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Authors

Fairlie, Robert W.
Grunberg, Samantha

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**Access to Technology and the Transfer Function of Community Colleges:
Evidence from a Field Experiment**

Robert W. Fairlie
University of California, Santa Cruz
rfairlie@ucsc.edu

Samantha Grunberg
Securities and Exchange Commission
grunbergs@sec.gov

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Abstract

Access to information may represent an important barrier to finding information and ultimately transferring to 4-year colleges for low-income community college students. This paper explores the role that access to information technology, in particular, plays in enhancing, or possibly detracting from, the transfer function of the community college. Using data from the first-ever field experiment randomly providing free computers to students, we examine the relationships between access to home computers and enrollment in transferable courses and actual transfers to 4-year colleges. The results from the field experiment indicate that the treatment group of students receiving free computers has a 4.5 percentage point higher probability of taking transferable courses than the control group of students not receiving free computers. The evidence is less clear for the effects on actual transfers to 4-year colleges, but we do find some suggestive evidence of small positive effects. Finally, we find that the treatment group has an 11 percentage point higher probability of using a computer to search for college information than the control group, possibly representing one of the mechanisms for positive effects.

Keywords: computer, experiment, ICT, community college, transfers
JEL Codes: I21, J24

1. Introduction

Community colleges enroll nearly half of all students attending public universities and an even larger share of low-income and minority students (U.S. Department of Education 2011).¹ Community colleges are likely to play an increasingly important role in higher education and educating the future high-skilled workforce. Growth in the total number of enrollments in two-year colleges has outpaced the growth rate for four-year colleges over the past three decades, and President Obama recently proposed an unprecedented funding increase for community colleges with the goal of boosting the number of graduates by 5 million by 2020 (U.S. White House 2009). One of the primary goals of community colleges is to provide basic requirements training for entry to 4-year colleges. The cost savings from spending two years at a community college before entering a 4-year college can be substantial – average full-time annual tuition at a community college is \$2,439 compared with \$7,136 at a public university and \$22,771 at a private university (U.S. Department of Education 2011). In some states with large community college systems, such as California, nearly half of all students attending a 4-year college previously attended a community college (California Community Colleges Chancellor’s Office 2009).

A potential constraint to transferring to 4-year colleges for some students, however, is limited access to information (Furchtgott-Roth, Jacobson, and Mokher 2009, American Association of Community Colleges 2004, Dowd and Gabbard 2006). Acquiring information about 4-year university choices, admission requirements, tuition, financial aid, and which courses are transferable is likely to be greatly enhanced through the use of information technology.² In California for example, the widely-used web page, assist.org, provides detailed school-to-school information on transferable courses, articulation agreements and majors for all community

¹ In some states the share is even higher. For example, in California, community colleges enroll more than 70 percent of all students attending public colleges (Sengupta and Jepsen 2006).

² A proliferation of web sites, such as collegeboard.com, fastweb.com, and www.fafsa.ed.gov, provide financial aid, application, course, SAT, and other information about 2- and 4-year colleges.

colleges and 4-year universities in the state.³ But, 1.2 million community college students do not have access to computers at home with the Internet.⁴ The lack of access to home computers is especially acute among low-income students attending community colleges -- roughly one-third of students living in households with less than \$20,000 in household income do not have computers with Internet access at home (see Figure 1). These disparities mirror broader patterns of disparities in access to home computers, Internet and other technology by income (U.S. Department of Commerce 2008, Fairlie 2004, Goldfarb and Prince 2008, Ono and Zavodny 2003, Warschauer 2003, Mossberger, et al. 2003, 2006). Unlike four-year colleges, where many students live on campus and have access to large computer labs, community college students often have limited access to on-campus technology making home access important for acquiring information. Additionally, the increased time and flexibility provided by having access to computers at home may improve the ability of community college students perform better in college and take more challenging transferable courses.⁵ Therefore, disparities in access to technology might represent an inefficient barrier for low-income students who could otherwise benefit from transferring to 4-year colleges and experiencing higher labor market returns.

On the other hand, having access to a home computer may also enhance the ability of community college students to acquire information about the value, requirements and career opportunities provided by 2-year college degrees and certificates. Although the original goal of community colleges was to provide basic requirements training for entry to 4-year colleges, their role in providing terminal degrees, workforce training, and basic skills education has expanded (Leigh and Gill 2007). The labor market returns to the various degrees, diplomas, and certificates

³ All four-year public institutions in California also provide college admission notifications on password protected web sites (Venegas 2007).

⁴ Estimates are derived from microdata from the 2010 Computer and Internet Supplement to the Current Population Survey.

⁵ The previous literature provides some evidence of positive effects of home computers on educational outcomes such as test scores, grades and graduation, but overall the evidence is mixed (see Attewell and Battle 1999, Schmitt and Wadsworth 2006, Fuchs and Woessmann 2004, Fairlie 2005, Beltran, Das and Fairlie 2010, Fiorina 2010, and Malamud and Pop-Eleches 2010 for example).

offered by community colleges are large (Jepsen et al. 2009). The acquisition of this information may divert students away from transferring to 4-year colleges. A similar concern has been raised about the overall "diversion" effect of community colleges. Several previous studies find that attending a community college lowers the likelihood of ultimately obtaining a bachelor's degree possibly due to increased opportunity costs, inadequate preparation, part-time enrollment, and displacement through curricular emphasis on vocational degrees (Long and Kurlaender 2009, Alfonso 2006).⁶ The increased autonomy offered by access to a home computer may also lead to extensive use for games, networking, downloading music and videos, communicating with friends, and other entertainment, potentially crowding out schoolwork time, college search, and interest in taking more demanding transferable courses (U.S. Department of Commerce 2004, Jones 2002, Lenhart 2009).⁷

Because of these potentially opposing forces, the net effect of having access to a home computer on transferring among community college students is theoretically ambiguous. An empirical test of the hypothesis is therefore needed, but has not been conducted in the previous literature. This is due, in part, to the inherent selection problems in estimating the effects of personal computers on educational outcomes. To address the lack of empirical evidence on the question and concerns about causal inference, we use data from the first-ever field experiment providing free computers to community college students for home use to explore the relationship between access to computers and transferring to 4-year colleges. Participating students were randomly selected to receive free computers and their course taking and transfer behavior was tracked in subsequent years. The random-assignment evaluation is conducted with 286 entering students receiving financial aid at a large community college in Northern California. Previous

⁶ But, previous research also finds evidence that community colleges have increased overall access to higher education often referred to as the "democratization" effect (Leigh and Gill 2003, 2004, Rouse 1995, 1998, Gonzalez and Hilmer 2006).

