The Value of a Higher ACT Exam Score*

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Abstract

Entrance exams are an integral aspect of the college admissions process. We use rounding in ACT composite exam scores to identify the causal effect of receiving a higher score. Using data for over 3 million test takers, we estimate that "randomly" receiving one extra point on the ACT leads to a 0.44 percentage point increase in the probability of attending a 4-year college. Our results have implications for the importance of entrance exams in the admissions process, the value of test preparation and retaking, and the inequities that can be created by unequal access to test prep and resources.

Keywords: College admissions, ACT exam

JEL Codes: I20; I23

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1 Introduction

College entrance exams continue to serve as gatekeepers for high school students seeking admission into high-quality, four-year colleges. In 2019, 1.78 million and 2.2 million graduating students took the ACT and SAT, respectively (ACT, 2019; Board, 2019), and the majority of four-year colleges required scores. The centrality of entrance exams in the college admissions process leads many students to spend significant time and money practicing, preparing, and retaking exams in hopes of achieving a high score and a top college placement. The effort required to prepare for exams has led to concerns that the test score process disadvantages low-income and underrepresented minority students, who may be less likely to sit for the exams or have less access to test preparation materials and classes (Page and Scott-Clayton, 2016; Bloem et al., 2021; Vigdor and Clotfelter, 2003).

But what exactly is the value of obtaining a higher score on the ACT/SAT? While achieving a high score on a college entrance exam is clearly correlated with outcomes, the degree to which scores directly impact admissions is less clear. If certain students (e.g. those from high-income backgrounds) are able to hire tutors and take test-prep classes that increase their ACT scores by one or two points, how does that translate into college-going rates and the quality of colleges attended? Ascertaining a causal effect of entrance exams on college admission success is difficult since ACT/SAT scores are likely to be correlated with other unobservable inputs to admissions decisions (letters of recommendation, essays, etc.). To overcome this identification issue, one might be tempted to conduct a case study into the admissions process of one or two universities in order to shed light on the importance of entrance exam scores for a particular school. But since students apply to many schools and admission standards differ widely by school, a case study would be of limited value. For example, selection might occur where students with lower-than-expected test scores might simply apply to and get accepted by colleges that put less emphasis on test scores in their admissions. Thus, pinpointing the causal effect of standardized tests scores on college admissions requires overcoming the issue of unobservable correlates and treating the college admissions system in a holistic fashion.

In this paper, we estimate the causal effect of scoring higher on the ACT for the universe of ACT test takers over a two-year period (around 3.3 million students). Our identification strategy is based on the fact that an individual's composite ACT score (the final whole number value that is typically used by college admission offices) is the simple average of individual subscores across four subjects (English, math, reading, and science). This accounting creates a discontinuity where the composite score jumps to the next whole number when rounding occurs. For example, consider a student who receives a composite ACT score of 24 based on individual subscores of 24 on each of the English, math, reading, and science sections. Had the student received a 23 in one of the four subjects, the composite ACT would still be 24 (rounded up from an average of 23.75). Had the student achieved a 25 in one of the four subjects, the composite ACT would once again still be 24 (rounded down from an average of 24.25). However, if the student achieves a 25 in two of the four subjects, the ACT composite score would now jump to 25 (rounded up from an average of 24.5). As long as unobservable factors (e.g. essay quality) change smoothly across these rounding thresholds – an assumption which we test – we are able to exploit these discontinuities to statistically estimate a causal effect of receiving a higher ACT composite score on college admission outcomes.

The data used for this project were provided by ACT, Inc. and include the test scores and other student characteristics for all ACT takers who graduated from high school in 2011 and 2012. These data were merged at the individual level with data from the National Student Clearing House that indicates the college, if any, that each student attended. Importantly, the data contain the four ACT subscores, which allow us to create an unrounded score for each test taken. We can therefore look at the impact of a higher composite ACT score while controlling for the underlying unrounded score. We start by showing that the density function of the unrounded test score on the first ACT test taken is smooth across the many rounding thresholds. We focus our primary analysis on students with ACT scores above 10, excluding the 0.34 percent of test takers score below this cutoff.

Identifying off of composite score discontinuities, we find that a student who "randomly" receives an ACT score that is one point higher is 0.73% more likely to attend a 4-year college (a 0.44 pp increase from a base of 60%). Because many students retake the ACT, being discontinuously rounded up by one composite score only increases a student's max ACT composite score by 0.66. Thus, due to test retaking, the statistic cited above is an underestimate of the effect of a higher maximum composite score. Adjusting for retake rates, the causal impact of increasing a student's composite score by one point is a 1.2% (0.67pp) increase in the likelihood of going to a 4-year college.

Our identification strategy relies on students being unable to selectively place themselves in a position to have their ACT composite score rounded up. For example, it would be problematic for our design if unobservable factors such as essay quality changed discontinuously at the ACT rounding points. As discussed above, the fact that the density function is smooth across the rounding thresholds is supportive of our strategy. However, we also show that there is not selection on observables in our dataset. For example, being rounded up to a higher composite score does not predict pre-determined characteristics such as race, gender, or parent's education.

In addition to showing the impact of a higher ACT score on 4-year college going rates, we also document the impact of higher scores on the quality of the college attended and other outcomes. For example, discontinuous increases in ACT scores lead to attending a college with a higher average parental income and higher graduation rates. Perhaps surprisingly, we do not find that the value of a higher ACT score differs by gender, race, or family background. Finally, although a higher ACT score increases the likelihood of attending a 4-year college, it has null effects on the number of semesters completed and graduation rates.

Our results have implications for individual students as well as the college market overall. At the individual level, students and parents who are trying to decide how much time and money to spend on test preparation classes or how many times to retake the ACT should compare the cost of doing so to the benefits that we document (an increase in the probability of attending a four-year college and attending a higher quality institution). More broadly, our results speak to the size of the advantage that students with better access to test preparation materials (tutors, classes, etc.) have over their peers.

Our paper adds to a rich literature in the economics of education. The most closely related paper to ours is work by Goodman et al. (2020). Using administrative data on millions of SAT-takers, they document that retaking the SAT leads to (super-) scores that are 0.3 standard deviations higher on average. They also show that retaking is more likely to occur when students fall short of round number targets. Because of these round number targets, they are able to use a fuzzy RD design to estimate the impact of retaking the SAT on college enrollment. They find that threshold-induced retaking leads to approximately 90 points (0.3 standard deviations) higher on average on the SAT. They then find that retaking increases the probability of enrolling in a 4-year college by 13 percentage points – an effect that is significantly larger than the 1 percentage point effect that we predict to be the value of receiving a similar 0.3 standard deviation (1.5 points) higher ACT composite score.[1] Our paper complements this work by contributing additional estimates for the value of a higher test score. Two key differences include the fact that we have a very different identification strategy and we are showing evidence for the ACT as opposed to the SAT.

There are many studies in the economics of education literature focused on how to improve 4-year

[1]The standard deviation for the ACT score in our data is 5.1, so a 0.3 standard deviation increase is a 1.5 point increase. Thus, we scale the treatment effect adjusted for retaking (0.67pp) by this number to arrive at the 1 percentage point effect.

college going rates. Several studies show that small interventions related to information or financial incentives can lead to a significant increase in college attendance (e.g., Bettinger et al. (2012); Hoxby et al. (2013)). Several of these interventions involve college admission exams. For example, Pallais (2015) finds that when the ACT increased the number of schools to which a student could send their scores for free from 3 to 4, students applied to more colleges and low-income students attended more selective schools. Other studies have found that policies that make it easier for students to take the ACT/SAT (state mandating testing, more easily accessible testing centers, etc.) improve college enrollment rates – especially for underrepresented minorities and lower income students (Klasik, 2013; Bulman, 2015; Hurwitz et al., 2017; Goodman, 2016; Hyman, 2017). The size of the results from these studies are worth thinking about in relation to those that we find. For example, Bulman (2015) argues that if a testing center was opened at every school that did not currently have a testing center (so that students could more easily take the exam), that 4-year college going rates would increase by 1.6 percentage points. Hyman (2017) shows that a policy change in Michigan requiring all students to take the ACT led to a 1.9 percentage point increase in 4-year college enrollment. Our paper suggests improving a student's ACT score by one point (through either test prep, retaking, or other means) can lead to a 0.67 percentage point increase in 4-year college-going rates.

