Why Not Apply?
The Effect of Application Costs on College Applications for Low-Income Students

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Abstract:

This paper estimates the sensitivity of students' college application decisions to a small change in the cost of sending standardized test scores to colleges. In the fall of 1997, the ACT increased the number of free score reports it allowed students to send from three to four, maintaining the same $6 marginal cost for each additional score report. After the cost change, there was a large increase in the fraction of ACT-takers who sent four score reports and a large decrease in the fraction that sent three, but very little change in the fraction of SAT-takers who sent either three or four score reports. Comparing the number applications sent by ACT- and SAT-takers, I find that 23% of students sent an additional application in response to the cost change.

When students sent an additional score report, they mechanically widened the range of colleges they sent scores to: sending scores to colleges that were both more- and less-selective than those they would have sent scores to before. Sending an additional score report could particularly benefit low-income students as they are less likely than their higher-income peers both to attend college and to attend selective colleges. I estimate that sending an additional score report could increase a low-income student's future earnings by over $6,000 by increasing the probability that she attends college and that she attends a selective college. I provide evidence that students' large response to this $6 cost change is inconsistent with optimal decision-making and consider two explanations for students' behavior. I show that it is almost impossible for a student to determine which application portfolio will give her the highest utility and suggest that in the face of uncertainty students may rely on rules of thumb in deciding how many colleges to apply to.

I. Introduction

Whether students go to college and which colleges they attend greatly affect the human capital they accumulate and their future earnings. The colleges students apply to significantly determine if and where they will attend college, yet very little is known about how students decide where to apply.

This paper analyzes the change in the number and type of colleges to which students sent their standardized test scores in response to a $6 decrease in the cost of sending their scores to colleges. I find that as a result of the cost decrease, students sent substantially more score reports and applications. I present a simple accounting exercise to show that the benefits low-income students receive from sending an additional score report are much larger than $6. Then, I consider two explanations for students' large reaction to such a small cost change. In the preferred explanation, I show that choosing which colleges to apply to is a complex problem. In light of this complexity, students may rely on rules of thumb in making their decisions. The decrease in the cost of sending score reports appears to change students' rule of thumb, greatly impacting their application decisions.

Before the fall of 1997, students taking the ACT could send their test scores to three colleges for free while each additional score report cost $6. Afterwards, students could send four score reports for free with the same marginal cost for each additional report. Thus all students graduating high school in 1996 or earlier were eligible for only three free score reports while all students graduating in 2000 or later were eligible for four. Students in the high school class of 1998 were eligible for four free score reports if they took the ACT in their senior year, but only three if they took the test in their junior year.

Using micro data from the ACT Corporation on which colleges students sent their ACT scores to, I show that many students sent an additional score report when the fourth score report become free. Figure 1 shows the fraction of each graduating class that sent exactly three and exactly four score reports by whether they took the ACT or SAT. In classes that received only three free ACT score reports, over 70% of ACT-takers sent three score reports and less than 5% sent four. However, once the fourth score report became free, less than 10% sent three score reports while approximately 60% sent exactly

four. Over this period, the fraction of SAT-takers that sent three score reports stayed relatively constant, while there was a small decrease in the fraction that sent four scores.

Since score reports sent are not a perfect proxy for applications, I also use the Beginning Postsecondary Survey (BPS) to show that the increase in score-sending translated into an increase in applications. The number of applications sent by ACT-takers over this period increased much more than did the number of applications sent by SAT-takers.

Sending an additional college application could have large welfare effects for low-income students. Low-income students are less likely to apply to and attend selective colleges than there are higher-income peers conditional on high school achievement (Bowen *et al.* 2005, Pallais and Turner, 2006, and Spies, 2001) even though they receive particularly high returns from attending selective colleges (Dale and Krueger, 2002 and Saavedra, 2008). Additionally, over a quarter of low-income students who say they would like to attend a four-year college and apply to at least one do not matriculate at one (Avery and Kane, 2004).

When students received four free score reports, they widened the selectivity range of colleges to which they sent scores. Some students sent scores to colleges that were more selective than any they would have sent scores to before. This gave students an additional opportunity to be accepted at and attend a more-selective college. Some students also sent scores to colleges that were less selective and had higher admission rates than any they would have sent scores to before. This increased the probability that they were accepted at a college they could afford.

Students did not appear to choose their fourth college to purposely widen the range of colleges they sent scores to. Instead, their ranges widened mechanically as they sent scores to an additional college. If students had consciously attempted to widen the range of colleges they sent scores to, the variance of the selectivity of the colleges to which they sent scores should have increased. Yet, conditional on students' demographics, ACT scores, high school grades, classes taken, extracurricular activities and a linear time trend, there was no change in this variance. However, students did send their score reports to slightly more-competitive colleges on average after the cost change.

I do not have application or matriculation data for the students in the ACT database. However, I use conservative assumptions, such as the assumption that students who sent score reports to colleges as a result of receiving the fourth free score report were only 50% as likely to be admitted as traditional applicants, to show that low-income students could have gained over $6,000 each in future earnings by sending an additional score report.

To interpret students' large response to the cost change, I derive the maximization problem that students should solve when choosing which colleges to apply to. The value of applying to any portfolio of colleges depends on the probability that the student would attend each college in the portfolio and the utility she would get from attending. I argue that students' large response to the small cost change is inconsistent with optimizing behavior. I show that students' maximization problem is complex and difficult to solve because students have many different choices, they cannot easily evaluate the utility they will get from attending each college (Avery and Kane, 2004), and they are likely uncertain about the probability they will be admitted to different colleges.

Thaler and Sunstein (2008) argue that when faced with complex choices, individuals may rely on rules of thumb. In this context, students may interpret the ACT providing three (or four) free score reports as an indication that sending three (or four) score reports is recommended and decide to send the recommended number of scores. Thus, this paper's findings are similar to the findings in Madrian and Shea (2001), Choi *et al.* (2002), and Thaler and Sunstein (2008) where, in making complex decisions about savings and health insurance plans, individuals are greatly affected by the default plan. Additionally, students may respond to the fact that part of the fourth application, sending the fourth score report, costs nothing after the cost change.

The paper proceeds as follows. Section II describes the policy change and the datasets used. Section III discusses the literature on low-income students' college decisions and shows that low-income students of all ability levels send score reports to less-competitive colleges than do similarly-able higher-income students. Section IV shows that students sent more score reports and applications after the cost change and Section V shows that students also widened the range of colleges to which they sent scores. Section VI shows that this widening arose mechanically as students sent an

additional score report. I provide an estimate of the earnings gain low-income students could receive from sending an additional score report in Section VII. Section VIII describes how students should make application decisions and sheds light on why their application decisions deviate from optimality. Section IX concludes.

II. Background Information

Policy Change

Before the fall of 1997, the ACT allowed students to send three free score reports. Starting in the fall of 1997, the ACT provided four free score reports. Thus, students graduating from high school in 1996 or earlier received only three free score reports. Students in the class of 1998 who took the ACT in their senior year received four free score reports, while those in the class who took the ACT in their junior year or earlier received only three. All students in the classes of 2000 and 2004 received four free score reports.

The cost of each additional score report was constant at $6 from the fall of 1995 to the fall of 2001. Before the fall of 1995, each additional score report cost between $4 and $5.50 while after the fall of 2001, each additional score report cost $7. Thus, students in the classes of 1991, 1992, and 1994 paid slightly less for each additional score report than did most students in the classes of 1996, 1998, and 2000 while students in the class of 2004 paid $1 extra. Focusing the results on the classes of 1996, 1998, and 2000 where most students paid $6 for each additional score report does not change the results.

Data

This paper uses three datasets: a large micro database from the ACT Corporation, the BPS, and the ACS.

ACT Database

While the SAT is better known, the ACT is a popular college entrance exam, especially in the Midwest. More students take the ACT than the SAT and almost all United States colleges, including the entire Ivy League, accept ACT scores.

