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Thomas Bailey, Juan Carlos Calcagno, Davis Jenkins,
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EXECUTIVE SUMMARY

The goal of this report is to measure the institutional characteristics that affect the success of community college students, particularly low-income and minority students. While there is a growing literature on this topic for baccalaureate institutions, few researchers have attempted to address the issue for community colleges. Since this line of research is so new, there remain open many methodological and conceptual issues.

Much research has been done to identify individual student characteristics that impact their outcomes at community colleges. Characteristics such as academic preparedness, household income, parents' level of education, gender, race/ethnicity, and patterns of enrollment have all been found to impact individual student outcomes. Yet, individual factors cannot completely explain the graduation rates of different community colleges, nor even the likelihood of an individual student completing at a particular college. Evidence shows that different community colleges enrolling essentially similar types of students may have vastly different graduation rates. What characteristics of these institutions might play a role in explaining student outcomes, when controlling for student characteristics? This report investigates that question using different models and sets of data.

The Study. In this study, a team of researchers at the Community College Research Center (CCRC) pursued two broad empirical strategies. First, we developed a model of the determinants of *institutional* graduation rates using the Student Right-to-Know (SRK) three-year graduation rates published by the National Center for Education Statistics (NCES). We used measures of institutional characteristics provided by the Integrated Postsecondary Education Data System (IPEDS) as the independent variables (the determinants of graduation rates). Second, we used individual data from the National Education Longitudinal Study of 1988 (NELS:88) to analyze *individual* student probabilities of completing a certificate or degree or transferring to a baccalaureate institution. Using this approach we were able to control for individual characteristics such as a student's socioeconomic background or scores on pre-college assessment tests. We assessed the effects of institutional characteristics on individual student outcomes by linking the same institutional variables from IPEDS that we used in the institutional analysis to the individual student records (by the institution in which each student enrolled).

There are strengths and weaknesses to the SRK institutional graduation rate data. The data are readily available from IPEDS for most colleges and therefore allow for easy analysis of the comparative performance of individual colleges. Yet the SRK data are criticized because they poorly report transfer students who do not earn a degree prior to transfer, in effect assuming that all students want degrees. Furthermore, the three-year window for measuring community college graduation is too short—substantial numbers of community college students take longer than three years to complete an associate degree. In addition, IPEDS does not include many important variables that are known to influence graduation rates, with student economic background and pre-college academic records being the most important. These are all valid criticisms. However, we argue that the graduation rates are still important measures, especially when used comparatively, and that the distortion caused by transfers is not very large for three-year rates. Moreover, the institutional variables that are available from IPEDS allow us to make some

adjustments to the graduation rates, and therefore to calculate better comparative benchmarks than the raw graduation rates.

Our second set of analyses that link the NELS:88 individual student outcomes and characteristics to the institutional variables from IPEDS address some of the problems with the SRK data. The individual outcome variable (individual degree completion or transfer) from NELS:88 is a more reliable measure than the SRK graduation rate, while the individual student data allow us to control for important background characteristics. Since NELS:88 includes student transcripts, we can also use credit accumulation as an outcome variable. Finally, NELS:88 also allows us to track students for up to eight years, rather than the three years for the SRK rates.

Even with NELS:88 some analytic problems remain. For example, we still must rely on the crude institutional measures available in IPEDS. So, while we may know that an individual is from a low-income family, we have no reliable information on the economic background of the typical student at that individual's college. And we still do not have measures of specific institutional policies such as the types of student services or pedagogic strategies typically used to improve retention and completion. Finally, the NELS:88 sample is made up almost entirely of traditional-age college students, and therefore provides no information on older students, who comprise an important part of community college enrollments.

Findings. The results discussed here are based on the most salient findings from both the institutional graduation rate analysis and the individual student outcomes analysis. Community college characteristics that exhibit consistent impacts on student outcomes are as follows.

Institution size is negatively correlated with successful student outcomes. Students complete at higher rates in smaller community colleges, perhaps because such institutions can provide a more personalized environment. It may also be that smaller institutions have a more limited and focused set of programs, which may attract students who know what they want or provide a structure to guide students who do not know what they want toward a clearer set of outcomes.

A larger percentage of minority students (black, Hispanic, and Native American) at an institution is associated with lower graduation rates. Students in colleges with more minority students graduate at lower rates, even after controlling for the race of individual students. Thus, the graduation rates at colleges with many minorities is lower, not because minorities are less likely to graduate and therefore lower the graduation rate, but rather because all students tend to graduate at lower rates when they attend high minority colleges. This is certainly a disturbing conclusion that needs further investigation.

Higher percentages of students who are part-time tend to be related to lower graduation rates. Like the finding with minority students, the proportion of part-time students at the institution is the significant variable in this finding – and not necessarily the intensity of enrollment of any individual student.

A larger percentage of faculty who are part-time also correlates with lower student graduation rates at community colleges.

Rates of instructional expenditures and student service expenditures have some positive impacts on graduation rates. More instructional expenditures appear to promote completion in the institutional analysis using the SRK graduation rate, but this effect disappears when we control for individual student characteristics. On the other hand, expenditures on student services are not related to higher graduation rates in the SRK analysis, but in some permutations of the model that include individual characteristics, we find a positive relationship between outcomes and student services expenditures. The latter suggests that student services may be effective in increasing the probability that a student will have a positive outcome. In sum, these results suggest that cuts in instructional expenditures and student services will lower college performance and thwart retention and completion.

The state in which a college is located has significant impact on institutional graduation rates. Dummy control variables for each state in the SRK graduation model helped explain much of the variation in institutional graduation rates, suggesting that state policies and how they play out at individual community colleges matter for student outcomes. These effects seem to be independent of the effect of the level of expenditures by individual institutions, although they may have to do with the level of state appropriations, something we do not measure. Other recent research on the impact of institutional finances on student persistence at baccalaureate institutions finds that the percent of revenue derived from tuition is positively related to student persistence. The explanation for this effect is that, as institutions rely more on tuition for revenue, they become increasingly customer focused. This may also be true at community colleges, and may be an important finding as competition intensifies for state and local funding. Therefore, individual state-level variables that distinguish funding and other policies might tease out differences in outcomes – including, perhaps, the outcomes for minority students and other student populations.

Implications. As indicated, this research identified several important methodological issues that should be noted and must be addressed in future research. Similarly, the findings suggest directions for future research that may tease out some of the pedagogical, practical, and policy features of individual states or institutions. They are noted below.

There are important contrasts between the findings for all community college students and for those in an associate degree program. These contrasts suggest that certificate and associate programs have different dynamics, and policies that promote success in one might not work for the other. We suspect that the contrasts would be even larger if we had a more representative sample of community college students than is available in NELS:88. NELS:88 is comprised primarily of traditional aged college students. Adult community college students are more likely than younger students to enroll in certificate programs and probably also respond differently to particular types of policies and practices.

Conventional models of institutional performance appear to work better for baccalaureate institutions than they do for two-year institutions. One reason why is that baccalaureate institutions have a much simpler and more universally applicable outcome measure – attainment of a bachelor's degree. In contrast, community college students have a wider variety of goals, including certificates, occupational and academic associate degrees, transfer, and many personal objectives that do not even include a credential. Furthermore, this finding suggests that we

simply have a much weaker understanding of the determinants of student success in community colleges than we do in baccalaureate institutions. This is not surprising since the vast majority of both theoretical and empirical work on completion and retention is focused on the baccalaureate sector.

Incorporating more accurate measures of the important student characteristic of socioeconomic status (SES) might strengthen the explanatory power of the models. Our research contains no measure of the institutional average student income (which is found to be positively associated with degree completion in the literature), though we used as a proxy federal aid per full-time equivalent (FTE) student. This was generally insignificant in our models, although it reduced the likelihood of associate degree program completion.

Overall, the individual student characteristics appear to be more important determinants of graduation and retention than the institutional variables. Even though we include controls for institutional variables as well as for individual effects, the results are consistent with analyses that only include individual characteristics. And, when we add individual variables to analyses using institutional variables, many of the institutional effects weaken: we get strong and consistent effects only for enrollment size and minority enrollment. This finding suggests that some of the measured institutional effects in the first analysis actually result from the individual characteristics of students that are correlated with institutional variables. Clearly, controlling for individual characteristics yields more reliable results.

There may be several explanations for this apparent importance of individual characteristics. First, well-prepared students with economic resources may be likely to survive and perhaps do well in a variety of institutions. Likewise, students with many barriers may have trouble even in strong colleges. Alternatively, the magnitude of some variables may reflect a college's response to perceived student needs as well as to some exogenously determined institutional policy. For example, colleges whose students face multiple barriers may spend more on student services. While we have tried to control for student characteristics, there may be important factors that are not measured in our datasets. If this is true, even if student services are effective in increasing retention, the negative effect of having many students who face barriers to completion may offset the positive program effect, showing a result that suggests no effect. Finally, we may simply not have data on the most effective institutional policies. Since good national survey data on institutional practices are not available, we must rely on field research to identify differences in practices that might explain differences in student outcomes by college. We suspect that, at the institutional level of analysis, one can observe policies and practices that would specifically affect the outcomes of minority students and students who enter community college with economic or educational disadvantages.

The limitations of national survey data for examining institutional practices and the evident importance of state policy in shaping student outcomes have led us to pursue research using data from particular states that collect longitudinal data on students. With individual student data across all state colleges combined with the specific state financial and policy variables, we can produce much more robust models that can identify effective practices that promote student completions. CCRC has begun to analyze data on student performance from Florida and

Washington State that will allow us to answer questions that cannot readily be addressed using national datasets.

We have made considerable progress in understanding the factors that influence college performance, but the larger project of identifying community college characteristics and policies that promote student success is still at an early stage. The overall strategy needs to be multi-pronged. Both quantitative and qualitative approaches need to be used. The growing availability of state unit record data needs to be encouraged and exploited. Results from state analyses can be compared to conclusions using national data to check the accuracy of the latter. The quality and quantity of national NCES data must be enhanced. One important step is that NCES will soon release retention rates as well as graduation rates. Methods should be developed to collect more fine-grained quantitative data on institutional activities and practices. Qualitative methods such as case studies of colleges and states with higher than expected graduation rates will yield important insights. A comprehensive approach to this problem is needed to develop a reliable understanding of the policies and practices that can improve outcomes for low-income, minority, and, indeed, all community college students.

THE EFFECTS OF INSTITUTIONAL FACTORS ON THE SUCCESS OF COMMUNITY COLLEGE STUDENTS

Introduction

Community colleges are the gateway to higher education for many students who would otherwise have limited access to college. College students who are from minority populations or low-income households, first-generation enrollees, or immigrants are overrepresented in community colleges. Research shows that many of these students would not be in college at all if they did not have access to these low-cost institutions which are distributed across states to be within commuting distance of the vast majority of the population (Alfonso, 2003; Kane & Rouse, 1999). But much work remains to be done before class, race, and ethnicity cease to be central determinants of the college education that an individual receives. Only about one third of all community college students receives any degree or certificate, even eight years after initial college enrollment. Twenty percent do not complete ten credits in that period of time. Credit accumulation and completion rates are even lower for minority and low-income students.

What can be done to improve the success of community college students once they have enrolled in college? Many baccalaureate institutions improve their completion rates by judiciously selecting their students. Nothing can boost completion rates more than raising the SAT scores of entering students. But this is not an option for community colleges. Indeed such a strategy violates the principle of open admissions which is central to the community college movement. Another potential alternative involves making changes in the educational, social, and policy environment in which the colleges operate. We know that many community college students confront work and family challenges that complicate their education. Thus, employment, flexible welfare regulations, publicly funded day care, need-based financial aid, public transportation, and many other social policies could have profound positive effects on college success. A comprehensive solution to the problem of college access and success will in the end require such broader social and economic policy changes. But, for the most part, such measures are not under the control of the colleges.

This report focuses on policies and programs that colleges themselves might be able to implement to improve student success. Even though community colleges are similar types of institutions on many levels, there is wide variation among colleges in various student outcome measures such as graduation, transfer, and retention. The central premise of this report and the broader research program, of which the report is one component, is that there are important lessons and insights that can be learned from this variation. Why do some colleges have higher graduation rates than others? Can these differences be attributed to different institutional characteristics or practices that can be emulated by other colleges?

There are many factors that might cause variation in student success. A great deal of research suggests that students who attend part-time, come from lower income households, or have weaker academic skills tend to complete at lower rates. So, for example, two colleges with different graduation rates may actually be equally effective if the college with lower rate enrolls

a larger proportion of students from lower income families. State policies that affect tuition levels and financial aid or that create incentives for certain types of college practices also may be influential. Therefore, any research that tries to relate outcomes to institutional practices must also take account of individual student and policy factors that might explain graduation rates.

