score impacts in Table 4 are not solely a product of superscoring.

4.2 | College enrollment outcomes

Table 5 shows our estimates of the relationship between exam-taking strategies and college enrollment outcomes. Consistent with the estimated score returns, taking more exams is associated with higher enrollment in 4-year colleges and lower enrollment in 2-year colleges, albeit with each additional exam exhibiting a diminishing return. In columns (1) and (2), coefficients on strategies involving three or more exams are generally larger than coefficients on strategies involving two exams, which themselves are generally larger than coefficients on one-exam strategies. For example, relative to taking the SAT only once, strategies that involve two exams are associated with 10–12 percentage points higher enrollment in four-year colleges, while strategies that involve three or more exams are associated with 18–19 percentage points higher 4-year enrollment rates. Higher 4-year enrollment rates result partially from less enrollment in 2-year colleges, with strategies involving two and three or more exams associated with 1–5 and 6–7 percentage points lower enrollment, respectively, relative to taking the SAT only once.

Conditional on the number of exams taken, the exam portfolio does not appear to play a significant role in college enrollment outcomes. For instance, there is a less than 1 percentage point difference between the estimate of taking the SAT only three or more times and taking three or more exams with attempts on both the SAT and ACT. This comes in contrast with our estimates of score returns. This could mean that our admissions score measure does not accurately capture how colleges consider students with both SAT and ACT scores. Alternatively, this could result because college admissions decisions are not made solely upon SAT and ACT scores, but rather made through a holistic consideration of additional factors such as high school coursework, extracurricular contributions, personal essays, and external recommendations.

Finally, in columns (3)–(6) we show the relationships between exam-taking strategies and college quality, conditional on enrollment, as measured by college-level graduation rates, average earnings 6 years after entering the labor market, and student loan default and repayment rates 3 years after entering repayment. The patterns we find here are consistent with the college enrollment outcomes. In general, taking more exams is associated with enrollment in college where students experience better outcomes on average. Relative to taking the SAT only once, strategies involving two exams are associated with enrollment in colleges with 2–4 percentage points higher graduation rates, \$500–\$1200 higher average annual earnings, and 0.5–

TABLE 5 Exam-taking strategies and college enrollment outcomes, all takers

	4-year college enrollment (1)	2-year college enrollment (2)	College's graduation rate (3)	College's mean earnings (000 s) (4)	College's default rate (5)	College's repayment rate (6)
SAT only, once	(omitted)	(omitted)	(omitted)	(omitted)	(omitted)	(omitted)
ACT only, once	0.026*	0.003	0.019***	0.314**	0.000	0.010***
	(0.014)	(0.009)	(0.004)	(125.838)	(0.002)	(0.002)
SAT only, twice	0.120***	−0.048***	0.042***	1.209***	−0.012***	0.024***
	(0.003)	(0.002)	(0.002)	(0.060)	(0.000)	(0.001)
ACT only, twice or more	0.101***	−0.014*	0.037***	0.764***	−0.005***	0.019***
	(0.010)	(0.008)	(0.004)	(0.154)	(0.002)	(0.003)
Both, each once	0.101***	−0.025***	0.028***	0.570***	−0.006***	0.015***
	(0.006)	(0.004)	(0.002)	(0.062)	(0.001)	(0.001)
SAT only, three or more	0.181***	−0.070***	0.081***	2.420***	−0.018***	0.045***
	(0.005)	(0.004)	(0.004)	(0.123)	(0.001)	(0.002)
Both, three or more exams	0.188***	−0.061***	0.069***	1.694***	−0.015***	0.037***
	(0.004)	(0.004)	(0.002)	(0.081)	(0.001)	(0.002)
Demographic controls	X	X	X	X	X	X
HS academic controls	X	X	X	X	X	X
HS by cohort fixed effects	X	X	X	X	X	X
Observations	483,324	483,324	327,297	359,486	320,004	319,994

Note: Each column is a regression of a college enrollment outcome on the exam-taking strategies. The sample consists of all exam takers in the Georgia public high school classes of 2009–2015. 4-year and 2-year college enrollment is observed from NSC records in the GA•AWARDS data. College graduation rates are observed from IPEDS. Mean earnings, student loan default, and repayment rates are observed from the College Scorecard. Mean earnings are from students entering the labor market in 2008, measured 6 years after entry. Student loan default and repayment rates are from students entering repayment in 2013, where rates are observed 3 years after entering repayment. The college scorecard defines students as being in "repayment" if they are not in default and have loan balances that have declined since entering repayment, while excluding currently enrolled and military deferment from the calculation. Heteroskedasticity robust *SE* clustered at first exam scores are in parentheses.
$^{*}p < .10$, $^{**}p < .05$, $^{***}p < .01$.

1.2 percentage points lower student loan default rates. Meanwhile, strategies with three or more exams are associated with enrollment in colleges with 6–8 percentage points higher graduation rates, $1600–$2400 higher average annual earnings, and 1–2 percentage points lower student loan default rates. Again, similar to the enrollment outcomes, we see little differences in impacts of different strategies conditional on the number of exams taken.

4.3 | Validation exercises

In this subsection, we briefly summarize the exercises we conduct to assess our selection-on-observables empirical strategy. A full description and discussion of these analyses is available in Appendix C. We compare magnitudes between our estimates and other estimates that answer slightly different questions but use different identification strategies. First, we use thresholds from USG's minimum admissions requirements and round number scores to make RD estimates of the effect of taking more than one exam. These RD estimates of taking more than one exam on admissions scores are all substantially larger than the strategy impacts we estimated using our selection-on-observables approach in Table 4. We find this reassuring since the primary omitted variable bias concerns with our selection-on-observables approach would lead us to over-estimate the effects of exam-taking strategies. Second, we use our selection-on-observables approach to estimate the effects of retaking an exam. Strikingly, we estimate very similar coefficients to the estimated causal effects of SAT retaking from Goodman et al. (2020).

5 | DISCUSSION

5.1 | Implications for college enrollment gaps

We use the estimated impacts of exam-taking strategies to infer the share of 4-year college enrollment gaps by FRL status would be reduced by closing the disparities in exam strategies. We find that eliminating strategy disparities between FRL and non-FRL students would close about 20% of the 4-year college enrollment gap among exam takers. To show this, we begin with the strategy disparities between FRL and non-FRL students in Figure 1. We then multiply these strategy disparities by our estimated 4-year enrollment impacts among FRL students for each strategy presented in column (5) of Table A4. Summing these products across the strategies suggests that eliminating disparities across each strategy would increase 4-year college enrollment rates among FRL exam takers by 2.2 percentage points. This represents about 20% of the initial 12-point gap in 4-year enrollment rates between FRL and non-FRL exam takers. These calculations ignore any possible general equilibrium effects that initiatives to equalize strategy take up between student groups might have on colleges or other students.

