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9

Estimating the Productivity of Community Colleges in Paving the Road to Four-Year College Success

Scott E. Carrell and Michal Kurlaender

Community colleges are the primary point of access to higher education for many Americans. More than 40 percent of all undergraduates attend a community college (College Board 2014). In recent years, the federal government has focused heavily on community colleges as critical drivers in the effort to increase the supply of college graduates in the United States. Moreover, the push for free community colleges, proposed by the Obama administration and modeled after programs such as the Tennessee Promise,[1] has also captured the attention of policy makers and the public at large.

Despite a relatively rich literature on the community college pathway, the research base on the quality differences between these institutions has been decidedly thin. The distinct mission and open-access nature of community colleges and the diverse goals of the students they serve make it difficult to assess differences in quality across campuses. Many suggest it is difficult to identify which outcomes should actually be measured (Bailey et al. 2006). Nevertheless, strengthening outcomes at community colleges has been a large part of the national conversation about higher education account-

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1. See the Tenness Promise home page: http://tennesseepromise.gov.

ability. Given the importance of the transfer pathway, it is critical to better understand the institutional determinants of transfer success. Although several papers have explored the potential quality differences across community colleges, to our knowledge, no paper has explored differences in institutional quality in the preparation for transfer by tracking students from the two-year to the four-year sector.

In this chapter, we investigate institutional differences in both the extensive and intensive margins of the transfer function across California's community college campuses. Specifically, we start with the extensive margin as in Kurlaender, Carrell, and Jackson (2016) by examining whether some community college campuses are significantly better (or worse) at producing students who transfer from the community college to a four-year college. Next, we examine the intensive margin of the transfer function by asking whether some community college campuses are better (or worse) at preparing students once they transfer to a bachelor of arts (BA) degree–granting institution. Importantly, due to the richness of our data set, we are able to adjust our estimates for a host of observed student differences and potential unobserved determinates that drive selection. Most notable is the fact that our student-level college outcomes are linked to California high school records, which include scores on 11th-grade math and English standardized tests. We are also able to control for unobservable differences that drive selection by controlling for four-year college fixed effects.

Additionally, we examine whether the community colleges, which are relatively more (or less) productive on the extensive margin of the transfer function, are also those colleges that are more (or less) productive on the intensive margin. Finally, we examine whether any observable characteristics of the community college are significantly correlated with transfer productivity.

The rest of the chapter is organized as follows: in section 9.1, we provide a brief background, reviewing some of the prior work on the transfer function and on community college quality; in section 9.2, we describe the setting, data, and methodological approach we employ for this analysis; in section 9.3, we describe the findings; in section 9.4, we discuss mechanisms; and in section 9.5, we conclude, providing a discussion of our findings and offering policy implications.

9.1 Background and Setting

The multiple missions and goals of community colleges have been well documented in the academic literature (Bailey, Jaggars, and Jenkins 2015; Brint and Karabel 1989 ; Dougherty 1994; Grubb 1991; Rosenbaum 2001). The majority of community college systems balance at least three goals: basic skills instruction, career-technical education programs, and baccalaureate transfer pathways. Rising tuition, admissions standards, and capacity constraints have limited access at many four-year universities, making community colleges the primary pathway to a baccalaureate degree for many students.

The transfer function is one of the most important and scrutinized indicators of community college success (Long and Kurlaender 2008; Melguizo, Kienzl, and Alfonso 2011). On the one hand, community colleges offer an open pathway to the BA to those for whom a four-year BA-granting institution may be out of reach (for financial, academic, or other reasons). However, the greater flexibility in enrollment afforded by community colleges (e.g., late entry, part time, combining employment with schooling) may be detrimental to a student's academic progress and lower his or her chances of transferring to a four-year college (Brint and Karabel 1989; Dougherty 1994; Grubb 1991).

Much has been written about who utilizes the transfer route from community colleges and about the individual determinants of transfer success. Several papers have concluded that those who transfer from a community college to a four-year college are of a higher social class, have higher academic preparation, are less likely to be minority, and are less likely to be female compared to the typical community college student (Adelman 2006; Dougherty 1987, 1994; Dougherty and Kienzl 2006; Gross and Goldhaber 2009; Grubb 1991; Lee and Frank 1990; Whitaker and Pascarella 1994). In fact, early work on the community college transfer route found that the socioeconomic status of the transfer group closely resembled the average social class of the original four-year college group (Dougherty 1994). Students' intent to transfer (Bradburn and Hurst 2001; Horn 2009), need for developmental courses (Bettinger and Long 2009), and course enrollment patterns while at community college (Doyle 2009; Roksa and Calcagno 2010) are also key predictors of community college transfer. Among those who do transfer to four-year institutions and complete their degrees, community college students attain similar if not the same educational and occupational rewards (Kane and Rouse 1999; Melguizo and Dowd 2008; Whitaker and Pascarella 1994).

Far less is known about institutional differences in transfer success—specifically, quality differences in the preparation community colleges offer students that transfer to BA-granting institutions. In a prior chapter, we investigated institutional quality differences among community colleges and found meaningful differences in student outcomes across California's community colleges. For example, after adjusting for differences in student inputs, our lower bound estimates show that going from the 10th to 90th percentile of campus quality is associated with a 3.68 (37.3 percent) increase in student transfer units earned, a 0.14 (20.8 percent) increase in the probability of persisting to year two at the community college, a 0.09 (42.2 percent) increase in the probability of transferring to a four-year college, and a 0.08 (26.6 percent) increase in the probability of completion of a two-year degree (Kurlaender, Carrell, and Jackson 2016).

Prior studies have explored quality differences across community colleges in the transfer function. Ehrenberg and Smith (2004) first examine differences across community colleges in New York using group data; their results indicate substantial variation in the probability of graduating with a four-year degree. They also highlight the importance of adjusting for student characteristics in academic preparation. Clotfelter and colleagues (2013) explore variation in success measures across North Carolina's 58 community colleges and find that conditional on student differences, colleges were largely indistinguishable from one another in degree receipt or transfer coursework, save for the differences between the very top and very bottom performing colleges (Clotfelter et al. 2013). Similarly, Cunha and Miller (2014) examine institutional differences in student outcomes across Texas's 30 traditional four-year public colleges. Their results show that controlling for student background characteristics (e.g., race, gender, free lunch, SAT score), the quality of high school attended, and application behavior significantly reduces the mean differences in average earned income, persistence, and graduation across four-year college campuses.

Several other researchers have also looked at the role of different institutional inputs as proxies for institutional quality. In particular, Stange (2012) exploits differences in instructional expenditures per student across community colleges and finds no impact on student attainment (degree receipt or transfer). Calcagno and colleagues (2008) identify several institutional characteristics that influence student outcomes: larger enrollment, more minority students, and more part-time faculty are associated with lower degree attainment and lower four-year transfer rates.