Our paper also relates to a growing literature in behavioral economics on behavioral firms. This literature explores the limits to firm optimization (Bloom and Van Reenen, 2007; Hortaçsu and Puller, 2008; Golfarb and Xiao, 2011; Massey and Thaler, 2013; Hanna et al., 2014; DellaVigna and Gentzkow, 2019). In our paper, colleges are failing to fully optimize with respect to how they treat ACT scores. Rather than use the unrounded and more informative scores, we see jumps occur when a coarser measure of performance (the composite score) increases. This adds to at least two other papers that have shown that colleges fail to use all of the information at their disposal when making college admission decisions. Bettinger et al. (2013) show that colleges should (but fail to) weight certain ACT subscores (English and math) more than other subscores (reading and science). Bulman (2017) documents that colleges admit students based on their overall high school GPA, but could improve the quality of students they admit by placing less weight on the GPA of early high school years (freshman and sophomore years).[2] Our results add to this literature by showing an additional manner in

[2]Our work also relates to research reconsidering the value of standardized testing as an input to the college admissions process as a whole. For example, Rothstein (2004) shows that most of the SAT's power to predict college performance among University of California freshmen is driven by its strong correlation with demographics. We go one step further, isolating the component of a standardized test that is both orthogonal to demographics but also to ability, and similarly find that this component predicts enrollment but has null effects on a measure of college performance (graduation rate).

which colleges may fail to optimize (insofar as they are attempting to maximize student quality) when admitting high school students.

2 Data

Our analysis relies on three administrative datasets that we link: (1) ACT scores for the entire universe of test takers across two years (2010-11 and 2011-12) provided by ACT, Inc., (2) National Student Clearinghouse (NSC) data on college attendance and graduation for all ACT test-takers, and (3) Institutional characteristics of colleges based on tax records from Opportunity Insight's College Mobility Report Cards (Chetty et al., 2020). For each of the 3,289,129 ACT takers, we observe their first and maximum exam performance, including their subscores on each section (math, English, science, and reading) and their rounded composite scores. These scores compose our treatment variables of interest. We also observe a set of baseline student characteristics that allow us to examine balance on observables for our research design and to examine heterogeneous treatment effects. We observe the race (White, Black, Asian, Hispanic) and gender for every student, as well as all responses to a voluntary survey administered at the time of the testing. This survey provides us with family income (for 2.41 million students), high school GPA (2.95 million), and maternal and paternal education (2.07 million and 2.00 million) for the student respondents.

Our outcomes of interest are college enrollment, graduation, and the characteristics of the first college attended. We use National Student Clearinghouse (NSC) data merged with the ACT data to measure college enrollment and graduation. As of 2012, the NSC tracked college enrollment data included 94% of students at Title IV, degree-granting institutions NSC (2012). We first characterize colleges by information provided by NSC, including the institution type (4-year vs. Less-Than-4-year program) and graduation rate. We further supplement this with information on the average parental income and the eventual adult earnings of a prior cohort of students who attended that college (Chetty et al., 2020).[3]

Table 1 shows summary statistics for the analysis sample. The first column of the table shows the full sample, while columns 2 through 5 split the sample by the decimal value of the average of the four subscores, which we return to in the next section. Panel A summarizes baseline characteristics of the students in our sample. Both the gender and racial composition of our sample are similar

[3]Specifically, these data are based on millions of anonymous adult tax records. The measures of parental income are for students born in 1991 (approximately the class of 2013) while measures of student income correspond those those born between 1980 and 1982 (who are roughly around 35, a time around which adult relative income stables). (Source: https://www.nytimes.com/interactive/projects/college-mobility/city-college-of-new-york).

to college enrollment in general: 54% of our sample is female (vs. 57% in college), 60% White (vs. 61%), 14% Black (vs. 15%), 4% Asian (vs. 6%), and 13% Hispanic (vs. 14%).[4] Moving to survey responses, roughly 48% of the sample reports a family income less than $50,000, 41% report an A-average GPA (3.3 to 4), and 68% have a mother with post-secondary education. Panel B summarizes some of our outcomes of interest. Most students (83%) in our sample go on to enroll in college, with about three-quarters of those attending a four-year school. About half of the students in our sample had graduated college by March of 2019 when our NSC data sample window ends. The mean first composite ACT score is 20.62, but 43% of students retake and, often, improve their score so that the mean maximum score is 21.29. Finally, Panel C summarizes institutional characteristics taken from the College Mobility Report Cards. Weighted by the 2.6 million test takers who go onto college, we see that the average parental income of these colleges is roughly $86k, students go on to an average income of $40k by age 35, and the graduation rate of these schools is 50 percent.

Before moving onto causal estimates, Figure 3 documents the raw correlation between ACT performance and attending a four-year college. About 20% of students with an unrounded score of 12 go to a four-year school, with the share steadily climbing until it levels off just below 90% for students who score in the thirties. Since standardized test scores are highly correlated with background characteristics of students (Rothstein, 2004), these simple correlations may not reveal the underlying causal relationships between these variables. We therefore outline an identification strategy in the next section.

3 Methodology

Standardized test scores are strongly correlated with college outcomes, however, a key challenge for understanding the causal content of this relationship is the extremely tight link between these scores and the pre-existing characteristics of test takers. This challenge has long been recognized by researchers interested in the predictive validity of standardized tests for college success (Rothstein, 2004), but even the more basic question of the causal effect of SAT/ACT scores on enrollment outcomes is plagued by this problem. In the case of ACT exams, a student's raw (unrounded) score depends on a large set of observable and unobservable characteristics, such as access to test preparation resources and student familiarity with tested topics – therefore, enrollment outcomes of students with different scores would likely differ even if they were not an input into admissions decisions.

[4] Gender: https://nces.ed.gov/programs/digest/d20/tables/dt20_303.10.asp?current=yes
Race: https://nces.ed.gov/programs/digest/d20/tables/dt20_306.30.asp?current=yes

Composite ACT scores depend on all of these factors, plus one more that we leverage to overcome this causal identification challenge: Rounding. Specifically, the summary score often most directly used by admissions officers is the average of four exam sub-scores (math, English, science, reading) which is then rounded to the nearest whole number. Thus, if student characteristics smoothly vary with the unrounded score *and* admissions officers narrowly focus on the rounded score, we can identify the causal effect of being rounded up a point on the composite. By comparing students on either side of the discontinuity, we estimate the causal effect of a higher composite ACT exam score.

Formally, we estimate the impact of receiving one more point on the ACT by regressing each individual's outcome (y_i) on the rounded composite score (C_i) and a flexible function in the unrounded average of the four section scores (U_i):[5]

$$y_i = \beta_0 + \beta_1 C_i + f(U_i) + X_i' \gamma + \epsilon_i \tag{1}$$

We use a fifth degree polynomial for $f(U_i)$ for our main results, but obtain similar results with unrounded score entering linearly. We include a vector of demographic controls (X_i) in some specifications. The coefficient of interest, β_0, measures the effect of having a composite (rounded) score that is one point higher, after controlling for predicted differences in average outcomes across the range of unrounded scores.

We also present specifications that parameterize the effect of the unrounded score slightly differently. Specifically, we show that results are robust to using splines in unrounded scores, and to using a specification that separates students into four groups based on the decimal value at the end of their unrounded scores. We estimate the differences in outcomes across the four decimal value groups using a regression model similar to equation 1, but that replaces the constant term and the composite score term with indicator variables for each decimal value group (rounded down by 0.25, not rounded, rounded up by 0.25, and rounded up by 0.5).

3.1 Support for Identification Assumptions

The key identification assumption for this research design is that observable and unobservable (e.g. essay quality) determinants of college outcomes vary smoothly as a function of the unrounded scores. Columns 2 through 7 of Table 1 provide support for this assumption. Specifically, we average the observable baseline characteristics of ACT-takers in four buckets of unrounded ACT composite scores:

[5] The ACT score that we use for C_i and U_i is the *first* ACT exam taken by a student. This is beacause, as we'll show later, having one's exam score rounded up has a causal effect on retaking the ACT exam.