⁷ The impact of the extensive use of Facebook among college students on academic outcomes has recently received some attention (Karpinski 2009 and Pasek and Hargittai 2009). The attention is partly due to the dramatic increase in the use of social networking sites such as Facebook in the past few years (Lenhart 2009). These concerns are similar to those over television (Zavodny 2006).

findings from the experiment provide some evidence that the randomly selected group of students receiving free computers achieved better educational outcomes than the control group that did not receive free computers, but the study does not examine the potential transfer function of the community college (Fairlie and London 2012).⁸ In this paper, we conduct a detailed analysis of the causal effects of home computers on the transfer function of community colleges for low-income students. New data from the National Student Clearinghouse on actual transfers to 4-year colleges among study participants are used.⁹ We examine impacts on taking transfer courses and searching for college information as well as impacts on actual transfer rates to measure preferences, incidence, and potential mechanisms in transferring. All information on transfer course taking and actual transfers is taken from administrative data removing concerns about differential attrition or reporting biases.

2. The Field Experiment

To examine the effects of home computers on transferring to 4-year colleges, we randomly assigned free computers to entering community college students who were receiving financial aid. The students attended Butte College, which is located in Northern California and has a total enrollment of over 20,000 students. Compared with the average community college in the United States, Butte College is larger, but does not differ substantially in the composition of its student body. For example, Butte College has a roughly similar share of female students as the U.S. total (55.0 percent compared with 58.5 percent) and roughly similar share of non-minority students (65.4 percent compared with 60.8 percent).

⁸ Previous results from the experiment also indicate that estimates of the effects of home computers on graduating from community college are much smaller than non-experimental estimates from matched CPS data suggesting that non-experimental estimates may be biased upwards (Fairlie and London 2009).

⁹ The Institutional Research Department at the community college recently analyzed transfer rates of all of its students through specially commissioned data from the National Student Clearinghouse. We obtained these data for our sample of 286 students participating in the study.

To implement the field experiment, letters advertising the computer giveaway program were sent to all financial aid students with less than 24 units attending the college in Fall 2006 (see Fairlie and London 2012 for more details on the field experiment). In Fall 2006, there were 1,042 financial aid students and 6,681 students in total who met the course unit restriction. Participating students were required to return a baseline questionnaire and consent form releasing future academic records from the college for the study. Students who already owned computers were not excluded from participating in the lottery because their computers may have been much older and not fully functional with the latest software and hardware.¹⁰ There were 286 students who participated in the study with 141 of these students receiving free computers. All of the computers were refurbished and were provided by Computers for Classrooms, Inc., a computer refurbisher located in Chico, California.¹¹ Internet service was not provided as part of the experiment, but we found at the end of the study that more than 90 percent of the treatment group had Internet service. Because of high rates of Internet subscription among computer owners we cannot identify separate effects of computers and the Internet, which has been a problem in previous studies (Beltan, Das and Fairlie 2009). More than 90 percent of eligible students picked up their free computers by the end of November 2006.

Who applied for the computer lottery?

Table 1 reports administrative data from the original application to the college for students applying to the computer-giveaway program, all financial aid students, and all entering students.¹² The racial composition of study participants is very similar to that of all financial aid students, the group initially targeted for the study. A total of 60.1 percent of study participants

¹⁰ Twenty-eight percent of students reported already owning a computer. The results presented below are not sensitive to the exclusion of these students.

¹¹ The computers were refurbished Pentium III 450 MHz machines with 256 MB RAM, 10 GB hard drives, 17" monitors, modems, ethernet cards, CD drives, and Windows 2000 Pro Open Office (with Word, Excel and PowerPoint). Computers for Classrooms offered to replace any computer not functioning properly during the two-year study period.

¹² Baseline and follow-up survey data is only available for study participants.

are white compared to 61.3 percent of all financial aid students. The largest minority group, Latinos, comprise 16.8 percent of study participants and 15.6 percent of all financial aid students. A similar percentage of primarily English language students also participated in the study compared to all financial aid students. The one difference between study participants and the population of financial aid students is that a larger percentage of women applied for the computer lottery than men. Women comprise 62.6 percent of all study participants which is higher than the 54.7 percent for all financial aid students.

A comparison to all students reveals that study participants are more likely to be female than the total student body. Women comprise 55.2 percent of all students attending the college. Study participants as well as all financial aid students are more likely to be from minority groups than all students, but are less likely to be non-primary English language students, which may be related to applying for financial aid. These differences, however, are small.

Although study participants are a self-selected group from all financial aid students, they do not appear to be very different from either financial aid students or the entire student body along observable characteristics. They may differ, however, along dimensions directly related to participation in the study. Specifically, they may have less access to computers and disposable income than other financial aid students. These differences have implications for our ability to generalize the results based on study participants to all community college students receiving financial aid. But, students with limited access to computers and financial resources are the population of most interest for any policy intervention involving the provision of free or subsidized computers.

Comparability of Treatment and Control Groups

Table 2 reports a comparison of background characteristics for the treatment and control groups. All study participants were given a baseline survey that included detailed questions on gender, race, age, high school grades, household income, parents' education, and other

characteristics. The average age of study participants is 25. More than half of the students have a parent with at least some college education, and about one third of students received mostly grades of As and Bs in high school. A little over one quarter of study participants have children and one third live with their parents. As would be expected among financial aid students, study participants have low income levels with only 17 percent having current household incomes of \$40,000 or more. The majority of study participants have household incomes below \$20,000 and more than half are employed.

The similarity of the mean values of these baseline characteristics confirms that randomization created comparable treatment and control groups for the experiment. We do not find large differences for any of the characteristics, and none of the differences are statistically significant.

Educational Goals at Time of Application

Butte College provided us with administrative data on the educational goals of all students as reported on their original application to the college. Table 3 reports the distribution of educational goals for all study participants, the treatment and control groups, all financial aid students, and all entering students. For all study participants, the most common response is "undecided on goal," which represents 37.4 percent of study participants. The next most common goal reported by applicants is to transfer to a 4-year institution, with 31.5 percent of study participants reporting this goal. Roughly one-fourth of study participants reported a goal other than transferring to a 4-year college.¹³ Due to randomization, the treatment and control groups do not differ in their educational goals as reported on their admission applications. In comparison to all financial aid students, study participants are very similar in their educational goals. In

¹³ These goals include obtaining an associate's degree, vocational degree, or vocational certificate without transferring, and discovering career interests, preparing for a new career, updating job skills, maintaining occupational certificates or licenses, intellectual or cultural development, improving basic skills in English, reading or math, and completing credits for a high school diploma or GED.

comparison to all entering students, study participants are less likely to report having a transfer goal and are more likely to report having a non-transfer goal, but the overall patterns are roughly similar. These patterns are also generally consistent with those found for the entire California Community College System (Sengupta and Jepsen 2006). We control for educational goals in estimating treatment effects and explore differential treatment effects by educational goal below.