9.2 Research Design

9.2.1 Setting

California is home to the largest public higher education system in the nation. The 1960 Master Plan for Higher Education articulated the distinct functions of each of the state's three public postsecondary segments. The University of California (UC) is designated as the state's primary academic research institution and is reserved for the top one-eighth of the state's graduating high school class. The California State University (CSU) is intended primarily to serve the top one-third of California's high school graduating class in undergraduate training as well as graduate training through the master's degree, focusing mainly on professional training such as teacher education. Finally, the California Community Colleges (CCC) are meant to provide subbaccalaureate instruction for students through the first two years of undergraduate education (lower division) as well as vocational instruction, remedial instruction, English-as-a-second-language courses, adult noncredit instruction, community service courses, and workforce training services.

Although the vision of the Master Plan and its legacy have been heavily debated among scholars and policy makers, the result is that the state has invested heavily in its postsecondary schooling systems, and today, 84 percent of California postsecondary students attend a public two-year or four-year college. In addition to building coherence across the state's public higher education institutions, the Master Plan is also often applauded for strengthening the importance of universal access to postsecondary schooling through the community colleges. Two-thirds of all college students attend a community college in California; in 2015 the community college system served more than 2.1 million students across 113 colleges, representing 20 percent of the nation's community college students. Students enrolled at community colleges represent enormous diversity in their backgrounds and educational goals; however, the vast majority of community college enrollees intend to transfer to a four-year BA-granting institution.

A central component of California's Master Plan is the articulation of transfer pathways from the community colleges to the state's BA-granting institutions through specific general education coursework. This was recently strengthened through California's Senate Bill 1440, known as the Student Transfer Achievement Reform Act, which further reinforced articulation between the CCC and the CSU. The legislation required the community colleges to collaborate with the CSU to develop specific associate degrees for transfer based on specified general education and lower-division coursework at the community colleges that would translate to junior standing at the CSU upon transfer. The primary goal of the legislation was to reduce unnecessary course-taking and shorten the time to achieve a degree.

The architects of the Master Plan envisioned an efficient process for students who start their postsecondary schooling at a community college to obtain a baccalaureate degree. Researchers, higher education leaders, and state policy makers alike have discussed and debated the community college transfer function for more than half a century. Many of these discussions have focused on the importance of the transfer pathway for ensuring access, given capacity constraints at four-year institutions (Bohn, Reyes, and Johnson 2013). However, to date, we know very little about how institutions fare in meeting their transfer function role.

The CCC Chancellor's Office calculates transfer rates for first-time freshmen enrolled at community colleges based on two criteria: (1) 12 units earned and (2) attempt of a transfer-level math or English course. Based on this definition, the transfer rates within five years of entry at a CCC are about 41 percent system-wide and vary widely from college to college.[2] Other estimates are much lower and suggest that only 26 percent (Sengupta and Jepsen 2006) or even 18 percent (Shulock and Moore 2007) succeed in transferring to a

2. Calculations based on Transfer Rate Study of California Community College (2005–6 report), available at http://www.cccco.edu/Portals/4/TRIS/research/reports/transfer_report.pdf.

four-year university or earn an associate's degree within six years. Horn and Lew (2007) compare CCC transfer rates across different denominators that define transfer seeking and find very similar rates. Transfer rates also vary considerably by race/ethnicity. The raw gap in transfer rates between Hispanics and whites is 11.8 percentage points and between African Americans and whites is 7.7 percentage points (California Community Colleges Chancellor's Office 2011). National statistics—albeit somewhat dated—on the racial/ethnic gaps in transfer rates among BA-intending students who are enrolled in 12 or more credit hours note only 5 percentage points between whites and African Americans and no difference between whites and Hispanics (Bradburn and Hurst 2001).

The community college students in California who do successfully transfer to a four-year college overwhelmingly (about 80 percent) enroll at one of the campuses of the CSU system. The 23-campus CSU system is the largest public four-year higher education system in the country, educating about 1 in 10 California high school graduates and roughly 5.5 percent of the undergraduates enrolled in public four-year colleges in the entire nation.[3] The CSU system enrolls the majority of CCC transfer students. Among those who transfer, nearly 90 percent apply to only one CSU, and 80 percent enroll in the CSU closest to their community college (home).

California is an ideal state in which to investigate institutional differences at community colleges because of the large number of institutions present. Moreover, articulation between the public two-year and broad-access four-year colleges offers a unique opportunity to explore the transfer route more directly. California's public two-year and four-year colleges are situated in urban, suburban, and rural areas of the state, and their students come from public high schools that are among both the best and the worst in the nation. Thus the diversity of California's community college population reflects the student populations of other states in the United States and the mainstream public two-year colleges that educate them. As such, we believe that other states can learn important lessons from California's public postsecondary institutions.

9.2.2 Data

To explore institutional differences between community colleges in their transfer role as well as BA completion, we constructed two administrative data sets that linked cohorts of California high school juniors to both the CCC and the CSU campus they attended. These data were provided by the CCC Chancellor's Office, the CSU Chancellor's Office, and the California Department of Education.

First, to examine the extensive margin of the transfer function (the prob-

3. This calculation is based on a published CSU enrollment of 437,000 students (http://www.calstate.edu/pa/2013Facts/documents/facts2013.pdf) and enrollment of 7.9 million students in public four-year colleges nationwide in 2007 (http://nces.ed.gov/pubs2013/2013008.pdf).

ability of transferring to a four-year college), we linked all transcript and completion data for four first-time freshmen fall-semester cohorts (2004–8), ages 17–19, enrolled at a CCC with the census of California 11th-grade students with standardized test score data. The match, performed on name and birth date, high school attended, and cohort, initially captured 69 percent of first-time freshmen, ages 17–19, enrolled at a CCC (consistent with similar studies conducted by the CCC Chancellor's Office matched to K–12 data).[4]

We restrict the sample for our study to first-time freshmen at the community college who are of traditional age. We built cohorts of students who started in the summer or fall within one year of graduating high school, who attempted more than two courses (six units) in their first year, and who had complete high school test and demographic information. This sample contains 389,187 students across 108 CCC campuses.[5]

Second, to examine the intensive margin of the transfer function (how well students perform after transferring to a four-year college), we linked transcript-level records of four cohorts (2005–8) of CSU students who had transferred from a CCC to their California high school records provided by the California Department of Education. Similar to the community college data match, we linked the data on name, birth date, and gender. Using these identifiers, we were able to successfully match 70 percent of all CSU transfers. Importantly, these data from the CSU system record whether the student transferred from a CCC and from which campus specifically. Additionally, these data include information on academic performance (grade point average [GPA]), persistence at the CSU, graduation, and time to degree.

9.2.3 Measures

To examine institutional differences across community colleges in transfer and BA completion, we use multiple outcome measures. First, we start with the extensive margin by examining the probability that a student transfers from a CCC to *any* four-year college. Using National Student Clearinghouse data provided by the CCC Chancellor's office and linked to his or her own data records, we are able to tell whether a student transferred to a four-year college at any point after attending a CCC. As shown in table 9.1, 27 percent of first-time freshmen at a CCC eventually transfer to a four-year school.