The database from the ACT Corporation includes information on one out of every four Caucasians, one out of every two minorities, and every student who did not provide a race who planned to graduate from high school in 1991, 1992, 1994, 1996, 1998, 2000, or 2004 when taking the ACT. This provides a large sample: 2,486,159 observations on students who attended a valid high school with over 287,000 in each year.[1] I observe each student's ACT score, high school GPA, race, gender, family income, high school, classes taken, and extracurricular activities. I also observe up to six colleges to which each student sent her ACT scores. Seeing only six colleges does not lead to a large censoring problem. As only 2% of students who sent any score reports sent six, very few students could have sent more than six score reports.

Using score-sending data as a proxy for application data has become quite common in the literature.[2] By comparing applications sent to SAT score reports sent, Card and Krueger (2005) find that score-sending data are a good proxy for application data. However, score-sending data are not a perfect proxy. I see only the colleges students indicated they wanted their scores sent to at the time of test registration. Some students may not have applied to colleges to which they sent score reports. Others may have applied to colleges I do not observe them sending ACT scores to because they sent SAT scores instead or sent ACT score reports after test registration. (Empirically, this later concern is not too large: in 2004, the only year for which data on score reports sent after registration are available, only 8% of students who sent score reports at registration sent additional score reports afterwards.) However, because of these potential concerns, I also use the BPS to analyze application behavior directly.

Beginning Postsecondary Student Longitudinal Survey

The BPSs of 1996 and 2004 report the number of applications sent by approximately 27,000 students who first entered postsecondary education between July 1,

[1] For much of the analysis, I exclude students who sent no score reports. Since the ACT Corporation believes that people only take the ACT to apply to college, it seems likely that students who sent no score reports at the time of test registration sent score reports after viewing their scores or sent SAT score reports instead. However, Appendix Table 1 shows that the dramatic change in score-sending caused by the cost change is robust to including these observations. Excluding students who sent zero score reports still leaves a large sample: 2,049,389 observations with more than 253,000 in each year.

[2] See, for example, Card and Krueger (2005), Abraham and Clark (2006), Pope and Pope (2006), Long (2004), and Pallais and Turner (2006).

1995 and June 30, 1996 and July 1, 2003 and June 30, 2004 respectively. The survey also reports whether the students took the ACT or SAT. The public-use BPS does not allow multivariate regression, only tabulations. However, the demographics of the two test-taking populations realized similar small changes between the two waves of the survey.

American College Survey

The ACS provides information on the colleges to which students sent their scores. For each college, it provides the 25th and 75th percentile ACT scores of the entering freshman class,[3] the number of applicants and admitted students, and the application fee.

I use test scores from freshmen matriculating in 1993 as my measure of college selectivity so that the analysis is not confounded by colleges becoming more competitive over time. I only discuss the results using colleges' 25th percentile ACT scores because the results are so similar for the 25th and 75th percentiles. However, results for the 75th percentile are available from the author. As many readers may not be familiar with the meaning of different ACT scores, I convert the ACT scores of colleges' freshmen into percentiles of the distribution of the ACT scores of the colleges the class of 1996 sent scores to. For example, if a college has a normalized 25th percentile ACT score of 30, 30% of score reports students sent in 1996 went to colleges with lower 25th percentile ACT scores. I also report the results using the actual 25th percentile of ACT scores in footnotes for readers who are familiar with the metric.

III. College Choices of Low-Income Students

Low-income students are less likely to attend college, conditional on high school achievement, than are their higher-income peers. Ellwood and Kane (2000) find that in the class of 1992, 66% of students with family incomes in the top quartile attended a four-year college, while only 28% of students from the bottom income quartile did so. They estimate that 40% of this gap remains after controlling for 12th grade test scores.

[3] Many colleges do not provide both SAT and ACT scores of matriculating freshmen. For schools that only provide SAT data, I impute the 25th and 75th percentile of ACT scores using a concordance produced by the College Board. The ACS does not provide information on the freshmen class's median ACT or SAT scores.

This is troubling as Card (1995) finds that the return to a year of college is higher for disadvantaged students.

Low-income students are also underrepresented at selective colleges. Hill *et al.* (2005) find that in the 2001-2002 school year only 10% of students at 28 elite private colleges (COFHE colleges)[4] were from the bottom 40% of the income distribution. Winston and Hill (2005) find that this was 35% less than the fraction of high-achieving low-income students nationally.

Many studies have found a large return to college quality for students of all income levels (*e.g.* Hoxby, 1998; Black, Daniel, and Smith, 2005; Zhang 2005; Brewer *et al.*, 1999; and Black and Smith, 2006). There is no consensus on this in the literature, however, because Dale and Krueger (2002) find there is no return to college selectivity for most students when they compare students admitted to the same colleges. Yet, Dale and Krueger do find large returns for low-income students. Many other studies (e.g. Saavedra, 2008, Monks, 2000, Behrman *et al.*, 1996, and Loury and Garman, 2000) find that low-income students and minorities have particularly high returns to attending a selective college.

Low-income students' application choices may play a role in their underrepresentation in college and at selective colleges. In their evaluation of the COACH program, Avery and Kane (2004) argue that providing disadvantaged high school students with help in choosing which colleges to apply to increased the fraction of these students who attended college. Even with substantial college counseling, however, 27% of disadvantaged students who wanted to attend a four-year college and applied were not admitted to one at which they decided to matriculate, including a large number of students who had high GPAs. This suggests that choosing more appropriate sets of colleges could have increased the probability that many low-income students attended college.

Similarly, Bowen *et al.* (2005), Spies (2001), and Pallais and Turner (2006) find that low-income students were less likely to apply to elite colleges than were their higher-income peers, conditional on their high-school achievement. Bowen *et al.* (2005) finds

[4] The COFHE (Consortium on Financing Higher Education) colleges are 31 elite private schools that include the entire Ivy League. Hill *et al.* (2005) and Winston and Hill (2005) have data on only 28 of these colleges.

that, conditional on applying, low-income students were no less likely to gain admission to or matriculate at elite colleges than were their higher-income peers.

Score-Sending by Family Income

Among those who sent score reports, low-income students sent fewer score reports than did their higher-income peers before the cost of sending score reports changed.[5] Table 1 displays the results from estimating

$$y_i = \alpha + \beta_1(middle\_income_i) + \beta_2(high\_income_i) + X_i\beta_3 + \varepsilon_i \quad (1)$$

where *y* is the number of score reports individuals sent to colleges. The variables *middle_income* and *high_income* are dummies for having a family income between $36,000 and $80,000 per year and above $80,000 per year, respectively. The dummy for being low-income, having a family income less than $36,000 per year, is omitted. The vector *X* contains many background variables including dummies for each ACT score, many controls for demographics, high school achievement, and extracurricular participation, and high school fixed effects.[6] The first column contains no controls, while the second column adds dummies for each ACT score and all of the controls in footnote six, and the third column adds high school fixed effects.[7] Throughout the paper, standard errors are clustered at the state level.

[5] Students with higher family incomes were more likely to send zero score reports at the time of test registration, however. As the free score reports were available only at registration, this suggests higher-income students were more likely to pay $6 for the option of seeing their scores before sending them to colleges or more likely to take both the SAT and ACT.

[6] I control for state dummies, race dummies, a dummy for United States citizenship, and indicators for English being the primary language spoken in the home, the number of siblings the student has under the age of 21, the size of the community the student lives in, and the student's gender. I also control for whether she attended a private high school, was on a college preparatory track, had any college credit, the number of years of English and math classes she had taken, dummies for whether she had taken honors English or math, her high school GPA, whether she had ever been elected to a student office, worked on the staff of a school paper or yearbook, earned a varsity letter for sports participation, and held a regular part-time job.