Column (2) shows averages for scores rounded down by 0.25 points (e.g. a student who received a 24, 24, 24, and 25 for an unrounded composite score of 24.25), Column (3) scores that average to a whole number, Column (4) scores rounded up by 0.25 points, and Column (5) scores rounded up by 0.5 (e.g. a 24.5 score). Column (7) reports the p-values from an F-test of the equality of the means across the four groups. Consistent with our assumption, we do not find any systematic evidence of differences in these observable baseline characteristics. By contrast, Panel B and C of the table highlight the significant differences in the downstream outcomes of rounding (i.e. in college enrollment, in the likelihood of retaking the exam, and in the type and characteristics of first college attended).

Figures 1 and 2 show additional evidence consistent with our research design. In particular, Figure 1 shows the smooth distribution of unrounded ACT composite scores. We see no evidence of bunching around the 0.5 point rounding threshold. Consistent with this smoothness, Figure 2 shows that each of the decimal value groups have similar fractions of the total sample.

4 Results

In this section, we estimate the causal effects of a 1-point increase in ACT score (via rounding) on students' college outcomes. We start in Table 2 by showing effects on our primary outcome of interest: Attending a Four-Year College (relative to attending no college or any college with a degree program under 4 years, e.g. community college). In the first column, we estimate 1, controlling linearly for unrounded score. The coefficient on *Composite ACT Score* shows that a 1-point increase in one's rounded score, adjusting for the effect predicted by the unrounded score, results in a 0.41 percentage point increase in 4-year-college attendance. Although Table 1 showed balance on observables, Column 2 adds these demographics to improve precision. We find a similar 0.44 percentage point increase in four year college enrollment ($p<0.01$). Relative to the mean enrollment of 60%, this coefficient reflects a 0.73% increase in the outcome. However, since unrounded scores might have nonlinear effects on college enrollment, Columns 3 & 4 allows unrounded score to enter through a fifth-degree polynomial – using this specification, we find that the coefficients reported in Columns 1 & 2 are unchanged. Figure 4 disaggregates the result in Table 2 by bins of the rounding magnitude (using a somewhat different specification that replaces *Composite ACT Score* with indicator variables for each decimal value group – coefficients on these indicators are plotted). We see that students whose scores are rounded down are systematically less likely to enroll in four-year college, especially compared with students whose scores are rounded up by a full half-point.

To get a better sense of the magnitude of the 0.44pp increase in college enrollment, we present a comparison to the correlation between unrounded scores and enrollment. As previously discussed, unrounded scores not only reflect the direct effect of ACT scores on admissions, but also all the confounding factors associated with it (e.g. GPA, parental income, essay quality). Nonetheless, it helps situate the magnitude of rounding relative to this endogenous benchmark. Specifically, we calculate the slope of the polynomial in U_i for every unrounded score value from estimating equation 1 with a fifth degree polynomial. This tells us the predicted marginal change in outcomes associated with a higher unrounded score for each point in the unrounded score distribution. We take the average of these slope values, weighting by the number of people who received each unrounded score, and report the ratio of the coefficient on composite score (β_1) with the weighted average of the polynomial slope values. These numbers are reported as the "% Impact of Score from Rounding" in our regression tables. Column 2 shows that a 1 point increase in ACT score drive by rounding is roughly 21% of the unrounded score effect.

We next examine a set of related outcomes to better understand the increase in four-year college enrollment. Column 1 of Table 3, Panel A repeats the analysis of Table 2 (using the Column 3 specification), while Column 2 looks at enrollment in less-than-four-year colleges (e.g. community college) and Column 3 at the combination of the two outcomes (i.e. any college enrollment).[6] We see that the 0.44 percentage point increase in four-year college enrollment is largely driven by students who would have otherwise first gone to a community college or similar – Column 2 shows a 0.34pp drop in less-than-four-year college enrollment, and Column 3 shows that majority of the remainder is an insignificant 0.08pp increase in any college enrollment. Columns 4 through 6 use data from the College Mobility Report Card to further break down this result. Consistent with four-year colleges typically enrolling students from higher-income backgrounds, Column 5 shows that students whose scores end up rounded up by 1 point enroll in schools for which the average parent earns about $226 more per year, whose students go on to earn $101 more in annual income by age 35, and whose graduation rates are 0.23pp higher (i.e. roughly a 1% of a standard deviation on all three measures).

Returning to our primary outcome of four-year college enrollment, Figure 5 examines heterogeneous treatment effects. We first do so by sub-group analysis on baseline observable characteristics such as parents' education, student's GPA, and race – across these cuts, we find consistent positive effects that are statistically significant for most groups, without a clear indication that one group or

[6] Panel B shows that we find relatively similar effects in a specification that models the unrounded score with a fifth-degree polynomial, similar to Column 4 of 2.

set of groups is driving the result. We also look across the range of composite scores to see if effects are concentrated anywhere in the distribution. To do this, we modify equation 1 to include indicator variables for each rounded composite score (e.g. an indicator for 13, 14, etc.) and plot the coefficients and 95% confidence intervals for each coefficient. Figure 6 shows the results. We don't have enough statistical power to distinguish effect sizes by composite score, and the point estimates do not suggest a clear pattern, other than showing that rounding up is positively associated with four-year college attendance for almost all scores.

Finally, our results on four-year college enrollment are robust to clustering standard errors by unrounded score (Table 4) and using a spline in unrounded score rather than a polynomial (Table 4). To validate that our analysis is picking up a real effect, we re-run our main specification on a series of placebo outcomes taken from pre-test characteristics of the students in our sample. The results are in Table 5. As expected, all of the placebo outcomes have a strong relationship with unrounded score, but not with rounded composite score. The placebo outcomes analysis reassures us that our main results are picking up the meaningful impact of marginal score increases due to rounding on student outcomes.

4.1 Mechanisms and Consequences

How does an increase in composite ACT score (driven by rounding) translate into increased four-year college enrollment, and what are the further downstream consequences of the higher score? Our data limits our ability to peer deeply into the underlying mechanisms, however, we discuss and examine a few potential channels. First, it bears repeating that what we identify is the effect of having one's composite score rounded up, holding constant one's unrounded score – this parameter might be different than the causal effect of perturbing one's ACT score more broadly. If both students and universities fully incorporated the four sub-scores (which are typically available to them) into their decisions, we would expect to find no treatment effect from rounding. This stands in contrast to research designs that exploit rounding in underlying scores that are only observable to the test administrators but not to end-users (e.g. the Advanced Placement exams studied in Avery et al. (2018)). The observed effects thus could be driven by students and/or universities narrowly bracketing on composite scores. We examine both sides in turn.

Students might adjust their behavior in response to having their score rounded up. First, since our estimates correspond to the effect of having one's *first* ACT score rounded, this could affect college outcomes through the propensity to retake the exam. Consistent with recognizing students recognizing the value of a higher composite ACT score, we find evidence that students whose scores are rounded up are less likely to retake the ACT, a pattern that it visually clear in Figure 7. Column 1 of Table 6 estimates that increasing the rounded composite score by one, conditional on unrounded score, decreases the probability of retaking by 1.6 percentage points. However, retaking behavior does not entirely erase the impact of first score rounding on final score. Figure 8 shows discrete jumps up in the maximum composite ACT score across all ACT attempts that coincide with rounding cutoffs in the first unrounded score. The estimates in Column 2 of Table 6 suggest that the net effect of rounding up the first ACT score on the maximum ACT score is an increase of about 0.66 points. This has implications for thinking about the effect of the ACT score, holding fixed the retaking channel. If we divide the coefficient on four-year college enrollment by the final ACT score increase, we infer that having a full point higher on the final ACT score would increase four-year college enrollment by 0.67 percentage points (i.e. 0.44/0.66).