4. Our match rates may be the result of several considerations. First, the name match occurred on the first three letters of a student's first name and last name, leading to many duplicates. Students may have entered different names or birth dates at the community college. Students may have omitted information at either system. Second, the denominator may also be too high; not all community college students attended California high schools. Finally, students who did attend a California high school but did not take the 11th-grade standardized tests were not included in the high school data.

5. We excluded the three campuses that use the quarter system as well as three adult education campuses. Summer students were only allowed in the sample if they took enough units in their first year to guarantee that they also took units in the fall.

Table 9.1 **Sample descriptive statistics by student**

Variable	Mean	SD	Min.	Max.	Observations
CC outcomes					
Ever Transfer	0.27	0.44	0	1	389,187
transfer to CSU	0.14	0.43	0	1	389,187
Transfer to UC	0.04	0.34	0	1	389,187
CSU outcomes					
First-term GPA	2.78	0.88	0	4	66,427
Persist to year 2	0.95	0.23	0	1	66,427
Graduate with BA	0.71	0.46	0	1	66,427
Time to degree (TTD; years)	3.14	1.21	1	9	46,378
TTD <= 2 years	0.34	0.47	0	1	46,378
TTD <= 3 years	0.71	0.45	0	1	46,378
Covariates					389,187
English test score	333.65	55.7	150	600	389,187
Math test score	291.64	48.98	150	600	389,187
Asian	0.08	0.27	0	1	389,187
Pacific Islander	0.01	0.08	0	1	389,187
Filipino	0.05	0.21	0	1	389,187
Hispanic	0.39	0.49	0	1	389,187
Black	0.07	0.25	0	1	389,187
White	0.40	0.49	0	1	389,187
Did not state race	0.01	0.08	0	1	389,187
Female	0.50	0.50	0	1	389,187
Eligible for subsidized lunch	0.32	0.47	0	1	389,187
Parent income < $24K	0.11	0.32	0	1	66,427
Parent income $24K–$36K	0.09	0.28	0	1	66,427
Parent income $36K–$48K	0.07	0.25	0	1	66,427
Parent income $48K–$60K	0.07	0.25	0	1	66,427
Parent income 60K–$72K	0.07	0.25	0	1	66,427
Parent income >$72K	0.27	0.44	0	1	66,427
Parent income missing	0.33	0.47	0	1	66,427
High school API	707.91	79.00	272.00	987.00	254,865

Notes: Variables with 389,287 observations come from the California Community College datafile, while variables with 66,427 observations come from the CSU datafile.

We then split this outcome by whether the student transferred to a CSU campus or a UC campus.

To examine the intensive margin of the transfer function, we next focus on what happens to students once they transfer to the CSU. We focus on the CSU because 52 percent of students in our sample who transferred to a BA-granting institution transferred to one of the 23 CSU campuses, while only 15 percent transferred to one of the nine UC campuses. Specifically, we measure first-term GPA, persistence rates to year two, BA degree completion, and time to degree as measured by the probability of graduating within two or three years of transfer. Tables 9.1 and 9.2 show summary statistics for these key outcome measures at the individual and college levels. The average transfer student earns a 2.78 GPA during his or her first term at the CSU

Table 9.2 Sample descriptive statistics by community college

Variable	Mean	SD	Min.	Max.
Outcomes				
Ever transfer	0.25	0.08	0.06	0.43
Transfer to CSU	0.12	0.05	0.01	0.22
Transfer to UC	0.04	0.03	0.00	0.16
CSU outcomes				
First-term GPA	2.74	0.17	2.22	3.12
Persist to year 2	0.93	0.04	0.67	1.00
Graduate with BA	0.68	0.09	0.29	0.81
Time to degree (TTD; years)	3.20	0.24	2.67	4.05
TTD <= 2 years	0.32	0.09	0.00	0.55
TTD <= 3 years	0.69	0.09	0.25	0.86
Covariates				
English test score (std.)	–0.05	0.27	–0.79	0.56
Math test score (std.)	–0.04	0.25	–0.72	0.44
Asian	0.07	0.07	0	0.37
Pacific Islander	0.01	0.01	0	0.05
Filipino	0.04	0.05	0	0.27
Hispanic	0.37	0.2	0.06	0.91
Black	0.08	0.11	0.01	0.69
White	0.41	0.22	0.01	0.85
Did not state race	0.01	0.01	0	0.05
Female	0.5	0.04	0.39	0.65
Eligible for subsidized lunch	0.34	0.16	0.07	0.73
Parent income < $24K	0.11	0.08	0	0.41
Parent income $24K–$36K	0.09	0.04	0	0.17
Parent income $36K–$48K	0.07	0.03	0	0.27
Parent income $48K–$60K	0.07	0.05	0	0.50
Parent income $60K–$72K	0.07	0.02	0	0.13
Parent income >$72K	0.27	0.10	0	0.46
Parent income missing	0.33	0.08	0	0.66
High school API	703.26	45.03	588.34	799.11
Community college characteristics (n = 102)				
Tenured to adjunct faculty ratio	0.94	0.37	0.24	2.53
Female to male faculty ratio	0.96	0.20	0.55	2.00
Faculty to student ratio	56.47	23.55	16.21	160.02
Support staff to student ratio	3.26	2.34	0.00	12.30
Faculty years of experience	5.10	0.83	2.49	7.61
Distance to the nearest CSU (miles)	19.42	25.12	0.89	159.52
Student Population (1,000s)	8.62	5.46	1.93	28.87
Fraction vocational education degrees/certificates	51.33	13.81	6.35	82.51

(on a 0- to 4-point scale). A vast majority of transfer students persist to the second year at CSU, with persistence rates greater than 90 percent in our sample. Graduation rates among transfer students are relatively high at 71 percent. Finally, the average time to degree in our sample is just over three years, while 34 percent and 71 percent of students graduate within two and three years of transfer, respectively.

Our data are unique in that we have the ability to connect a student's performance and outcomes at the community college and CSU with their high school data. As community colleges are open access, students do not submit transcripts from their high school and have not necessarily taken college entrance exams such as the SAT or ACT to enter. As a result, community colleges often know very little about their students' prior educational backgrounds. Researchers interested in understanding the community college population often face the same constraints (Ehrenberg and Smith 2004). Examining the outcomes of community colleges without considering the educational backgrounds of the students enrolling in a college may confound college effects with students' self-selection. Likewise, students who transfer to the CSU are also not required to take the ACT or SAT.