5.2 | Conclusion

Millions of students in the United States who take college entrance exams each year face decisions about how many exams to take and whether to take the SAT, ACT, or both. Using administrative data from Georgia, we document disparities in college entrance exam-taking strategies, explore determinants of these strategies, and provide evidence of the relative benefits of different strategies. Relative to the prior literature which focuses exclusively on either the SAT or ACT, we use data on all students' attempts on both exams, which provides a complete picture of exam taking. We show that conditional on the number of exams taken, the portfolio of exams taken does not make a large difference for college enrollment outcomes or measures of college quality. Meanwhile, we do find evidence that, relative to taking a mix of SAT and ACT exams, sticking with one type of exam can be beneficial in terms of admissions-relevant scores. Together, this evidence suggests there are little to no benefits to diversifying the exam portfolio with attempts on both the SAT and ACT compared with sticking with one type of exam.

We also show that, consistent with previous research, exam-taking strategies that involve taking additional exams are associated with substantial improvements in college enrollment outcomes of students. In light of recent evidence on the long-run impacts of enrollment in the 4-year public sector (Goodman et al., 2017; Smith et al., 2020), this is important because there are large differences in take-up rates of different exam-taking strategies between FRL and non-FRL students.

While our results offer some insights, they also open up several questions. Why do colleges use exam scores the way they do? Vigdor and Clotfelter (2003) calculate that the current environment where colleges rely on superscores for admissions considerations is “the costliest, least accurate, and most biased” among the other options such as using the average score across all exams or simply using students' first exam scores. In addition, are students better or worse off by the existence of two types of exams? Most other countries have a single college admission exam. Future research should consider the welfare implications of the higher education admission processes with regards to exams.

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APPENDIX A: Tables and figures

TABLE A1 State comparison of exam taking and Google trends search intensity

	SAT takers		ACT takers				
	Number (1)	Percent of graduates (2)	Number (3)	Percent of graduates (4)	Ratio of SAT to ACT takers (5)	SAT Google search intensity (6)	ACT Google search intensity (7)
Maine	13,936	91	1434	9	9.72	62	12
Delaware	9823	100*	1869	20	5.26	74	20
Rhode Island	8103	71	2015	18	4.02	60	16
Pennsylvania	96,826	68	29,776	21	3.25	73	21
Massachusetts	61,277	82	19,617	26	3.12	71	18
Maryland	48,845	73	15,753	24	3.10	78	23
New Hampshire	10,738	67	3487	22	3.08	63	18
District of Columbia	4718	86	1602	29	2.95	53	19
New Jersey	85,021	78	30,263	28	2.81	100	25
Connecticut	36,445	82	13,175	30	2.77	88	27
New York	153,543	72	58,136	27	2.64	77	23
Washington	44,423	60	16,944	23	2.62	49	17
Idaho	17,695	95	7362	39	2.40	40	36
Virginia	59,621	66	25,038	28	2.38	61	16
Vermont	4564	62	2179	30	2.09	64	23
California	241,553	53	121,815	26	1.98	60	21
Indiana	47,548	64	27,415	37	1.73	64	30
Texas	193,768	59	124,764	38	1.55	60	29
Georgia	**72,898**	**67**	**54,653**	**50**	**1.33**	**72**	**40**
Alaska	3799	47	2868	35	1.32	50	20
Nevada	11,487	47	9308	38	1.23	42	20

TABLE A1 (Continued)

	SAT takers		ACT takers				
	Number (1)	Percent of graduates (2)	Number (3)	Percent of graduates (4)	Ratio of SAT to ACT takers (5)	SAT Google search intensity (6)	ACT Google search intensity (7)
Oregon	17,405	45	14,198	37	1.23	35	13
South Carolina	26,336	58	25,151	55	1.05	68	38
Florida	122,939	66	130,798	70	0.94	62	40
Hawaii	7888	55	11,957	84	0.66	60	21
Arizona	21,545	31	35,248	50	0.61	38	20
North Carolina	58,022	56	100,557	96	0.58	68	26
West Virginia	2501	14	11,289	62	0.22	36	61
Ohio	17,253	13	91,607	68	0.19	36	61
New Mexico	2292	11	13,393	64	0.17	31	43
Montana	1362	14	9489	97	0.14	30	31
Colorado	6485	12	57,328	100*	0.11	25	32
Minnesota	3205	5	46,862	77	0.07	22	51
Tennessee	4497	7	68,737	100*	0.07	29	69
Kansas	1528	4	23,708	69	0.06	24	49
Oklahoma	1720	4	30,844	77	0.06	26	61
Alabama	2929	6	55,427	100*	0.05	30	98
Wisconsin	2277	3	46,738	71	0.05	19	53
Missouri	2379	3	49,640	72	0.05	22	57
Arkansas	1207	4	26,955	84	0.04	24	90
Iowa	986	3	22,675	65	0.04	20	52
Louisiana	1976	4	49,082	100	0.04	25	79
Nebraska	723	3	18,347	79	0.04	20	60
Utah	1527	4	40,629	100*	0.04	20	48
Illinois	5728	4	157,047	100	0.04	24	52
South Dakota	238	3	6615	78	0.04	19	54
Kentucky	1731	4	49,538	100*	0.03	25	69
Michigan	3765	3	118,555	100*	0.03	26	49
Wyoming	181	3	6042	100*	0.03	15	37
Mississippi	858	3	29,345	100*	0.03	24	100
North Dakota	134	2	7162	97	0.02	15	35

Note: Columns (1) and (3) show the number of high school graduates from 2015 who took the SAT and ACT, which we obtain from publicly available reports from the College Board and ACT, respectively. For columns (2) and (4), we divide the number of test takers by projections of 2015 high school graduates from the National Center for Education Statistics. Asterisks indicate instances where we round down to 100 because percent calculations were greater than 100. Columns (6) and (7) are Google trends data between 2008 and 2015 for searches for the SAT or ACT test. Google calculates these values on a scale from 0 to 100, where 100 is the location with the most popularity as a fraction of total searches in that location, a value of 50 indicates a location which is half as popular. The search intensity presented here is not comparable across the test types.