These factors must also be taken into account when graduation rates are used for purposes of accountability, that is, to judge the performance of an individual college. Failing to control for students' academic readiness unfairly penalizes institutions, such as community colleges, which enroll less well prepared students and gives undeserved credit to those with selective admissions policies.

This report also serves as an important component of a Ford Foundation-funded study on minority degree attainment at community colleges. In two descriptive reports prepared as part of that study (see Bailey, Jenkins, & Leinbach, 2005a, 2005b), we saw that the rates of degree attainment and transfer of black and Hispanic, as well as low-income and first-generation college students, are lower than the rates for whites, those from higher income households, and those whose parents earned college degrees. However, student background and characteristics are not the sole factors influencing postsecondary achievement. Therefore, this analysis is a first step toward better understanding what other factors – in this case institutional factors – affect student outcomes.

The research reported here used institution-level data available from the Integrated Postsecondary Education Data System (IPEDS) of the National Center for Education Statistics. We used both the institution-reported graduation rates and the institutional characteristics data available in IPEDS. These data include student characteristics; institutional characteristics, such as location and enrollment size; and some financial characteristics, including expenditures for various types of services. The analysis attempts to understand the ways that these factors are related to student outcomes, as measured by graduation rates.

The structure of this report is as follows. We begin in Section II with a discussion of the relevance of institutional graduation rate data, examining the important limitations to the use of this information, but also the valuable insights that it can provide about the effectiveness of community colleges. Section III contains a review of the existing literature addressing graduation rates and the factors that affect these rates at both baccalaureate institutions and community colleges.

Then, in Section IV, we introduce the model we developed using exclusively IPEDS data to measure the institutional effects on community college graduation rates, and report the findings and conclusions from this analysis. The analysis has two goals. First, it measures the relationship between institutional characteristics and graduation rates. Second, it allows us to evaluate the performance of individual institutions after taking into account those characteristics and practices that are measured in IPEDS. Even after taking the factors into account, wide variations in institutional completion rates remain. The next step in this research program, then, will be to use a variety of quantitative and qualitative methods to try to identify the institutional practices that explain the remaining variation.

IPEDS data have two drawbacks. First, they do not allow us to control for many characteristics that may contribute to student outcomes. For example, IPEDS does not include data on the academic skills of entering students. As a result, we performed an additional analysis of institutional effects on student outcomes using data from the National Education Longitudinal Study of 1988 (NELS:88). Merging the individual student characteristics and eight-year student postsecondary outcomes from NELS:88 with the institutional characteristics from IPEDS allows us to control for those student characteristics that might influence outcomes. It also permits a better understanding of the effects of institutional characteristics. Unfortunately, it does not allow us to analyze or judge the performance of any individual institution.

A second problem is that IPEDS does not include measures of many of the institutional policies, such as pedagogic strategies, student services, or developmental education programs, which colleges use to improve student outcomes. Our long-term research strategy includes a plan to conduct qualitative case studies of colleges that vary in their performance according to our IPEDS derived measures. Thus our extensive quantitative analysis of national data will provide a foundation for more qualitative analyses based on institutional and particularly state-level data designed to identify more specific policies that promote student success.

These plans are described in the conclusion to the report, Section V. This section also summarizes our overall findings and addresses their relevance to understanding factors influencing minority degree attainment at community colleges. We link the work in this paper with a companion report discussing findings from research on attainment by low-income adult students at community colleges in Washington State.

The Importance of Community College Graduation Rates

A central purpose of this report is to determine the role that institutional characteristics play in influencing students' outcomes. The most common and direct measure of community college student attainment is completion of a degree or certificate, or a transfer to a baccalaureate institution (collectively referred to here as completion). By identifying and implementing institutional practices and characteristics that contribute to completion, community colleges should be able to increase the rates of graduation and transfer among their students.

Several forces are converging to bring about an increasing emphasis on community colleges' completion rates, and it is important to consider whether they are valid indicators of student success. For example, many community college students benefit from the skills they learn in college, even if they never earn a degree (Bailey, Kienzl, & Marcotte, in press). This positive finding indicates the need to consider how much significance should be placed on completion outcomes. In this section we examine the growing emphasis on completion rates and discuss the controversy associated with that trend. We conclude that increasing degree completion and transfer rates should be central institutional goals, although other measures of student success should certainly be considered.

Outcomes and Accountability

Several recent developments are leading the public and policymakers to take a greater interest in measuring the performance of higher education institutions by the outcomes of their students, particularly graduation rates. The popularity of college rankings such as those produced by *U.S. News and World Report* are a reflection of the increasing attention by the public toward measures of the quality of higher education. Furthermore, accrediting agencies, long criticized for an overemphasis on "inputs" such as the credentials of the faculty and the number of books in the library, are now beginning to focus more on outcomes. The North Central Association of Colleges and Schools and other accreditation agencies, for example, now require colleges seeking accreditation to give evidence of learning by all of their students, not just by those who complete programs.

Policymakers are also demanding greater accountability. According to the Rockefeller Institute of Government at the State University of New York at Albany, 44 states issue annual "report cards" on their colleges, up from 30 in 2000 ("Linking Spending," 2003). More than half the states now engage in "performance budgeting," under which state officials, in drafting annual budgets, take into account the performance of public colleges. Eighteen states have performance funding schemes in which public colleges gain or lose set amounts of money based on how well they meet certain standards.

In the 2004 debate over reauthorization of the Higher Education Act, the Bush administration articulated its desire to hold higher education to higher standards of accountability, just as it had with the public schools through the No Child Left Behind Act. Under the Higher Education Amendments of 1998, to be eligible to receive federal financial aid, colleges are required to

report graduation rates for cohorts of first-time, full-time (FTFT) students in 150 percent of the "traditional" graduation period (i.e. three years for associate degrees and six years for baccalaureate degrees). Beginning with the IPEDS 2002-03 survey, colleges are now required to report overall student graduation rates, as well as those for black, Hispanic, and female students. These are referred to collectively as the Student Right-to-Know (SRK) data, after the legislation that established the reporting requirement.

The Accountability Debate and Graduation Rates at Community Colleges

While the focus of policymakers' increasing demands for accountability has been primarily on baccalaureate institutions, community colleges are unlikely to escape increased public scrutiny of their outcomes. As competition for public funding intensifies, and as community colleges are forced to compete both with other educational institutions – including the more politically powerful universities and K-12 systems – and with other non-education groups, such as seniors seeking support for health care and retirement (Kane, Orszag, & Gunter, 2003), community colleges will increasingly need to measure and document their outcomes and the returns on the public's investment that they produce.

Community college advocates have, however, resisted the use of completion rates either as an accountability measure or a normative goal. They have advanced three broad arguments for this stance. First, they argue that many students at community colleges are seeking neither degrees nor transfer to a baccalaureate institution. In many cases, students enroll with the goal of learning some specific skills, perhaps to gain a promotion at their current job. Indeed, in response to a question in the Beginning Postsecondary Students Longitudinal Study of 1996-2001 (BPS:96/01) asking community college students to report their "primary reason for enrolling," 36 percent of the students in associate degree programs said that they either wanted to learn "job skills" or had enrolled for "personal enrichment."[1] From this perspective, the range of non-degree outcomes of students may be an indication that community colleges are serving multiple student needs, as they are chartered to do. Criticizing colleges for low completion rates would reflect a misunderstanding of the mission of community colleges and the goals of their students.

A second reason why community college advocates resist the use of completion as an accountability measure is that many factors that may thwart graduation are beyond the control of the colleges. Many community college students face serious barriers to success in college, such as family and work responsibilities and deficient academic preparation. Indeed, it is precisely students such as these, who may not have access to baccalaureate institutions, whom community colleges seek to serve. Furthermore, many of these barriers are not under the control of community colleges, nor can the colleges mitigate them. Therefore, advocates argue, community colleges should be neither criticized nor penalized for the failure of many of their students to complete.

A third reason for resisting the use of graduation rates as a performance measure is that, increasingly, college students may attend several colleges before completing their degrees. For example, one out of five students in the NELS:88 sample who earned a bachelor's degree

[1] Authors' calculations.

received it from a baccalaureate institution other than the one in which they enrolled initially (Adelman, 2003). Adelman pointed out that students change colleges for lots of reasons, stating in a recent article in *The Chronicle of Higher Education*, "Why should institutions be judged for choices, made by students, that are beyond their control? College students are legal adults, after all" (Burd, 2004, p. A1).

Our own findings from BPS:96/01 indicate that up to 40 percent of first-time community college students attended more than one institution during their six years of observation in the survey.[2] Furthermore, we used BPS:96/01 to evaluate the difference between institutional graduation rates (the percent of an entering cohort that graduates within a given number of years from the institution of first enrollment) and individual graduation rates (the percent of entering students who graduate from *any* institution within a given number of years). We found that 23 percent of all first-time, full-time students in degree programs in BPS:96/01 graduated (earned a certificate or associate degree) from their institutions of first enrollment within three years. This is conceptually equivalent to the SRK graduation rate. Yet, 26 percent of first-time, full-time students earned a certificate or associate degree at any institution within three years. The comparison suggests that the difference between institutional and individual graduation rates is not that large for a three-year period. However, this difference is much greater for longer periods of time. Over a six-year period, while 28 percent of first-time, full-time students in degree programs in the BPS:96/01 sample earned a certificate or an associate degree from their initial institution, 46 percent earned a certificate or associate degree from any institution. Therefore, while institutional graduation rates do not significantly underestimate individual graduation rates over the three-year period that the NCES uses in its SRK data, institutional and individual graduation rates do diverge substantially as the time period increases to six years.

These reasons against using completion rates as accountability measures for community colleges are all valid points. Community college students do have varied goals and many face particularly challenging barriers that are beyond the control of colleges. Many students also transfer to baccalaureate-granting or to other two-year colleges without earning a degree, reducing a college's graduation rate while producing outcomes that may be positive for individual students. However, using the completion rates for measuring community college effectiveness is not without merit, as we argue in the next section.

The Case for Using Graduation Rates

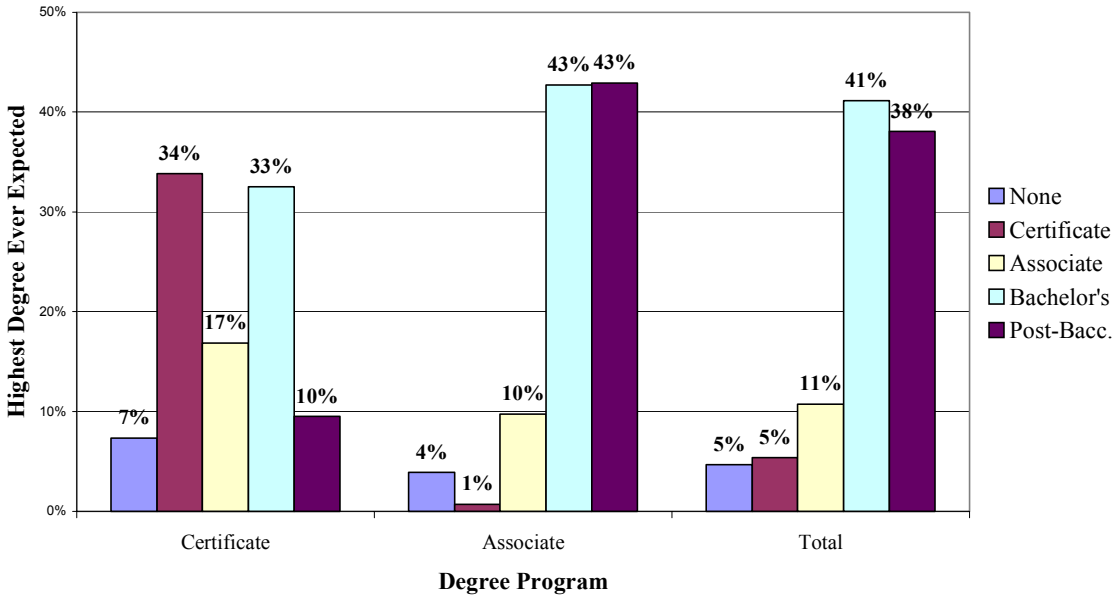
As indicated, institutional graduation rates may underestimate individual graduation rates, yet there is still useful information to be gleaned in examining *differences* among colleges in institutional graduation rates. Explaining why some colleges with similar characteristics and similar types of students have much higher rates than others might offer insights into policies and practices that could improve colleges' effectiveness in serving students. In addition, any individual college can analyze its persistence and completion rates as important measures of the effectiveness of its policies and practices.

[2] Authors' calculations.