To address these selection issues, we are able to adjust our estimates of quality by first including important background information about a student's high school academic performance. We measure a student's performance on the 11th-grade English and mathematics California State Tests (CSTs).[6] We are also able to determine which math course a student took in 11th grade. In addition, we measure race/ethnicity, gender, and parental income.[7] To account for high school quality, we include the Academic Performance Index (API) of the high school attended (California's school accountability metric). Importantly, as students are enrolling in community college, they are asked about their goals for attending community college. Students can pick from an extensive list of 15 choices, including to transfer with an associate's degree, transfer without an associate's degree, gain a vocation certification, discover interests, improve basic skills, undecided, and others. We include students' self-reported goals as an additional covariate for their postsecondary degree intentions. Lastly, we add additional controls for college by year-level means of our individual characteristics (11th-grade CST math and English scores, race/ethnicity, gender, parental income, API, and student goal). Table 9.1 includes descriptive statistics on all our measures at the individual level, and table 9.2 includes descriptive statistics at the college level.[8]

6. We include CST scaled scores, which are approximately normally distributed across the state.

7. Our community college data set contains information regarding whether the student was eligible for free or reduced-priced lunch. Our CSU data file contains self-reported parental income measures.

8. Unlike the four-year-college quality literature, we do not account for students' college choice set, since most community college students enroll in the schools closest to where they attended high school. Using nationally representative data, Stange (2012) finds that in contrast to four-year college students, community college students do not appear to travel farther in search of higher-quality campuses, and importantly, "conditional on attending a school other than the closest one, there does not appear to be a relationship between student characteristics, school characteristics, and distance traveled among community college students" (Stange 2012, 81).

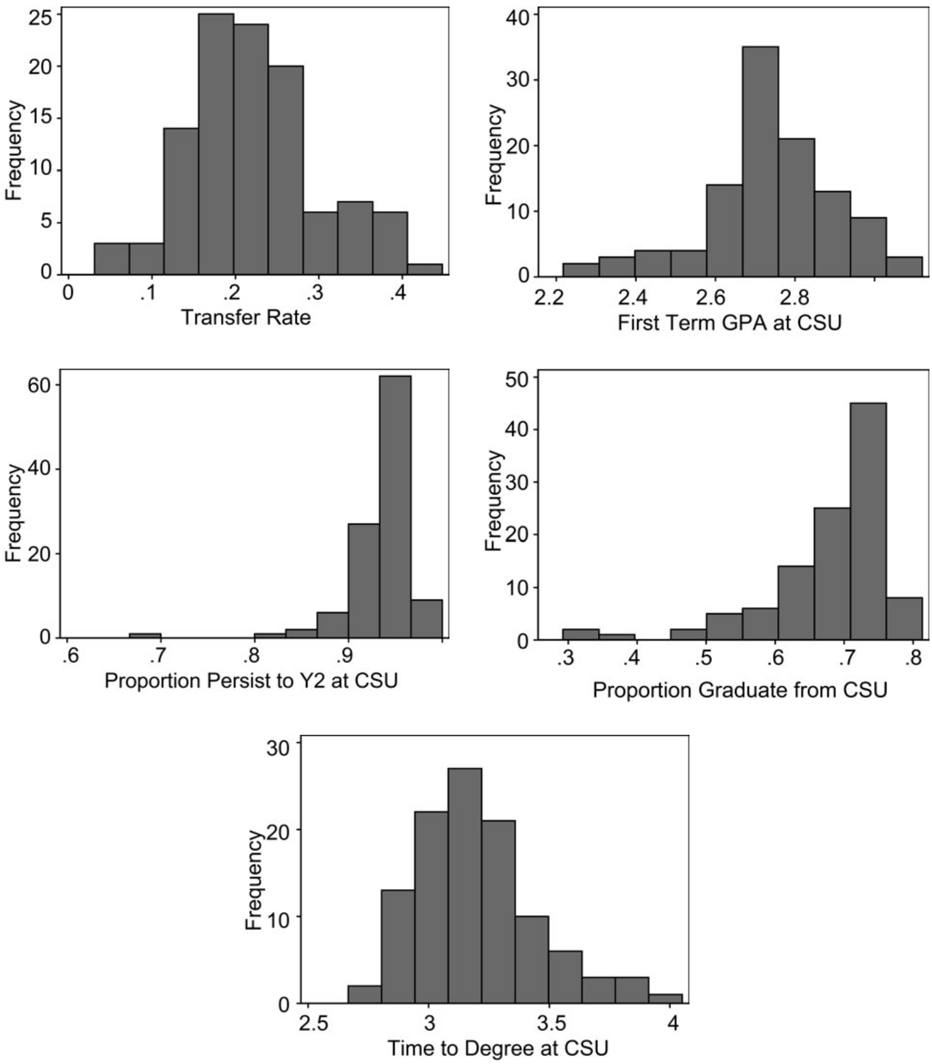

Fig. 9.1 Distribution of outcomes by community college
Source: Author's calculations based on data from CSU and CCCO Chancellor's Offices.

9.2.4 Empirical Methods

We begin by visually examining the raw outcome measures across the community colleges in our sample. Figure 9.1 presents the distribution of the proportion who transfer from a CCC, first-term GPA at CSU, proportion persisting to year two at the CSU, proportions completing a BA, and time to degree across the 108 community colleges. This figure shows consider-

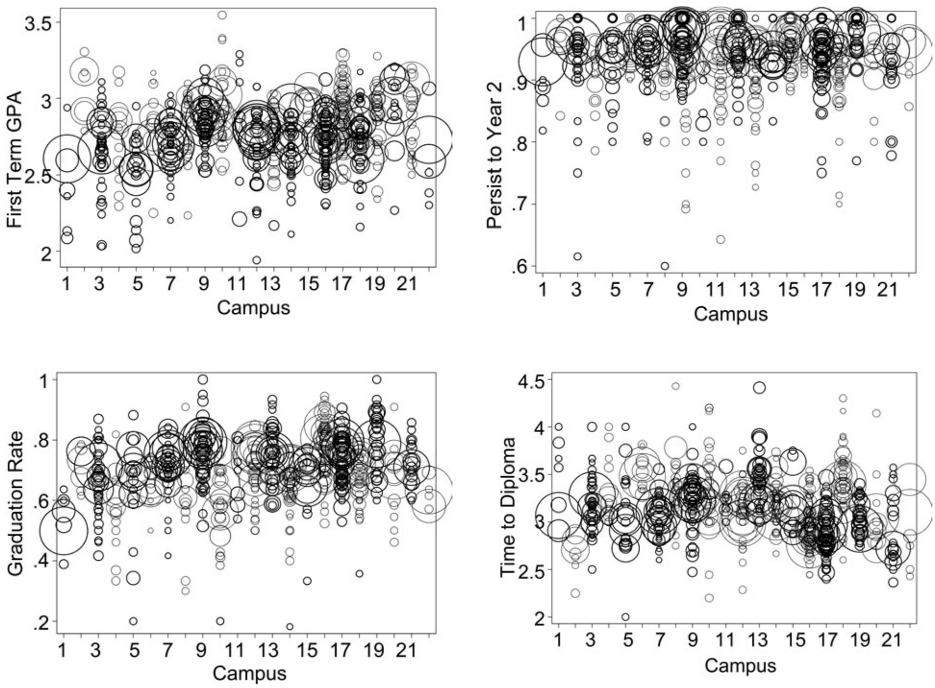

Fig. 9.2 Distribution of outcomes by community college and CSU
Source: Author's calculations based on data from CSU and CCCO Chancellor's Offices.

able variation across community college campuses in four of the five outcomes. The one exception is persistence to year two at the CSU, where a vast majority (95 percent) of students persists to year two. To further examine the amount of variation in the four posttransfer CSU outcomes (first-term GPA, persistence, graduation, and time to degree), in figure 9.2, we plot the variation in these outcomes by community college campus and CSU campus. Each CSU (receiving institution) is plotted along the *X*-axis with the corresponding sending community colleges plotted by size. These figures show two important facts. First, within each of the 23 CSU campuses, students transfer from many different community colleges. Specifically, the average CSU campus in our sample period received transfer students from 79 different CCCs. Second, there is considerable variation in the average outcomes across these community colleges from which the students transfer within each CSU campus.