TABLE A2 Heterogeneity in effects of USG's minimum admission and round number thresholds on exam taking

	SAT-first takers		ACT-first takers	
	Retook SAT (1)	**Ever took ACT (2)**	**Retook ACT (3)**	**Ever took SAT (4)**
Panel A: USG thresholds				
FRL	0.066***	0.025***	0.033***	−0.0003
	(0.006)	(0.006)	(0.006)	(0.004)
	[88,195]	[88,195]	[63,462]	[63,462]
Non-FRL	0.023***	0.020***	0.018***	−0.004
	(0.005)	(0.003)	(0.005)	(0.004)
	[87,453]	[87,453]	[53,274]	[53,274]
URM	0.059***	0.031***	0.036***	−0.001
	(0.009)	(0.006)	(0.006)	(0.004)
	[80,259]	[80,259]	[55,401]	[55,401]
Non-URM	0.031***	0.015***	0.019***	−0.004
	(0.003)	(0.004)	(0.003)	(0.005)
	[95,389]	[95,389]	[61,335]	[61,335]
Panel B: Round number thresholds				
FRL	0.0004	−0.0004	0.017***	−0.006
	(0.004)	(0.003)	(0.006)	(0.011)
	[161,170]	[161,170]	[52,447]	[52,447]
Non-FRL	0.007*	0.003	0.018***	0.014***
	(0.004)	(0.004)	(0.005)	(0.004)
	[186,655]	[186,655]	[63,841]	[63,841]
URM	−0.001	0.002	0.019***	−0.004
	(0.005)	(0.004)	(0.006)	(0.011)
	[145,717]	[145,717]	[44,307]	[44,307]
Non-URM	0.008**	0.001	0.016***	0.009***
	(0.004)	(0.003)	(0.005)	(0.002)
	[202,108]	[202,108]	[71,981]	[71,981]

Note: In Panel A, each coefficient is from a separate regression representing the impact of scoring below the USG minimum admission threshold on exam taking. Bandwidths are [−60, 60] for SAT scores and [−6, 6] for ACT scores. In Panel B, the sample in columns (1) and (2) consist of all SAT-first takers from the high school classes of 2009–2015 within a 50-point bandwidth of a multiple of 100 between 700 and 2300. Each coefficient is an estimate of the impact of scoring below a multiple of 100 on exam taking strategies. The sample in columns (3) and (4) consist of all ACT-first takers from the same cohorts within a five-point bandwidth of a 20 or 30 score. Each coefficient is an estimate of the impact of scoring below a 20 or 30 on exam taking strategies. Heteroskedasticity robust *SE* clustered at the score's distance from the USG minimum threshold are in parentheses. Sample sizes are in brackets.

*$p < .10$, **$p < .05$, ***$p < .01$.

TABLE A3 Exam-taking strategies and maximum scores

	All takers (1)	SAT-first takers (2)	ACT-first takers (3)
SAT only, once	(omitted)	(omitted)	
ACT only, once	10.3		(omitted)
	(25.9)		
SAT only, twice	47.3***	46.4***	
	(3.7)	(2.5)	
ACT only, twice or more	45.4**		36.1***
	(19.7)		(6.2)
Both, each once	48.3***	41.0***	52.6***
	(9.2)	(3.5)	(5.2)
SAT only, three or more	70.5***	69.0***	
	(4.6)	(2.7)	
Both, three or more exams	56.7***	55.5***	47.3***
	(5.9)	(2.9)	(5.4)
Demographic controls	X	X	X
HS academic controls	X	X	X
HS by cohort fixed effects	X	X	X
Observations	483,273	347,757	135,403

Notes: Each column is a regression of a maximum exam score on mutually exclusive exam-taking strategies. Maximum scores are a student's highest total/composite score from a single exam attempt. ACT scores are converted into SAT-equivalent terms using official SAT-ACT concordance tables. If students take both the SAT and ACT, we use the higher of their SAT and ACT maximum scores, where the ACT maximum score is in SAT-equivalent terms. Column (1) consists of all exam takers in the Georgia public high school classes of 2009–2015. Columns (2) and (3) consist of the subset of students who took the SAT and ACT first, respectively. Heteroskedasticity robust *SE* clustered at first exam scores are in parentheses.
$^{*}p < .10$, $^{**}p < .05$, $^{***}p < .01$.

TABLE A4 Exam-taking strategies, admissions scores, and college enrollment, by FRL status and race/ethnicity

	Admissions score				4-year college enrollment			
	FRL (1)	Non-FRL (2)	URM (3)	Non-URM (4)	FRL (5)	Non-FRL (6)	URM (7)	Non-URM (8)
SAT only, once	(omitted)	(omitted)	(omitted)	(omitted)	(omitted)	(omitted)	(omitted)	(omitted)
ACT only, once	9.7	10.3	9.7	11.3	0.009	0.044***	0.018	0.034***
	(27.7)	(27.1)	(28.2)	(27.6)	(0.018)	(0.009)	(0.020)	(0.009)
SAT only, twice	68.0***	65.5***	69.2***	63.3***	0.139***	0.102***	0.143***	0.101***
	(3.7)	(3.4)	(4.3)	(3.7)	(0.004)	(0.003)	(0.004)	(0.003)
ACT only, twice or more	70.0***	74.8***	72.4***	72.8***	0.124***	0.089***	0.139***	0.081***
	(16.9)	(23.5)	(16.4)	(24.1)	(0.015)	(0.007)	(0.016)	(0.007)
Both, each once	53.6***	40.8***	51.6***	44.0***	0.100***	0.100***	0.111***	0.092***
	(10.4)	(8.3)	(10.3)	(9.1)	(0.008)	(0.005)	(0.009)	(0.005)

(Continues)

TABLE A4 (Continued)

	Admissions score				4-year college enrollment			
	FRL (1)	Non-FRL (2)	URM (3)	Non-URM (4)	FRL (5)	Non-FRL (6)	URM (7)	Non-URM (8)
SAT only, three or more	102.0***	95.7***	87.1***	99.2***	0.208***	0.160***	0.212***	0.157***
	(5.0)	(3.7)	(5.6)	(4.4)	(0.007)	(0.005)	(0.008)	(0.004)
Both, three or more exams	79.2***	66.3***	75.0***	67.4***	0.198***	0.174***	0.203***	0.171***
	(6.4)	(5.7)	(6.8)	(6.1)	(0.006)	(0.004)	(0.007)	(0.004)
Demographics	X	X	X	X	X	X	X	X
HS academics	X	X	X	X	X	X	X	X
HS by cohort FE	X	X	X	X	X	X	X	X
Observations	229,070	255,151	204,803	279,491	229,106	253,884	204,423	278,642

Note: Each column is a regression of a college enrollment outcome on the exam taking strategies. The sample consists of all exam takers in the Georgia public high school classes of 2009–2015. 4-year college enrollment is observed from NSC records in the GA•AWARDS data. Heteroskedasticity robust *SE* clustered at first exam scores are in parentheses.
$^*p < .10$, $^{**}p < .05$, $^{***}p < .01$.