Data on Transfer Courses and Transfer Rates

Following previous research, we use the course taking behavior of students as a measure of the interest and likelihood of transferring to 4-year colleges (Sengupta and Jepsen 2006, California Community Colleges Chancellor's Office 2009). From an analysis of a special cohort of entering students for the 1997-98 school year linked through system-wide administrative data, Sengupta and Jepsen (2006) find that enrollment in transferable courses in the first and second years of study is a major predictor of who eventually transfers. Butte College provided us with administrative data on all courses taken by study participants over a two-year period starting at the beginning of the experiment. All of the courses taken by students can be identified as being transferable to the California State University (CSU) or University of California (UC) systems.

Table 4 reports the number of transferable courses offered by the college and in each department. For all courses offered at Butte College, 71 percent are transferable to CSU or UC campuses. Transferable courses are spread across a large number of different departments with 86 percent of departments offering at least one transferable course. Transferable courses can be higher-level courses even though they satisfy lower division credit. In Mathematics, for example, Intermediate Algebra is not transferable and Analytic Geometry/Calculus I is transferable to CSU and UC campuses. Of all courses taken by participants in the experiment 63 percent are transferable to CSU or UC systems.

We also examine actual transfer rates of students participating in the study. For a special study of transfer rates to 4-year colleges, the Institutional Research Department at Butte College

purchased data tracking college enrollment activity from the National Student Clearinghouse. The Institutional Research Department purchased data tracking college enrollment activity through summer 2010 for every student attending Butte College over the previous several years. We recently found out about the project, and the Institutional Research Department provided us with the data from this special run for all students participating in our random experiment. The system tracks attendance at most colleges in the United States and includes information from all CSU and UC campuses. This source is essential because community colleges do not collect (and have no easy way of collecting) information themselves on which students leave and ultimately transfer to 4-year universities. Using these data we find that 21.6 percent of study participants ultimately transfer to a 4-year college. Most of the transferring students transfer to CSU campuses (89.9 percent). Of these students transferring to CSU campuses, most transfer to California State University Chico (75.9 percent). No study participants transfer to University of California campuses.

3. The Role of Community College as a Gateway to 4-Year Colleges

Before turning to the results from the experiment, we examine how the California Community College System provides a transfer function to 4-year universities. Butte College is part of the California Community College system, which is the largest higher educational system in the nation. It includes 112 colleges and educates 2.6 million students per year (California Community Colleges Chancellor's Office 2012). As stated in the *Master Plan for Higher Education in California*, the primary mission of community colleges is to provide academic and vocational instruction through the first two years of undergraduate education (University of California Office of the President 2009). The Plan specifically calls for community colleges to play an important role in admission to the state's 4-year universities. Eligible students transferring from community colleges are given priority in the admissions process at California

State University (CSU) and University of California (UC) campuses, and CSU and UC campuses are required to establish a specified lower division to upper division ratio to facilitate transfers.

Attending a community college before attending a 4-year university may be especially attractive to low-income students. The tuition savings from attending two years at a community college are substantial. At the national level, average annual tuition at community colleges is \$2,439 compared with \$7,136 for public universities and \$22,771 for private universities (U.S. Department of Education 2011). In California, the cost at community colleges is \$36 per unit or \$864 per year for a full-time student (California Community Colleges Chancellor's Office 2011). The average annual costs of full-time tuition at a CSU campus are \$6,489 and \$13,200 at a UC campus and have been rising rapidly (California Colleges.edu 2012).¹⁴ In addition to the substantial savings on the cost of education, attending a community college may allow students to improve their academic record and ultimately attend a higher-quality 4-year college (Hilmer 1997).

The number of community college students transferring to 4-year colleges in California has increased steadily over the past several years (California Community Colleges Chancellor's Office 2009). In 2007-08, 105,957 students transferred to 4-year colleges, which represents a 16 percent increase from 2002-03 (see Figure 2). Among all entering California community college students, roughly 15 percent transfer to a 4-year institution within seven years (Sengupta and Jepsen 2006). Transfer rates increase to 26 percent when focusing on community college students who take primarily transfer-eligible courses in their first year and 38 percent for students taking primarily transfer-eligible courses in both their first and second years.

From the perspective of the UC and CSU systems, a strikingly large percentage of students first attended a community college in California (California Community Colleges Chancellor's Office 2009). In the CSU system, 55.3 percent of students from the 2007-08 cohort

¹⁴Average annual tuition was \$8,062 at UC campuses and \$3,797 at CSU campuses in 2008-2009 (California Teachers Association 2012).

previously attended a community college. Of the 42,416 students in the 2007-08 cohort in the University of California system, 29.4 percent previously attended a community college. The community college system clearly provides a route to university education for many students in California. Identifying the potential barriers to transferring to 4-year colleges for other students is important for improving overall access to higher education. Informational constraints may represent one such barrier to attending 4-year colleges, especially among low-income students (Furchtgott-Roth, Jacobson, and Mokher 2009, American Association of Community Colleges 2004, Dowd and Gabbard 2006).

4. Home Computer Impacts

The impact of home computers on students deciding to transfer is ambiguous. Home computers may provide an important tool for finding information about 4-year colleges and help students take challenging transferable courses and ultimately transfer to 4-year colleges. For example, students with home computers and access to the internet would have more flexibility to explore websites such as, “assist.org.” which allows California community college students to enter their current college and 4-year college of interest and obtain detailed information on which courses are transferrable, different majors, general requirements to earn a degree in that major, and links to other college-related websites. However, computers may also provide information on the value and requirements of getting an associates or vocational degree, which may discourage students from transferring to 4-year colleges, as well as provide a distraction through their entertainment value. In this section we turn to the field experiment to estimate the transfer function of home computers. We first examine impacts on the likelihood that community college students take courses that are transferable to the CSU or UC systems before turning to an analysis of data on actual transfers. Enrollment in transfer courses proxies for potential interest in transferring which is an important outcome in addition to actual transfers.

Among study participants, 63 percent of all courses taken over the study period are transferable. Of all courses taken by the treatment group, 66 percent are transferable to a CSU or UC campus compared with 61 percent of courses taken by the control group. Table 5 reports estimates of the treatment-control difference from regressions for which there is an indicator variable for whether a course is transferable to a CSU or UC campus. The regression equation is straightforward in the context of the field experiment:

$$(4.1) y_{ij} = \alpha + \beta X_i + \delta T_i + \lambda_t + u_i + \varepsilon_{ij},$$

where y_{ij} is whether the course is transferable to a CSU or UC campus for student i in course j , X_i includes baseline characteristics, T_i is the treatment indicator, λ_t are quarter fixed effects, and $u_i + \varepsilon_{ij}$ is the composite error term. The effect of winning a free computer or the "intent-to-treat" estimate of the giveaway program is captured by δ . All specifications are estimated using OLS and robust standard errors are reported with adjustments for multiple observations per student (i.e. clustered by student). Marginal effects estimates are similar from probit and logit models, and are thus not reported.