Because we only observe enrollment decisions, we have less insight into other mechanisms through which ACT scores could affect college outcomes. On the institution side, universities often have thresholds that are tied to composite ACT scores. This could affect either admission or financial aid decisions. For example, the Tennessee HOPE scholarship requires either a 3.0 GPA or an ACT score of 21 or above. Beyond these mechanical thresholds, admissions officers may also narrowly bracket on composite ACT scores while failing to fully incorporate the full information conveyed by the sub-scores. On the student side, decisions on whether to apply might be affects due to students rationally anticipating this behavior by colleges. It may also affect aspirations if students draw a signal of their ability from the rounded composite score. Holding constant where students apply, either of these channels could affect the decision of which institution to enroll at given a set of admissions. Ultimately, we think all of these channels are of interest, but would require information on the intermediate stage of where students apply.

Having established that student enrollment in 4-year institutions increases, a natural question is how this affects student performance in college. We have one set of proxies for college performance which is graduation as well as overall attainment of a bachelor or higher degree. It's theoretically ambiguous which direction graduation should go. On the one hand, Column 6 of Table 3 showed that students end up at institutions with slightly higher graduation rates – if those institutions take greater care of preventing dropout of all students, that may result an increase in graduation rates for students induced to attend these institutions. On the other hand, a variation of the "mismatch hypothesis" would suggest that the students induced to attend a more selective university could harm lower-testing students.[7] Ultimately, Columns 3 and 4 find insignificant effects on graduation (-0.06pp) and achieving a bachelors degree or higher (0.02pp). Throughout, we've focused on the *first* college attended, and so in Columns 5 and 6 we turn to whether students with higher ACT scores end up with different final higher education outcomes. We find mixed evidence. Column 5 shows that the higher likelihood of attending a four-year college as one's first institution (i.e. the 0.44pp shown in Column 4 of Table 2) ultimately translates into a smaller but still significant likelihood of ever attending a four-year college (0.21pp), while Column 6 shows that this doesn't translate into more semesters of higher education ultimately received.

5 Conclusion

This article introduces a novel linked dataset and identification strategy to estimate the effects of a higher ACT score on test takers' eventual college enrollment outcomes. Using the entire universe of test takers across two years, we find that moving up one point (roughly 0.2 SD) increases the likelihood of attending a four-year college by between 0.4 to 0.7 percentage points. This improvement largely comes from substitution away from two-year colleges, and does not increase the likelihood of attending any college or the total number of semesters ultimately completed. While the higher score does not induce an increase in total schooling, these students attend schools that are higher on a proxy for quality (higher graduation rates) and whose students earn slightly more on average. It's thus plausible that the higher scores could result in test takers facing improved labor market outcomes.

While we find a significant increase in four-year college attendance from receiving a higher ACT score, a natural question is why our estimates are roughly an order of magnitude smaller than causal estimates from the SAT (Goodman et al., 2020). There are at least two key differences between the studies other than studying different standardized exams. First, Goodman et al. (2020) are identified off of students who are induced to retake the SAT by scoring just below a round number threshold. It's possible that the compliers in the Goodman et al. (2020) study may have higher unobserved return to standardized test scores, although they show that this group is relatively similar in terms of observables to the population of SAT-test takers. It could also be the case that compliers have an es-

[7] The "mismatch hypothesis" is typically discussed in the context of affirmative action programs (Sowell, 1973). Recent evidence that used Calfiornia's ban on race-based affirmative action found evidence inconsistent with the "Mismatch Hypothesis"(Bleemer, 2021).

pecially high return given that a test score improvement bumps them above a round number, which may make them discontinuously more attractive to application readers. A second key difference is that our identification strategy isolates the component of ACT scores driven by rounding. In order for our approach to generate any differences in outcomes it's necessary that universities both utilize the ACT in their admissions decisions *and* that they fail to fully adjust for the full information set (the ACT sub-scores) that would fully smooth out the discontinuity. Thus, our estimates only reflect the total causal effect of a higher ACT score under the assumption that universities are fully inattentive to the sub-scores they possess. A more likely assumption is that we are capturing the effects of the ACT score under partial inattention, and thus the estimates in this paper can be thought of as a lower bound on the total causal effect.

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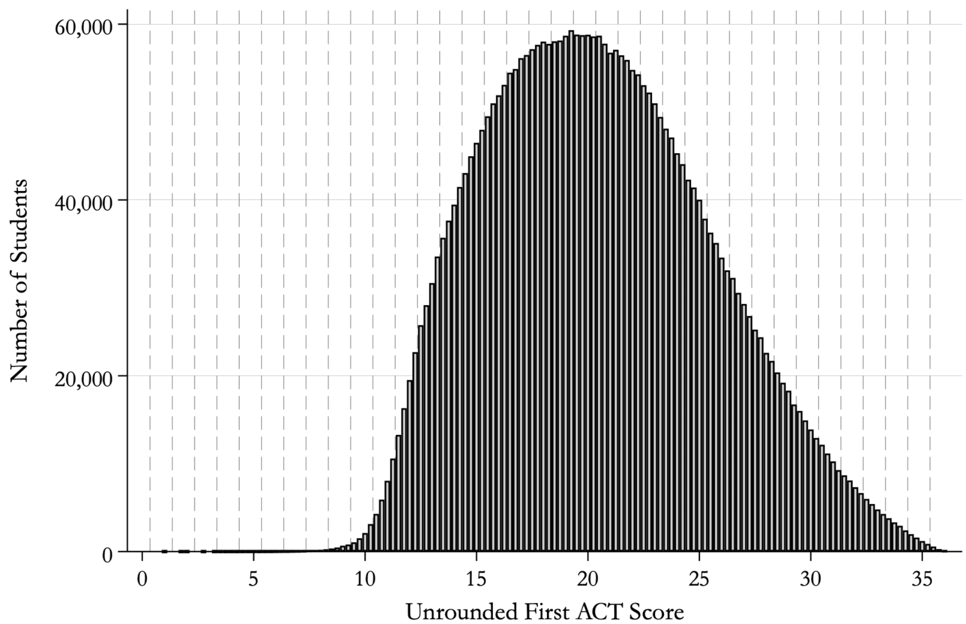
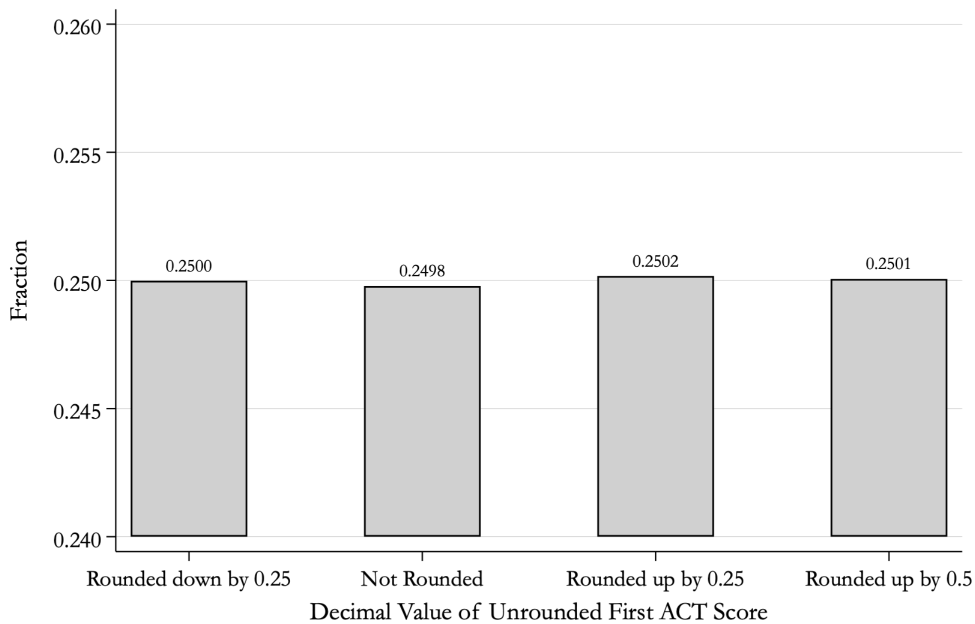
6 Figures and Tables