APPENDIX B: Methodology for effects of USG and round number thresholds

To study how students respond to USG's minimum SAT and ACT score requirements, we use a local linear regression discontinuity (RD) specification. Specifically, we estimate the following:

$$S_{ic} = \alpha_0 + \alpha_1 Below_{ic} + \alpha_2 Distance_{ic} + \alpha_3 Below_{ic} * Distance_{ic} + \gamma X_i + \delta_c + \mu_{ic} \quad \text{(B1)}$$

where S is an indicator for an exam-taking strategy taken by individual i in high school cohort c. *Below* is an indicator for failing to meet relevant exam score threshold and *Distance* measures the number of SAT or ACT points each student's score is from the threshold.[24] We include student-level demographics and high school academics (X), and control flexibly for time-varying shocks by including high school cohort fixed effects (δ_c). We use a bandwidth of 60 points on either side of the SAT threshold and six points on either side of the ACT threshold. *SE* are clustered at the distance to the threshold. The parameter α_1 represents the effect of scoring below USG's minimum score threshold on exam taking. Additional details about this empirical strategy and its validity can be found in Goodman et al. (2017).

We estimate the influence of round numbers on exam-taking strategies using the following RD specification:

$$S_{irc} = \beta Below_{irc} + \theta X_i + \eta_c + \sum_n \left[R_n * (\alpha_n + \gamma_n Distance_{irc} + \delta_n Below_{irc} * Distance_{irc}) \right] + \varepsilon_c \quad \text{(B2)}$$

where S is an indicator for an exam-taking strategy taken by individual i near round number threshold r in high school cohort c. R is defined as an indicator for the nearest round

[24]Since there are subject-specific thresholds, we take the minimum distance across subjects, which generates a unidimensional running variable.

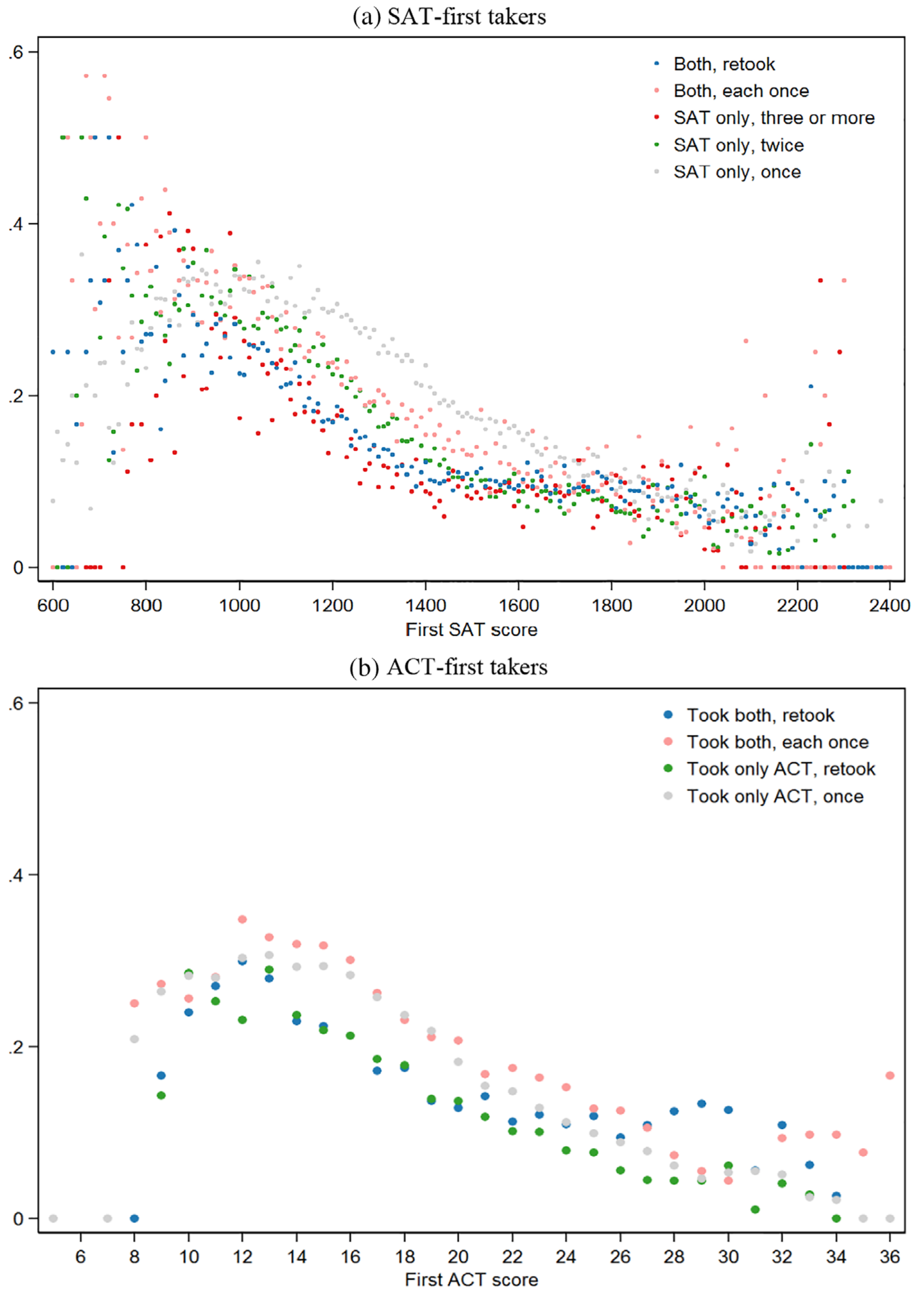


FIGURE A1 Two-year college enrollment rates by strategy and first exam score. (a) SAT-first takers (b) ACT-first takers. Shown above are the two-year college enrollment rates as a function of their first score. Panel A shows students who first took the SAT and Panel B shows students who first took the ACT. The sample consists of all exam takers from the Georgia public high school classes of 2009–2015 [Color figure can be viewed at wileyonlinelibrary.com]