[7] It is not clear that I should control for high school fixed effects. If students' high schools are partially a function of their incomes, regressions that include high school fixed effects likely underestimate the effect of family income on application choices. However, if students' high schools are a function of characteristics correlated with income, omitting high school fixed effects would likely lead to overestimates. Because I would rather conservatively underestimate the gap between the income groups, I prefer the specification with high school fixed effects. However, I almost always report the results both ways.

Including all of the controls and high school fixed effects, I find that high-income students sent 0.13 more score reports on average than did observationally equivalent low-income students. Middle-income students also sent more score reports than did their low-income peers, though substantially fewer than did high-income students.

Low-income students also sent scores to less-competitive colleges on average than did their higher-income peers. Figure 2 plots the average selectivity of colleges that high- and low-income students with each ACT score sent scores to. To compute the selectivity of each college, I normalize the 25th percentile ACT score of the college's incoming freshmen as described in Section II. Students' ACT scores, plotted on the x-axis are converted to percentiles of the 1996 ACT distribution for ease of interpretation. The graph shows that virtually throughout the ability distribution low-income students sent their scores to less-selective colleges than did their higher-income peers, though this difference is larger for high-ability students.

Table 2 shows that low-income students were less likely than their higher-income peers to send scores to selective "reach" colleges and more likely to send scores to "safety schools" whose students were below their ability level. Panels A and B show the results of estimating equation (1) where the dependent variables are the highest and lowest 25th percentile ACT scores of the colleges students sent scores to, respectively. Columns 1 through 3 contain the same controls as in Table 1. Columns 4 through 8 contain all the controls and high school fixed effects and are limited to students in different parts of the ACT score distribution.

Without controlling for students' differential high school achievement or demographics, low-income students' most-selective colleges were 12 percentage points less selective than those of high-income students: the difference between the University of Pennsylvania and the University of Nevada, Reno. Background characteristics explain approximately 60% of this disparity and adding high school fixed effects on top of these controls explains approximately 35% of the remaining gap. Conditional on background characteristics and high school fixed effects, the disparity was 3 percentage points: the difference in selectivity between the University of Pennsylvania and Kenyon College. The differences between low- and high-income students' least-selective colleges were

slightly smaller.[8] Similar to Figure 2, columns 4 through 9 show that these differences in college competitiveness existed throughout most of the ability distribution, but were larger for high-ability students.

IV. Increase in Applications Sent

When the fourth score report became free, there was a dramatic increase in the fraction of ACT-takers sending exactly four score reports and a large decrease in the fraction sending exactly three, but very little change in the number of score reports sent by SAT-takers. Figure 1 plots the fraction of each graduating class that sent exactly three and exactly four score reports by whether students took the ACT or the SAT. In each class in which all students received only three free score reports over 70% of ACT-takers sent exactly three score reports while less than 5% sent exactly four. In the class of 1998 in which some ACT-takers were eligible for four free score reports, the fraction of ACT-takers sending four score reports jumped to over 40%, while the fraction of students sending three score reports plummeted to less than a third. In classes where all ACT-takers were eligible for the fourth free score report, over 55% of students sent four score reports and less than 10% sent exactly three. Yet, among SAT-takers, there was actually a small decrease in the fraction of students sending four score reports and no change in the fraction of students sending three.[9] There was a small decrease in the fraction of ACT-takers sending four score reports between 2000 and 2004. Appendix Figure 1, which replicates Figure 1 excluding students who sent no score reports, shows that some of this decrease resulted from an increase in the number of students sending zero scores.

While there were large changes in the fraction of ACT-takers sending exactly three and exactly four score reports, there were very small changes in the fraction of students sending other numbers of scores. Aside from the percentage of students sending one score report in 2004, over the 13 years spanned by this data, the percentage of

[8] The differences in the actual (not normalized) 25th percentile ACT scores of low- and high-income students' most-selective colleges were 1.4 ACT points with no controls and 0.3 ACT points conditional on all of the background characteristics and high school fixed effects. The differences in the 25th percentile ACT scores of the least-selective colleges these students sent scores to were 0.9 ACT points with no controls and 0.2 ACT points conditional on all of the controls and high school fixed effects.

[9] Since I do not have access to confidential SAT data, I thank Jesse Rothstein for tabulating these statistics.

students sending one, two, five, and six score reports each varied by less than one percentage point, remaining almost unchanged after 1997.

Table 3 displays regression estimates of the effect of the cost change on the number of score reports sent. The first two columns report estimates of the equation

$$y_i = \alpha + \beta_1(class\ of\ 1998_i) + \beta_2(post\_1998_i) + \beta_3 lowinc_i + \beta_4 t + \beta_5(t \times lowinc_i) + X_i\beta_6 + \varepsilon_i . \quad (2)$$

The dependent variable, *y*, is the number of score reports sent. The variable *class of 1998* is an indicator for the class of 1998, and *post_1998* is an indicator for the classes of 2000 and 2004. I include separate indicators for the class of 1998 and the classes after 1998 because I expect the policy to have larger effects in later years when all test-takers were eligible for the fourth free score report. The variable *lowinc* is a low-income dummy, *t* and $t \times lowinc$ represent a linear time trend and a separate linear time trend for low-income students, and *X* is a vector of dummies for each ACT score, high school fixed effects, and the covariates in footnote six.

To show the differential response of low-income students to the cost change, the last three columns of Table 3 report the results of estimating

$$y_i = \alpha + \beta_1(class\ of\ 1998_i) + \beta_2(post\_1998_i) + \beta_3 lowinc_i + \beta_4(lowinc_i \times class\ of\ 1998_i) + \beta_5(lowinc_i \times post\_1998_i) + \beta_6 t + \beta_7(t \times lowinc_i) + X_i\beta_8 + \varepsilon_i \quad (3)$$

where *lowinc* × *class of 1998* and *lowinc* × *post_1998* are the interactions of the two time indicators with the low-income dummy.

The estimates show that on average, students sent 0.79 more score reports in the classes of 2000 and 2004 than in classes in which students only received three free score reports. On average, middle- and high-income students sent 0.78 additional score reports and low-income students sent 0.81 additional reports. Predictably, the class of 1998 did not increase its score-sending as much as did later classes.[10] Estimating these regressions separately for students in different quartiles of the ACT distribution shows that once all

[10] In the class of 1998, middle- and high-income students sent an additional 0.46 score reports on average, while low-income students sent an additional 0.56 reports. If low-income students were more likely than their higher-income peers to take the ACT in their senior year as opposed to their junior year, a higher fraction of low- than high-income students in the class of 1998 would have received four free score reports. This would explain why low-income students realized a larger increase in score-sending over their higher-income peers in the class of 1998 than in later classes.

test-takers received four free score reports, students of all ability levels increased their score-sending by similar amounts.

These results change very little with the exclusion of the controls and high school fixed effects. Appendix Table 1 shows that the results are also similar when students who sent no score reports are included. Excluding the time trends attenuates the coefficients (though they are still large and significant) as, on average, middle- and high-income students sent 0.02 fewer score reports each year between 1991 and 2004 and low-income students sent 0.01 fewer score reports.

The ACT database does not include information on applications, so I use the BPS to show that the additional score reports translated into additional applications. Table 4 reports the average number of applications sent by ACT-takers and SAT-takers who entered college during the 1995-1996 school year and by those who entered during the 2003-2004 school year. It shows that the average ACT-taker in the 2003-2004 entering class sent 0.33 more applications than did the average ACT-taker in the 1995-1996 entering class, while the average SAT-taker in the entering class of 2003-2004 sent only 0.11 more applications than her 1995-1996 counterpart. Low-income ACT-takers sent 0.40 more applications each over this period, while low-income SAT-takers sent only 0.13 more.

The ACT and SAT realized the same changes in their test-taking populations between the classes of 1995 and 2003.[11] Assuming that without the cost change ACT-takers would have realized the same increase in applications over this period as did SAT-takers, ACT-takers sent 0.23 additional applications as a result of the cost change.[12] Regressions indicate that they sent 0.79 more score reports on average, implying that 29% of their additional score reports turned into applications. Low-income students sent 0.26 additional applications and 0.81 additional score reports per capita as a result of the cost change, implying that 33% of their additional score reports turned into applications.