Figure 1: Distribution of Unrounded First ACT Scores



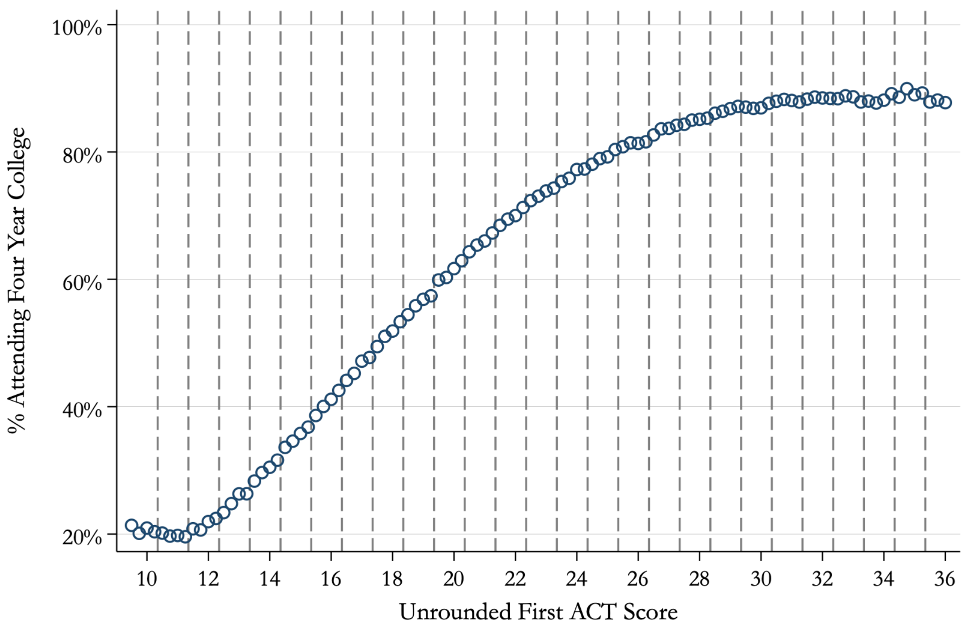
Notes: This figure shows the number of students whose ACT score fall in each bin of unrounded ACT score ranging from 0 to 36, on their first ACT attempt in the years 2010-11 and 2011-12.

Figure 2: Distribution of Unrounded First ACT Scores by Decimal Values



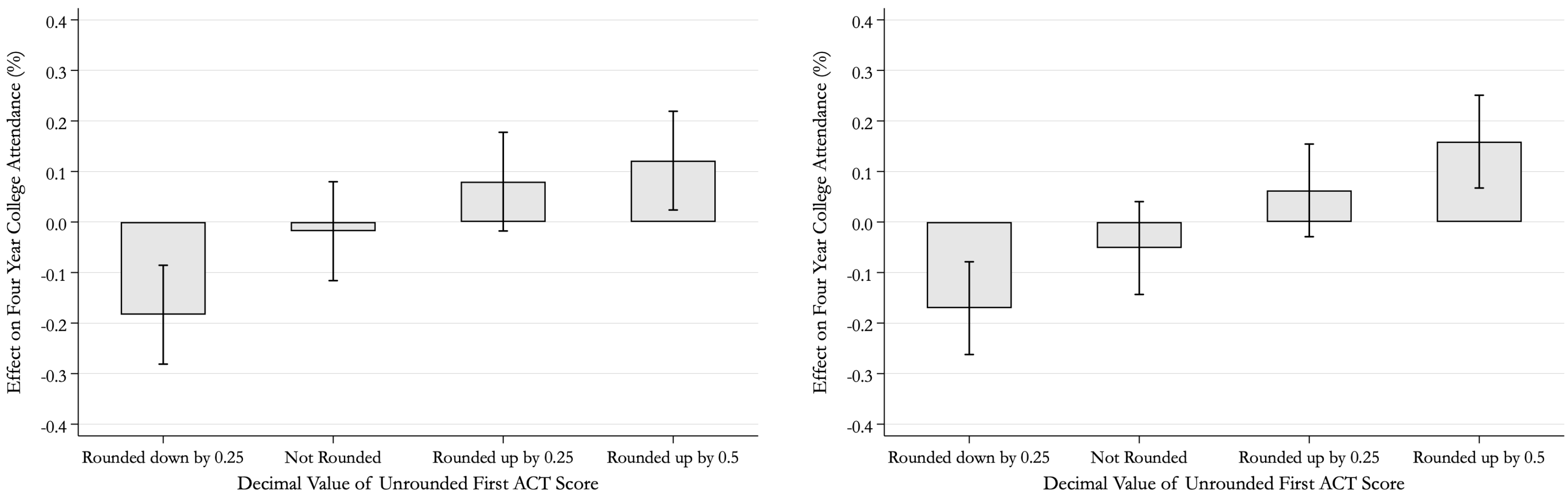
Notes: This figure shows the fraction of students whose ACT score gets rounded up or down by the indicated amount on their first ACT attempt in the years 2010-11 and 2011-12. Since the ACT score is averaged over 4 sections, the unrounded scores can fall into one of four bins – scores that end in .25 are rounded down by 0.25, scores that end in .0 are not rounded, scores that end in .75 are rounded up by 0.25, and scores that end in .5 are rounded up by 0.5.

Figure 3: Went to Four Year College by Unrounded First ACT Score



Notes: This figure shows the mean likelihood of students going to a four year college for each bin of unrounded ACT score ranging from 10 to 36, on their first ACT attempt in the years 2010-11 and 2011-12.

Figure 4: Impact of Decimal Value of Unrounded First ACT Score on Four Year College Attendance