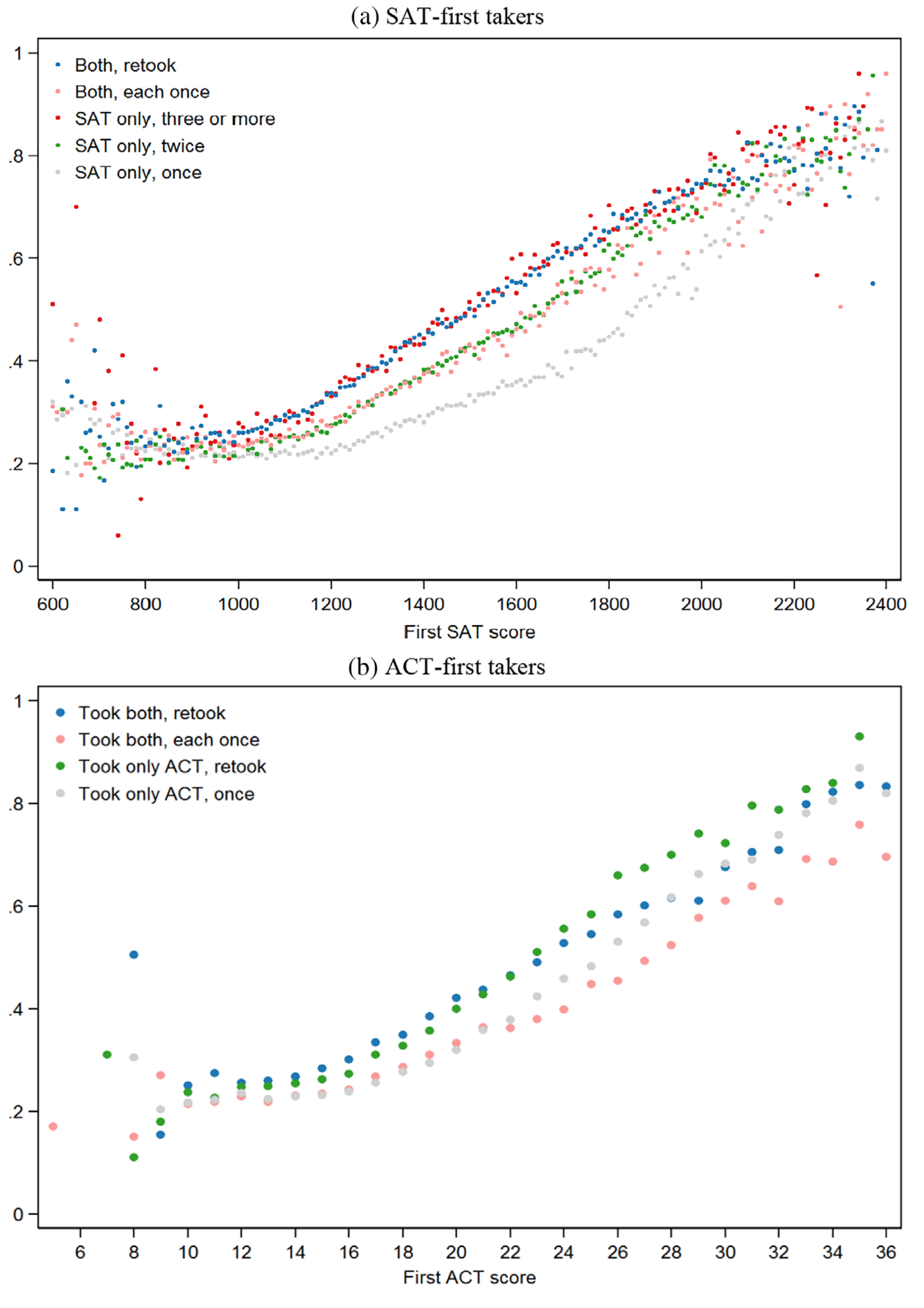


FIGURE A2 College's graduation rate by strategy and first exam score. (a) SAT-first takers (b) ACT-first takers. Shown above are the average institution-level graduation rates of college enrollees as a function of students' first exam score. College graduation rate data is sourced from IPEDS. Panel A shows students who first took the SAT and Panel B shows students who first took the ACT. The sample consists of all exam takers from the Georgia public high school classes of 2009–2015 [Color figure can be viewed at wileyonlinelibrary.com]