[11] Slightly smaller fractions of both pools of test-takers were white, but there were no significant changes in the percentage of students of any other race or either gender. As one would expect, the average nominal parental income of both sets of test-takers increased.

[12] This is slightly different than the 0.33 – 0.11 = 0.22 applications that would be expected from the text because of rounding to report the two-digit figures 0.33 and 0.11. The figures for low-income students are also rounded in the text.

V. Changes in the Selectivity of Colleges To Which Scores Were Sent

When students sent more score reports, they widened the range of colleges they sent scores to, sending scores to colleges that were both more- and less-selective than any they would have sent scores to before. Table 5 displays the results of estimating equations (2) and (3) where the dependent variable is the selectivity of the most- and least-competitive colleges each student sent scores to.

The most-selective colleges middle- and high-income students sent scores to were 4.1 points more selective in classes where all students received four free score reports than in classes where all students received only three. Their least-competitive colleges were 3.6 percentage points less competitive. Low-income students saw a larger, 5 percentage point, increase in the selectivity of their most-competitive colleges, and a decrease in selectivity of their least-competitive colleges statistically indistinguishable from that of higher-income students. A 5 percentage point selectivity difference is the difference between Cornell and Furman Universities, while a 3.6 percentage point difference is the difference between Princeton and Washington and Lee Universities. The average selectivity of colleges students sent scores to increased by 0.9 percentage points for middle- and high-income students and a not-significantly-different 1.0 percentage points for low-income students.[13] This is approximately the difference between the University of Pennsylvania and Emory University. These results are very robust.[14] These selectivity changes are smaller for the class of 1998 in which not all students were offered four free score reports.

[13] Middle- and high-income students increased the selectivity of the most-competitive colleges they sent scores to by 0.51 (not normalized) ACT points, while low-income students increased the selectivity of these colleges by 0.57 ACT points. The selectivity of the least-competitive colleges middle- and high-income students sent scores to both decreased by 0.37 ACT points. The average selectivity of the colleges students sent scores to increased by 0.07 ACT points for higher-income students and 0.11 points for low-income students.

[14] Adding a quadratic time trend, a separate quadratic time trend for low-income students, and covariates for the student's interest in science, social service, business, and arts, whether the student had done community service, and her grades in algebra 1, biology, and United States history does not change the coefficients of interest. Additionally, I estimate counterfactual regressions as in Table 5 while assuming that instead of being implemented in the fall of 1997, the new cost structure was first implemented for the class of 1992, 1994, or 1996. I drop students graduating after 1996. Only one of the six coefficients on the dummy for graduating after the counterfactual policy change is significant and this effect is small, less than 15% of the actual policy effect, with a t-statistic of 2.5.

Sending scores to less-selective colleges entailed sending scores to colleges with higher admissions rates and less-able applicant pools. As a result of the cost change, the highest admissions rate among colleges students sent scores to increased by 1.3 and 1.8 percentage points for higher- and low-income students, respectively. The average ACT scores of students who, in 1996, sent score reports to students' least-selective colleges decreased by 1.0 and 1.1 percentile for higher- and low-income students respectively.[15]

Table 6 re-estimates equation (3) for students in different parts of the ability distribution. It shows that all ability groups realized significant changes in the most- and least-competitive colleges to which they sent scores. Higher-ability students realized smaller increases in the selectivity of their most-competitive colleges. This may be because higher-ability students were sending their scores to more-competitive colleges than were lower-ability students before the cost change, so they had relatively smaller untapped pools of more-competitive colleges to which they could send their scores. The ability groups realized similar decreases in the selectivity of their least-competitive colleges.

VI. Mechanism

Students sent their scores to a wide range of colleges even before receiving the fourth free score report. In classes where students only received three free score reports, the average difference in selectivity between a student's most- and least-selective colleges was 28 percentage points, approximately the difference in selectivity between Brown University and the University of Northern Iowa. Estimating equation (3) with the dependent variable as the difference in selectivity between a student's most- and least-selective college shows that the average higher-income student increased the range of colleges she sent scores to by 8 percentage points as a result of the cost change, while the average low-income student increased her range by 8.5 percentage points.

Theoretically, most students might have deliberately chosen to send their fourth score report to a college that was either more- or less-selective than any they would have

[15] So that my results are not confounded by colleges becoming more competitive over time, I use consistent measures of colleges' admissions standards for the different cohorts. I use admissions rates for the class of 1993 and the average ACT scores of students who sent score reports to colleges in 1996.

otherwise sent scores to. However, this does not have to be the case. No matter how students chose their fourth college, if they continued to send their scores to the three colleges they would have sent scores to if they had only received three free score reports, their most-selective colleges must have been weakly more-selective and their least-selective colleges must have been weakly less-selective when they sent four score reports. This is because the maximum and minimum of a set must be weakly greater and weakly smaller, respectively, than the maximum and the minimum of any subset.

Students did not systemically send their fourth score reports to colleges outside their original selectivity ranges. If they had, the variance of the selectivity of colleges they sent scores to should have increased when the fourth score report became free, conditional on their characteristics. The squared residuals from a regression of the selectivity of each college to which scores were sent on all of the independent variables in equation (3) are measures of this conditional variance. Regressing these squared residuals on dummies for being in the class of 1998 and graduating after 1998 should produce positive coefficients if students systematically sent their fourth score reports to colleges outside their original selectivity ranges. However, the coefficients from this regression are very small, only the coefficient for the class of 1998 is significant, and together the dummy variables explain less than 0.01% of the variation in the squared residuals.

The magnitudes of changes in the selectivity of students' most- and least-competitive colleges are roughly consistent with students choosing three colleges at random from a selectivity distribution before the cost change and choosing four colleges at random from the same distribution afterwards. Because the average selectivity of the colleges students sent scores to increased after the cost change, we know students did not choose colleges in this way. However, the fact that these magnitudes could have arisen purely mechanically from students choosing colleges at random supports the notion that students were not purposely trying to widen the range of colleges they sent scores to.

The standard deviation of the selectivity of colleges students sent scores to before the cost change, conditional on all of the covariates, is 25 points. If students chose colleges at random from a normal distribution of selectivity, with a mean depending on their observed characteristics and this standard deviation, the most- (least-) selective

college of students who sent four score reports would be approximately 4.5 percentage points more (less) selective than the most- (least-) selective college of students who sent only three. This is similar to the 4.4 and 3.5 percentage point changes in the selectivity of students' most- and least-selective colleges that occurred as a result of the cost change.

VII. Assessing Benefits to Students

This section provides a benchmark calculation of the benefit low-income students receive from sending an additional score report. I calculate the return that comes through two channels. First, sending an additional score report may increase the probability that a student attends college by increasing the probability that she is admitted to a college she can afford. Second, sending an additional application may increase the probability that a student attends a more selective college by increasing the probability that she is admitted to one.

There may be many other benefits and costs of sending an additional application that, without a good deal more data, I cannot evaluate. Sending an additional score report may give the student more college options, allowing her to attend a college that offers her a better financial aid package or that is a better "fit." At the same time it takes time and sometimes money[16] to apply to an additional college and costs an admissions officer time to read the application. With more applications to complete and read, students and admissions officers may spend less time on each application, potentially leading to worse matches between students and colleges. However, the calculations in this section suggest that the benefit to sending an additional score report is so large that it is likely to greatly outweigh these costs.

Attending College

Avery and Kane (2004) find that 27% of students from disadvantaged high schools in Boston who stated that they wanted to attend a four-year college and applied to at least one nonetheless did not end up matriculating at one. They argue that this number would have been higher if they had not provided the students with extensive help in

[16] Most colleges allow low-income students to waive the application fee.

selecting which colleges to apply to. To be conservative, I assume that only 10% of Avery and Kane's non-matriculators, 2.7% of students, who sent an additional application would be induced to attend four years of college by doing so. Given that only 33% of low-income students who sent an additional score report sent an additional application, this implies that only 0.89% of students who sent an additional score report attended college because they did so.