Although—as already stated—institutional graduation rates taken alone can be misleading, there are reasons that college completion or transfer should be important goals for community college students. Research indicates that earning credits without completing a degree or certificate does have an economic value, but students get additional financial benefit from a credential (Bailey, Kienzl, & Marcotte, in press; Grubb, 2002). Indeed, for students in academic majors in community college, the real benefit comes from eventually earning a bachelor's degree. There appears to be little economic return to a transfer-oriented education for students who do not transfer. Earning small amounts of credit in academic subjects also has no measured economic value. Therefore, research does not refute the argument that short-term course taking to upgrade skills can be valuable for students, but neither does it provide strong support for this hypothesis. In contrast, the literature consistently demonstrates the value of degrees, particularly bachelor's degrees. For these reasons, it might be argued that even when students themselves do not seek degrees, community colleges should strive to raise those students' aspirations, including helping them recognize the opportunities for advancement in education and subsequently in employment that can come with further education (Jenkins, 2003).

The student-as-course-taker argument implies that enrollment in an associate degree program may overstate students' goals, since some students may only want some specific skills that they can learn in a few courses. However, when students are asked about their long-term educational expectations, the goals almost always are equal to, and in most cases exceed, the level of the programs in which they are enrolled. For example, Figure 1 shows that 86 percent of students in community college associate degree programs in BPS:96/01 actually expected to eventually earn either a bachelor's (43 percent) or a graduate (43 percent) degree. These data suggest that the program in which a student is currently enrolled actually understates, rather than overstates, their long-term aspirations.

Figure 1. 1995-96 First-Time Students in Community Colleges: Highest Degree Ever Expected, by Student's Initial Degree Program



Source: Authors' calculations using data from BPS:96/01.

Degree completion and transfer data for minority and low-income students present a final challenge to the argument that completion at community colleges should not be emphasized (see Bailey, Jenkins, & Leinbach, 2005a, 2005b). Even after controlling for high school test scores, other personal characteristics, and stated degree goals, socioeconomic status (SES) and race/ethnicity continue to be strongly related to the probability of completion (Bailey, Alfonso et al., in press). If this fact represents systematic barriers faced by lower income and minority students, then colleges should try to do something about those barriers. Alternatively, if it represents systematic differences in aspirations, even after controlling for high school academic record, then we should ask why such students have lower aspirations.

There is no question that community colleges encounter many challenges that affect their ability to increase graduation rates. Nevertheless, completion or transfer should be important goals for community college students and thus for the colleges themselves. Even among community colleges that face similar challenges, certain institutions perform considerably better than others. What do these institutions do to achieve better-than-expected results? In the next section, we review the available research on that question, and in Section IV we report on our own empirical work that seeks to go beyond the existing understanding.

Existing Research on Institutional and Individual Effects on Graduation Rates

Several studies have analyzed the effect of institutional characteristics on graduation rates, although the majority of them focus on baccalaureate institutions and use institutional graduation rates as the dependent variable. We, however, are interested in the effects at community colleges and also recognize limitations to the use of institutional completion rates. Therefore, we discuss here only those studies at baccalaureate institutions most informative for our analysis of community colleges. Also, we divide the literature review into two parts. The first discusses research using only *institutional factors* or student characteristics at the institutional level (average SAT scores, for example) that affect *institutional graduation rates*. This research informs our empirical work examining only IPEDS institutional characteristics as explanatory variables for community college institutional graduation rates. Since we know that individual student characteristics have a significant impact on their outcomes, and we showed above that institutional graduation rates underestimate the true rates of student completion, we use data on individual student characteristics and graduation rates in a second set of impact models. Therefore, the second part of the literature review discusses those studies that incorporate *individual student characteristics* and *individual completions* into their analysis.

Research Using Institutional Graduation Rates with Institutional Characteristics

In a study of baccalaureate institutions, Porter (2000) found that average SAT scores and the percent of students who are female were associated with higher graduation rates, while institutions with higher percentages of students over age 25 tended to have lower graduation rates. Some more structural characteristics, such as expenditures per student, undergraduate enrollment, and the availability of on-campus housing, were also related to higher graduation rates. Porter showed that performance measures such as graduation rates are sensitive to the variables used in the analysis and to the specification of the model. His study also highlights a serious methodological problem with this type of research. For example, one might conclude that building housing for students might increase graduation rates, but it is also possible that the availability of housing attracts a particular type of student who would have a higher likelihood of graduating, with or without the housing. Thus, housing might be associated with a college graduation rate without increasing the probability that any particular student would graduate.

Goenner and Snaith (2004) also argued that using different model specifications can lead to contrary findings on the factors associated with graduation rates, given the uncertainty about the true set of variables that explains the phenomena of interest. They estimate a university graduation rates model while accounting for uncertainty in variable selection. Similar to previous findings, their results suggest that students' average GPA or SAT scores are important and positive predictors of institutional graduation rates. Furthermore, they found that institutions in urban environments, the percentage of Native American students, the percentage of male students, and the average age of students are all factors negatively associated with increases in the institutional graduation rate.

Astin, Tsui, and Avalos (1996) used data from a nationally representative sample of first-time, full-time students to compare the graduation rates of 365 baccalaureate institutions in 1985. They found that private universities had the highest graduation rates, and believed that this finding resulted from the fact that such institutions tend to enroll better prepared students. They also found that highly selective institutions and those that enroll large numbers of students in fields like business, psychology, and the social sciences have higher graduation rates. Institutions with large engineering programs, commuter schools, and larger colleges have lower than expected rates. Mortenson (1997) also used a regression model to estimate predicted graduation rates for 1,100 baccalaureate-granting colleges. He had similar findings to Astin et al. (1996), namely that institutions whose students have higher average SAT scores and those with a higher percentage of freshmen living on campus had higher graduation rates, while those with many part-time students and relatively large engineering programs had lower rates.

Ryan (2003) used data on 363 baccalaureate institutions to estimate the impact of institutional expenditures for instruction, academic support, student services, and administrative support on the six-year graduation rates of cohorts within each institution. He controlled for student SAT/ACT and other factors. His findings suggest that instructional and academic support expenditures have positive and significant effects on cohort graduation rates, as previously indicated by Astin (1993). However, expenditures on student services and expenditures on administrative (institutional) support failed to produce any significant impact on graduation rates. Ryan suggested that there are trade-offs in the utilization of financial resources within an institution in terms of degree attainment, and that institutions should be careful when deciding where to allocate resources.

More recently, Scott, Bailey, and Kienzl (2004) conducted an analysis of six-year graduation rates for baccalaureate-granting institutions based on data from the College Board's American Survey of Colleges and from IPEDS. They used grouped logistic regression, arguing that the ordinary least squares method used by previous researchers is not an appropriate technique since graduation rates are constrained within an interval ranging from 0 to 100. Using this new methodology, they found that private colleges and those with students with higher average SAT scores, a higher proportion of women, and higher instructional expenditures per full-time equivalent (FTE) student had higher graduation rates. Institutions with higher proportions of minority students, older students, and part-time students had lower graduation rates. In addition, they found that institutions with higher in-state tuition also tended to have higher graduation rates, even after controlling for student characteristics.

These studies from the last ten years generally confirm the findings summarized in 1991 by Pascarella and Terenzini (1991), who also identified the effects of institutional characteristics on student outcomes. They found that colleges with students having higher SAT scores and from higher income families, and more full-time and female students, had higher graduation rates. Private and residential institutions also had higher rates. Specifically, they found that, at baccalaureate institutions, characteristics promoting social integration, such as residential campuses, same-sex or same-race institutions, and smaller college size and control (private

institutions) have positive impacts on student outcomes.[3] These findings are consistent with the implications of Tinto's integration model (see below). Pascarella and Terenzini also reported interesting findings on historically black and women's colleges: black students enrolling in predominantly white colleges are more likely to drop out than are black students who attend a Historically Black College or University (HBCU). They hypothesized that black students experience higher levels of social integration in HBCUs than in majority white ones. They used the same reasoning to argue that attendance at a single-sex institution increases the level of persistence and educational attainment of women, although studies indicate that the magnitude of this effect is quite small. Finally, the researchers noted that institutional factors such as instructional expenditures and selectivity also increase the likelihood of student attainment of a bachelor's degree.

Table 1 summarizes the institutional characteristics that research has found to be associated with attainment by undergraduate students. Again, most of this research has been conducted on baccalaureate institutions.

Table 1. Institutional Characteristics Associated with Bachelor's Degree Completion

Institutional Characteristic	Effect on Degree Completion
Instructional expenditures	+
Selectivity	+
Social integration	+
Student body compositional characteristics	
• Average student household income	+
• Percent full-time students	+
• Percent female	+

+ = statistically significant positive effect on completion with an increase in the institutional characteristic.

A recent study by Habley and McClanahan (2004) analyzed the association between outcome measures for community college students and institutional practices. Their study was based on data collected from 386 colleges (out of 991 that received questionnaires). Colleges were classified as "high performing" if their first-to-second year retention rates *and* their three-year graduation rates were both above the median for those rates; they were classified as "low performing" if they were below the median for both rates. Colleges were given a list of 82 retention practices and were asked to report whether or not they used each of them. Respondents were also asked to state whether each practice made a "major," "moderate," or "no" contribution to retention. Of the 82 practices, those that were reported to have more than a "moderate" contribution and for which there was at least a 10 percentage point difference in the incidence of use between high-performing and low-performing colleges were deemed to be "successful" retention practices. This evaluation yielded the following list of "successful" practices: mathematics center, writing center, reading center, advising interventions with special populations of students, learning communities, foreign language center, and programs for racial/ethnic minorities.

[3] However, Pascarella and Terenzini (1991) concluded that, because of conflicting findings from investigations of the direct effect of institutional size on student performance, the evidence is inconclusive or at least the effect is dependent on individual student characteristics.

Habley and McClanahan's study is unique in that it uses a relatively large sample of community colleges and collected data on specific institutional practices. It therefore presents interesting and suggestive conclusions. The study does not, however, control for any other institutional characteristics (for example, institutional size) and it examines practices one by one, making it difficult to determine whether each practice is effective individually or in combination with other factors, or whether those measured practices are correlated with some other characteristics (either measured or unmeasured) that are the true determining factors. Nevertheless, more analyses with these sorts of data are needed.

Research Using Individual Completions with Individual and Institutional Characteristics

This section of the literature review examines the contributions of individual characteristics to the educational outcomes of community college students. Studies find that student background characteristics such as SES, race/ethnicity, gender, academic preparation, and enrollment patterns significantly impact their outcomes.

As with the institutional studies, most of the research on student attainment examines the experience of students at baccalaureate institutions and, in many cases, within a single institution. The most widely applied models of undergraduate student attainment are Tinto's *Student Integration Model* (1993) and Bean's *Student Attrition Model* (1985). Both models consider the "fit" between an institution and the student as a key to persistence. However, "institutional fit" refers to a student's feeling of belonging in the institution, it does not measure institutional characteristics or practices. In addition, both Tinto and Bean relied on data from only one baccalaureate institution. As a result, their findings cannot be applied to other baccalaureate institutions, let alone community colleges, which generally serve students with greater rates of multi-institutional attendance. The use of single cases also makes it impossible to examine the effects on student attainment of different sorts of institutions and institutional practices. Another disadvantage of most institutional studies is that they measure outcomes in terms of persistence and graduation at a given institution. Therefore, for example, students who transfer to a baccalaureate institution, a positive outcome for community college students, are not captured in such studies.

Research on community colleges is much less likely to show a positive relationship between measures of integration and student persistence and degree completion. Some research found small positive effects (Bers & Smith, 1991; Napoli & Wortman, 1998), while other studies found no effect and, in at least one case, social integration was found to have a negative effect (Nora, Attinasi, & Matonak, 1990). In their review of empirical research on undergraduate student attainment, Pascarella and Terenzini (1991) contended that social integration models do not work as well for commuter colleges as residential colleges. They stated that "with a few exceptions, the weight of evidence is clear that various measures of social integration (including interaction with faculty, interaction with peers, and extracurricular involvement) show little if any positive relationship with persistence at commuter institutions. This lack of a positive relationship holds regardless of the specific measure of social integration used and irrespective of whether or not student background characteristics were taken into account in the study design" (p. 402). In a

much more recent review of empirical tests of Tinto's integration model for community colleges, Braxton, Hirschy, and McClendon (2004) concluded that "the explanatory power of Tinto's theory to account for student departure in two-year colleges remains undetermined and open to empirical treatment." (pp. 17-18).

Recent studies have overcome the single-institution focus by using nationally representative surveys that track cohorts of students over time, thereby allowing researchers to chart students' progress both within and across multiple institutions (Adelman, 1999; 2003). These recent studies have identified the following factors associated with educational attainment at both two-year and baccalaureate institutions: academic preparation and achievement, race/ethnicity, socioeconomic status, gender; attendance patterns (delayed enrollment, interrupted enrollment, and part-time attendance), and children and other household responsibilities (Adelman, 1999; 2003; Bailey, Alfonso et al., in press; Cabrera, Burkum, & La Nasa, 2003). However, the models in these studies do not account for variation between institutions and their effects on student outcomes. That is, they do not consider that the characteristics of the institution that a student attends might influence his or her outcome.