Although there appears to be considerable variation in average outcomes within CSUs and across CCCs, we note that our figures are unadjusted by student inputs. Therefore, to motivate the importance of accounting for student inputs, we next plot each outcome against students' 11th-grade math

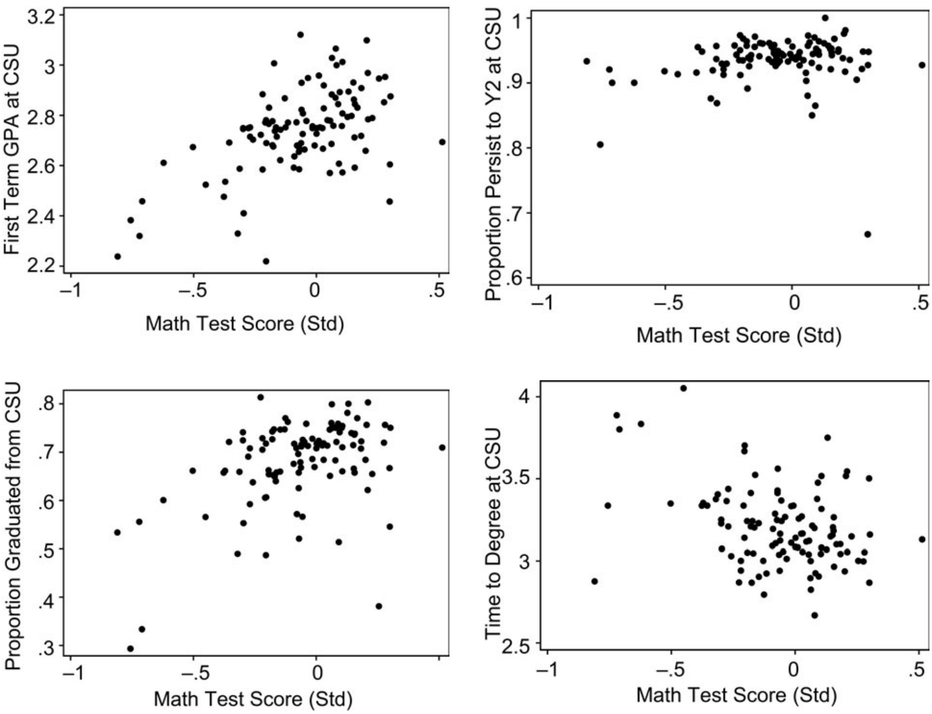

Fig. 9.3 Scatterplot of average CSU outcomes against students' 11th-grade math test scores

Source: Author's calculations based on data from CSU and CCCO Chancellor's Offices.

test scores at the college level (figure 9.3). From these simple scatterplots, it is clear that higher average student test scores are associated with better average CSU outcomes among transfer students, save for persistence. We also note that there is considerable variation in the average outcomes for students with similar high school test scores across the community colleges.

To examine whether there are significant causal differences in the extensive transfer margin (i.e., the probability of transfer) across community college campuses, we start by estimating the following linear random effects model as in Kurlaender, Carrell, and Jackson (2016):

$$(1) \qquad Y_{iscty} = \beta_0 + \beta_1 x_i + \beta_2 \bar{x}_{cy} + \beta_3 w_s + \lambda_t + \phi_y + \zeta_c + \varepsilon_{iscty},$$

where Y_{iscty} is our outcome variable of interest (transfer to any four-year institutions, transfer to a CSU, or transfer to a UC) for individual i, from high school s, who is a first-time freshman enrolled at community college c, in term t in year y; x_i is a vector of individual-level characteristics (race/ethnicity, gender, parental education, and 11th-grade math and English language arts test scores), $\bar{x}_{cy}$ is community college by cohort means of x_i, and w_s is a measure of the quality of the high school attended (California's API score)[9] for each individual. Finally, ε_{iscty} is the individual-level error term.

The main parameter of interest is the community college random effect, ζ_c.[10] We estimate $\widehat{\zeta_c}$ using an empirical Bayes shrinkage estimator to adjust for reliability. The empirical Bayes estimates are best linear unbiased predictors (BLUPs) of each community college's value added, which takes into account the variance (signal to noise) and the number of observations (students) at each college campus. Estimates of ζ_c with a higher variance and a fewer number of observations are shrunk toward zero (Rabe-Hesketh and Skrondal 2008).

The empirical Bayes technique is commonly used in measuring the quality of hospitals (Dimick, Staiger, and Birkmeyer 2010), schools or neighborhoods (Altonji and Mansfield 2014), and teachers (Carrell and West 2010; Kane, Rockoff, and Staiger 2008). In particular, we use methodologies similar to those recently used in the literature to rank hospital quality, which shows the importance of adjusting mortality rates for patient risk (Parker et al. 2006) and statistical reliability (caseload size; Dimick, Staiger, and Birkmeyer 2010). In our context, we similarly adjust our college rankings for "student risk" (student preparation, high school quality, and unobserved determinants of selection) as well as potential noise in our estimates driven by differences in campus size and student population.

Next, to examine whether there are significant differences in the intensive transfer margin (i.e., how well students perform after transfer) across the community college campuses, we estimate a slightly modified linear random effects model to account for selection into the CSU:

$$(2) \qquad Y_{isctyu} = \beta_0 + \beta_1 x_i + \beta_2 \bar{x}_{cy} + \beta_3 w_s + \lambda_t + \phi_y + \zeta_c + \sigma_u + \varepsilon_{isctyu},$$

where Y_{isctyu} are the posttransfer outcome variables of interest (first-term GPA, persistence, graduation, and time to degree) for individual i, from high school s, who is a first-time freshman enrolled at community college c, in term t in year y at CSU campus u. All other variables in the model are the same as in equation (1), and σ_u are CSU campus fixed effects. Importantly, the CSU fixed effects control for all unobserved (fixed) variation at the CSU campus level—for example, professor experience and teaching quality, level of support services, and other unobservable differences across

9. The API is a measure of California schools' academic performance and growth. It is the chief component of California's Public Schools Accountability Act, passed in 1999. API is composed of schools' state standardized test scores and results on the California High School Exit Exam; scores range from a low of 200 to a high of 1000.