To calculate the earnings gain for these low-income students who were induced to attend college, I use Carniero, Hansen, and Heckman's (2003) estimate that, on average, students on the margin of going to college would have 51% higher lifetime earnings as college graduates than as high school graduates. This includes college graduates' forgone earnings while in college, their lower experience at any given age than high school graduates, and the cost of college tuition. This is approximately a 10.8% return for each year of college, unsurprisingly smaller than Card's (1995) estimates of the return to a year of college that do not include forgone earnings and experience or tuition costs. I use Day and Newburger's (2002) estimate that the lifetime earnings of high school graduates from these cohorts will be approximately $1.2 million in 1999 dollars. Under these assumptions, a low-income student receives a benefit of almost $5,500 from sending an additional score report through this channel. The benefit is

$$0.89\% \times \$1.2\ million \times 51\% = \$5{,}447 \qquad (4)$$

where 0.89% of low-income students who sent an additional score report were induced to attend college and $1.2 million × 51% is the return these students get from attending college.

Attending a Preferred College

Dale and Krueger (2002) estimate that low-income students receive a 4% wage premium for attending a college whose students score 100 points higher on the SAT.[17] Day and Newburger (2002) estimate that the average college graduate will earn $2.1

[17] As discussed in Section II, there are many studies that estimate the return to college selectivity. I use estimates from the Dale and Krueger (2002) study because it examines low-income students separately and because Dale and Krueger's methodology generally finds smaller returns to college quality than do other approaches, allowing my statements about the benefit of sending an additional score report to be more conservative.

million in 1999 dollars over their lifetime. Under these assumptions and several others, the return to sending an additional score report is approximately $3,700.[18] That benefit is

$$\$2.1\,million \times 4\% \times 0.44 \times 0.10 \;=\; \$3{,}696\,. \qquad (5)$$

Here, $2.1 million × 4% is the estimated return a low-income student gets from attending a college with students who have 100-point higher SAT scores and 0.44 is the conversion rate between 100 SAT points and one (non-normalized) ACT point (calculated from a concordance produced by the College Board). I estimate that, on average, students who send an additional score report will attend a college whose students have (non-normalized) ACT scores 0.10 points higher as a result of some students sending their additional score report to a more-competitive college.

To calculate the 0.10 figure I make four assumptions. First, I assume that score reports sent to students' most-competitive colleges translated into applications at the same rate as did other score reports: 33%. Second, to be conservative, I assume that these new applicants were only 50% as likely to be admitted to these colleges as the average applicant. Third, I assume that before the cost change, students attended the most-selective colleges they sent scores to. This is a very conservative assumption since students may not have been admitted to or even applied to these colleges. Finally, I assume that after the cost change, students who were admitted to the most-selective college they sent scores to attended that school, while those who were not admitted attended the same school they would have without the fourth free score report. While probably not every student attended the most-competitive college that admitted her, Dale and Krueger (2002) find that the vast majority of students in their highly-able sample attended the most selective college to which they were admitted.[19] Even if all students attended the most-competitive college *they sent scores to* before the cost change, but only

[18] This is only an estimate of the return students receive from sending a score report to a more-competitive college than any they would have otherwise sent scores to. Students who do not send a score to a more-competitive college than any they would have sent scores to without the fourth free score report may still attend a more-competitive college because of the fourth score report. For example, if before the cost change a student would have applied to Harvard, Princeton, and the University of Missouri and attended the University of Missouri because she was rejected from Harvard and Princeton, but after the cost change she would have also applied to Cornell and matriculated there, I would not capture these benefits.

[19] The fact that students did not send score reports to these more-competitive colleges without the fourth free score report does not indicate that students did not want to attend these colleges. It may simply reflect the fact that students thought they were unlikely to be admitted. The return to college selectivity literature suggests that these students would receive substantially higher earnings from attending more-selective colleges.

a third of students attended the best college *they were admitted to* after the cost change, the return to sending an additional score report through this channel would be over $1,200, much larger than the $6 cost change. Appendix Table 2 lays out each of the steps to calculating this 0.10 figure.

VIII. Interpretation of Behavior Change

As $6 is much smaller than the estimated return from sending an additional score report, much less an additional application, it seems unlikely that it could be optimal for 23% of students to send an additional application as a result of a $6 cost change.

Since students only benefit from sending score reports to colleges they apply to, they should treat score-sending costs and other application costs equivalently. Yet, while applications increased by 9% in response to the $6 decrease in score-sending costs, there is no relationship in the ACS data between changes in application fees and changes in the number of applications colleges receive from 1993 to 2002. In fact, if students treated application and score-sending costs equivalently, we would expect applications to any college that decreased its application fee by $6 to increase by more than 9%, since some students would substitute towards this college from others that did not decrease their fees.

The lack of relationship between changes in application fees and changes in applications could result from the endogeneity of application fees if colleges decrease their fees when they expect to have few applicants and raise them when they expect to have many. However, if colleges believed that changing their application fees led to large changes in the number of applications they received, colleges that go to great lengths to encourage applications by sending representatives to high schools and purchasing radio and television advertisements would likely eliminate or greatly reduce their application fees to encourage more applications.

It is not surprising that students do not optimally choose the colleges to which they apply given that it is almost impossible to do so. Students must choose one of over $2^{2,400}$ combinations of colleges to apply to, while determining the value of applying to even one combination is not straightforward. The value depends on the utility the student would get from attending each college, the probability that she would be admitted to each

combination of the colleges in the set she applies to, and the cost of applying to the colleges. Specifically, the utility student i gets from applying to a set of colleges θ is

$$\left[\sum_{I} p_{i\varphi\phi} \sum_{j\in\varphi} \Pr(A_{j\varphi}) \times E_1[u_{ij} \mid A_{j\varphi}]\right] - E_1[c_{i\theta}] \tag{6}$$

where event

$$A_{j\varphi} = \{E_2[u_{ij}] > E_2[u_{ik}] \; \forall k \neq j, k \in \varphi\} . \tag{7}$$

Here I is the set of all sets $\{\varphi, Ø\}$ that partition the set of colleges θ. In this expression, $p_{i\varphi Ø}$ is the probability that the student is admitted to all of the colleges in φ, but none in Ø (conditional on applying), u_{ij} is the utility student i would get from attending college j, $c_{i\theta}$ is the cost of applying to the colleges in θ, E_1 indicates the expectation when the student chooses where to apply and E_2 indicates the expectation when the student decides where to matriculate.

The intuition behind this expression is that with probability $p_{i\varphi Ø}$, the student is only admitted to the colleges in φ. She will then attend the college in the set φ which gives her the largest expected utility. This is college j when event $A_{j\varphi}$ occurs. When she attends college j, she will, on average, obtain the expected utility from attending that college, conditional on her having chosen to attend. This will be different from her expected utility from attending at the time she applies if she learns more about the college after she applies but before she decides where to matriculate.[20]

Expression (6) is difficult to evaluate because students face uncertainty about u_{ij}, $p_{i\varphi Ø}$, and often even $c_{i\theta}$. The utility a student would get from attending a given college, u_{ij}, depends on her financial aid package (which is often not revealed until after admissions decisions), her earnings after attending the college, her earnings if she does not attend a four-year college, and the utility derived from experiences she would have at the college. Avery and Kane (2004) show that students have great difficulty estimating u_{ij}. The high school seniors they surveyed overestimated college graduates' average earnings by 50% and tuition at local colleges by 100% to 200%, on average. Twenty-five percent estimated that the net present value of college was negative.

[20] Howell (2004) proposes a similar model of students' college application decisions which she estimates structurally using data from the Department of Education.