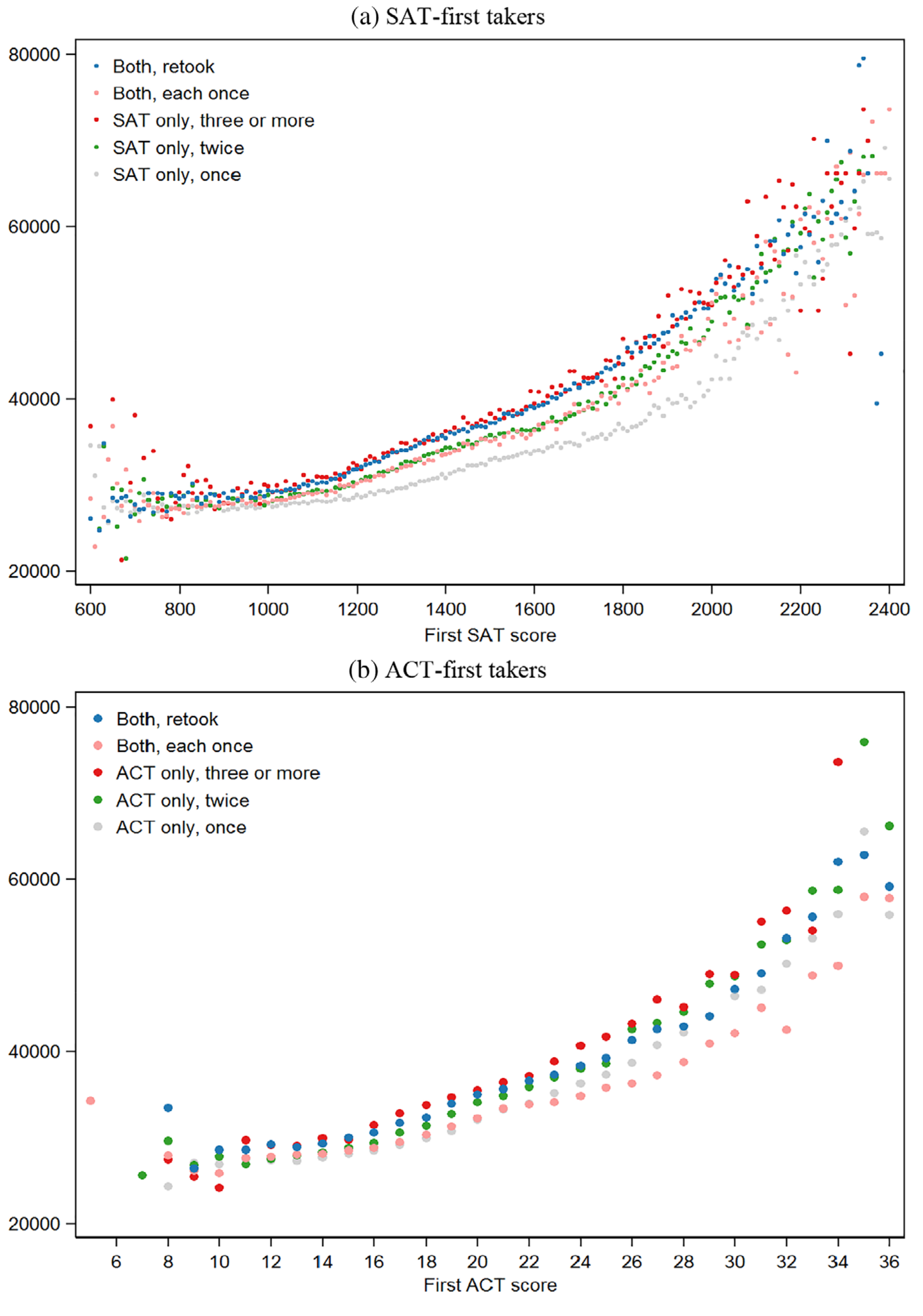
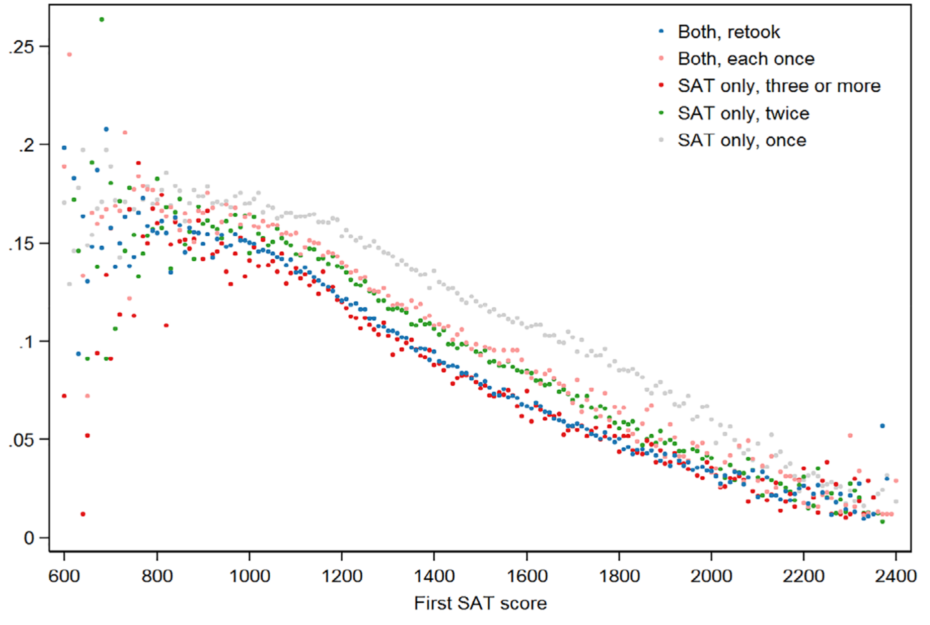


FIGURE A3 College's mean earnings by strategy and first exam score. (a) SAT-first takers (b) ACT-first takers. Shown above are the average institution-level earnings as a function of students' first exam score. Institution-level earnings data come from the College Scorecard, where earnings are measured for students entering the labor market in 2008 and measured 6 years after labor market entry. Panel A shows students who first took the SAT and Panel B shows students who first took the ACT. The sample consists of all exam takers from the Georgia public high school classes of 2009–2015 [Color figure can be viewed at wileyonlinelibrary.com]

(a) SAT-first takers



(b) ACT-first takers

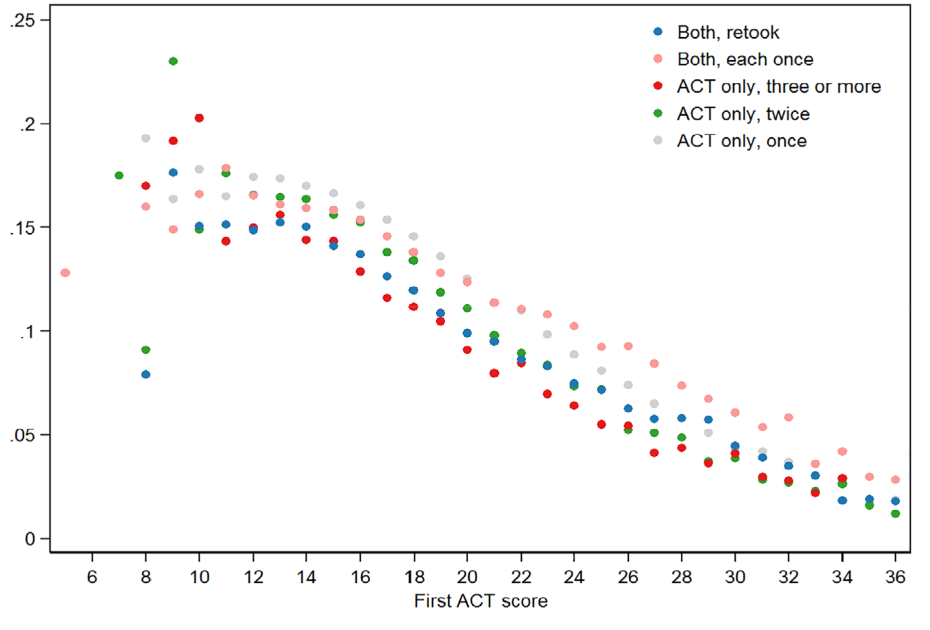


FIGURE A4 **College's student loan default rate by strategy and first exam score**. (a) SAT-first takers (b) ACT-first takers. Shown above are the average institution-level student loan default rates as a function of students' first exam score. Institution-level default rate data come from the College Scorecard, where defaults are measured for students entering repayment in 2013 and measured 3 years after entering repayment. Panel A shows students who first took the SAT and Panel B shows students who first took the ACT. The sample consists of all exam takers from the Georgia public high school classes of 2009–2015 [Color figure can be viewed at wileyonlinelibrary.com]