10. We use a random-effects model instead of a fixed-effects model due to the efficiency (minimum variance) of the random-effects model. However, our findings are qualitatively similar when using a fixed-effects framework; for our main results in table 9.3, the correlations between the fixed- and random-effects estimates range between 0.983 and 0.991.

the CSU campuses that influence posttransfer outcomes. Importantly, the CSU fixed effects also control for individual unobservable differences that drive selection and choice.

9.3 Results

9.3.1 Extensive Margin Transfer Outcomes

We start by examining whether there are significant differences across community colleges in the probability of transferring to a four-year college, as in Kurlaender, Carrell, and Jackson (2016). To do so, we examine whether there is significant variation in our estimates of $\widehat{\zeta}_c$s for our three transfer outcomes of interest. Table 9.3 presents the results of the estimated standard deviation, $\sigma_{\hat{\zeta}}$, in our college effects for various specifications of equation (1). High values of $\sigma_{\hat{\zeta}}$ indicate there is significant variation in the probability of transferring across community college campuses, while low values of $\sigma_{\hat{\zeta}}$ would indicate that there is little difference in student transfer outcomes across campuses.

In specification 1, we start with the most naive estimates, where we include only year and term indicator variables. Results show that a one-standard-deviation change in campus quality is associated with a 0.072 percentage point increase in the probability of transfer. This effect is quite large, representing a 27 percent increase from the mean in the probability of transfer. However, these unadjusted estimates are analogous to comparing simple

Table 9.3 **Standard deviations in random effects: Community college outcomes**

		SD of random effects estimates		
Specification	Controls	Transfer	Transfer to CSU	Transfer to UC
(1)	Year/term	0.072	0.040	0.029
		[0.063, 0.082]	[0.035, 0.046]	[0.025, 0.033]
(2)	Test scores	0.054	0.034	0.023
		[0.047, 0.062]	[0.030, 0.040]	[0.020, 0.026]
(3)	Demographics	0.047	0.031	0.022
		[0.041, 0.054]	[0.027, 0.036]	[0.019, 0.025]
(4)	Goal	0.044	0.029	0.021
		[0.038, 0.050]	[0.025, 0.033]	[0.019, 0.025]
(5)	School API	0.039	0.027	0.021
		[0.034, 0.045]	[0.023, 0.031]	[0.018, 0.024]
(6)	College means	0.041	0.026	0.019
		[0.035, 0.047]	[0.022, 0.031]	[0.016, 0.022]
# of community colleges		108	108	108

Notes: Each cell represents the standard deviation of the community college random effects; 95 percent confidence intervals in brackets.

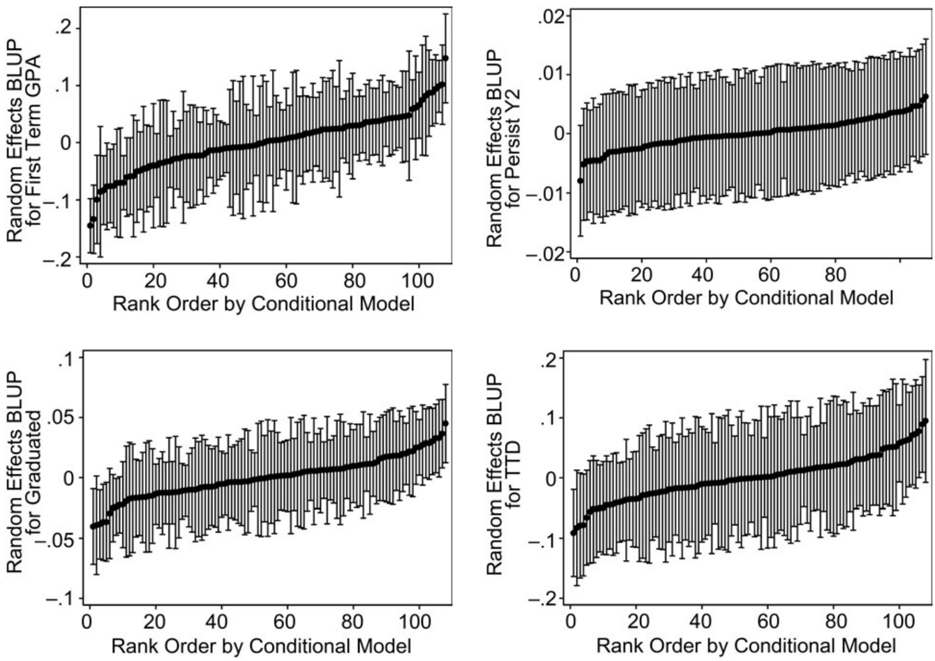

Fig. 9.3 Scatterplot of average CSU outcomes against students' 11th-grade math test scores

Source: Author's calculations based on data from CSU and CCCO Chancellor's Offices.

means in student transfer rates across college campuses and likely overstate the true value added of college campuses.

To adjust our estimates for differences in student-level inputs, in specifications 2–4 of table 9.3, we sequentially adjust our estimates of $\widehat{\zeta_c}$ for a host of student-level covariates. This procedure is similar to the hospital quality literature that calculates risk-adjusted mortality rates (Dimick, Staiger, and Birkmeyer 2010). Importantly, starting in specification 2, we include scores from the 11th-grade California State Test (CST). Doing so likely removes a significant amount of potential bias in our estimates, as the teacher-quality literature has previously shown that teacher value-added estimates are unbiased when conditioned on prior-year test scores (Kane, Rockoff, and Staiger 2008). In specification 3, we add individual-level demographic characteristics (race/ethnicity, gender, and parental income level). In specification 4, we control for the student's goal for attending community college. In specification 5, we add California's API scores for each student's high school to control for differences in high school quality.

Results in specifications 2–5 indicate that even after controlling for student-level observable characteristics, there is considerable variation in transfer rates across California's community colleges. For specification 5, a one-standard-deviation increase in community college quality is associated with a 0.039 percentage point (14.4 percent) increase in the probability of transferring to a four-year college.

In specification 6, we add campus by cohort means of our various individual demographic variables to address concerns with selection on unobservables (Altonji, Elder, and Taber 2005), as suggested by Altonji and Mansfield (2014), and to control for differences in peer quality, which has been shown to affect transfer outcomes (Smith and Stange 2016). Doing so likely provides a *lower bound* of the estimated variance in the campus quality effects.[11] In this fully specified model, our estimate remains substantively unchanged with a one-standard-deviation increase in campus quality associated with a 0.041 percentage point (15.2 percent) increase in the probability of transferring.