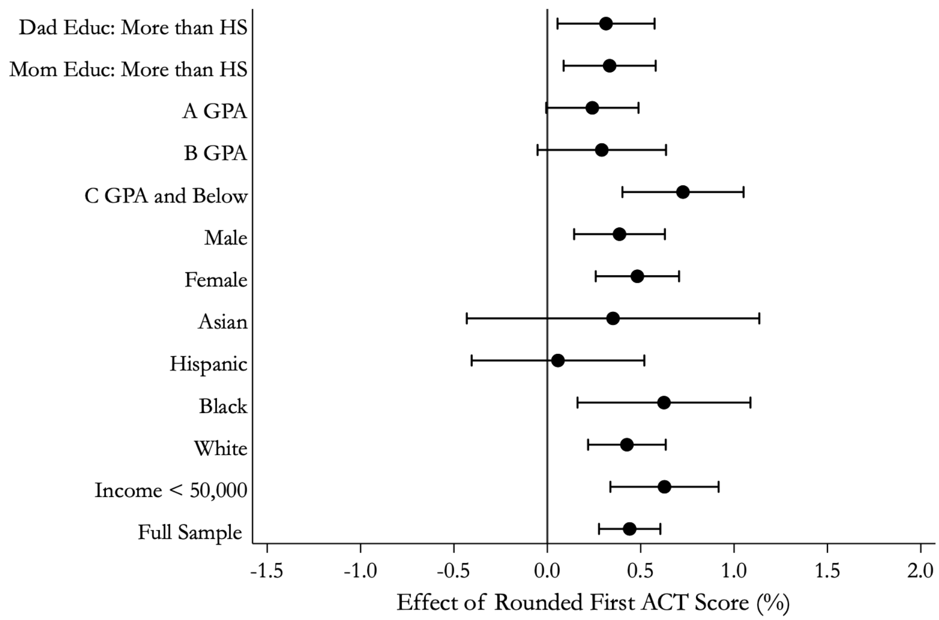


(a) No Controls

(b) With Controls

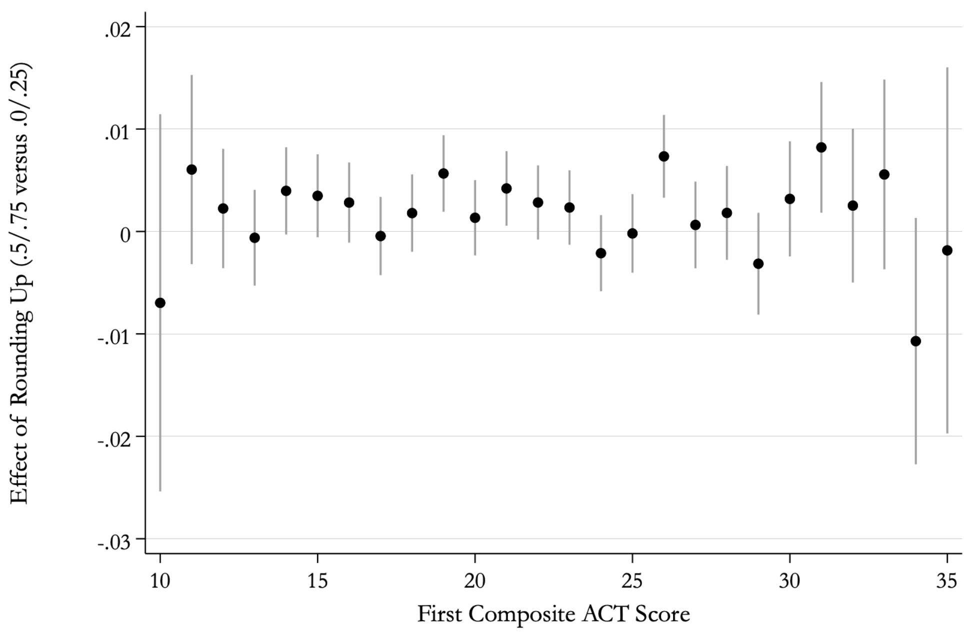
Notes: This figure shows the coefficients and 95 percent confidence intervals from a regression of whether a student went to a four year college on how much ACT score was rounded while controlling for the unrounded ACT score itself. Controls included in Panel (b) are fixed effects for parental income, mother and father's education levels, HS GPA, state, gender and race as well as a fifth degree polynomial of the unrounded first score. The 95 percent confidence intervals use robust standard errors. The sample includes students on their first ACT attempt in the years 2010-11 and 2011-12, who have ACT scores between 10 and 36.

Figure 5: Heterogeneous Treatment Effects: Impact of Rounded First ACT Score on Four Year College Attendance by Subsample



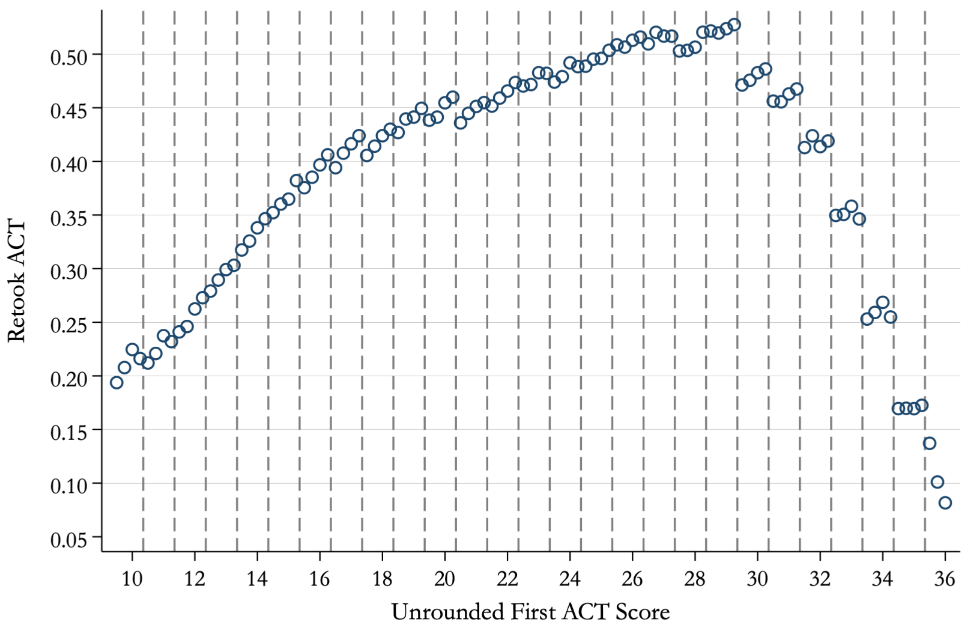
Notes: This figure shows the coefficients and 95 percent confidence intervals of regressions of whether a student went to a four year college on the composite ACT score after controlling for the unrounded ACT score, in different sub-samples of the population. Other controls included are fixed effects for parental income, mother and father's education levels, HS GPA, state, gender and race as well as a fifth degree polynomial of the unrounded first score. The 95 percent confidence intervals use robust standard errors. The sample includes students on their first ACT attempt in the years 2010-11 and 2011-12, who have ACT scores between 10 and 36.

Figure 6: Effects across the Score Distribution



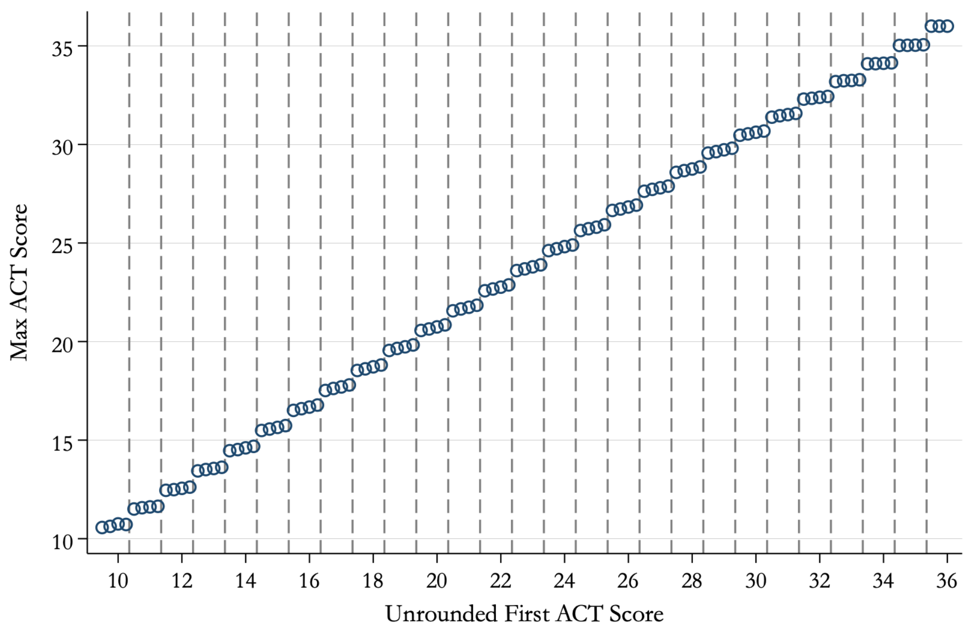
Notes: This figure shows the coefficients and 95 percent confidence intervals from a regression of whether a student went to a four year college on indicators for each composite ACT score, controlling for the unrounded ACT score itself. Other controls include fixed effects for parental income, mother and father's education levels, HS GPA, state, gender and race as well as a fifth degree polynomial of the unrounded first score. The 95 percent confidence intervals use robust standard errors. The sample includes students on their first ACT attempt in the years 2010-11 and 2011-12, who have ACT scores between 10 and 36.

Figure 7: Probability of Retaking ACT By Unrounded First ACT Score



Notes: This figure shows the mean likelihood of students retaking the ACT for each bin of unrounded ACT score ranging from 10 to 36, on their first ACT attempt in the years 2010-11 and 2011-12.

Figure 8: Max Composite ACT Score By Unrounded First ACT Score



Notes: This figure shows the mean max ACT score of students (from all attempts) for each bin of unrounded ACT score ranging from 10 to 36, on their first ACT attempt in the years 2010-11 and 2011-12.