Specification 1 reports estimates of the treatment effect without any controls. The point estimate for δ implies that the treatment group of students receiving free computers has a 4.8 percentage point higher likelihood of taking transfer courses than the control group not receiving free computers.¹⁵ The treatment-control difference is large relative to the mean and is statistically significant. Including detailed controls for gender, race/ethnicity, age, parents' highest education level, high school grades, presence of own children, live with parents, family income, and educational goals does not change the result (Specification 2). These control variables are taken from the baseline survey administered to all study participants before receiving free computers. We continue to find a large, positive difference between the treatment and control groups.

¹⁵ We do not find evidence of a trend over the two academic years. The levels and treatment/control difference are very similar in each quarter.

These estimates are not sensitive to alternative methods of measuring transfer course enrollment. First, we estimate regressions for a dummy variable indicating whether the majority of courses taken by students are transferable, following the approach of Sengupta and Jepsen (2006). We find a difference of 7.1 percentage points between the treatment and control groups. Including the full set of controls, we find a very similar estimate for the treatment effect. We also estimate a specification in which the dependent variable measures the percentage of courses taken that are transferable by students. In this case, each student contributes only one observation to the sample. We find a difference between the treatment and control groups of 5.4 percentage points without controls and 6.1 percentage points with all of the controls included.

We focus on the probability that a course taken is a transferable course in the regressions above (conditioning on taking the course). We also estimate regressions for the total number of courses of any type taken over the sample period and the probability of being enrolled in each quarter. In both cases, we find no evidence of treatment effects. Thus, the computers appear to have affected the types of courses taken (i.e. transfer vs. non-transfer), but not the total number of courses or enrollment at the college.¹⁶

Adjusting for Non-Compliance

The estimates presented thus far capture the "intent-to-treat" from the experiment and do not adjust for noncompliance in the treatment and control groups. Some of the students in the treatment group did not pick up their free computers, and some of the students in the control group purchased their own computers during the study period. Although the intent-to-treat estimate is often a parameter of interest in evaluating policies to address the consequences of disparities in access to technology, the "treatment-on-the-treated," or more general, local average

¹⁶ Given these results, we find that mechanically the treatment group takes more transferable courses than the control group.

treatment effect (LATE) estimates are also of interest. They provide estimates of the effects of having a home computer on the probability of taking transfer courses.

Of the 141 students in the study that were eligible to receive a free computer, 129 students (or 92 percent) actually picked them up from Computers for Classrooms. To adjust for this non-compliance by the treatment group and obtain the TOT estimate, an instrumental variables regression is estimated. Computer eligibility (winning a free computer) is used as an instrumental variable for whether the student picked up the free computer. The first-stage regression for the probability of computer receipt is:

$$(4.2) C_i = \omega + \gamma X_i + \pi T_i + \lambda_t + u_i + \varepsilon_{ij}.$$

The second-stage regression is:

$$(4.3) y_{ij} = \alpha_2 + \beta_2 X_i + \Delta \hat{C}_i + \lambda_t + u_i + \varepsilon_{ij},$$

where \hat{C}_i is the predicted value of computer ownership from (4.2). In this case, Δ provides an estimate of the "treatment-on-the-treated" effect. The IV estimates for the transfer course rate are reported in Specification 3 of Table 5. Given the high compliance rate for students in the treatment group, the estimates are only slightly larger than the intent-to-treat estimate and approximate the simple OLS coefficient divided the pick-up rate of 92 percent.

The control group cannot be prevented from purchasing a computer on their own during the study period. This problem of the control group receiving an intervention that potentially has the same effect as the treatment intervention is a similar problem in most social experiments. Results from the follow-up survey taken at the end of the study period indicate that 28 percent of the control group reports getting a new computer, although no information is available on when they purchased the computer. The more general local average treatment effect (LATE) estimator is used to expand on the "treatment-on-the-treated" estimates. Specification 3 can be thought of as implicitly assuming that all students in the control group received their computers at the end of the study period. In Specification 4 we instead assume that all of the students in the control group reporting obtaining a computer in the follow-up survey received that computer at the beginning of

the study period. This new "upper bound" estimate of the LATE is 6.3 percentage points. Given this range of IV estimates, the LATE estimate is between 0.049 and 0.063, which represents 8 to 10 percent of the mean level of taking transferable courses.

Impacts on Transfers to 4-year Colleges

We now turn to estimating the effects of home computers on actual transfers to 4-year colleges. Although home computers increase the likelihood of taking transferable courses they might have a different effect on actual transfers to 4-year colleges in which students face additional constraints. Constraints may include the high cost, reduced flexibility in course offerings to accommodate working, and more challenging coursework of 4-year universities (Council on Postsecondary Education 2004). As noted above, information on transfers to 4-year colleges is obtained from college enrollment data from the beginning of the experiment through four years later. We find that 21.3 percent of the treatment group transfers to a 4-year college compared with 20.0 percent of the control group. The difference of 1.3 percentage points, however, is not statistically significant. Table 6 reports estimates of treatment effects using (4.1) for the transfer rate to 4-year colleges. After controlling for baseline characteristics, we find a similar point estimate for the treatment effect, but the coefficient is also statistically insignificant.

The magnitude implied by the point estimate of roughly 1 percentage point is smaller than the effect on taking transferable courses. A 1 percentage point increase in the transfer rate represents a 5 percent of the mean transfer rate. This is roughly half the treatment effect on taking transfer courses of 8-10 percent. We would expect home computers to have a larger effect on influencing interest in transferring and taking transfer courses than on actual transfers. For actual transfers there are likely to be many additional constraints, especially higher 4-year college tuition costs and ability to pay.

Focusing on transfers to public universities in California, we also estimate specifications in which the dependent variable is whether the student transfers to a CSU campus. Transfers to

CSU campuses capture 90 percent of all transfers to 4-year colleges among study participants. Indeed, one of the primary goals of the California community college system is to encourage students to transfer to CSU campuses. Additionally, there are no transfers to the University of California system in the data and some of the transfers to other 4-year colleges are to religious or other specialized colleges, which could be influenced by different factors than transfers to the California State College system. We find that 19.9 percent of the treatment group transfers to a CSU campus compared with 17.1 percent of the control group. Table 7 reports estimates of treatment effect estimates for the CSU system. We find larger, positive point estimates, but the estimates remain statistically insignificant.