In columns 2 and 3, we present results when we split the outcome by whether the student transferred to a CSU campus or a UC campus. Results show substantially higher variation across community college campuses in the probability of transferring to a CSU compared to a UC. Specifically, in our fully specified model, one standard deviation in the community college effect is associated with a 2.7 percentage point increase in the probability of transferring to a CSU and a 1.8 percentage point increase in the probability of transferring to a UC.

9.3.2 Intensive Margin Transfer Outcomes

The previous results show significant variation across community college campuses in the probability of transferring to a BA-granting institution. However, a natural follow-up question is whether some campuses produce students who perform better once they transfer. This question is analogous to the recent teacher-quality literature that examines how teachers affect both contemporaneous academic achievement as well as longer-term outcomes, such as later academic performance and labor market outcomes (Carrell and West 2010; Chetty et al. 2014). To answer this question, we next present results for our intensive margin outcomes that measure first-term GPA at the CSU, persistence to year two at the CSU, BA degree receipt, and time to degree as measured by the probability of graduating within two or three years at the CSU. As previously discussed, to overcome selection issues in college choice, we include CSU fixed effects in all our specifications, with results presented in table 9.4.

Analogous to our previously presented results, we start with a naive model that includes only year and term effects as well as CSU campus fixed effects. We then sequentially add control variables to the model. While the addition

11. Altonji and Mansfield (2014) show that, under reasonable assumptions, controlling for group means of individual-level characteristics "also controls for *all* of the across-group variation in the unobservable individual characteristics." This procedure provides a lower bound of the school-quality effects because school quality is likely an unobservable that drives individual selection.

Table 9.4 **Standard deviations in random effects: CSU outcomes**

		SD of random effects estimates				
Specification	Controls	First-term GPA	Persist to year 2	Graduate with BA	TTD <=2 years	TTD <=3 years
(1)	Year/term	0.122	0.011	0.039	0.041	0.036
		[0.103, 0.145]	[0.008, 0.015]	[0.031, 0.048]	[0.033, 0.050]	[0.028, 0.044]
(2)	Test scores	0.105	0.011	0.038	0.040	0.036
		[0.088, 0.126]	[0.008, 0.014]	[0.030, 0.047]	[0.032, 0.050]	[0.028, 0.045]
(3)	Demographics	0.088	0.010	0.034	0.035	0.030
		[0.072, 0.106]	[0.007, 0.014]	[0.027, 0.042]	[0.027, 0.044]	[0.023, 0.038]
(4)	School API	0.085	0.010	0.031	0.033	0.028
		[0.070, 0.104]	[0.007, 0.014]	[0.024, 0.040]	[0.026, 0.043]	[0.021, 0.036]
(5)	College means	0.066	0.009	0.025	0.028	0.023
		[0.054, 0.082]	[0.006, 0.013]	[0.019, 0.033]	[0.022, 0.037]	[0.017, 0.031]
# of community colleges		108	108	108	108	108

Notes: Each cell represents the standard deviation of the community college random effects. All specifications include CSU fixed effects; 95 percent confidence intervals in brackets.

of control variables reduces the variation in the campus effects, significant variations in outcomes across community college campuses persist. Results for the fully specified model (specification 5) show that a one-standard-deviation increase in community college campus quality is associated with a 0.066 (2.3 percent) increase in first-term GPA at the CSU, a 0.009 percentage point (1 percent) increase in the probability of persisting to year two, a 0.025 percentage point (3.6 percent) increase in the probability of BA completion, a 0.028 percentage point (8.2 percent) increase in the probability of graduating within two years of transfer, and a 2.3 percentage point (3.2 percent) increase in the probability of graduating within three years of transfer.

9.4 Mechanisms

Understanding why some colleges are more successful than others in the transfer function (or in other outcomes) is of critical importance and has captured the attention of higher education leaders in discussions about college quality, prompted in part by the US Department of Education's College Scorecard.[12] Although there are many factors that may influence productivity, we explore this question by regressing the community college campus effects (BLUPs) that we estimate in tables 9.3 and 9.4 on observable characteristics of the community college. Specifically, we explore whether the following attributes at the community college are correlated with college effectiveness: (1) tenured-to-adjunct faculty ratio, (2) female-to-male faculty ratio, (3) faculty-to-student ratio, (4) support staff-to-student ratio,

12. See https://collegescorecard.ed.gov.

(5) faculty experience, (6) distance to the nearest CSU, (7) school size, and (8) the fraction of degrees or certificates conferred that are vocational (career technical) education.[13]

Although we cannot claim the causality of the estimates, results show suggestive evidence that community colleges that are closer to a CSU, are larger in size, have more female faculty, and have a smaller fraction of students pursuing vocational education degrees are associated with better student transfer outcomes (table 9.5).

For example, a one-mile increase in the distance to the CSU is correlated with a –0.02 percentage point decrease in the probability of graduation ($p = 0.052$); however, distance is not correlated with our other outcomes. Likewise, a 1,000 student (0.18 standard deviations) increase in the size of the community college is associated with significant increases in first-term GPA (0.37 grade points), persistence to year two (0.03 percentage points), and graduating with a BA (0.08 percentage points).

As previously discussed, community colleges often have multiple missions. As such, it is not surprising that we find a negative correlation between our campus effect measuring the probability of transfer and the fraction of degrees and certificates conferred that are vocational. Specifically, we find that a 1 percentage point increase in the fraction of vocationally oriented degrees/certificates awarded is associated with a nearly 9 percentage point decrease in the probability of transferring.

Finally, faculty characteristics appear to be potentially related to student outcomes. Although imprecisely estimated, results show that a 0.10 point increase in the female-to-male faculty ratio is associated with a 0.42 increase in GPA ($p = 0.14$) and a 0.016 percentage point increase in the probability of graduating within two years of transfer ($p = 0.17$). Several experimental and quasi-experimental studies have explored specific faculty characteristics and institutional practices and programs and their impact on persistence and degree attainment. Studies exploring faculty characteristics have shown that professor gender, race/ethnicity, rank, education, and experience can significantly influence course performance, choice of major, and graduation (Carrell, Page, and West 2010; Carrell and West 2010; Fairlie, Hoffman, and Oreopoulos 2013; Hoffman and Oreopoulos 2009). However, it is unclear exactly why professor characteristics are correlated with student achievement.

A natural follow-up question is whether the community colleges that are relatively successful (or unsuccessful) in having their students transfer to a four-year college are the same community colleges that produce students

13. We also examined financial indicators such as faculty salaries and institutional spending; however, these data were only available for a subset of our colleges (67 of 108). Within this subset of schools, we found no significant correlations between our estimated college effects and financial indicators.