Table 1: Summary Statistics by Decimal Value of Unrounded First ACT Score

	Full Sample (1)	Down 0.25 (2)	Nothing (3)	Up 0.25 (4)	Up 0.5 (5)	N (6)	p-value (7)
Panel A: ACT Test Taker Characteristics							
Female	0.543	0.543	0.543	0.544	0.542	3,289,129	0.406
	[0.498]	(0.001)	(0.001)	(0.001)	(0.001)		
White	0.597	0.598	0.597	0.597	0.597	3,289,129	0.390
	[0.490]	(0.001)	(0.001)	(0.001)	(0.001)		
Black	0.135	0.135	0.136	0.135	0.136	3,289,129	0.450
	[0.342]	(0.000)	(0.000)	(0.000)	(0.000)		
Asian	0.043	0.043	0.043	0.043	0.043	3,289,129	0.177
	[0.203]	(0.000)	(0.000)	(0.000)	(0.000)		
Hispanic	0.132	0.133	0.132	0.132	0.133	3,289,129	0.248
	[0.339]	(0.000)	(0.000)	(0.000)	(0.000)		
Family Income < 50,000	0.475	0.475	0.475	0.475	0.475	2,407,446	0.917
	[0.499]	(0.001)	(0.001)	(0.001)	(0.001)		
C GPA and Below (Less than 2.3)	0.303	0.304	0.303	0.303	0.304	2,951,347	0.090
	[0.460]	(0.001)	(0.001)	(0.001)	(0.001)		
B GPA (2.3 – 3.3)	0.284	0.284	0.285	0.284	0.284	2,951,347	0.353
	[0.451]	(0.001)	(0.001)	(0.001)	(0.001)		
A GPA (3.3 – 4)	0.412	0.412	0.412	0.413	0.412	2,951,347	0.430
	[0.492]	(0.001)	(0.001)	(0.001)	(0.001)		
Mother's Educ: More than HS	0.682	0.683	0.682	0.683	0.682	2,065,394	0.821
	[0.465]	(0.001)	(0.001)	(0.001)	(0.001)		
Father's Educ: More than HS	0.621	0.621	0.621	0.621	0.620	1,998,563	0.899
	[0.485]	(0.001)	(0.001)	(0.001)	(0.001)		
Panel B: Student Outcomes							
Went To College	0.826	0.825	0.827	0.827	0.826	3,289,129	0.036
	[0.379]	(0.000)	(0.000)	(0.000)	(0.000)		
Went To Four Year College	0.600	0.597	0.600	0.601	0.601	3,289,129	0.000
	[0.490]	(0.001)	(0.001)	(0.001)	(0.001)		
Ever Went to Four Year College	0.695	0.694	0.695	0.696	0.695	3,289,129	0.007
	[0.460]	(0.001)	(0.001)	(0.001)	(0.001)		
Went To Less Than Four Year College	0.219	0.221	0.220	0.219	0.218	3,289,129	0.000
	[0.414]	(0.000)	(0.000)	(0.000)	(0.000)		
Retook ACT	0.431	0.436	0.433	0.429	0.425	3,289,129	0.000
	[0.495]	(0.001)	(0.001)	(0.001)	(0.001)		
First Composite ACT Score	20.623	20.237	20.502	20.759	20.995	3,289,129	0.000
	[5.072]	(0.006)	(0.006)	(0.006)	(0.006)		
Max Composite ACT Score	21.293	21.038	21.212	21.384	21.537	3,289,129	0.000
	[5.251]	(0.006)	(0.006)	(0.006)	(0.006)		
Graduated College	0.509	0.509	0.509	0.509	0.508	3,289,129	0.457
	[0.500]	(0.001)	(0.001)	(0.001)	(0.001)		
BA or more	0.426	0.426	0.426	0.427	0.426	3,289,129	0.315
	[0.495]	(0.001)	(0.001)	(0.001)	(0.001)		
Associate Degree or More	0.486	0.487	0.487	0.487	0.486	3,289,129	0.457
	[0.499]	(0.001)	(0.001)	(0.001)	(0.001)		
Number of Semesters/Quarters Attended	8.312	8.304	8.308	8.329	8.305	3,289,129	0.018
	[5.847]	(0.006)	(0.006)	(0.006)	(0.006)		
Panel C: Characteristics of First College Attended							
Median Parent Income	86,078	85,975	86,061	86,133	86,142	2,582,676	0.001
	[26,859]	(33.448)	(33.438)	(33.403)	(33.417)		
Median Student Income	40,399	40,347	40,400	40,423	40,424	2,582,676	0.001
	[11,918]	(14.841)	(14.837)	(14.821)	(14.827)		
Graduation Rate	0.500	0.500	0.501	0.501	0.501	2,686,196	0.000
	[0.228]	(0.000)	(0.000)	(0.000)	(0.000)		

Notes: Panel A reports the individual characteristics of students who took that ACT in either the 2010-11 or 2011-12 school years. Students were surveyed just prior to taking the ACT. The number of students is 3,289,129, but not all students answered all questions. Panel B reports the outcomes for students in Panel A. Panel C reports the college characteristics of college first attended for students in Panel A who attended a college using matched tax data from opportunityinsights.org via Chetty et al (2020). Column (1) reports the mean for the full sample of students along with the standard deviation in brackets. Columns (2) through (5) report the mean for student whose ACT score was round by up or down by the indicated amount along with standard errors in parentheses. Column (6) reports the number student observations for each outcome. Column (7) reports the p-value from the F-test testing whether the means for each of the groups in columns (2) through (5) are equal.

Table 2: Impact of Rounded ACT Score on Four Year College Attendance

	(1)	(2)	(3)	(4)
Composite ACT Score	0.0041***	0.0044***	0.0041***	0.0044***
	(0.0009)	(0.0008)	(0.0009)	(0.0008)
Unrounded Score	0.0334***	0.0203***	-0.6253***	-0.3777***
	(0.0009)	(0.0008)	(0.0284)	(0.0274)
Unrounded Score^2			0.0589***	0.0378***
			(0.0028)	(0.0027)
Unrounded Score^3			-0.0024***	-0.0016***
			(0.0001)	(0.0001)
Unrounded Score^4			0.0000***	0.0000***
			(0.0000)	(0.0000)
Unrounded Score^5			-0.0000***	-0.0000***
			(0.0000)	(0.0000)
% Impact of Score from Rounding	12.14	21.46	12.19	19.74
N	3,285,719	3,285,719	3,285,719	3,285,719
R^2	0.15	0.24	0.16	0.25
Mean of Dep. Var.	0.60	0.60	0.60	0.60
Includes Demographic Controls	N	Y	N	Y

Notes: This table reports the coefficients on the rounded ACT score (i.e. composite ACT score) on going to a four year college after controlling for the unrounded ACT composite score. Demographic Controls in Columns (2) and (4) include fixed effects for parental income level, education levels of their mother and father, HS GPA, state, race and gender. ACT scores range from 10 to 36. Robust standard errors are in parentheses.

Table 3: Impact of Rounded ACT Score

Panel A: With Linear Unrounded ACT Score Control				Characteristics of First College Attended		
	4Y College	<4Y College	College	Parent Inc.	Student Inc.	Grad. Rate
	(1)	(2)	(3)	(4)	(5)	(6)
Composite ACT Score	0.0044***	-0.0034***	0.0008	225.5941***	100.5251***	0.2266***
	(0.0008)	(0.0008)	(0.0007)	(46.4630)	(20.3906)	(0.0377)
Unrounded Score	0.0203***	-0.0093***	0.0107***	1867.1827***	808.6427***	1.5467***
	(0.0008)	(0.0008)	(0.0007)	(46.6246)	(20.4574)	(0.0378)
% Impact of Score from Rounding	21.46	36.08	7.42	12.08	12.43	14.65
N	3,285,719	3,285,719	3,285,719	2,580,976	2,580,976	2,684,385
R^2	0.24	0.12	0.12	0.40	0.41	0.43