In one interesting exception, Titus (2004; in press) addresses explicitly the effect of institutional characteristics on student persistence. He merged two nationally representative datasets (BPS:96/98 and IPEDS 1995) to consolidate individual student data with the institutional information from the college in which each student enrolled. As with other research cited, his work was confined to baccalaureate institutions. He provided evidence that more selective institutions and residential institutions are positively associated with student persistence. Surprisingly, he also found that larger institutions have significant positive impacts on persistence, explained by the belief that larger baccalaureate institutions have stronger institutional socialization capabilities and offer degrees possessing higher status. Pascarella and Terenzini (1991) also cited research with similar findings, though they noted that other work contradicted their conclusions. Because issues of socialization and institutional status are less important at community colleges, we may find that institutional size will have an ambiguous relationship to student outcomes.

Other recent research (Alfonso, 2003; Astin et al., 1996) found that institutional characteristic variables have differential effects on degree attainment depending on the race/ethnicity of the student. In particular, Alfonso (2003) found that Hispanics who enroll in large community colleges are less likely to earn associate degrees than those who attend smaller two-year colleges, while blacks' educational attainment is higher when they attend private two-year colleges. Thus, this literature suggests that controlling for institutional characteristics might improve the understanding we have about the factors that contribute to educational attainment of minority students.

Implications for this Study

As we noted, most of the research on institutional factors affecting student outcomes has been carried out at baccalaureate institutions. Such studies find that average student characteristics such as higher ability, higher family income, and full-time attendance patterns all positively

affect outcomes. Furthermore, it is fair to say that there is a consensus among researchers that, on average, measures of academic and social integration and fit positively affect persistence and degree attainment at baccalaureate institutions. Institutional selectivity is also found to contribute to student success.

These findings, while informative, raise two important concerns when applying similar models to studies of community colleges. First, the conceptual basis for applying such models to community colleges is weak because of their wholly different character from baccalaureate institutions. For one thing, community colleges generally have substantially different structures, missions, and funding mechanisms than do most baccalaureate institutions. Furthermore, community colleges, as open access institutions, are intentionally non-selective, available to students from all income levels, and support part-time enrollment, among other characteristics. Studies consistently find that the typical characteristics of students at community college are also those characteristics that predict lower graduation rates.

Second, existing educational attainment models either ignore or use single institutional characteristics when trying to explain students' postsecondary outcomes. Such models fail to capture all of the institutional influences contributing to an individual student's outcome. Students are more frequently attending more than one postsecondary institution (Adelman, 1999; 2003; Burd, 2004), with each contributing to the intellectual and social development of the student and affecting his or her educational outcome. Given the common reality of multi-institutional attendance, particularly among students who enter higher education through community colleges, studies should incorporate the effect on a student's educational outcome of *every* institution attended, thus accounting for the entire postsecondary enrollment of a student.

We find that the focus of much of this research on baccalaureate institutions distorts our assumptions about the similar characteristics and relationships at community colleges. Therefore, it is important that researchers develop new conceptual models on which to base their research on institutional factors affecting student outcomes at community colleges.

Consequently, as we describe in the subsequent sections, the research models we developed extend current research in two ways. First, we examined the outcomes of students who attend *community colleges*. We used a theoretical framework based on the nature of community colleges and models that use the characteristics of those institutions. Second, we incorporated into the same model both *student and institutional characteristics* so that we could control for student characteristics to more conclusively identify key institutional characteristics that promote or detract from student outcomes.

Analysis of the Institutional Effects on Community College Graduation Rates

We investigated the institutional effects of community colleges using two sets of data. The first set includes institutional completion rates as the outcome variable to be explained, with the institutional characteristics as the explanatory variables in a regression model. All the data come from the National Center for Education Statistics (NCES), as reported in the Integrated Postsecondary Education Data System (IPEDS). The second set includes the institutional characteristics from IPEDS together with individual student characteristics from the National Education Longitudinal Study of 1988 (NELS:88) dataset as the explanatory variables, and student outcomes from NELS:88 as the dependent variable. We present each analysis, including descriptions of the data, variables, methods, and findings, separately. Section A discusses the analysis of institutional completion rates and Section B discusses the analysis of individual student outcomes.

Explanation of Community College Institutional Graduation Rates Using Institutional Characteristics

Institutional Graduation Rate Data. We conducted, for the first time in the literature, an analysis of institutional graduation rates at community colleges. NCES publishes three-year degree completion rates for community colleges in its IPEDS Graduation Rate Survey (GRS) data. The "degree completion rate" refers to the percentage of first-time, full-time students who entered a community college in a particular year and received a certificate or associate degree from that same institution within 150 percent of the time traditionally associated with earning the particular credential (three years for an associate degree).4 Colleges exhibit wide variation in graduation rates, and we exploited this variation to determine the institutional characteristics that are related to higher institutional completion rates. Using the GRS and other data from IPEDS, we analyzed the institutional determinants of degree completion rates.

We used data from the 2002-03 IPEDS GRS. IPEDS includes information about the entire population of higher education institutions in the United States and its outlying areas. To extract a community college sample, we first considered only public two-year institutions in the United States. We also excluded institutions without regional accreditation and those that are non-degree-granting (granting only certificates). Finally, we used the procedure recommended by Hadi (1992; 1994) to identify outliers, and eliminated three institutions with improbably high values for instructional expenditures.[5] Thus, the final sample contains 915 community colleges.

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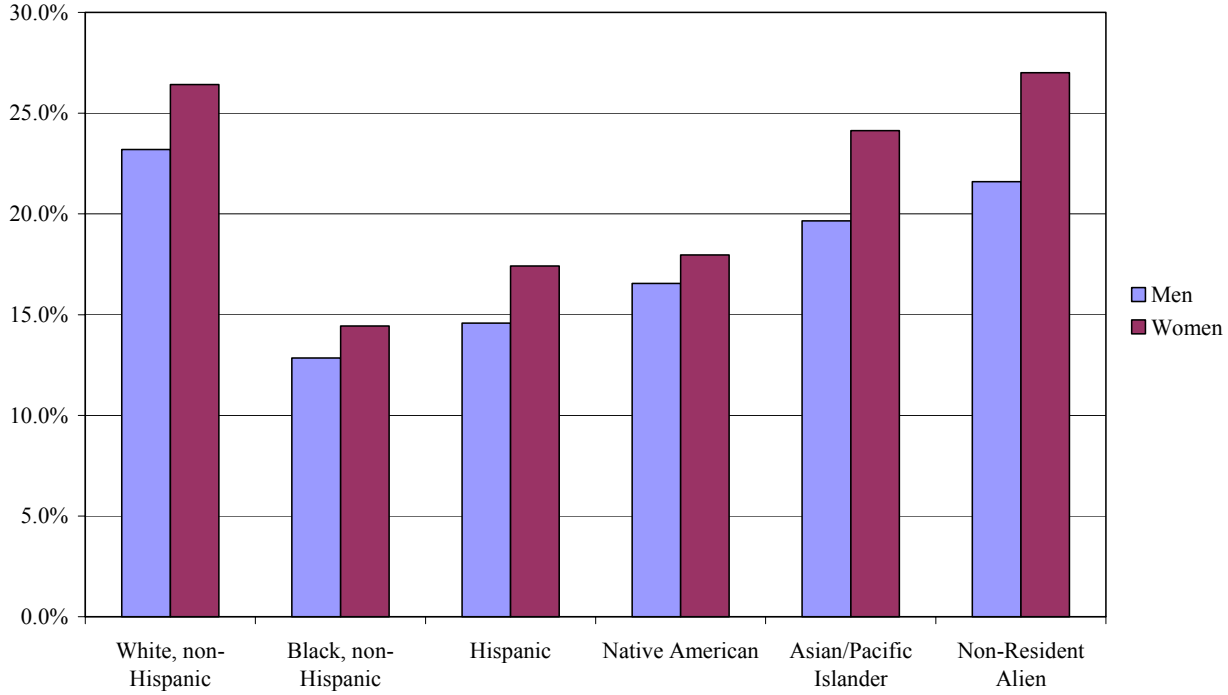
[4] The 2002-03 IPEDS GRS also provides data on "transfer-out" students from community colleges. These are students who leave the reporting institution prior to earning a credential and subsequently enroll in another institution. However, these data have many missing values because many schools do not have complete information on the destinations of their departing students and because the transfer is not necessarily to a baccalaureate institution (rather, "another eligible institution in any program for which the reporting institution provided substantial preparation"). Therefore, we did not use this data when calculating the institutional completion rate. See the IPEDS GRS data dictionary in http://nces.ed.gov/ipedspas/dct/download/data/GR2003_Dict.zip.

[5] These community colleges are Ilisagvik College (AK), College of the Marshall Island (MH), and Los Angeles County College of Nurse and Allied Health (CA).

Figure 2 shows the institutional completion rates by race/ethnicity and gender for all community colleges. The survey population for this dataset includes all first-time, full-time (FTFT), degree- or certificate-seeking undergraduate students entering the institution during the fall term (by October 15) of the 1999-2000 school year.[6] These completion rates are institution-specific measures in that they only capture outcomes for students who begin and complete in the same college. They do not capture students who start at a given college and move to another institution before earning a certificate or degree.

Figure 2. 1999-2000 First-Time, Full-Time Students: Three-year Community College Graduation Rates by Race/Ethnicity and Gender



Source: IPEDS Graduation Rate Survey 2002-03; authors' calculations.

Overall, 22.3 percent of FTFT community college students in the sample earned a postsecondary credential in their starting institutions after three years. These findings are consistent with other results from the research literature. Graduation rates for women are higher than for men; and blacks, Hispanics, and Native Americans all graduate at lower rates than whites. Contrary to findings at baccalaureate institutions, Asian students in community colleges are also less likely to earn a degree or certificate than are whites.

Caution must be taken when using completion rate data for individual institutions for any single year because of instability in the year-to-year rates. We measured the variation in completion

[6] Institutions that do not offer programs based on standard academic terms use the 12-month period (September 1 to August 31) to determine their cohort. This description comes from the NCES "Instructions for Graduation Rates – 2-year Institutions." See http://nces.ed.gov/ipeds/pdf/webbase2002/grs_2yr_form.pdf.

rates at community colleges over the six years for which the GRS data are available (1997-98 through 2002-03) and found significant instability within some institutions across different years. Stability was calculated by taking the average variance of the entire sample and comparing it to the individual variance of each institution. If the institution's variance was greater than the average sample variance, the completion rates for that college were deemed unstable. We found that about 20 percent of all community colleges had unstable completion rates, though we observed a positive and statistically significant correlation between college size (measured by FTE enrollment) and completion rate stability. That is, smaller institutions are more likely to have unstable rates from year to year.

Outcome Variable. To identify the institutional characteristics affecting the institutional completion rates just reported, we used the degree completion rate for each institution from the 2002-03 IPEDS GRS. These three-year time limited completion rates at community colleges are low both because most students attend part-time (and therefore take longer to complete, even if they eventually do complete) and because many may not be seeking degrees (they may enroll in a limited number of courses in order to advance their job skills or pursue a personal interest). The dependent outcome variable measures completion rates only among first-time students who were enrolled full-time and were seeking a credential. These FTFT students represent only a minority of community college students: 17 percent of community college FTE enrollments in 1999-2000, according to IPEDS. This means that the measure used here, based on full-time credential-seeking students, likely overestimates the graduation rate for most community colleges. In any case, as is indicated below, we controlled for the proportion of an institution's students who are enrolled part-time.

Our dependent variable does have limitations. It measured completion by students at their *first* postsecondary institution and did not capture students who complete programs at other institutions.[7] Also, IPEDS does not provide data to break out the degree completion measure by type of credential awarded. Since graduation rates for certificate programs are higher than they are for associate programs (Alfonso, Bailey, & Scott, 2005), institutions such as technical colleges that specialize in awarding certificates may have higher overall graduation rates than comprehensive community colleges, which are relatively more likely to emphasize programs leading to associate degrees. To account for this fact, we include a dummy variable indicating whether an institution awards more certificates than associate degrees.[8]

Explanatory Variables. We selected the explanatory variables for the model based on factors that previous studies have indicated are related to degree completion in community colleges. We grouped these variables into three categories: fixed characteristics, compositional characteristics, and financial characteristics. Table 2 lists the explanatory variables in the model along with the expected effect (positive or negative) for each.

[7] We overcome this limitation by using the NELS:88 dataset in our second analysis.

[8] Missing values in the IPEDS variable "Total certificates awarded" have a differential treatment. Our sample contains 43 institutions with missing values in this variable and we checked the accuracy of this information on their web pages. For those cases where the community college does *not* award certificates, we imputed a zero instead of a missing value. Finally, changes were made for 21 institutions, which are available from the authors on request.