While a student may know a college's admissions rate and statistics on its entering students, she may not know the admissions rate of applicants with her grades and test scores or how the school's admissions officers would weight her extracurricular activities, recommendation letters, and essays. It is even less likely that the student would know the strength of the correlation between different colleges' admissions decisions which is necessary to determine $p_{i\varphi\emptyset}$. Finally, she might not even know her cost of applying to a set of colleges because this depends on how long it takes to complete the applications.

Several behavioral explanations can explain students' large response to the cost change. Thaler and Sunstein (2008) argue that faced with uncertainty, people may turn to behavioral biases such as following rules of thumb. In this case, students may interpret the ACT providing three (or four) free score reports as a signal that sending three (or four) applications is recommended and use that signal as a rule of thumb about how many colleges to apply to. When the cost of score-sending changes, students respond to the change in the rule of thumb, not the actual cost change. This explanation is consistent with the Madrian and Shea (2001), Choi *et al.* (2002), and Thaler and Sunstein (2008) results that default 401(k) plans and Medicare Part D plans have large effects on individuals' plan choices. Deciding which financial investments and health care plan best suit an individual family is exceedingly complex. When individuals are unsure what to choose, they may assume that the default choice is recommended or follow the rule of thumb of simply sticking with the default.

College application guides show that many students are looking for an authority to provide a rule of thumb about how many colleges they should apply to. "How many applications are enough?" is the first frequently asked question on the College Board's website for college counselors[21] and is prominently featured in many other college guides. The College Board suggests sending five to eight applications, many more than students send on average.

An additional consideration is that the cost of the fourth score report did not just decrease by $6, it decreased to $0. Several recent studies have found that demand is discontinuous at a price of zero. For example, Kremer and Miguel (2007) find that the

[21] See http://professionals.collegeboard.com/guidance/applications/how-many.

take-up of deworming drugs in Kenya decreased from 75% to 19% when students were charged $0.30 per pill instead of receiving the drugs for free, even though there are extremely large benefits of deworming. Demand was not sensitive to changes in price once the price was above $0. In this context, though the fourth score report cost $0, the cost of sending an additional application was still positive for higher-income students because of application fees. Ariely (2008) documents, however, that people buy much more of a product when part of the item (such as shipping-and-handling) costs $0 than they would from an equivalent reduction in the total price of the item where each part retained a positive price.

IX. Conclusion

The colleges students apply to greatly affect whether they attend college, the quality of colleges they attend, and their future earnings. Yet, little is known about how students decide where to apply. This paper analyzes the effect of a small, $6 decrease in the cost of sending ACT score reports to colleges on the number and selectivity of colleges to which students sent scores. Before the fall of 1997, students taking the ACT could send their test scores to three colleges for free while each additional score report cost $6. Afterwards, students could send four score reports for free with the same marginal cost for each additional report.

The paper finds that many students sent an additional score report and application in response to the cost decrease. Additionally, students widened the range of colleges they sent scores to, sending score reports to colleges that were both more- and less-selective than any they would have otherwise considered. Because sending an additional score report could increase the probability that students attend college and attend a selective college, it could be particularly beneficial for low-income students, increasing their future incomes by thousands of dollars.

I provide evidence that the large increase in applications sent in response to this $6 cost change is inconsistent with optimal decision-making. Moreover, I show that optimal decision-making is almost impossible because students' maximization problem is so difficult to solve. Faced with great uncertainty, students may rely on rules of thumb

about where to apply: in this case interpreting the ACT providing three (or four) score reports as a recommendation to send that many scores. Under this explanation, when the fourth score report became free, students responded to the change in their rules of thumb, not the $6 cost change. Given students' apparent reliance on rules of thumb, providing them with rules of thumb based on data as opposed to the pricing structure of the ACT could lead to large changes in application behavior, facilitating higher college attendance and better student-college matches.

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Table 1. Number of Scores Sent by Family Income in the Class of 1996

	(1)	(2)	(3)
Middle-Income	0.107	0.047	0.039
	(0.005)	(0.005)	(0.005)
High-Income	0.238	0.160	0.134
	(0.013)	(0.013)	(0.012)
ACT Score Dummies	No	Yes	Yes
Background Characteristics	No	Yes	Yes
High School Fixed Effects	No	No	Yes

Notes: Each column presents results from a separate regression of the number of score reports sent on income dummies. The omitted dummy is the low-income indicator. All regressions are limited to students in the class of 1996 who sent at least one score report. Standard errors, clustered at the state level, are in parentheses. Low-income students have family incomes less than $36,000 per year, middle-income students have family incomes between $36,000 and $80,000, and high-income students have family incomes above $80,000. The controls included in "background characteristics" are listed in footnote six. Data come from the ACT database.

Table 2. College Selectivity by Family Income in the Class of 1996

A. Most-Selective College

	All Students			*By ACT Quartile*				
	(1)	(2)	(3)	Bottom Quartile	2nd Quartile	3rd Quartile	Top Quartile	Top 10%
Middle-Income	7.83	1.42	0.75	0.85	0.31	0.96	0.68	1.33
	(0.70)	(0.20)	(0.16)	(0.37)	(0.25)	(0.29)	(0.35)	(0.42)
High-Income	12.03	4.83	3.09	1.53	2.45	3.58	3.34	3.42
	(0.94)	(0.31)	(0.25)	(0.69)	(0.48)	(0.43)	(0.53)	(0.91)

B. Least-Selective College

	All Students			*By ACT Quartile*				
	(1)	(2)	(3)	Bottom Quartile	2nd Quartile	3rd Quartile	Top Quartile	Top 10%
Middle-Income	5.46	1.09	0.32	0.39	0.20	0.30	0.33	1.13
	(0.68)	(0.25)	(0.15)	(0.32)	(0.27)	(0.30)	(0.30)	(0.59)
High-Income	8.59	3.99	2.19	0.11	1.31	2.74	3.27	3.84
	(0.78)	(0.39)	(0.32)	(0.70)	(0.56)	(0.49)	(0.58)	(0.99)
ACT Score Dummies	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Background Characteristics	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
High School Fixed Effects	No	No	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Each column presents results from a separate regression where the dependent variable is either the highest (Panel A) or lowest (Panel B) normalized 25th percentile ACT score of freshmen at the colleges a student sent scores to. The dependent variables are regressed on income dummies where the omitted dummy is the low-income indicator. All regressions are limited to students from the class of 1996 while the regressions in the last five columns are additionally limited to students in the parts of the ACT distribution indicated. Standard errors, clustered at the state level, are in parentheses. Low-income students have family incomes less than $36,000 per year, middle-income students have family incomes between $36,000 and $80,000, and high-income students have family incomes above $80,000. The controls included in "background characteristics" are listed in footnote six. Data come from the ACT database and the American College Survey.

Table 3. Change in the Number of Scores Sent by Family Income

	(1)	(2)	(3)	(4)	(5)
Low-Income	-0.049	-0.058	-0.084	-0.110	-0.059
	(0.007)	(0.007)	(0.005)	(0.011)	(0.009)
Class of 1998	0.429	0.492	0.388	0.505	0.459
	(0.027)	(0.022)	(0.028)	(0.031)	(0.022)
Low-Income × Class of 1998			0.114	0.084	0.098
			(0.011)	(0.011)	(0.010)
Post-1998	0.612	0.791	0.587	0.808	0.780
	(0.037)	(0.013)	(0.037)	(0.035)	(0.015)
Low-Income × Post-1998			0.069	0.006	0.029
			(0.011)	(0.021)	(0.012)
Time Trends	No	Yes	No	Yes	Yes
ACT Score Dummies	No	Yes	No	No	Yes
Background Characteristics	No	Yes	No	No	Yes
High School Fixed Effects	No	Yes	No	No	Yes

Notes: Each column presents results from a separate regression of the number of score reports sent on a low-income dummy, an indicator for graduating high school in 1998, and an indicator for graduating after 1998. In the last three columns, interactions of these two graduation-year indicators with the low-income dummy are included. All regressions are limited to students who sent at least one score report. Standard errors, clustered at the state level, are in parentheses. Low-income students have family incomes less than $36,000 per year. The controls included in "background characteristics" are listed in footnote six. The time trends included are a linear time trend and a linear time trend interacted with the low-income indicator. Data come from the ACT database.