Treatment Heterogeneity by Educational Goal

Thus far we have focused on estimating the average treatment effect for all study participants. The literature on the transfer function of community colleges, however, has emphasized the importance of controlling for the educational goals of community college students (see Leigh and Gill 2003, 2007, Alfonso 2006, and Long and Kurlaender 2009 for example). Students attend community colleges for many different reasons potentially placing them at varying levels of risk of having a desire to take transfer courses and transfer to 4-year colleges. As reported in Table 3 and discussed above, we find from administrative data based on the self-reported educational goals of students on their original application to the college, 37.4 percent of study participants reported being "undecided," 31.5 percent reported "transfer to a 4-year institution," and 24.5 percent reported a goal other than transferring to a 4-year college. Controlling for these educational goals has little effect on the treatment effect estimates, but there is the possibility that having a home computer may have differential effects on transfer behavior depending on the initial goals of the student.

Table 8 provides evidence on this question from regressions in which treatment status is interacted with the three major educational goals at the time of application. The main treatment

effect captures the treatment effect for the most common educational goal, "undecided." For taking transfer courses, we find that home computers have essentially no effect on "undecided" students. The effects of home computers on taking transfer courses are stronger, however, for students with an initial goal of transferring to a 4-year college. We also find that students with non-transfer goals are relatively more likely to take transferable courses when receiving a free computer. The computer may have changed their goal or simply allowed these students to take more challenging and demanding courses at the community college.

We also explore heterogeneity in treatment effects on transfers to 4-year colleges by initial educational goal. Specification 3 of Table 8 reports these estimates. The results are less clear. We find a positive point estimate on the treatment interaction with having a transfer goal, but the coefficient is small and insignificant. We also find a large negative point estimate on the treatment interaction with having a non-transfer goal, but the coefficient is not significant at conventional levels ($t\text{-stat}=1.31$). Although we should interpret this coefficient with some caution, it suggests the possibility that home computers facilitated these students in taking more advanced transfer courses, but did not ultimately increase their likelihood of transferring to a 4-year college.

Instead of using educational goals self-reported by students at the time of application as a measure of transfer goals, we can use pre-treatment transfer course-taking behavior in fall 2006.¹⁷ Fall 2006 is generally the first year of courses taken for study participants, and course choices for this term were made prior to when the computers were distributed, which was in October and November 2006. We create a variable that measures the percentage of courses taken in fall 2006 that are transferable for each student. The average value for this variable is 60.5 percent for the control group and 61.4 percent for the treatment group. The difference of 0.9 percent is small and not statistically significant. We interact a dummy variable indicating whether the student had a

¹⁷ Sengupta and Jepsen (2006) argue that first-year course taking represents a more reliable measure of transfer goals than responses on the application form.

fall 2006 transfer course percentage higher than the median (0.67) and treatment status, and include it in the regressions reported in Specifications 2 and 4 of Table 8. For the transfer course regression we find a positive main effect of computers, but find a small negative and insignificant coefficient on treatment interacted with taking a large percentage of transfer courses prior to treatment. In the actual transfer regression, we find a small negative coefficient on the main treatment effect and a large positive coefficient on the treatment effect interacted with taking a large percentage of transfer courses in fall 2006. Although the interaction coefficients are not precisely measured, they line up with the findings for treatment interactions with the educational goals students reported at the time of application to the college.

Overall, we find some suggestive evidence indicating that home computers might have helped community college students with the goal of transferring more in taking transfer courses and ultimately transferring to a 4-year college.¹⁸ For community college students who did not have the goal of transferring, home computers may have encouraged them to take more challenging and demanding transfer courses, but had no differential effect on actual transfers. Unfortunately, we cannot draw strong conclusions from any of these results because of the general lack of precision of estimates.

College Search

Students receiving free computers may have been more likely to search for information about colleges because of the increased time, flexibility, and autonomy of use offered by having a home computer. Finding more information about 4-year college choices, requirements, financial aid, and what courses are transferable may represent one of the main reasons computer recipients are more likely to take transferable courses. It also might explain why treatment students have a higher level of actual transfers (although we note again the lack of statistical significance). On

¹⁸ We also examine treatment heterogeneity by race and gender. Jepsen (2008) finds differences in 2-year and 4-year college completion rates by race and gender. We find no evidence of different effects by race or gender.

the follow-up survey, we asked students what they used computers for in the past month.¹⁹ In particular, we asked them whether they searched for information about college choices. We found that the treatment group was nearly 10 percentage points more likely to report searching for college information than the control group in spring/summer 2008. Among the treatment group, 43.3 percent of students reported searching for college information in the past month compared with 34.1 percent of the control group.

From a regression analysis reported in Table 9, we find that the treatment effect estimate is not sensitive to the inclusion of controls. We find that the treatment group has a 10.9 percentage point higher likelihood of searching for college information than the control group. Although the difference is not significant at conventional levels for a two-tailed test (the p-value is 0.126 for a two-tailed test), the point estimate suggests a potentially large effect. The IV results indicate that having a home computer increases the probability of college search by 11.9 to 15.4 percentage points among students complying with the experiment. These effects are large relative to the average probability of searching for college information among the control group of 34.1 percent.

These findings are consistent with previous qualitative research indicating the importance of computers and the Internet for acquiring college information (Venegas 2007, Jones 2009, Owens 2007). Venegas (2007) finds that the Internet is used extensively by students in the search and application process for college and financial aid. She finds that low-income students in her study were at a major disadvantage in applying to colleges and for financial aid because of their lack of access to computers at school and home. In her study of African-American students, Jones (2009) finds that middle-class families have better access to computers at home than working-class families, and take advantage of this access to search more for college information.

¹⁹ We conducted a follow-up survey of study participants (treatment and control) in late spring/summer 2008 with a response rate of 65 percent. The baseline characteristics of the respondent sample look roughly similar to those of the full sample (see Fairlie and London 2012). The response rate was 61 percent for the control group and 69 percent for the treatment group. The difference is not statistically significant.

There is also direct evidence on the extensive use of technology among community college students, especially with colleges' online systems, to help in the transfer process to 4-year colleges (Owens 2007). In contrast, there is evidence of the varying, "haphazard," or "accidental" quality of transfer counseling at community colleges (Dowd 2006), and criticism of transfer advising because of the use of part-time faculty and large caseloads (Council on Postsecondary Education 2004).

The increased flexibility, time and autonomy offered by having access to a home computer may enable low-income community college students to expand their ability to search for information about 4-year colleges.²⁰ Although home computers also improve the ability to search for information about 2-year degrees and certificates, the relative effect may be much lower because these students are already enrolled in a community college where non-electronic information is readily available on campus. Improving college search might be an important mechanism for the causal relationship between home computers and taking transferable courses, although there is also the possibility that it reflects another measure of desire to transfer.