Table 2. Explanatory Variables in a Model of Community College Completion Rates

Explanatory Variable	Hypothesized Effect
Fixed Characteristics	
Urban	-
Suburban [reference group]	
Rural	-
State in which college is located	+/-
Historically Black College or University or tribal college	-
Compositional Characteristics	
Size	
0-1000 FTE [reference group]	
1,001-2500 FTE	-
2,501-5,000 FTE	-
5,000+ FTE	-
Proportion FTE minority (black, Hispanic, Native American)	-
Proportion FTE part-time	-
Proportion FTE female	+
Proportion part-time faculty	-
College awards more certificates than associate degrees	+
Financial Characteristics	
In-state tuition	+
Instructional expenditures per FTE undergraduate	+
Academic support per FTE undergraduate	+
Student services per FTE undergraduate	+
Administrative expenditures per FTE undergraduate	+
Federal aid per FTE undergraduate	-

\+ = statistically significant positive effect on completion with observance of or increase in characteristic.
\- = statistically significant negative effect on completion with observance of or increase in characteristic.
+/- = state effects depend on the state.

To create these variables, we compiled data from four IPEDS surveys for 1999-2000, the base year for the cohort of students for which we had the most recent GRS completion data: Institutional Characteristics, Fall Enrollment, Finance, and Completions. Table 3 presents the mean values of each variable in the model for the sample studied. Based on these data, we see that most community colleges in our sample are located in suburban areas. The "average college" enrolls 3,044 FTE students, most of whom are female (57.5 percent) and nearly one fourth of whom are from a minority group (23.3 percent). These colleges charge an average of $1,659 per academic year for in-state tuition. One in five colleges awards more certificates than associate degrees.

Table 3. Descriptive Statistics of the Sample of Community Colleges

Variable	Mean	Standard Error
Cohort		
Full-time, first-time degree-seeking undergraduates	505	494.177
Number who earned a degree or certificate within three years	113	123.948
Fixed Characteristics		
College is located in urban area	38.7%	0.487
College is located in suburban area [reference group]	52.4%	0.500
College is located in rural area	9.0%	0.286
College is a Historically Black College or University	0.9%	0.093
College is a tribal college	1.9%	0.135
Compositional Characteristics		
Total full-time equivalent undergraduates	3,044	2.927
1,000 FTE undergraduates or less [reference group]	20.7%	0.405
1,001-2,500 FTE undergraduates	37.0%	0.483
2,501-5,000 FTE undergraduates	25.0%	0.433
More than 5,000 FTE undergraduates	17.3%	0.378
Proportion FTE minority undergraduates	23.3%	0.007
Proportion FTE part-time undergraduates	33.9%	0.132
Proportion FTE female undergraduates	57.5%	0.074
Proportion part-time faculty	52.6%	0.009
College awards more certificates than associate degrees	17.1%	0.377
Financial Characteristics		
In-state tuition[a]	1.659	1.184
Instructional expenditures[b]	4.157	1.491
Academic support[b]	0.817	0.695
Student services[b]	0.981	0.697
Administrative expenditures[b]	1.461	0.032
Federal aid (Pell Grants)[b]	0.824	0.467

Source: Authors' calculations using data from IPEDS Graduation Rate Survey 2002-03.
Notes: [a] in $1,000s.
[b] in $1,000s per FTE undergraduate.

States have fundamental influences on the graduation rates of colleges, and community colleges play very different roles within the overall systems of higher education in different states. For example, Florida has a statewide articulation agreement that guarantees admission to a public baccalaureate institution as a junior to any student who earns an associate degree. This agreement gives Florida students a strong incentive to complete a degree. As a result of these

types of regulations, we also included state dummy variables for all states that have at least two community colleges.[9]

Our list of explanatory variables has some key omissions. As discussed, studies of the graduation rates of baccalaureate institutions show, not surprisingly, that institutions that enroll better-prepared students as measured by standardized test scores tend to have higher graduation rates. However, there is not a widely used and available measure of academic preparation or readiness of entering community college students. Moreover, the IPEDS dataset does not include information on the income characteristics of students. We used the amount of federal aid per FTE undergraduate (primarily Pell Grants) as a crude proxy for the extent of financial need among a college's students, although we realize that this measure is problematic. For example, an institution might serve a large number of low-income students, but still receive relatively little funding through federal financial aid because it is prohibited from doing so due to high default rates or, for whatever reason, does not encourage and assist students in applying for aid. The amount of institutional aid a college provides to its students may be a better measure of the wealth of the institution than of the financial need of its students.

Methodology. Following Scott et. al (2004) we estimated predicted three-year graduation rates for the community colleges in the sample using a grouped logistic regression method.10 The method allows for an aggregate analysis in the sense that the mean values of the "inputs" are used in the evaluation of institutional graduation rates, which are themselves the aggregation of individual student successes. In this study, each observation is an institution; however, the outcome variable is the result of responses of a cohort. Specifically, the dependent variable is the proportion of a cohort of first-time, full-time students in 1999-2000 who completed a certificate or degree program at the starting institution within 150 percent of the time traditionally associated with earning the credential.

We note here that using grouped information has clear limitations. The method explains institutional characteristics associated with completions rates, while the behavior of each individual in each cohort is not explicitly taken into account. Moreover, the model assumes that each individual in a given institution has the same probability of graduation. In another words, the method assumes that each student cohort member is affected by the fixed, compositional, and financial characteristics of his or her institution in a similar way.

Findings. Table A1 in Appendix A presents the results of grouped logistic regressions of three sequential models when the outcome variable is degree completion. The group logit coefficients have no easy-to-understand interpretations. Therefore, in the table we include the marginal effect for each variable to make the results easier to interpret. The marginal effect represents the change in the completion rate of a one unit change in the characteristic, holding all other characteristics constant. It is important at this point to explain the meaning of our coefficients. Given that we

[9] Although we introduced individual state fixed effect dummies to control for any unobservable effect, we do not report their coefficients. Since the number of states is finite, coefficients on the dummies are not asymptotically consistent. This is an example of the "incidental parameters problem" (see Lancaster, 2000).

[10] The institutional graduation rate, while a continuous variable, is constrained to lie within 0 and 1. This procedure produces more robust results than does the ordinary least squares (OLS) method applied in most previous studies (see, for example, Mortenson, 1997).

are dealing with institutional-level data, the interpretation of these variables represents the effect of campus or other environmental factors on the likelihood of FTFT community college students in our sample of colleges to earn a degree – and not the likelihood of a particular individual with particular characteristics to earn a degree.

The first model uses only the fixed characteristic variables, such as location (urban or rural) and the state fixed effect dummies to control for state differences. In general, colleges located in urban areas are predicted to have 3.5 percent lower graduation rates while rural colleges can expect nearly 4 percent higher completion rates. Note that the performance of historically black community colleges and tribal colleges is not significantly different from the performance of other institutions. We introduced into this model the state dummies as control variables. These state variables do not tell us *why* the average performance differs among states; however, the state regulatory, economic, and social environment, do comprise an important part of the fixed institutional measures and have important effects that should be investigated further with detailed state-by-state analysis. With just these fixed institutional variables the model explains roughly 41 percent of the variation in institutional graduation rates.

The second model adds dummy variables for compositional characteristics, including enrollment size, and the racial/ethnic and gender composition of the campus. Using dummy variables for FTE undergraduates reveals that size is an important predictor of an institution's degree completion rate. Larger community colleges, especially those with more than 2,500 FTE undergraduates, have 9 to 14 percent lower graduation rates than do smaller colleges. This result remains even after controlling for the urbanicity of the college, which remains negative, but now becomes insignificant.

In terms of the demographic characteristics of the student body, having a large proportion of minority students enrolled at a college lowers the probability of FTFT students' completing, even after controlling for other characteristics of the college. Colleges with relatively larger part-time student populations have lower completion rates (even for full-time students). Similarly, a high proportion of women in the student body is negatively associated with completion rates. As mentioned above, caution must be taken when interpreting the marginal effects. The marginal effect on the "percent FTE female" variable is negative 50 percent, implying that a one percentage point increase in the percent female lowers the institution's FTFT graduation rate by one half of one percentage point. This relationship is surprising and quite unexpected and will be analyzed in detail in the next section. As expected, colleges that award more certificates than associate degrees have slightly higher rates of degree completion.

The final model adds the financial variables. Only instructional expenditure is statistically significant, but the magnitude of the effect is not very large. Community colleges that invest relatively more in instruction have higher rates of degree completion. An additional $1,000 spent on instruction per FTE undergraduate improves graduation rates by 1.3 percent. The effect of other variables remains similar to what was found using the previous models, and the model fit does not improve greatly with the addition of the finance-related measures. Model 3 explains approximately 63 percent of the variation in the outcome.

Robustness of the Results. As noted above, the relationship between graduation rates and the share of women in the student body is surprising. Almost all the research on retention and graduation shows that women graduate at higher rates than men, after controlling for other individual demographic characteristics and enrollment variables. Even more, studies of baccalaureate institutions like those by Porter (2000) and Scott et. al. (2004) found a positive relationship between the proportion of female students and graduation rates. Indeed, even in GRS, FTFT women have higher graduation rates than FTFT men. Nevertheless, we have found that colleges with more female students tend to have lower graduation rates. Of course it is possible, but unlikely, that women graduate at higher rates while the FTFT graduation rate of the college is lower. After all, the GRS sample only includes on average 17 percent of the FTE student population. We did additional analysis to investigate this finding.

IPEDS data allow us to disaggregate the institutional completion rate by gender. Using as a dependent variable the institutional graduation rate for males and females, we were able to analyze the impact of the covariates on each group. Table A2, columns 1 and 2, show the results of replicating the previous model with separate runs by gender. This calculation produced a finding of particular relevance here: the proportion of part-time students in an institution has no statistically significant effect for males. It suggests that the effects of part-time students and females need further investigation. To incorporate this relationship into the original model we created a dummy variable to isolate institutions with more than 50 percent women and interact it with the proportion of part-time students in the institution. This new variable introduced the effect of part-time students in institutions with a high proportion of women. We added this interaction in the original Model 3 and got two important results. First, the proportion of part-time students in the institution was no longer an important predictor, after controlling for the effect of part timers in institutions with more than 50 percent women. Second, the interaction term was highly statistically significant, suggesting that the proportion of part-time students is negatively associated with institutional completion rates only if the institution has more than 50 percent women. Based on these findings, our conclusion is that a high proportion of female and part-time students in an institution seems to be the driving force for the negative effects of the female coefficient found in the original model.

We noted earlier the instability of the IPEDS GRS completion rate variable among about 20 percent of all community colleges. To address this concern when performing a single-year cross-sectional analysis, we conducted a separate analysis using time-series data. We observed the evolution of the institutional completion rate over the six years from 1997 to 2002 by computing the average completion rate and variance within institutions across time. We also calculated an aggregate mean completion rate and variance for the whole community college sample. Those institutions with completion rate variability higher than the average for the group were recoded as unstable institutions in a dummy variable.[11] Finally, we introduced the stability variable in our more comprehensive Model 3 and found it a positive and highly significant coefficient. This result suggests that community colleges with unstable rates are more likely than those with stable

[11] We recognize that yearly variability might be due to changes in the composition of the students not controlled for with this analysis. Alternative specifications like panel data models might work better, although data limitations and missing values limit the possibilities with the datasets used here.

rates to have a higher completion rate in the 2002-03 GRS data. Specifically, unstable institutions have completion rates 4 percent higher than stable ones.[12]

Summary. This analysis confirms several hypotheses about institutional determinants of graduation rates at community colleges. Colleges with many part-time students have lower graduation rates, even for the full-time students. However, we also found that the proportion of part-time students in the institution is no longer an important predictor after controlling for the effect of part-timers in institutions with a higher proportion of women. Still, a higher share of women in the student body is negatively associated with completion rates. Many studies reveal lower graduation rates for black and Hispanic students and our results are consistent with them. Other research shows an ambiguous relationship between size and graduation, but our analysis indicates a consistent negative relationship between enrollment size and completion. Not surprisingly, colleges that emphasize certificates have higher completion rates, although this is an artifact of the dependent variable since certificates and associate degrees are combined without differentiation in the GRS data. A student is more likely to complete a certificate program than earn an associate degree in three years. A final significant finding among institutional characteristics is that greater instructional expenditure is related to a greater likelihood of graduation, as was found by Ryan (2003) at baccalaureate institutions. In addition to these findings, we observed that the effects of fixed institutional characteristics, which included dummy variables for the states, explained 41 percent of the variation in institutional graduation rates.

Use of Institutional Characteristics to Benchmark Performance of Community Colleges

In addition to identifying institutional characteristics that are related to higher graduation rates, our analysis can also be used to benchmark individual college performance. Graduation rates are published by NCES presumably so that students can get a sense of the level of performance of any college that they might be interested in attending. The raw graduation rate does give some useful information, but as we have shown, graduation rates can differ for many reasons that may not be related to the college's operations and policies. For example, a college that gives many certificates will have a higher graduation rate, but this fact does not mean that a student in an associate degree program will have a greater chance of completing that degree.