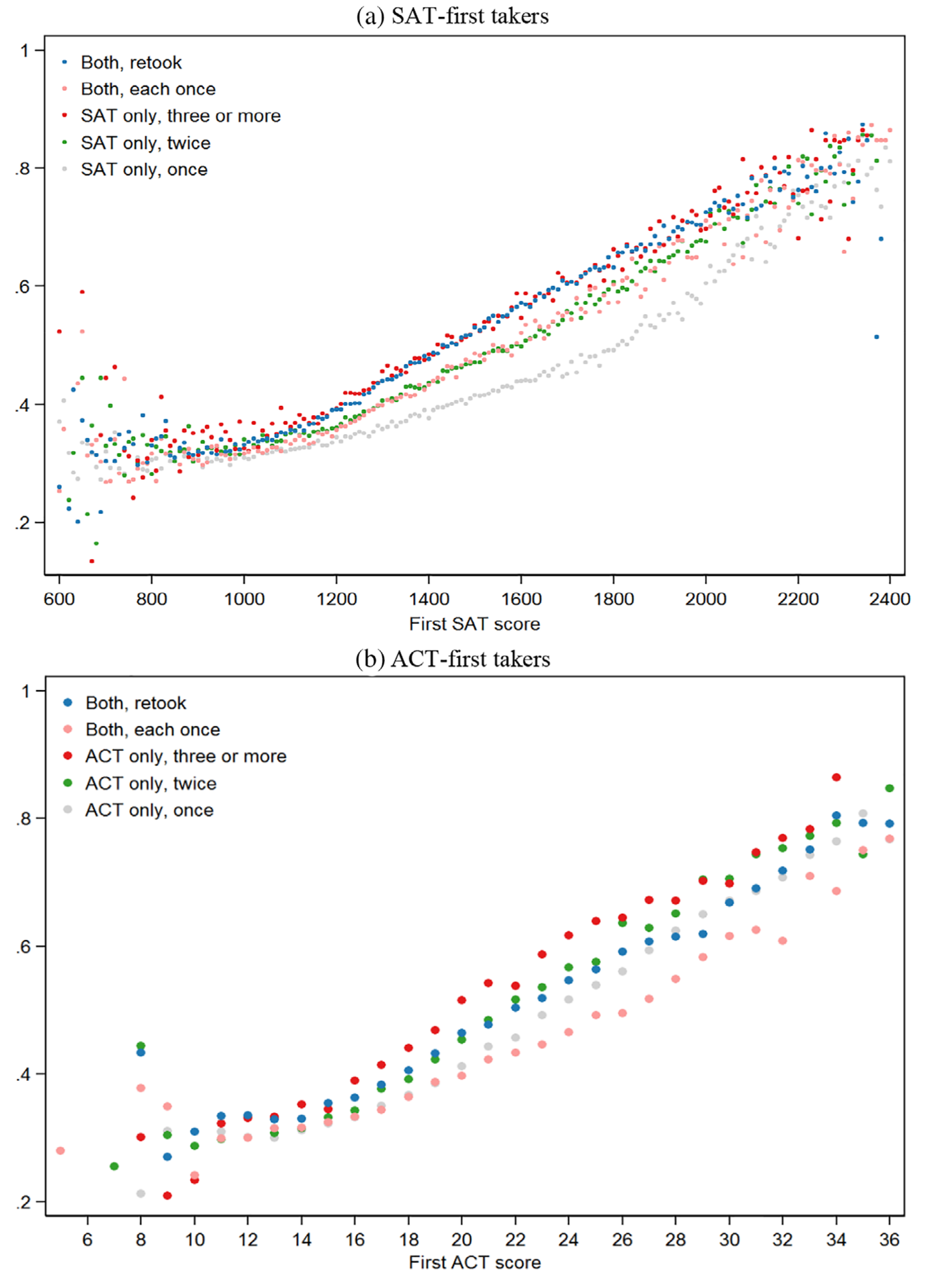


FIGURE A5 **College's student loan repayment rate by strategy and first exam score**. (a) SAT-first takers (b) ACT-first takers. Shown above are the average institution-level student loan repayment rates as a function of students' first exam score. Institution-level default rate data come from the College Scorecard, where repayment rates are measured for students entering repayment in 2013 and measured 3 years after entering repayment. College Scorecard defines students as being in "repayment" if they are not in default and have loan balances that have declined since entering repayment, while excluding currently enrolled and military deferment from the calculation. Panel A shows students who first took the SAT and Panel B shows students who first took the ACT. The sample consists of all exam takers from the Georgia public high school classes of 2009–2015 [Color figure can be viewed at wileyonlinelibrary.com] number threshold to a student's first SAT or ACT score. For SAT scores, R indicates being near a multiple of 100 ranging from 700 to 2300; for ACT scores R indicates being near either 20 or 30.[25] *Below* is an indicator for whether an individual's first score was below the nearest round number and *Distance* is the number of SAT or ACT points from the nearest round number. Our estimating equation allows each round number threshold to have its own intercept, the slope below the threshold, and slope above the threshold. We include student-level demographics and high school academics (X), and control flexibly for time-varying shocks by including high school cohort fixed effects (η_c). We use a bandwidth of 50 points on either side of SAT round numbers and five points on either side of ACT round numbers. *SE* are clustered at the appropriate first exam score. The parameter of interest is β, which represents the average effect of scoring below a round number threshold. Additional details about this empirical strategy and its validity can be found in Goodman et al. (2020).

APPENDIX C: Full description and discussion of validation exercises

This appendix provides a description and discussion of the validation exercises we conduct to assess our selection-on-observables empirical strategy. We compare magnitudes between our estimates and other estimates that answer slightly different questions but use different identification strategies. First, we use thresholds from USG's minimum admissions requirements and round number scores to make RD estimates of the effect of taking more than one exam. Second, we compare our estimates to the causal effects of SAT retaking from Goodman et al. (2020).

First, we use USG's minimum requirements or the round number thresholds as instruments to estimate the causal effects of taking more than one exam. While this has some value on its own, we are primarily interested in comparing the magnitude of the estimates here using the RD research design to our estimates of strategy impacts using our selection-on-observables approach. Equations (B1) and (B2) in Appendix B become the first stage equations. The second stage equations are nearly identical to the first stage equations, with the following two changes: (1) *Below* is replaced with $\widehat{S}$, the predicted values from the respective first stage estimation, and (2) S is replaced with Y, a second stage outcome.

We present these IV estimates in Table C1. In Panel A, the endogenous decision of whether to take a second exam is instrumented with an indicator for scoring below USG's minimum SAT threshold. Given the direct relationship between scoring above or below USG's minimum thresholds and college enrollment, we can only consider admissions scores as second stage outcomes with this instrument. The first stage estimate in column (1) shows that students scoring below USG's minimum threshold are 4.3 percentage points more likely to take a second exam than those scoring just above the threshold. The second stage estimates in columns (2) and (3) show that taking a second exam increases admissions scores by 84 points through two exams and 140 points through all exams.