Panel B: With Unrounded ACT Score Polynomial Control						
	4Y College	<4Y College	College	Parent Inc.	Student Inc.	Grad. Rate
	(1)	(2)	(3)	(4)	(5)	(6)
Composite ACT Score	0.0044***	-0.0032***	0.0010	219.6139***	98.0525***	0.2238***
	(0.0008)	(0.0008)	(0.0007)	(46.3210)	(20.3217)	(0.0377)
Unrounded Score	-0.3777***	0.2004***	-0.1575***	-7666.1301***	-63.4761	5.1148***
	(0.0274)	(0.0266)	(0.0274)	(1972.3279)	(822.9484)	(1.3031)
Unrounded Score^2	0.0378***	-0.0096***	0.0263***	773.7165***	9.2743	-0.5944***
	(0.0027)	(0.0025)	(0.0026)	(195.5202)	(82.1072)	(0.1268)
Unrounded Score^3	-0.0016***	0.0000	-0.0015***	-30.8133***	2.5008	0.0355***
	(0.0001)	(0.0001)	(0.0001)	(9.4230)	(3.9779)	(0.0060)
Unrounded Score^4	0.0000***	0.0000**	0.0000***	0.5474**	-0.1392	-0.0009***
	(0.0000)	(0.0000)	(0.0000)	(0.2210)	(0.0937)	(0.0001)
Unrounded Score^5	-0.0000***	-0.0000***	-0.0000***	-0.0028	0.0023***	0.0000***
	(0.0000)	(0.0000)	(0.0000)	(0.0020)	(0.0009)	(0.0000)
% Impact of Score from Rounding	19.74	42.34	6.68	12.49	12.85	15.43
N	3,285,719	3,285,719	3,285,719	2,580,976	2,580,976	2,684,385
R^2	0.25	0.12	0.13	0.40	0.41	0.43
Mean of Dep. Var.	0.60	0.22	0.83	86078.42	40399.05	50.07

Notes: This table reports the coefficients on the rounded ACT score (i.e. composite ACT score) on different outcomes after controlling for the unrounded ACT composite score. The % Impact of Score from Rounding reported in Panel A is the coefficient on composite ACT score, divided by the coefficient on unrounded score, multiplied by 100. Each column includes demographic controls including fixed effects for parental income level, education level of their mother and father, HS GPA, state, race and gender. ACT scores range from 10 to 36. Robust standard errors are in parentheses.

Table 4: Impact of Rounded ACT Score, Clustered Standard Errors or Using a Spline

Panel A: Clustered Standard Errors				Characteristics of First College Attended		
	4Y College	<4Y College	College	Parent Inc.	Student Inc.	Grad. Rate
	(1)	(2)	(3)	(4)	(5)	(6)
Composite ACT Score	0.0044***	-0.0032**	0.0010	219.6139***	98.0525***	0.2238***
	(0.0010)	(0.0014)	(0.0014)	(52.1410)	(24.6821)	(0.0376)
N	3,285,719	3,285,719	3,285,719	2,580,976	2,580,976	2,684,385
R^2	0.25	0.12	0.13	0.40	0.41	0.43
Mean of Dep. Var.	0.60	0.22	0.83	86094.97	40405.11	50.08
Panel B: Spline Specification						
	4Y College	<4Y College	College	Parent Inc.	Student Inc.	Grad. Rate
	(1)	(2)	(3)	(4)	(5)	(6)
Composite ACT Score	0.0043***	-0.0033***	0.0007	224.2195***	105.4099***	0.2490***
	(0.0010)	(0.0010)	(0.0009)	(57.9168)	(25.4102)	(0.0471)
N	3,283,150	3,283,150	3,283,150	2,579,729	2,579,729	2,683,075
R^2	0.25	0.12	0.13	0.40	0.41	0.43
Mean of Dep. Var.	0.60	0.22	0.83	86107.16	40409.59	50.10

Notes: This table reports the coefficients on the rounded ACT score (i.e. composite ACT score) on different outcomes. Panel A reports the coefficients when clustering the standard errors by the unrounded ACT score using the same specification as Column 4 of Table 2 which includes demographic controls and controls for the unrounded ACT composite score using a fifth degree polynomial. In Panel A, clustered standard errors are reported in parentheses. Panel B reports the coefficients using a spline to flexibly control for the unrounded ACT composite score. In Panel B, robust standard errors are reported in parentheses. Both panels include demographic controls including fixed effects for parental income level, education level of their mother and father, HS GPA, state, race and gender. ACT scores range from 10 to 36.

Table 5: Impact of Rounded ACT Score on Placebo Outcomes

	Income < $50k	White	Black	Female	GPA=A	Mom: BA+	Dad: BA+
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Composite ACT Score	-0.0002	-0.0018*	0.0009	-0.0073	-0.0006	0.0012	-0.0019*
	(0.0011)	(0.0009)	(0.0006)	(0.0096)	(0.0009)	(0.0011)	(0.0011)
N	2,405,511	3,285,719	3,285,719	3,285,719	2,949,035	2,063,710	1,997,039
R^2	0.12	0.11	0.12	0.00	0.29	0.11	0.14
Mean of Dep. Var.	0.47	0.60	0.14	0.78	0.41	0.36	0.36

Notes: This table reports the coefficients on the rounded ACT score (i.e. composite ACT score) on several placebo outcomes using the same specification as Column 4 of Table 2 which includes demographic controls and controls for the unrounded ACT composite score using a fifth degree polynomial. ACT scores range from 10 to 36. Robust standard errors are in parentheses.

Table 6: Impact of Rounded ACT Score on Additional Outcomes

	Retook	Max ACT	Graduate	BA+	Ever 4Y College	Number of Semesters
Panel A: With Linear Unrounded ACT Score Control						
	(1)	(2)	(3)	(4)	(5)	(6)
Composite ACT Score	-0.0161***	0.6548***	-0.0011	-0.0001	0.0021**	0.0054
	(0.0010)	(0.0026)	(0.0009)	(0.0009)	(0.0008)	(0.0110)
Unrounded Score	0.0260***	0.3489***	0.0398***	0.0430***	0.0317***	0.3444***
	(0.0010)	(0.0026)	(0.0009)	(0.0009)	(0.0008)	(0.0110)
% Impact of Score from Rounding	-61.72	187.67	-2.85	-0.33	6.48	1.57
N	3,285,719	3,285,719	3,285,719	3,285,719	3,285,719	3,285,719
R^2	0.01	0.94	0.15	0.19	0.14	0.09
Panel B: With Unrounded ACT Score Polynomial Control						
	Retook	Max ACT	Graduate	BA+	Ever 4Y College	Number of Semesters
	(1)	(2)	(3)	(4)	(5)	(6)
Composite ACT Score	-0.0152***	0.6564***	-0.0006	0.0002	0.0025***	0.0116
	(0.0009)	(0.0024)	(0.0009)	(0.0008)	(0.0008)	(0.0104)
Unrounded Score	0.0256	0.7407***	-0.3974***	-0.1898***	-0.6409***	-4.7559***
	(0.0297)	(0.0860)	(0.0267)	(0.0244)	(0.0274)	(0.3508)
Unrounded Score^2	0.0113***	-0.0378***	0.0383***	0.0128***	0.0669***	0.5242***
	(0.0029)	(0.0083)	(0.0026)	(0.0024)	(0.0027)	(0.0345)
Unrounded Score^3	-0.0011***	0.0014***	-0.0016***	-0.0002**	-0.0031***	-0.0246***
	(0.0001)	(0.0004)	(0.0001)	(0.0001)	(0.0001)	(0.0016)
Unrounded Score^4	0.0000***	-0.0000**	0.0000***	-0.0000	0.0001***	0.0005***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Unrounded Score^5	-0.0000***	0.0000	-0.0000***	0.0000***	-0.0000***	-0.0000***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
% Impact of Score from Rounding	-112.13	216.51	-3.30	1.21	11.91	6.33
N	3,285,719	3,285,719	3,285,719	3,285,719	3,285,719	3,285,719
R^2	0.19	0.95	0.26	0.30	0.24	0.19
Mean of Dep. Var.	0.43	21.29	0.51	0.43	0.69	8.31

Notes: This table reports the coefficients on the rounded ACT score (i.e. composite ACT score) on different outcomes. The % Impact of Score from Rounding reported in Panel A is the coefficient on composite ACT score, divided by the coefficient on unrounded score, multiplied by 100. Each column includes demographic controls including fixed effects for parental income level, education level of their mother and father, HS GPA, state, race and gender. ACT scores range from 10 to 36. Robust standard errors are in parentheses.