By using the model that we have developed here, we can adjust graduation rates to take account of the differences in the characteristics that we have been able to measure. We did this by calculating the expected graduation rate based on the characteristics of each college and comparing that expected rate to the actual rate. An actual rate that exceeds an expected rate suggests that the college is over performing relative to its characteristics. While such a finding does not directly reveal the factors that cause this over performance, it does suggest that case studies of over- and under-performing institutions would be useful to identify unmeasured characteristics or practices that could explain relative success in student outcomes.

To illustrate this approach, we examined the graduation rates of 27 colleges participating in the Achieving the Dream initiative funded by the Lumina Foundation for Education. The raw

[12] Coefficients for this regression, not shown here, are available from the authors upon request.

graduation rates range from 1 percent to 34 percent. Several of the colleges with the highest graduation rates also perform above their expected levels based on their characteristics. But for some, the ranking shifts significantly after controlling for college characteristics. The college with the fourth highest graduation rate (25 percent) actually has a predicted rate of 34 percent. Therefore, while this college ranks fourth based on its raw graduation rates, it ranks eighteenth when the difference between the expected and actual graduation rates are used. Similarly, a college ranked eighteenth based on its raw graduation rate rose to tenth based on its performance relative to its expected rate.[13] In future work, we plan to use this type of analysis to identify a sample of colleges that do better or worse than expected for more in-depth study of what institutional policies and practices result in improved attainment for students.

Examining state differences can also be instructive. For the state-level analysis, we included state dummy variables in our models. The coefficients of those dummies are a measure of how well colleges in the state perform on average, after taking account of the other characteristics in the model, compared with colleges in other states. California, Florida, and Nebraska are the three states with the highest average adjusted (for the control variables) graduation rates. But before we can conclude that these states have found the key to improved retention, we must first understand the institutional and legal context in these states. This is a fruitful area for further investigation.

Explanation of Individual Community College Student Outcomes Using Individual and Institutional Characteristics

Individual Outcome Data. The study of institutional effects on institutional graduation rates was informative, yet suffers from two important drawbacks. First, the institution-level outcome variable (institutional graduation rate) only informs us of the increased or decreased likelihood of the average student at an institution completing a degree, where the average student is determined by that institution's characteristics. However, we would also like to know the likelihood of a *particular type of student* at an institution completing a degree. For this, we need data on individual student outcomes and individual student characteristics. To create these measures, we merged national student survey data with the IPEDS institutional data. Thus, we were able to control for both individual student *and* institutional characteristics simultaneously to tease out particular effects of each.

To obtain student characteristic and enrollment information, we used data from the National Education Longitudinal Study of 1988 (NELS:88). NELS:88 follows a nationally representative sample of individuals who were eighth graders in the spring of 1988 and ready to start their postsecondary education in 1992. A sample of these respondents was surveyed through four follow-ups in 1990, 1992, 1994, and 2000. The NELS:88 database includes college transcripts of all individuals in the sample who enrolled in postsecondary education by 2000. Therefore, there is eight years of postsecondary information for students. The NELS:88 data allowed us to track the postsecondary enrollment patterns, institutions attended, and outcomes of students through 2000, and to obtain demographic, ability, and socioeconomic measures of the respondents. Note

[13] The community college completion benchmark index is available in a spreadsheet from CCRC. Colleges can use the index to benchmark their institutional completion rates against those of other institutions.

that the NELS:88 sample contains mostly students who entered college soon after high school graduation, following the traditional pattern of postsecondary enrollment. Therefore, the sample is not a representative cross-section of all community college students, but by design (of the survey) includes only younger cohorts of beginning postsecondary students.

Outcome Variable. The NELS:88 data provide complete information on type of credential earned (certificate, associate degree, bachelor's degree, and post-baccalaureate degree) as well as the date earned. For purposes of this analysis any certificate or degree earned is considered a successful outcome. In addition to credentials, the transcript data for students allowed us to observe whether a student transferred from a community college to a baccalaureate institution within the eight-year window. Such a transfer, regardless of whether it was accompanied by a degree at either the transfer-out or transfer-in institution, is also included as a positive outcome for community college students. Note that by including this outcome as a measure of success, the measure differs from the one used in the institutional completion rate analysis. By including transfer in our measure of completion, we introduced another element for accuracy into the current analysis that was unavailable with the IPEDS data. In the discussion that follows, we use the terms *graduate, complete,* and *succeed* interchangeably for readability; in this context they all refer to earning a certificate or degree or transferring to a baccalaureate institution.

Explanatory Variables. The explanatory individual characteristics and enrollment pattern variables include fixed controls for gender, race/ethnicity, SES, student ability, declared major type, financial aid received, remediation, delayed enrollment, full-time intensity, and interruptions in enrollment for more than four months. To measure SES, we used a composite variable in NELS:88 that includes total household income, parents' occupation, and the highest level of parents' education. Ability is approximated using a student's twelfth grade reading and math composite test scores.[14] Dummy variables for any financial aid received and taking remedial courses come from the student's first year of enrollment. Full-time intensity and interruptions refer to the whole period of a student's postsecondary enrollment.

The explanatory institutional variables come from IPEDS, which contains information on students, faculty, enrollment, and finances, as reported by institutions to NCES. From these data, we created a file of each institution's characteristics for every school year for which NELS:88 data were available. We merged the institutional characteristics file with the student characteristics file by institution identifier and initial school year of enrollment to assign the appropriate institutional characteristics for the first year of enrollment for each student at a given institution.

As with our institutional completion rate analysis, the set of institutional characteristics can be divided into three general groups: fixed characteristics, compositional characteristics, and financial characteristics. *Institution fixed characteristics* include dummy variables for college

[14] Note that the institutional variables in our first analysis do not include aggregate measures of ability. Since standardized test scores are not required by community colleges there is no commonly available measure of the academic preparedness of their entering students. Therefore, IPEDS does not have data on the academic readiness of community college students, and does not even have common proxies such as income or SES. Because we know that students at institutions that enroll better-prepared students tend to have a higher probability of degree completion, the current analysis can also be seen as an alternative to handle this important deficiency in the institution-level models.

location in an urban, suburban (reference group), or rural area; and for institutions that award more certificates than associate degrees. *Institution compositional characteristics* include dummy variables for institutional size (measured by FTE undergraduates), the proportion of part-time faculty, the proportion of FTE minority students (black, Hispanic, and Native American), the proportion of FTE females, and the proportion of part-time students. *Institution financial characteristics* include federal student aid per FTE, average undergraduate in-state tuition, and average expenditures per FTE in instruction, academic support, student services, and administration. The federal aid measure, which is primarily comprised of Pell Grants awarded to low- and middle-income students, acts as a proxy for the relative income level of the student body.

Our initial NELS:88 sample contained 2,438 students whose first postsecondary education was in one of 686 community colleges. However, there were only 1,464 students across 441 community colleges for which we had information for all our explanatory variables. Missing values occurred mainly in the high school tracking variables such as test scores, but also in many of the institutional variables merged from IPEDS. In addition, computation of the cluster variance in our random effect probit model (see below) requires institutions with at least two students. Therefore, in that model we lose an additional 50 students and institutions.

We estimated our models for two different samples. The first comprises all students whose initial postsecondary education is at a community college. The second is a subset containing community college students enrolled initially in an associate degree program. In the latter case, we excluded certificates as successful outcomes since students in an associate degree program generally do not have earning a certificate as their goal. Although the main interest of the research is to understand the effect of institutional characteristics on community college student outcomes, we recognize that these students are quite heterogeneous, especially in terms of their educational goals.[15] Conducting a separate analysis for associate degree student is a way to circumvent the problem.[16]

Descriptive statistics (means) for each sample group are provided on Table 4. They show that 52.1 percent of all students attained some outcome between 1992 and 2000. Community college students in the NELS:88 sample were most commonly enrolled in large urban institutions, with half of the faculty part-time. The student body in the average institution was composed of 19 percent minority students (black, Hispanic, and Native American), 56 percent female students, and 36 percent part-time students. The average student enrolled at an institution where students received on average $539 dollars in Pell Grants and paid $1,356 in tuition. Similarly, the average institution spent $2,773 on instruction, $463 on academic support, $574 on student service, and $1,293 on administrative expenses per FTE student. Note also that estimates are reasonably similar for the associate degree sample.

[15] A survey question asking first-time beginning community college students their primary reason for enrolling produced the following response distribution: job skills: 23 percent; degree or certificate: 21 percent; transfer: 39 percent; personal enrichment: 17 percent. (Source: BPS:96/01; authors' calculations.)

[16] Unfortunately, sample size limitations make impossible a separate analysis for certificate students.

Table 4. Descriptive Statistics for Students with First PSE in a Community College

Variable	Mean for Student Type	
	All	Associate Degree
Positive outcome by the end of survey	52.1%	48.9%
Student Characteristics		
Female	48.4%	48.2%
White	71.2%	70.9%
Black	8.5%	9.2%
Hispanic	15.8%	17.9%
Asian	3.8%	2.0%
SES: lowest quartile	17.0%	19.0%
SES: second quartile	29.4%	31.7%
SES: third quartile	30.3%	25.9%
SES: highest quartile	23.3%	23.3%
Test scores: lowest quartile	19.1%	19.1%
Test scores: second quartile	29.5%	30.4%
Test scores: third quartile	34.1%	35.8%
Test scores: highest quartile	17.3%	14.7%
Student Enrollment Characteristics		
Received any type of financial aid	42.3%	43.1%
Academic major	39.2%	41.6%
Occupational major	47.3%	51.5%
No major	9.6%	6.7%
Took remediation in first PSE	56.5%	56.9%
Delayed Enrollment	20.0%	21.1%
Interrupted enrollment	38.6%	36.6%
Full-time enrollment	17.2%	17.8%
Institution Fixed Characteristics		
College is located in urban area	50.1%	48.3%
College is located in rural area	3.1%	3.0%
Institution awards more certificates than associate degrees	8.9%	8.0%
Institution Compositional Characteristics		
1,001-2,500 FTE undergraduates	27.6%	27.4%
2,501-5,000 FTE undergraduates	24.2%	25.9%
More than 5,000 FTE undergraduates	44.0%	42.1%
Proportion part-time faculty	52.6%	54.0%
Percent FTE minority	19.0%	18.8%
Percent FTE female	56.1%	56.0%
Percent FTE part-time	36.6%	35.8%
Institution Financial Characteristics		
In-state tuition[a]	1.356	1.433
Instructional expenditures[b]	2.773	2.733
Academic support[b]	0.463	0.458
Student services[b]	0.574	0.568
Administrative expenditures[b]	1.293	0.878
Federal aid (Pell Grants) [b]	0.539	0.560
Observations	**1,464**	**892**

Source: Authors' estimates based on NELS:88.
Notes: [a] in $1,000s. [b] in $1,000s per FTE undergraduate.

Methodology. Community college student outcomes are measured as any degree attained (certificate, associate, or bachelor's) or as a transfer to a baccalaureate institution. Therefore, we coded the dependent variable as binary, taking the value of 1 if we observe any of the mentioned successful outcomes, and 0 otherwise. As discussed earlier, using both individual and institutional characteristics as covariates better explains community college student outcomes than using one or the other alone.

For the first model (Model 1) we used institutional data from the first year of a student's enrollment in the community college.[17] By using institutional data from the first year of a student's enrollment, Model 1 ignores the characteristics of other institutions in which a student enrolls. Based on the NELS:88 survey, we found that over 40 percent of community college students enroll in more than one institution during their postsecondary education.[18] We would expect that their enrollment at any particular institution has an impact on their outcome at all succeeding institutions in which they enroll. Therefore, in Model 2 we created an index value for each institutional characteristic which is a weighted average of all the institutions attended. The weight in each case is proportional to the full-time equivalent (FTE) months enrolled in each institution relative to the FTE months enrolled at all institutions, prior to the student outcome event (certificate; degree; transfer; or last enrolled, if no outcome).

Note that in this analysis the outcome variables are for individuals, but many of the explanatory variables are institutional aggregates. These variables might not measure important institutional effects that are unmeasured or unobservable. For example, they might include a particular institutional commitment to retention articulated through specific programs or policies designed to promote degree completion. Therefore, observations within an institution might be correlated. We use a statistical technique referred to as a random effects probit analysis to take account of this potential problem (see the discussion in Appendix B). The random effects probit is applied in Model 3.

Findings. The regression results can be found in Appendix C. First, we discuss briefly the results of the individual-level effects for both the complete sample of community college students and the subset of associate degree students, as shown on Tables C1 and C3 respectively. Tables C2 and C4 present the results of the institutional effects for each population, which we discuss separately. Each table shows the results for all three models.