5. Conclusions

Rapidly rising tuition costs and recent calls to expand 2-year college enrollments suggest that community colleges will provide an increasingly important transfer function to 4-year colleges. Community colleges in some states, such as California, already play a major role in university education with nearly half of all 4-year college students having previously attended a community college (California Community Colleges Chancellor's Office 2009). In this paper, we use data from the first-ever randomized field experiment providing free computers to students for home use to explore whether having access to home computers improves the transfer function of community colleges. If limited information is an important constraint for transferring to 4-year

²⁰ Having access to a home computer may be especially useful for finding financial aid and scholarship information (Grazzi and Vergara 2009).

colleges, especially among low-income community college students, then having access to computers at home may help overcome this barrier and lead to higher labor market returns.

The results from the field experiment indicate that the treatment group of students receiving free computers to use at home has a 4.8 percentage point higher probability of taking transferable courses than the control group of students not receiving free computers. Of courses taken by the treatment group, 66 percent are transferable to CSU or UC campuses compared with 61 percent of courses taken by the control group. Controlling for baseline characteristics does not change the conclusion – the treatment group of students receiving free computers has a 4.5 percentage point higher likelihood of taking transferable courses. LATE estimates of the effects of having a home computer on taking transferable courses range from 4.9 to 6.3 percentage points.

The results are less clear for the effects of home computers on actual transfers to 4-year colleges. We find positive point estimates for the treatment effect on actual transfers, but the estimates are not statistically significant. The magnitude of the point estimates is roughly half the size of the treatment effect estimates for taking transfer courses. Home computers may have changed the desire to transfer or increased student confidence in taking more challenging and demanding transfer courses, but other barriers to transferring to 4-year colleges were just too large. Barriers such as the cost of 4-year colleges, added challenge of 4-year college courses, and lack of courses offered to accommodate nontraditional or working students might be especially restrictive (Council on Postsecondary Education 2004). We find some evidence that students who did not initially have a goal of transferring to a 4-year college had larger positive effects from the computers than undecided and transfer goal students. We also find some suggestive evidence that students with transfer goals benefit more from home computers in terms of increasing their likelihood of transferring to 4-year colleges.

We also find suggestive evidence that college search increases from receiving home computers. Point estimates indicate that the treatment group has an 11 percentage point higher

probability of using a computer to search for college information than the control group. The expanded ability of low-income community college students to find information about 4-year colleges may represent one of the mechanisms by which home computers increase transferable course taking.

Although there is concern that information constraints may limit interest in and the likelihood of transferring to 4-year colleges among low-income community college students, there is little direct evidence on the question. The findings from this experiment suggest that having access to a home computer may be useful for finding information about 4-year university choices, admission requirements, tuition, financial aid, and which courses are transferable, which ultimately may counteract some of the "diversion" effects of attending a community college. The 1.2 million community college students in the United States without access to home computers and Internet, however, may be at a disadvantage in acquiring information helpful for transferring to 4-year universities and obtaining jobs requiring these skills. To overcome this barrier, policies that provide access to computers for low-income students, such as tax breaks or special loans for educational computer purchases, expanded computer refurbishing programs, and laptop checkout programs may be needed (Servon 2002, Warschauer 2006). Addressing this barrier may become increasingly important as more application, financial-aid, registration and course information is being placed online and public institutions reduce staff in response to budget cutbacks.

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Figure 1
Home Computer with Internet Access Rates for Enrollees in Community College
Current Population Survey, October 2007 Microdata

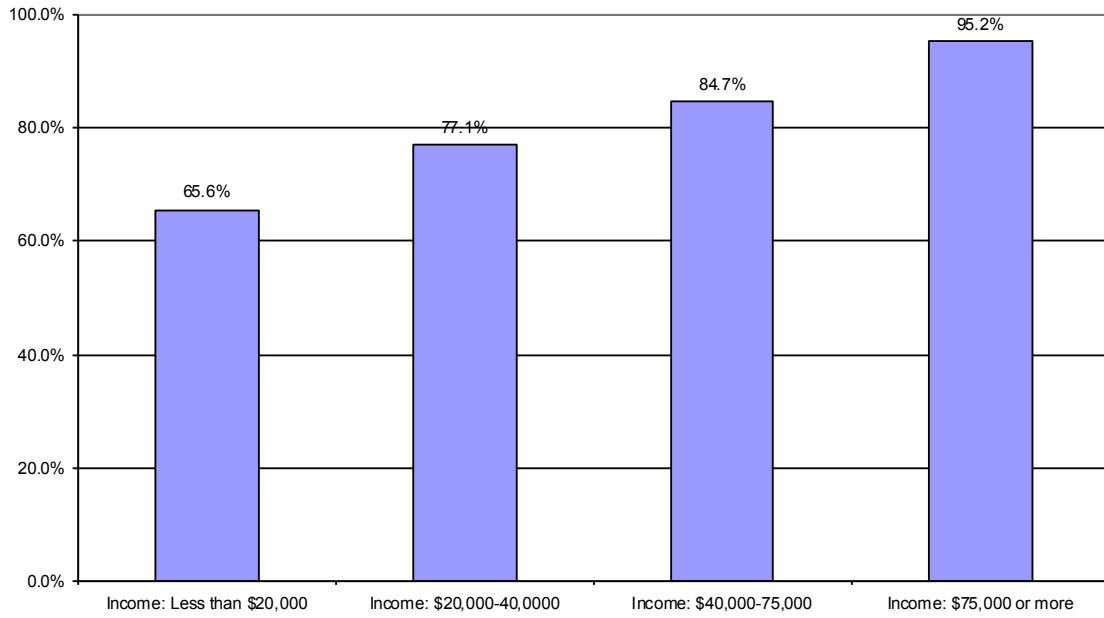


Figure 2
Total Number of California Community College Students Transferring to 4-Year Colleges
California Community Colleges Chancellor's Office (2002-2008)