Table 4. Change in Number of Applications Sent by Standardized Test Taken

	ACT		*SAT*	
	Everyone	Low-Income	Everyone	Low-Income
Average Number of Applications Sent by Class Entering College in 2003-04	2.94	2.93	3.26	3.05
Average Number of Applications Sent by Class Entering College in 1995-96	2.60	2.54	3.16	2.92
Difference	0.33	0.40	0.11	0.13

Notes: Low-income students are dependent students with family incomes less than $36,000. The data come from the Beginning Postsecondary Surveys of 1996 and 2004.

Table 5. Changes in College Selectivity by Family Income

	A. Most-Selective College				
	(1)	(2)	(3)	(4)	(5)
Low-Income	-7.62	-1.84	-7.98	-8.20	-1.75
	(0.62)	(0.17)	(0.60)	(0.58)	(0.16)
Class of 1998	1.61	2.70	1.23	2.56	2.37
	(0.20)	(0.22)	(0.19)	(0.18)	(0.20)
Low-Income × Class of 1998			1.09	0.91	1.01
			(0.24)	(0.21)	(0.20)
Post-1998	1.50	4.44	1.24	3.76	4.13
	(0.28)	(0.25)	(0.25)	(0.21)	(0.25)
Low-Income × Post-1998			0.75	0.31	0.87
			(0.33)	(0.26)	(0.22)
	B. Least-Selective College				
	(1)	(2)	(3)	(4)	(5)
Low-Income	-5.73	-1.29	-5.87	-5.97	-1.21
	(0.54)	(0.14)	(0.54)	(0.56)	(0.13)
Class of 1998	-2.52	-2.21	-2.55	-2.12	-2.17
	(0.23)	(0.13)	(0.22)	(0.18)	(0.14)
Low-Income × Class of 1998			0.03	-0.09	-0.16
			(0.27)	(0.20)	(0.19)
Post-1998	-4.48	-3.45	-4.63	-3.82	-3.58
	(0.43)	(0.20)	(0.38)	(0.23)	(0.20)
Low-Income × Post-1998			0.49	0.24	0.38
			(0.35)	(0.22)	(0.21)
Time Trends	No	Yes	No	Yes	Yes
ACT Score Dummies	No	Yes	No	No	Yes
Background Characteristics	No	Yes	No	No	Yes
High School Fixed Effects	No	Yes	No	No	Yes

Notes: Each column presents results from a separate regression where the dependent variable is either the highest (Panel A) or lowest (Panel B) normalized 25th percentile ACT score of freshmen at the colleges a student sent scores to. The dependent variables are regressed on a low-income dummy, an indicator for graduating high school in 1998, and an indicator for graduating after 1998. In the last three columns, interactions of these two graduation-year indicators with the low-income dummy are included. Standard errors, clustered at the state level, are in parentheses. Low-income students have family incomes less than $36,000 per year. The controls included in "background characteristics" are listed in footnote six. The time trends included are a linear time trend and a linear time trend interacted with the low-income indicator. Data come from the ACT database and the American College Survey.

Table 6. Changes in College Selectivity by Family Income and Ability

	A. Most-Selective College				
	Bottom Quartile	2nd Quartile	3rd Quartile	Top Quartile	Top 10%
Low-Income	-1.17	-1.54	-1.78	-1.76	-1.00
	(0.25)	(0.19)	(0.19)	(0.21)	(0.25)
Class of 1998	3.26	3.15	2.26	1.58	1.03
	(0.26)	(0.26)	(0.22)	(0.21)	(0.24)
Low-Income × Class of 1998	1.53	0.27	0.29	0.50	0.75
	(0.38)	(0.27)	(0.34)	(0.30)	(0.51)
Post-1998	4.66	4.83	4.09	3.49	2.64
	(0.37)	(0.33)	(0.29)	(0.26)	(0.28)
Low-Income × Post-1998	1.19	0.18	0.53	0.00	0.88
	(0.37)	(0.38)	(0.42)	(0.35)	(0.51)
	B. Least-Selective College				
	Bottom Quartile	2nd Quartile	3rd Quartile	Top Quartile	Top 10%
Low-Income	-0.48	-0.71	-0.95	-1.51	-1.73
	(0.18)	(0.17)	(0.15)	(0.19)	(0.29)
Class of 1998	-1.78	-2.17	-2.29	-2.08	-1.47
	(0.25)	(0.19)	(0.22)	(0.20)	(0.34)
Low-Income × Class of 1998	-0.33	-0.06	-0.49	0.02	-0.42
	(0.28)	(0.27)	(0.32)	(0.49)	(0.63)
Post-1998	-3.04	-3.12	-3.90	-3.65	-2.89
	(0.27)	(0.27)	(0.32)	(0.28)	(0.49)
Low-Income × Post-1998	-0.07	-0.12	0.41	-0.12	0.19
	(0.38)	(0.35)	(0.41)	(0.47)	(0.94)
Time Trends	Yes	Yes	Yes	Yes	Yes
ACT Score Dummies	Yes	Yes	Yes	Yes	Yes
Background Characteristics	Yes	Yes	Yes	Yes	Yes
High School Fixed Effects	Yes	Yes	Yes	Yes	Yes

Notes: Each column presents results from a separate regression where the dependent variable is either the highest (Panel A) or lowest (Panel B) normalized 25th percentile ACT score of freshmen at the colleges a student sent scores to. The dependent variables are regressed on a low-income dummy, an indicator for graduating high school in 1998, an indicator for graduating after 1998, and the interactions of these two graduation-year indicators with the low-income dummy. Standard errors, clustered at the state level, are in parentheses. The regressions are limited to students in the parts of the ACT distribution indicated by the column headings. Low-income students have family incomes less than $36,000 per year. The controls included in "background characteristics" are listed in footnote six. The time trends included are a linear time trend and a linear time trend interacted with the low-income indicator. Data come from the ACT database and the American College Survey.

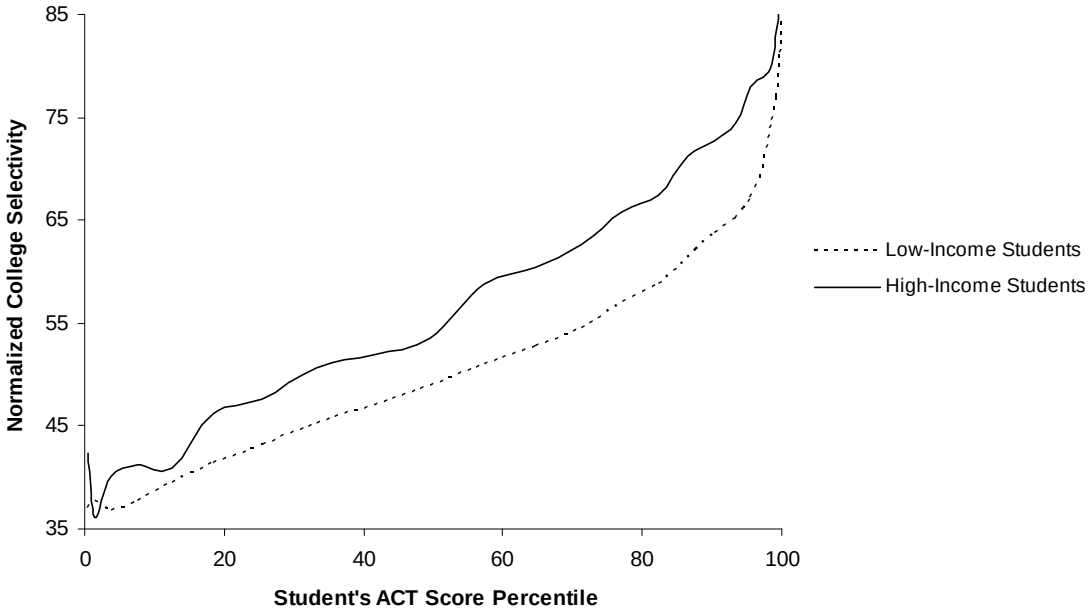
Figure 1. Number of Scores Sent by Graduation Year

1a: Students Who Took the ACT

1b: Students Who Took the SAT

Notes: The bars indicate the fraction of each graduating class that sent either exactly three or exactly four score reports. The analysis is not limited to students who sent at least one score report. Data in Panel A come from the ACT Database and data in Panel B come from a database of SAT-takers produced by the College Board.