The results for the student characteristic effects are consistent with previous studies (see Bailey, Alfonso et al., in press). Our findings show that being black, enrolling in an occupational major or no major, delaying enrollment by more than one year after high school graduation, and interrupting enrollment by more than four months all have consistently significant negative impacts on completion. We also found that females (among associate degree students), high SES students, high ability students, those who receive financial aid, and full-time enrollees are all more likely to graduate. Results are similar across different specifications. However, after controlling for unobservable institutional heterogeneity (Model 3), students enrolled in occupational majors (both samples) or those who delay enrollment (associate degree students

[17] See Appendix B for a detailed explanation of this and subsequent models.
[18] Authors' calculations.

only) turn out to be positively associated with the probability of graduating. These results are significant at the 5 percent level.

We now discuss the institutional characteristics effects for all community college students, as found on table C2. Model 1, column 1, shows that an enrollment of 2,501 to 5,000 FTE undergraduates at a community college negatively impacts student outcome attainment (compared with the reference group, small colleges, which have 1,000 or fewer FTE undergraduates). Students enrolled in these institutions are 20 percent less likely to achieve a successful outcome than students at small institutions. Similarly, students enrolled in institutions with a large minority population are less likely to attain a degree or to transfer. Consistent with previous research, a $1,000 increase in in-state tuition decreases the probability to graduate by 4 percent among community college students, although the result is statistically weak. Also, larger expenditures on academic support services by community colleges are negatively associated with the probability to complete. One conclusion from this finding is that these institutions may be spending large amounts on academic support to compensate for deficiencies in unmeasured background characteristic of their students. Conversely, funds spent on administration are associated with a higher probability of student success: a $1,000 per FTE increase in administrative expenditures improves individual success by 7 percent. We suspect that higher administrative expenditures may be associated with policies or practices that promote retention.

When we account for multiple institutions attended by the students using Model 2 on Table C2, we observe that the pattern for the significant institutional covariates remains. Specifically, size, proportion of minority students, and academic support remain as important negative factors associated with our measure of success. However, the relationship of in-state tuition and administrative expenditures with the probability to graduate is no longer statistically significant. Finally, the last column on Table C2 presents results for Model 3, the random effect probit model.[19] After accounting for possible unobservable institution-specific effects, only the coefficient for the proportion of minority students remains a statistically important negative factor associated with the probability of completion. Specifically, the marginal effect indicates that students enrolled in institutions with 75 percent minority students are approximately 10 percent less likely to succeed compared with students enrolled in institutions with only 25 percent minority population.[20]

We now focus our attention on a more homogeneous population, the associate degree students, using the results on Table C4. At first glance, the results mimic the pattern for the whole sample of community college students. The results of Model 1 show that institution size and proportion of minority students are also negative factors associated with the probability of graduation for associate degree students. Notice, however, that students enrolled in rural institutions are 18 percent more likely to have a successful outcome, and those enrolled in certificate-oriented institutions have roughly a 14 percent lower chance of graduating, though both have weak

[19] Note that coefficients in the pooled probit regression and random effect models are not directly comparable to differences in the normalizations. See Arulampalam (1999).

[20] Variables expressed in percentages, such as part-time faculty, minority, and female, and part-time students, are divided by 100. Therefore, the marginal effects are for a unit change from 0 to 1. A change of 50 percent (from 75 percent to 25 percent, for example) would be half of the full marginal effect.

statistical significance. Interestingly, student service expenditures per FTE have a positive impact on this population.

The second column on Table C4 shows the effects of multiple institutions on student completion. In this case, the statistical effect of institution size disappears although the direction remains. The outcomes for associate degree program students are affected negatively by increases in the proportion of FTE undergraduates who are enrolled part-time. Since earlier studies have shown that attending part-time is a detriment to outcome attainment (Adelman, 1999; 2003; Bailey, Alfonso et al., in press; Pascarella & Terenzini, 1991), this finding is expected. However, our regression analysis controls for individual student pathways. Therefore, regardless of an individual's enrollment – full-time or part-time – going to a school with larger proportions of part-time students (who are less likely to earn a credential in a timely manner) detracts from any student's outcome attainment. Similarly, a larger percentage of minority students is associated with a lower likelihood of graduation. For example, students enrolled in institutions with 75 percent minority students are 17 percent less likely to succeed compared with students enrolled in institutions with only 25 percent minority students (see footnote 20).

We found that Pell Grants per FTE undergraduate are negative and significant factors in outcome attainment for associate degree community college students. Pell Grants provide financial aid to low-income students, so institutions with higher rates of Pell Grants tend to have a less well-to-do student body. Thus, students starting in associate degree programs at a community college with a generally lower income population are expected to have lower graduation rates, even after controlling for individual SES. As at institutions with a high percentage of part-time students, a greater proportion of low-income students – who are less likely to attain an outcome (Bailey, Alfonso et al., in press) – hurts the attainment of all students on average.

The third column on Table C4 controls for unobservable institution-specific effects. In this case, results support the evidence found for the whole group of community college students. Increases in the size of the institution have a strong negative effect on the probability of student success. For example, students enrolled in institutions with 2,501 to 5,000 FTE undergraduates are 50 percent less likely to graduate than the reference group – those enrolled in community colleges with 1,000 students or less. Notice also that having more part-time faculty is also a negative factor affecting the probability of success of a student.

Summary. The most consistent result across both population and specifications is the negative relationship between individual success and institutional size. Community colleges with 2,501 to 5,000 FTE undergraduates have lower rates of degree completion and transfer than do smaller colleges. This finding is consistent with the notion that the more personalized atmosphere and services that would seem to be likely at a smaller institution may benefit the traditional-age student population in the NELS sample. Institutional race/ethnic composition has clear patterns too. Outcomes for community college students are negatively affected by increases in the proportion of minority students, although students enrolled in associate degree programs seem not to be affected. However, the latter group has less outcome success if the institution has a high proportion of part-time faculty.

We conducted an additional parallel analysis using a different dependent variable. A dummy variable as a measure of success of community college student outcomes can be hiding important information and, therefore, we used the total credits earned by each student in a separate analysis. This alternative measure of success has the important advantage of being a continuous variable and, consequently, common linear regression tools are now available. At the same time, the variable for credits earned has a highly non-normal distribution, since community college students have a high propensity to drop out before earning even 10 credits.[21] After accounting for the non-normality with a logarithmic transformation we re-estimated all three models with both student samples. The results are statistically consistent with the estimates presented in this paper.[22]

An additional investigation was conducted to determine whether the pooled probit or the random effect probit models is a better specification based on the assumptions of each model. We found that the random effect probit model is the superior specification. See the section comparing the models in Appendix B for a complete discussion.

Finally, to test the relative effect of individual student characteristics compared with institutional characteristics, we sequentially added blocks of covariates to the model and compared measures of fit. In particular, we first fit each model with a constant term, and then we added sequentially the individual characteristics (block 1) and the institutional variables (block 2) to compute the McFadden Pseudo-R^2. Although measures of fit in limited dependent variable models do not have the same interpretation as in linear regression models, they do provide some measure about the accuracy with which the model fits the data (Maddala, 1983). The analysis of measures of fit is presented on Table C5. Results suggest that the addition of 16 institutional covariates improves the fit of the model, although the impact is relatively small. This finding indicates that individual student characteristics have a greater bearing on graduation rates than do institutional characteristics, or at least the institutional characteristics that are measured by IPEDS data on more specific institutional policies and practices may show these to be more influential than the more macro characteristics such as size and overall expenditures that we have used.

Interestingly, the McFadden Pseudo R^2 for associate degree students increases after accounting for multiple institutions attended (Model 2) in the associate degree outcome version. However, recall that our index number for institutional characteristics includes baccalaureate institutions. We are not able to differentiate improvements of fit due to either community college or baccalaureate institution characteristics. Nonetheless, the analysis sheds light about the positive effect of transferring to a baccalaureate institution.

[21] Excellent examples of these distributions and a detailed analysis can be found in Kane and Rouse (1995).
[22] Results available upon request from the authors.

Conclusions

The overarching goal of this report is to measure the institutional characteristics that affect community college student success using national institutional and individual student data. While there is a growing literature on this topic for baccalaureate institutions, few researchers have attempted to address the issue for community colleges. Since this line of research is so new, there remain many open methodological and conceptual issues, and we have grappled with several of them. We see this project as only the beginning of a larger portfolio of activities designed to refine both our knowledge of the institutional factors that can promote community college student success and the methods used to analyze and study those effects. We first summarize the approach we took to the study. We then review our substantive conclusions. Following that, we summarize the methodological and conceptual insights gained through the process. We end with a discussion of plans for a wider analysis of institutional effects and policies to increase the success of low-income and minority students at community colleges.

Summary of Study Design

In this study we pursued two broad empirical strategies. First, we developed models of the determinants of *institutional* graduation rates using the Student Right-to-Know (SRK) three-year graduation rates published by the National Center for Education Statistics (NCES). We also used institutional measures provided in the Integrated Postsecondary Education Data System (IPEDS) as the independent variables (the determinants of graduation rates). Second, we carried out an analysis in which we used individual data from the National Education Longitudinal Study of 1988 (NELS:88) to analyze a student's probability of completing a certificate or degree or transferring to a baccalaureate institution. Using this approach we were able to control for individual characteristics such as a student's socioeconomic background or scores on pre-college assessment tests. We assessed the effects of institutional characteristics by linking the same institutional variables from IPEDS that we used in the institutional analysis to the individual student records (by the IPEDS ID number of the institution at which a student enrolled).

There are strengths and weaknesses in each of these two approaches. The SRK graduation rates are easily available for most colleges. They therefore allow an analysis of the comparative performance of individual colleges. The SRK information is criticized because it poorly reports transfer students who do not earn a degree prior to transfer,[23] it in effect assumes that all students want degrees, and the three-year horizon for measuring community college graduation is too short – typical community college students take longer than three years to complete an associate degree. These are all valid criticisms, although we have argued that graduation rates are still important variables, especially when used comparatively, and that the distortion caused by transfers is not very large for three-year rates. Moreover, the institutional variables that are available from IPEDS allowed us to make some adjustments to the graduation rates, and therefore to calculate better comparative benchmarks than the raw graduation rates. This approach to calculating adjusted graduation rates will form the basis of future research that uses qualitative techniques to carry out a more fine grained analysis to identify the characteristics of

[23] We noted earlier that transfer-out rates for community colleges are highly flawed and missing.

colleges that, based on quantitative analysis, have higher (or lower) graduation rates than would be expected from their institutional characteristics.

Analysis of institutional graduation rates using SRK data has other drawbacks. As we have pointed out, the rate fails to adequately take account of transfers or of students who have positive outcomes after the three-year time limit. Moreover, IPEDS does not include many important variables that are known to influence graduation rates, with student economic background and pre-college academic records the most important.

Our outcome analysis that links the NELS:88 individual student outcomes and characteristics to the institutional variables from IPEDS addresses some of these problems. The individual outcome variable (individual degree completion or transfer) from NELS:88 is a better measure than the SRK graduation rate, while the individual student data allow us to control for important background characteristics. Since NELS:88 includes student transcripts, we can also use credit accumulation as an outcome variable. Finally, NELS:88 allows us to track students for up to eight years, rather than the three years for the SRK rates. But analytic deficiencies remain. For example, we still must rely on the crude institutional measures available in IPEDS. So, we know that an individual may come from a low-income family, but we do not have a good idea about the economic background of the typical student at that individual's college. And we still do not have measures of specific institutional policies such as types of student services or pedagogic strategies typically used to increase retention. Finally, the NELS:88 sample is made up almost entirely of traditional-age college students, and therefore provides no information on older students, who comprise an important part of community college enrollments.

Given the strengths and weaknesses of these different strategies, research on community college institutional characteristics and policies that promote student success must continue, using both qualitative and quantitative approaches and a mix of national, state and college datasets. We conclude by outlining some plans for future research, after discussing the important findings from the current research.

Substantive Findings

Table 5, presented at the end of the Conclusions, summarizes the findings from our review of current research on the effects of institutional factors, along with the results from our research using the latest available national datasets. The most consistent finding across all these analyses is that institution size and the proportion of minority students (black, Hispanic, and Native American) are both associated with lower graduation rates. Students complete at higher rates in smaller colleges, perhaps because such institutions can provide a more personalized environment. It may also be true that smaller institutions have a more limited and focused set of programs, which may attract students who know what they want or provide a structure to guide students who do not know what they want toward a clearer set of outcomes. Students in colleges with more minority students also graduate at lower rates, even after controlling for the race of individual students. Thus the graduation rates at colleges with many minorities are lower, not because minorities are less likely to graduate and therefore lower the graduation rate, but rather because all students tend to graduate at lower rates when they are in colleges with a high

minority student population. This is certainly a disturbing conclusion that needs further investigation.