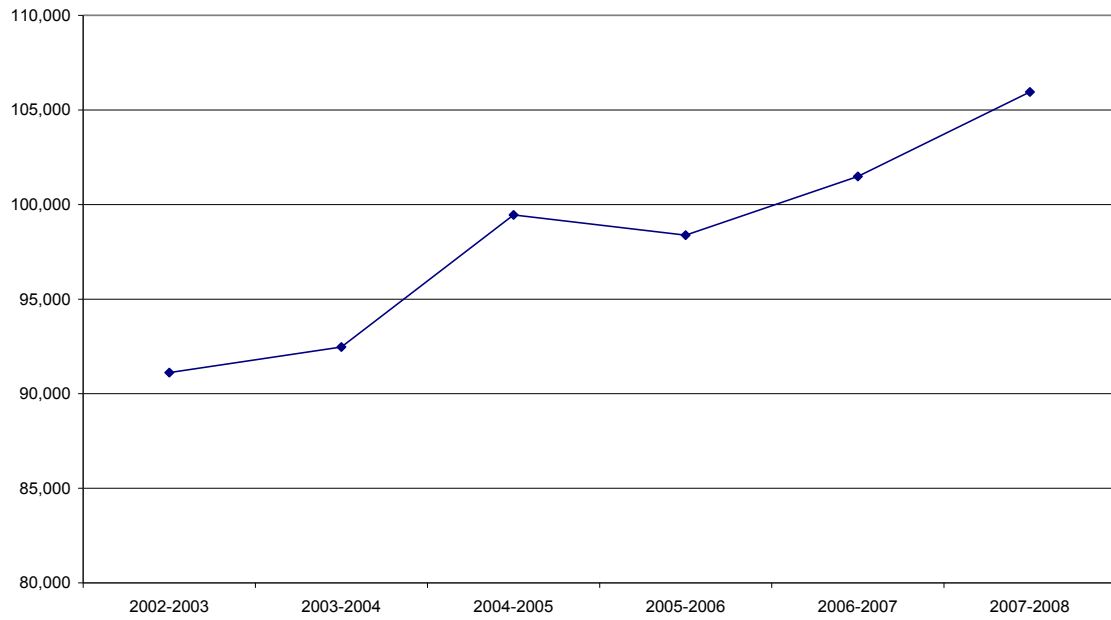


Table 1
 Application Information for Study Participants, Financial Aid Students, and All Students

	Study Participants	All Financial Aid Students	All Entering Students
Gender			
Female	62.6%	54.7%	55.2%
Male	35.7%	43.6%	43.6%
Missing	1.7%	1.7%	1.2%
Race/Ethnicity			
White	60.1%	61.3%	65.2%
Asian and Pacific Islander	8.0%	8.2%	7.0%
African-American	3.1%	3.2%	2.6%
Latino	16.8%	15.6%	13.1%
Native American	2.1%	2.9%	2.2%
Other	1.0%	1.2%	1.2%
Unknown	8.7%	7.6%	8.7%
English language			
English	81.8%	83.7%	80.1%
Not English	7.0%	6.7%	7.8%
Unknown/Uncollected	11.2%	9.6%	12.1%
Sample size	286	1,042	6,681

Note: Based on administrative data provided by Butte College for entering students in Fall 2006.

Table 2
Background Characteristics of Study Participants from Baseline Survey

	All Study Participants	Treatment Group	Control Group	P-Value for Treatment/ Control Difference
Female	63.3%	64.5%	62.1%	0.666
Latino	17.8%	15.6%	20.0%	0.333
Other Minority	18.2%	21.3%	15.2%	0.182
Age	25.0	24.9	25.0	0.894
Parent some college	37.8%	41.8%	33.8%	0.161
Parent college graduate	22.0%	18.4%	25.5%	0.150
High school grades As and Bs	30.4%	32.6%	28.3%	0.426
High school grades Bs and Cs	56.6%	55.3%	57.9%	0.657
Live with own children	27.3%	27.7%	26.9%	0.885
Live with parents	34.6%	31.2%	37.9%	0.234
Household income: \$10,000 - 19,999	31.5%	30.5%	32.4%	0.728
Household income: \$20,000 - 39,999	25.9%	27.7%	24.1%	0.498
Household income: \$40,000 or more	16.8%	14.9%	18.6%	0.401
Sample size	286	141	145	

Note: Based on baseline survey administered to all study participants.

Table 3
Educational Goals at Time of Application

	Study Participants	Treatment Group	Control Group	P-Value for Treat./Control Difference	All Financial Aid Students	All Butte College Students
Educational goals at initial application						
Transfer goal	31.5%	29.8%	33.1%	0.548	33.6%	24.5%
Non-transfer goal	24.5%	26.2%	22.8%	0.495	25.7%	32.2%
Undecided goal	37.4%	36.9%	37.9%	0.855	36.5%	33.9%
Unknown goal	6.6%	7.1%	6.2%	0.765	4.2%	9.4%
Sample size	286	141	145		1042	6681

Notes: (1) Based on administrative data provided by Butte College for students at the time of application. (2) Non-transfer goals include obtaining degree or certificate without transferring, and discovering career interest, preparing for a new career, updating job skills, maintaining occupational certificates or licenses, intellectual or cultural development, improving basic skills in English, reading or math, and completing credits for a high school diploma or GED.

Table 4
Number of Transferable Courses for CSU and UC Campuses by Department

Department Code and Title	CSU or UC Transferable		Total Number of Courses Offered
	Number	Percent	
Total	673	71%	942
AB Agricultural Business	6	100%	6
ACCT Accounting	6	55%	11
ADS Addiction Studies	17	100%	17
AET Agricultural Engineering Technology	8	80%	10
AGR Agriculture	1	17%	6
AGS Agricultural Science	4	80%	5
AJ Administration of Justice	13	100%	13
AJLE AJ-Law Enforcement	0	0%	6
AJS Agriculture Job Skills	1	0%	1
ALH Allied Health	1	33%	3
ANS Animal Science	3	100%	3
ANTH Anthropology	8	100%	8
ART Art	57	89%	64
AUT Automotive Technology	22	81%	27
BCIS Business and Computer Information Systems	31	60%	52
BIOL Biological Sciences	12	86%	14
BIT Building Inspection Technology	6	86%	7
BUS Business	13	87%	15
CDF Child Development and Family Relations	32	80%	40
CHEM Chemistry	6	86%	7
CLP Career Life Planning	3	38%	8
COS Cosmetology	0	0%	4
CS Career Skills	0	0%	2
CSCI Computer Science	28	90%	31
CSL Counseling	4	100%	4
DFT Drafting and CAD Technology	5	100%	5
DRAM Drama	8	53%	15
DSPS Disabled Student Programs and Services	0	0%	6
ECON Economics	5	100%	5
EDUC Education	2	29%	7
EH Environmental Horticulture	10	71%	14
EMT Emergency Medical Technology	0	0%	4
ENGL English	11	85%	13
ENGR Engineering	7	100%	7
FASH Fashion	10	91%	11
FN Food and Nutrition	2	67%	3
FREN French	2	50%	4
FSC Fire Science	17	52%	33
GEOG Geography	8	100%	8
GEOL Geology	3	100%	3
GERM German	4	100%	4
HIST History	11	100%	11
HLTH Health	1	100%	1
HMT Environmental Technology	0	0%	4
HON Honors	6	100%	6
HUM Humanities	4	100%	4
ID Interior Design	13	100%	13
IDST Interdisciplinary Studies	2	67%	3
ITAL Italian	2	50%	4
JOUR Journalism	2	100%	2
JPN Japanese	4	100%	4
LATN Latin	3	100%	3
LEAD Language Education/Development	0	0%	23
LIS Library and Information Science	1	100%	1
LM Life Management	1	100%	1