Table 9.5 **College random effects regressed on observable characteristics**

Variable Specification	Transfer ever (1)	Transfer to CSU (2)	First-term GPA (3)	Persist to year 2 (4)	Graduate with BA (5)	TTD <=2 years (6)	TTD <=3 years (6)
Tenured to adjunct faculty ratio	–0.707	0.749	2.237	0.068	0.359	0.359	0.640
	(1.066)	(0.721)	(1.494)	(0.147)	(0.524)	(0.602)	(0.452)
Female to male faculty ratio	–0.553	0.106	3.806	0.373	0.618	1.563	0.935
	(2.049)	(1.386)	(2.872)	(0.283)	(1.006)	(1.157)	(0.869)
Faculty to student ratio	–0.024	–0.014	0.030	0.002	–0.005	0.006	–0.008
	(0.019)	(0.013)	(0.027)	(0.003)	(0.009)	(0.011)	(0.008)
Support staff to student ratio	0.289	0.066	0.067	–0.014	–0.013	–0.109	0.063
	(0.184)	(0.125)	(0.258)	(0.025)	(0.091)	(0.104)	(0.078)
Average faculty years of experience at the college	–0.354	–0.089	–0.637	0.066	–0.180	–0.145	–0.106
	(0.519)	(0.351)	(0.727)	(0.072)	(0.255)	(0.293)	(0.220)
Distance to the nearest CSU (miles)	0.011	–0.014	0.023	0.000	–0.018**	0.006	0.007
	(0.018)	(0.012)	(0.025)	(0.002)	(0.009)	(0.010)	(0.008)
Student population (1,000s)	0.158*	0.028	0.404***	0.024**	0.082**	0.066	0.053
	(0.080)	(0.054)	(0.113)	(0.011)	(0.040)	(0.045)	(0.034)
Fraction vocational education degrees/certificates	–0.089***	–0.023	–0.042	0.009**	–0.006	–0.003	–0.018
	(0.030)	(0.020)	(0.042)	(0.004)	(0.015)	(0.017)	(0.013)
# of community colleges	102	102	102	102	102	102	102
R-squared	0.164	0.058	0.162	0.155	0.164	0.06	0.096

Notes: Each column represents a separate regression where the indicated community college random effects are regressed on observable characteristics of the community college. Random effects estimates were divided by 100 prior to running the regressions. ***, **, and * represent 0.01, 0.05, and 0.10 levels of significance, respectively.

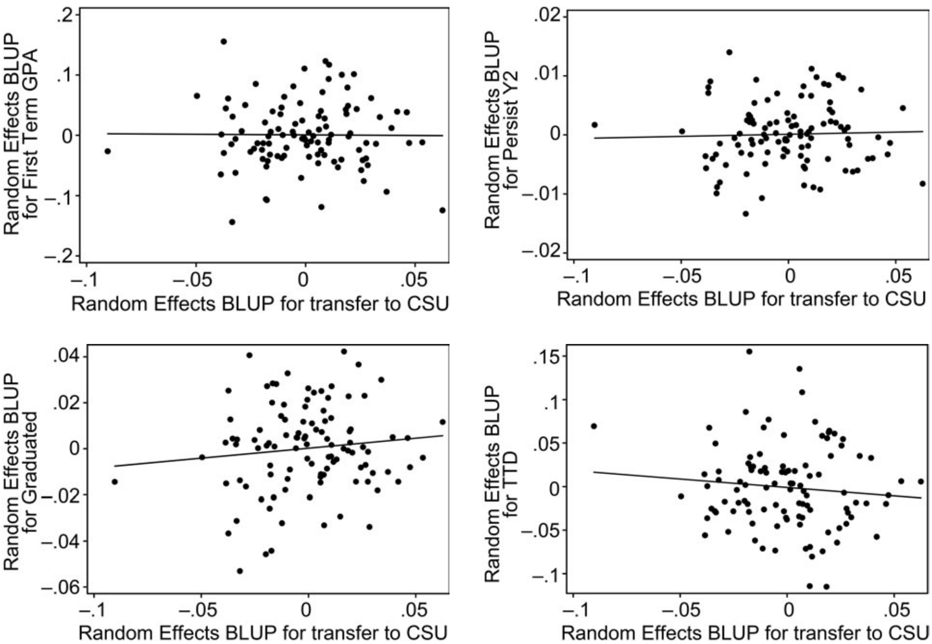

Fig. 9.5 Intensive transfer margin versus extensive transfer margin
Source: Author's calculations based on data from CSU and CCCO Chancellor's Offices.

who are relatively successful (or unsuccessful) at the four-year college after transferring. To explore this relationship, in figure 9.5, we plot each community college's extensive margin effects against their intensive margin effects.[14] The pattern of results suggests that there is a small positive relationship between the probability of transfer and student performance after transfer. That is, the community colleges that are more (or less) successful at producing students who transfer to a four-year college also produce students who tend to perform better (or worse) after transferring (in terms of GPA, graduation, and time to degree).

9.5 Conclusion

To our knowledge, this is the first study in the literature to examine how institutional differences across community colleges affect both the extensive and intensive margins of the transfer function. Results show there is significant variation in community college quality for both the probability of transfer and outcomes measuring how well students perform after transferring.

14. We plot the BLUPs of each community college's random effects.

Overall, our results show significant differences across community colleges in both the intensive and extensive margins of the transfer function. Specifically, after adjusting for observable student differences and unobservable factors that drive selection, we find that some community colleges are relatively more (or less) efficient in producing students who are more likely to transfer and to achieve at a higher level at their posttransfer institutions.

There is a small positive relationship between the extensive and intensive margin outcomes, indicating that the schools that are better at producing students who transfer also produce students who, on average, perform equally well or better at their four-year institutions posttransfer. We find some evidence that observable characteristics of the community colleges are correlated with transfer productivity. Specifically, larger community colleges, colleges closer to a CSU, and colleges with more female faculty are associated with a more positive transfer outcome. (In ongoing work, we also examine productivity by student type: academic preparation, income, and race.)

Of course, there may be a host of factors we don't observe that make some of these institutions more effective at the transfer function than others. The transfer process is complex, and navigating it successfully requires an understanding of the requirements to do so at two different institutions (i.e., the sending community college and the receiving CSU). Thus it is likely that colleges vary greatly in their ability to direct students along this pathway (e.g., through improved information, counseling, course articulation, or even scheduling). Moreover, colleges also vary in their implementation of state policies and programs aimed specifically at smoothing the transfer pathways. For example, as Baker (2016) shows, campus adoption of the Associate Degree for Transfer (an articulated a set of courses between community colleges and the CSU campuses), varied across the state's community college campuses. In addition, others have noted variation across colleges in the adoption of the Early Assessment Program (for student placement in remedial coursework; Friedmann, Kurlaender, and Van Ommeren 2016), in financial aid policies and procedures (Friedmann and Martorell 2017), and in the various components of the 2012 Student Success Act, which aims to improve completion and transfer outcomes at CCCs (Gordon 2017).

To date, much of the research on college quality has focused largely on more-selective four-year colleges and universities. Yet the increased policy focus on community colleges demands careful attention to quality differences among these open-access institutions, particularly in facilitating transfer and degree completion. In this chapter, we leverage rich administrative data from two of the largest public higher education systems to investigate institutional quality differences across community colleges in their efforts to prepare and pave the road for transfer students in pursuit of the BA.

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