Figure 2. College Selectivity by Family Income in the Class of 1996



Notes: The y-axis measures the average college selectivity of colleges that students sent scores to in the class of 1996. The x-axis measures students own (normalized) ACT score. The data come from the ACT database and the American College Survey. Low-income students have family incomes less than $36,000 per year, while high-income students have family incomes greater than $80,000 per year.

Appendix Table 1. Change in the Number of Scores Sent by Family Income: Including Students Who Sent No Score Reports

	(1)	(2)	(3)	(4)	(5)
Low-Income	0.149	-0.065	0.075	0.016	-0.061
	(0.022)	(0.006)	(0.017)	(0.019)	(0.007)
Class of 1998	0.335	0.453	0.286	0.504	0.423
	(0.028)	(0.022)	(0.028)	(0.022)	(0.024)
Low-Income × Class of 1998			0.133	0.053	0.093
			(0.013)	(0.012)	(0.016)
Post-1998	0.357	0.689	0.294	0.712	0.667
	(0.036)	(0.015)	(0.036)	(0.024)	(0.018)
Low-Income × Post-1998			0.194	0.027	0.062
			(0.021)	(0.015)	(0.013)
Time Trends	No	Yes	No	Yes	Yes
ACT Score Dummies	No	Yes	No	No	Yes
Background Characteristics	No	Yes	No	No	Yes
High School Fixed Effects	No	Yes	No	No	Yes

Notes: Each column in presents results from a separate regression of the number of score reports sent on a low-income dummy, an indicator for graduating high school in 1998, and an indicator for graduating after 1998. In the last three columns, interactions of these two graduation-year indicators with the low-income dummy are included. The regressions are not limited to students who sent at least one score report. Standard errors, clustered at the state level, are in parentheses. Low-income students have family incomes less than $36,000 per year. The controls included in "background characteristics" are listed in footnote six. The time trends included are a linear time trend and a linear time trend interacted with the low-income indicator. Data come from the ACT database.

Appendix Table 2. Procedure for Determining the Average Increase in Selectivity of Colleges Students Attended: Using Assumptions in Section VII

Step Number	Description	Output	Assumption Used
1	Restricting the sample to low-income students, regress dummies for the student's most-competitve college having each level of selectivity on all of the independent variables in Equation (2) including high school fixed effects.	The coefficient on the post-1998 dummy in each regression equals the change in the probability that a student's most-competitive college had that level of selectivity as a result of the cost change.	
2	Multiply the only positive coefficients from Step 1 by 33%, the probability that these additional score reports turned into applications.	The products are the increases in the probability that the most-competitive college a student applied to had this level of selectivity.	1
3	Multiply each product from Step 2 by 50% times the admission rate of students at colleges with that level of selectivity in 2000.	These products are the increases in the probability that a student was admitted to the most-competitive college they sent scores to and that college had the indicated level of selectivity.	2
4	Sum the probabilities from Step 3. Call the sum Z.	This gives the total mass of students who sent scores to more-selective colleges than they would have otherwise who were admitted and thus, attended (by Assumption 4).	4
5	Compute a weighted average of college selectivity levels using the probabilities from Step 3 as weights.	This gives the average selectivity of the more-selective colleges the students were accepted to and thus attended (by Assumption 4).	4
6	Consider the selectivity levels that had negative coefficients in Step 1. Starting from the highest selectivity levels, sum the absolute value of the probabilities until reaching Z. Let the amount that each selectivity level contributed towards this sum be weights and form a weighted average of these selectivity levels.	This gives the average selectivity of the colleges that the students who were admitted to more-selective colleges would have sent scores to and thus attended (by Assumption 3) without the cost change.	3 Without the cost change, the students who attended more-competitive colleges because of the cost change would have had the most-competitive colleges they sent scores to be more-competitive than those of students who sent a score report to a more competitive college because of the cost change but did not attend this more-competitive college either because they did not follow the score report with an application or because they were rejected.[a]
7	Subtract the average in Step 6 from the average in Step 5.	This is the average change in selectivity that students who attended more-selective colleges as a result of the cost change experienced.	
8	Multiply the result from Step 7 by the result from Step 4.	This gives the average change in selectivity that a low-income student experienced as a result of some students sending scores to more-competitive colleges.	
9	Divide the result from Step 8 by 0.81, the fraction of low-income students who sent an additional score report as a result of the cost change.	This gives the average change in selectivity that a low-income student who sent an additional score report experienced.	Conditional on all the controls and the time trend, students who did not send an additional score report did not change their application behavior as a result of the cost change.

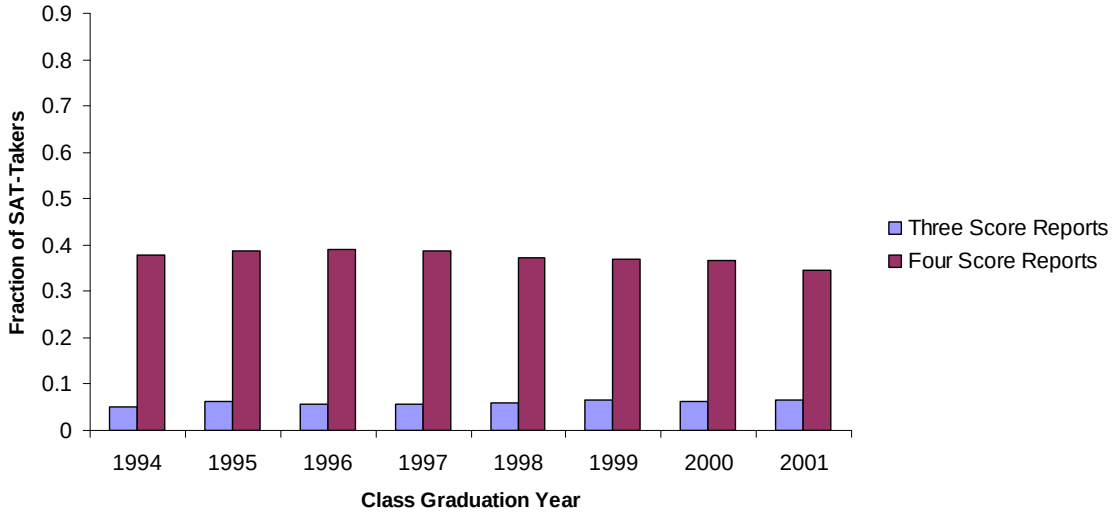
Notes: The assumptions are numbered in Section VII of the text.

[a] This assumption is very conservative. It implies that, without the cost change, students who attended more-competitive colleges as a result of the cost change would have attended the most-selective colleges that realized decreases in the probability that students sent scores to them in Step 1.

Appendix Figure 1. Number of Scores Sent by Graduation Year:
Excluding Students Who Sent Zero Score Reports

Appendix 1a: Students Who Took the ACT

Appendix 1b: Students Who Took the SAT



Notes: The bars indicate the fraction of each graduating class that sent either exactly three or exactly four score reports. The analysis is limited to students who sent at least one score report. Data in Panel A come from the ACT Database and data in Panel B come from a database of SAT-takers produced by the College Board.