(Continued on next page)

Table 4 (continued)

Department Code and Title	CSU or UC Transferable		Total Number of Courses Offered
	Number	Percent	
MATH Mathematics	14	64%	22
MCS Multicultural Studies	2	100%	2
MS Machine Shop	1	33%	3
MSP Multimedia Studies Program	7	64%	11
MUS Music	13	100%	13
NR Natural Resources	8	100%	8
NSG Nursing	32	97%	33
PE Physical Education	47	43%	110
PHIL Philosophy	8	100%	8
PHO Photography	13	93%	14
PHYS Physics	9	100%	9
PLS Plant Science	4	100%	4
POS Political Science	6	100%	6
PSC Physical Science	7	100%	7
PSY Psychology	12	100%	12
READ Reading	1	33%	3
REC Recreation	1	100%	1
RLS Real Estate	7	100%	7
RT Respiratory Therapy	0	0%	13
RTVF Radio, Television, and Film	9	100%	9
SBM Small Business Management	0	0%	3
SOC Sociology	9	90%	10
SPAN Spanish	5	71%	7
SPCH Speech Communication	4	80%	5
SPE Special Education	0	0%	4
TOUR Tourism and Travel	13	93%	14
WKE Work Experience	0	0%	1
WLD Welding	15	88%	17

Notes: (1) Based on administrative data from Butte College.

Table 5
Transfer Course Regressions

	OLS Estimates		IV Estimates	
	(1)	(2)	Lower Bound (3)	Upper Bound (4)
Treatment	0.0479 (0.0239)	0.0445 (0.0226)	0.0494 (0.0251)	0.0625 (0.0318)
Baseline controls	No	Yes	Yes	Yes
Mean of dependent variable	0.6343	0.6343	0.6342	0.6342
Sample Size	2,658	2,658	2,616	2,616

Notes: (1) The dependent variable is whether the course is transferable to a California State University or University of California campus. (2) Robust standard errors are reported and adjusted for multiple courses taken by study participants. (3) Baseline controls include gender, race/ethnicity, age, parents' highest education level, high school grades, presence of own children, live with parents, family income, and educational goals. (4) The dependent variable in the first-stage regression in the IV model is obtaining a new computer. The lower (upper) bound estimate assumes that all control group non-compliers obtained computers at the end (beginning) of the survey period.

Table 6
4-Year College Transfer Regressions

	OLS Estimates		IV Estimates	
	(1)	(2)	Lower Bound (3)	Upper Bound (4)
Treatment	0.0128 (0.0485)	0.0103 (0.0464)	0.0113 (0.0508)	0.0145 (0.0655)
Baseline controls	No	Yes	Yes	Yes
Mean of dependent variable	0.2064	0.2064	0.2064	0.2064
Sample Size	281	281	281	281

Notes: (1) The dependent variable is whether the student transfers to a 4-year college. (2) Robust standard errors are reported. (3) Baseline controls include gender, race/ethnicity, age, parents' highest education level, high school grades, presence of own children, live with parents, family income, and educational goals. (4) The dependent variable in the first-stage regression in the IV model is obtaining a new computer. The lower (upper) bound estimate assumes that all control group non-compliers obtained computers at the end (beginning) of the survey period.

Table 7
California State University Transfer Regressions

	OLS Estimates		IV Estimates	
	(1)	(2)	Lower Bound (3)	Upper Bound (4)
Treatment	0.0272 (0.0465)	0.0274 (0.0446)	0.0301 (0.0488)	0.0387 (0.0629)
Baseline controls	No	Yes	Yes	Yes
Mean of dependent variable	0.1851	0.1851	0.1851	0.1851
Sample Size	281	281	281	281

Notes: (1) The dependent variable is whether the student transfers to a California State University campus. (2) Robust standard errors are reported. (3) Baseline controls include gender, race/ethnicity, age, parents' highest education level, high school grades, presence of own children, live with parents, family income, and educational goals. (4) The dependent variable in the first-stage regression in the IV model is obtaining a new computer. The lower (upper) bound estimate assumes that all control group non-compliers obtained computers at the end (beginning) of the survey period.

Table 8
Transfer Course and 4-Year College Transfer Regressions with Interactions for Educational Goals

	OLS Estimates			
	Transfer Course		4-Yr College Transfer	
	(1)	(2)	(3)	(4)
Treatment	-0.0160 (0.0384)	0.0592 (0.0360)	0.0202 (0.0776)	-0.0242 (0.0610)
Treatment*transfer goal	0.0740 (0.0572)		0.0267 (0.1282)	
Treatment*non-transfer goal	0.1341 (0.0628)		-0.1412 (0.1078)	
Treatment*above median percentage of transferable courses taken prior to treatment (fall 2006)		-0.0272 (0.0451)		0.0640 (0.0957)
Above median percentage of transferable courses taken prior to treatment (fall 2006)		0.1092 (0.0334)		0.0452 (0.0687)
Baseline controls	Yes	Yes	Yes	Yes
Mean of dependent variable	0.6343	0.6343	0.2064	0.2064
Sample Size	2,658	2,658	281	281

Notes: (1) The dependent variable is whether the course is transferable to a California State University or University of California campus in Specifications 1 and 2 and whether the student transfers to a 4-year college in Specifications 3 and 4. (2) Robust standard errors are reported and adjusted for multiple courses taken by study participants. (3) Baseline controls include gender, race/ethnicity, age, parents' highest education level, high school grades, presence of own children, live with parents, family income, and educational goals.

Table 9
College Search Regressions

	OLS Estimates		IV Estimates	
	(1)	(2)	Lower Bound (3)	Upper Bound (4)
Treatment	0.0921 (0.0717)	0.1090 (0.0709)	0.1186 (0.0775)	0.1539 (0.1001)
Baseline controls	No	Yes	Yes	Yes
Mean of dependent variable	0.3892	0.3892	0.3892	0.3892
Sample Size	185	185	185	185

Notes: (1) The dependent variable is whether students used computers to search for information on colleges. (2) Robust standard errors are reported. (3) Baseline controls include gender, race/ethnicity, age, parents' highest education level, high school grades, presence of own children, live with parents, family income, and educational goals. (4) The dependent variable in the first-stage regression in the IV model is obtaining a new computer. The lower (upper) bound estimate assumes that all control group non-compliers obtained computers at the end (beginning) of the survey period.