In Panel B, taking a second exam is instrumented with an indicator for scoring below an SAT round number. Focusing on the results for students who took their first SAT before the end of 11th grade, we estimate a first stage effect of 1.3 percentage points. In the second stage, we estimate that taking a second exam increases admissions scores by 137 points through two

[25]We exclude scores around the round number of 10 because scoring below a 10 likely induces different behaviors than scoring below a 20 or 30. Empirically, it appears that students scoring just below a 10 are less likely to retake the ACT compared with those scoring just above, suggesting a discouraging effect of scoring so poorly.

TABLE C1 IV estimates of the effect of taking more than one exam on test scores

		Second stage outcomes	
	First stage (1)	Admissions score after two exams (2)	Admissions score after all exams (3)
Panel A: USG's SAT thresholds			
All takers	0.043***	83.5***	139.7***
	(0.006)	(21.3)	(19.3)
FRL	0.059***	61.3***	114.5***
	(0.008)	(11.4)	(12.1)
Non-FRL	0.027***	122.5**	182.8***
	(0.005)	(47.5)	(44.0)
URM	0.058***	58.3***	104.9***
	(0.009)	(7.2)	(9.1)
Non-URM	0.030***	117.0**	190.9***
	(0.005)	(46.3)	(42.5)
Panel B: SAT Round number thresholds			
All takers	0.007**	155.7***	136.0**
	(0.003)	(56.0)	(60.4)
Early takers	0.013***	137.4***	132.4***
	(0.003)	(40.7)	(42.5)

Notes: Each coefficient reported above is from a separate regression. Panel A uses whether a student scores above or below USG's minimum SAT threshold as an instrument for taking more than one exam. Panel B uses whether a student score above or below a multiple of 100 on their first SAT as an instrument for taking more than one exam. Column (1) reports the first stage estimates of the effect of scoring below the respective threshold on taking more than one exam. Columns (2) and (3) report the second stage estimates of the effect of taking more than one exam on admissions scores through two exams and through all exams. Heteroskedasticity robust *SE* clustered at the student's first exam score are reported in parentheses.
$^{*}p < .10$, $^{**}p < .05$, $^{***}p < .01$.

exams and 132 points through all exams. The estimated effects have wide confidence intervals but are still statistically significant. Here, we also estimate second stage effects on college enrollment and report them in Table C2, but the estimates are too noisy to interpret.

The magnitudes of the estimates of taking more than one exam on admissions scores are all substantially larger than the strategy impacts we estimated using our selection-on-observables approach in Table 4. The main concern with our selection-on-observables approach is that we cannot control for important covariates such as family income and preference for going to a more selective college that are positively associated with both taking more exams and higher scores. Failing to adequately capture the influence of these factors would cause us to overestimate the effects of exam-taking strategies. But, given that the RD estimates of taking more than one exam are higher than our selection-on-observables estimates, it appears that we may be under-estimating the impact of exam-taking strategies on admissions scores. One counterargument is that the true local average treatment effect of the RD is larger than the true average treatment effect in this setting. This may very well be true but the fact that we see larger effects than the selection-on-observables approach regardless of the USG or round number margins is encouraging.

TABLE C2 IV estimates of the effect of taking more than one exam on college enrollment

	First stage (1)	Second stage outcomes: 4-year college enrollment (2)	Second stage outcomes: 2-year college enrollment (3)
All takers	0.007**	−0.228	−0.353
	(0.003)	(0.387)	(0.390)
Early takers	0.013***	0.100	−0.105
	(0.003)	(0.215)	(0.240)

Notes: Each coefficient reported above is from a separate regression. Whether a student scores above or below a multiple of 100 on their first SAT is used as an instrument for taking more than one exam. Column (1) reports the first stage estimates of the effect of scoring below the round number threshold on taking more than one exam. Columns (2) and (3) report the second stage estimates of the effect of taking more than one exam on 4-year and 2-year college enrollment. Heteroskedasticity robust *SE* clustered at the student's first exam score are reported in parentheses.
*$p < .10$, **$p < .05$, ***$p < .01$.

TABLE C3 Comparison of estimates of the effect of retaking to Goodman et al. (2020)

	Selection-on-observables estimates (1)	Goodman et al. (2020) RD estimates (2)
Scores	59.1***	101.9***
	(4.6)	(5.9)
4-year enrollment	0.124***	0.125***
	(0.004)	(0.042)
2-year enrollment	−0.048***	−0.060
	(0.003)	(0.037)
College's graduation rate	0.046***	0.062**
	(0.002)	(0.024)
College's mean earnings	1.293***	0.724
	(0.064)	(2.104)
High school by cohort FE	X	n/a
Demographic controls	X	n/a
High school academic controls	X	n/a

Notes: Each coefficient in the table is from a separate regression. Column (1) estimates a variant of Equation (1) where a score or college enrollment outcome is regressed on an indicator for whether or not the student retook either the SAT or ACT including high school by cohort fixed effects, controls for demographic variables including gender, race, and ethnicity, and controls for high school academic performance including high school GPA fixed effects in bins of 0.25 points and indicators for gifted and dual enrollment coursework. Column (2) prints the corresponding regression discontinuity estimates from Goodman et al. (2020). Heteroskedasticity robust *SE* clustered at the student's first exam score are reported in parentheses.
*$p < .10$, **$p < .05$, ***$p < .01$.

Next, we compare the magnitude of our estimates to the causal estimates of SAT retaking from Goodman et al. (2020). They find that retaking the SAT increases 4-year enrollment by 12.5 percentage points and decreases 2-year enrollment by about 6 percentage points.

Comparing these to our estimates of the impact of taking multiple SAT exams, we find results that are of similar magnitude. We estimate that only taking the SAT twice is associated with a 12-point increase in 4-year enrollment and a 4.8-point decrease in 2-year enrollment, while taking the SAT three times or more is associated with an 18-point increase in 4-year enrollment and a 7-point decrease in 2-year enrollment.

In Table C3, we make this comparison more explicitly by estimating the effect of retaking the SAT or ACT using our empirical approach and comparing them to the RD estimates in Goodman et al. (2020). Column (1) reports our estimates using a variant of Equation (1) where a score or college enrollment outcome is regressed on an indicator for whether the student retook either the SAT or ACT while including our full set of controls. Column (2) prints the RD estimates from Goodman et al. (2020). Notably, our empirical approach estimates that retaking increases 4-year college enrollment by 12.4 percentage points, nearly identical to the RD estimate in column (2). Our estimated score impacts of retaking are substantially smaller, but it is worth noting that the score impacts estimated by Goodman et al. (2020) are of a similar magnitude to our RD estimates of taking more than one exam in Table C1. We also find that the estimated retaking effects on other college enrollment outcomes are very similar. We take the similarity in these estimates to be reassuring of our main empirical approach.