Our research contained no measure of the institutional average student income (which was found to be positively associated with degree completion in the literature), though we used as a proxy federal aid per FTE student. Income level was generally insignificant in our models, although a lower income reduced the likelihood of associate degree program completion. (The SES of the individual students was an important predictor of graduation.) As open access institutions, community colleges cannot be selective in their admissions. By design, they are intentionally non-selective by ability, are available to students from all income levels, and support part-time enrollment. Thus, attempting to improve graduation rates by becoming more selective in their student composition would violate a key tenet of the community college mission.

The percentages of the student body and of the faculty that are part-time both tend to be related to lower graduation rates, although this result is true for only some of the model specifications.

Greater instructional expenditures appear to promote completion in the institutional analysis using the SRK graduation rate, but this effect disappears when we control for individual student characteristics. This pattern of results could be accounted for if colleges spend more on instruction when they have students who have characteristics related to lower graduation rates, a reasonable policy. Conversely, expenditures on student services are not related to higher graduation rates in the SRK analysis. In some permutations of the model, we find a positive relationship between outcomes and student services expenditures when individual characteristics are taken into account. This finding does suggest that student services are effective in increasing the probability that a student will have a positive outcome. The lack of a relationship in the institutional (SRK) analysis could result from colleges spending more on services when they have more students who need those services, and while those expenditures may be effective, they are not enough to compensate for the problems that those students bring with them. Both of these results suggest that cuts in instructional expenditures and student services will lower college performance and thwart retention and completion.

Table 5 generates some more interesting insights. First, typically used models of institutional performance seem to work better for baccalaureate institutions than they do for two-year institutions. One reason for this difference is that baccalaureate institutions have a much simpler and more universally applicable outcome measure – attainment of a bachelor's degree. In contrast, community college students have a wider variety of goals including certificates, occupational and academic associate degrees, and transfer, as well as some non-credential objectives. Furthermore, the difference suggests that we simply have a much weaker understanding of the determinants of student success in community colleges than we do in baccalaureate institutions. This is not surprising since the vast majority of both theoretical and empirical work on completion and retention is focused on the baccalaureate sector (Bailey & Alfonso, 2005).

There are also some important contrasts between the analysis for all community college students and for those in an associate degree program. They suggest that certificate and associate programs have different dynamics, and policies that promote success in one might not work for

the other. We suspect that the contrasts would be even greater if we had a more representative sample of community college students than is available in NELS. NELS:88 is comprised primarily of traditional-aged college students. Adult community college students are more likely than younger students to enroll in certificate programs and probably also respond differently to particular types of policies and practices.

There are also more statistically significant variables in the institutional analysis using the SRK graduation rates than in the individual NELS:88 analyses. Thus, after controlling for individual characteristics, some institutional factors no longer appear important. This finding suggests that some of the measured institutional effects in the first analysis actually resulted from the individual characteristics of students that are correlated with institutional variables. Clearly, controlling for individual characteristics is a more reliable approach.

Overall, the individual characteristics appear to be more important determinants of graduation and retention than the institutional variables. Table C1 displays the results of our analysis of the effects of individual characteristics on student outcomes. Even though we have included controls for institutional variables, the results on Table C1 are consistent with other analyses that only include individual characteristics (Alfonso, Bailey, & Scott, 2005; and others). And, as we have seen, when we add individual variables to analyses using institutional variables, many of the institutional effects weaken – we get strong and consistent effects only for enrollment size and minority enrollment.

There may be several explanations for this apparent greater importance of individual characteristics. First, it suggests that well-prepared students with economic resources are likely to survive and perhaps do well in a variety of institutions. Likewise, students with many barriers have trouble even in strong colleges. Alternatively, the magnitude of some variables may reflect a response to perceived student need as well as some exogenously determined institutional policy. For example, colleges whose students face multiple barriers may spend more on student services. While we have tried to control for student characteristics, there may be important factors that are not measured in our datasets. In this case, even if student services are effective in increasing retention, the negative effect of the initial student characteristics may offset the positive program effect resulting in a coefficient that suggests no effect. Finally, we may simply not have data on the most effective institutional policies. Since we do not have good national survey data on institutional practices, we must rely on field research to identify differences in practices that might explain differences in student outcomes by college. We suspect that, at the institution level of analysis, we might observe policies and practices that would specifically affect the outcomes of minority students and students who enter community colleges with economic or educational disadvantages.

Plans for Future Research

Our finding that the state in which a college is located has significant impact on institutional graduation rates (Table 5, column 2) suggests that state policies and how they play out at individual community colleges matter a lot. These effects seem to be independent of the effect of the level of expenditures by individual institutions, although they may have to do with the level

of state appropriations, something we do not measure. In his analysis of the impact of institutional finances on student persistence at baccalaureate institutions, Titus (in press) found that the percent of revenue derived from tuition is positively related to student persistence. He cites Anderson (1985), who indicates that as institutions rely more on tuition for revenue, they become increasingly customer focused. This may also be true at community colleges, and may be an important finding as competition for state and local funding intensifies. Therefore, individual state-level variables that distinguish funding and other policies might tease out differences in outcomes – including, perhaps, the outcomes for minority students and other populations. If available, these variables could be incorporated into our models. In conjunction with individual data from the national student surveys (such as NELS:88 and BPS:96/01) and some institutional data from IPEDS, which provide important control variables, they could have significant explanatory power.

The limitations of national survey data for examining institutional practices and the evident importance of state policy in shaping student outcomes have led us to pursue research that uses data from specific states that collect longitudinal data on students.[24] With individual student data across all state colleges combined with the specific state financial and policy variables, we can produce much more robust models that can identify effective practices that promote student completions. For example, Prince and Jenkins (in press) use data from the Washington State Community and Technical College system to track the outcomes over five years of adults who entered one of the state's community or technical colleges with at most a high school education. That study was designed to give educators throughout Washington's community and technical college system a clearer idea of the characteristics of their low-skill adult students, who make up a third of the approximately 300,000 students served annually by the system. It identifies critical filter points or roadblocks at which adult students tend to drop out or fail to make it to the next level. The staff of the Washington State Board of Community and Technical College System (SBCTC) is using the study's findings to promote discussion among educators throughout the system on how to better serve low-skill adult students. The SBCTC staff has asked CCRC to help further analyze the data on the outcomes of low-skill adults and to compare the experience of adult students with that of students who enter the colleges directly out of high school.

In another study recently begun with funding from Lumina, the Community College Research Center (CCRC) is using longitudinal student data from the Florida Department of Education on students at each of the state's 28 community colleges and the statistical methods refined through this study to select a sample of six community colleges – three high performers and three low performers – for site visits during spring of 2005. During these visits, CCRC researchers will conduct structured interviews with administrators, faculty, staff and students to identify the key dimensions of organizational policy and practice related to degree completion.

We have already made considerable progress in understanding the factors that influence college performance, but the broad project of identifying community college characteristics and policies that promote student success is still at an early stage. The overall strategy needs to be multi-pronged. Both quantitative and qualitative approaches need to be used. The growing availability of state unit record data needs to be encouraged and exploited. Results from state analyses can be compared to conclusions using national data to check the accuracy of the latter. The quality and

[24] Florida and Washington are two such states with excellent databases with which we are familiar.

quantity of national NCES data needs to be enhanced. One improvement will be the forthcoming addition of retention rates to the graduation rates already reported in IPEDS. Methods should be developed to collect quantitative data on more fine-grained institutional activities. And case studies of apparently successful colleges and states will yield important insights. A comprehensive approach to this problem is needed to develop a reliable understanding of the policies and practices that can improve outcomes for low-income, minority, and, indeed, all community college students.

Table 5. Institutional Characteristics Associated with Degree Completion: Comparison of Findings from Research on Baccalaureate Institutions and Community Colleges

Institutional Characteristic	Studies of Baccalaureate Institutions	Studies of Community Colleges		
	Research on Bachelor's Degree Completion	Analysis of Institutional Graduation Rate	Analysis of Individual Completion Data (All CC Students)	Analysis of Individual Completion Data (Associate Degree Program Students)
Fixed Characteristics				
Urban (vs. suburban or rural) location	-	0	0	0
State where located	nm	+/-/0	nm	nm
Historically black college or university	+	+	nm	nm
Private college	+	na	na	na
Engineering school	-	na	na	na
Compositional Characteristics				
Residential (vs. commuter) college	+	na	na	na
Selectivity (SAT/ACT)	+	nm	nm	nm
Undergraduate student body composition				
• Average student household income (measured by federal aid per FTE in CC studies)	+	0	0	-
• Percent part-time students	-	-	0	0
• Percent female	+	-	0	0
• Percent minority (black, Hispanic, and Native American)	-	-	-	-
• Percent older	-	nm	nm	nm
Size (enrollment)	+/-	-	-	-
Percent part-time faculty	nm	0	0	-
Grants more certificates than associate degrees	na	+	0	0
Financial Characteristics				
In-state tuition	+	0	0	0
Instructional expenditures	+	+	0	0
Academic support expenditures	+	nm	0	0
Student support expenditures	0	0	0	0 or +
Administrative expenditures	0	nm	0	0
Federal aid (Pell Grants)	nm	0	0	0

Key: + = statistically significant positive effect on completion. - = statistically significant negative effect on completion. 0 = no statistically significant effect. +/- = research findings are contradictory. +/-/0 = state effects are statistically significant; the size and direction of the effects depend on the state. na = not applicable to institution type. nm = no measure for the given characteristic.

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APPENDIX A: INSTITUTIONAL GRADUATION RATES REGRESSION TABLES

Table A1. Results of Group Logistic Regression on Degree Completion

	MODEL 1		MODEL 2		MODEL 3	
	Coeff (std err)	dy/dx	Coeff (std err)	dy/dx	Coeff (std err)	dy/dx
College is located in urban area	**-0.199**	-0.035	-0.009	-0.002	-0.012	-0.002
	(0.043)		(0.037)		(0.038)	
College is located in rural area	**0.208**	0.037	0.055	0.010	0.052	0.009
	(0.091)		(0.079)		(0.080)	
College is a Historically Black College or University	0.170	0.03	0.379	0.068	0.398	0.071
	(0.247)		(0.203)		(0.205)	
College is a tribal college	-0.821	-0.145	-0.952	-0.171	-0.817	-0.145
	(0.631)		(0.828)		(0.825)	
1,001-2,500 FTE undergraduates			**-0.155**	-0.028	-0.145	-0.026
			(0.076)		(0.079)	
2,501-5,000 FTE undergraduates			**-0.517**	-0.093	**-0.498**	-0.089
			(0.082)		(0.087)	
More than 5,000 FTE undergraduates			**-0.776**	-0.139	**-0.750**	-0.134
			(0.085)		(0.093)	
Proportion FTE minority undergraduates			**-0.667**	-0.120	**-0.762**	-0.136
			(0.114)		(0.144)	
Proportion FTE part-time undergraduates			**-0.801**	-0.144	**-0.800**	-0.142
			(0.204)		(0.220)	
Proportion FTE female undergraduates			**-2.743**	-0.493	**-2.522**	-0.449
			(0.305)		(0.338)	
Proportion part-time faculty			-0.036	-0.006	-0.018	-0.003
			(0.087)		(0.089)	
Institution awards more certificates than associates			**0.348**	0.063	**0.309**	0.055
			(0.058)		(0.060)	
In-state tuition[a]					-0.057	-0.010
					(0.038)	
Instructional expenditures[b]					**0.071**	0.013
					(0.020)	
Academic support[b]					0.024	0.004
					(0.050)	
Student services[b]					-0.073	-0.013
					(0.042)	
Administrative expenditures[b]					-0.048	-0.008
					(0.038)	
Federal aid (Pell Grants)[b]					0.054	0.010
					(0.073)	
Constant	-3.128		0.568		0.354	
	(0.769)		(0.910)		(0.930)	
Number of observations	884		844		825	
Adjusted R squared	0.41		0.63		0.63	

Notes: [a] in $1,000s.
[b] in $1,000s per FTE undergraduate.
Bolded coefficients are significant at the 5% level. Regressions also include fixed effect state dummies.
Coefficients for these variables are available from the authors on request.

Table A2. Group Logistic Regression on Degree Completion - Gender Analysis

	MODEL 3 Female		MODEL 3 Male		MODEL 3	
	Coeff (std err)	dy/dx	Coeff (std err)	dy/dx	Coeff (std err)	dy/dx
College is located in urban area	-0.035	-0.007	0.015	0.002	-0.016	-0.003
	(0.038)		(0.043)		(0.038)	
College is located in rural area	0.018	0.003	0.118	0.020	0.072	0.013
	(0.081)		(0.091)		(0.080)	
College is a Historically Black College or University	**0.451**	0.085	0.292	0.049	**0.400**	0.071
	(0.203)		(0.237)		(0.203)	
College is a tribal college	-0.738	-0.139	-0.852	-0.143	-0.846	-0.151
	(0.798)		(1.090)		(0.819)	
1,001-2,500 FTE undergraduates	**-0.187**	-0.035	-0.126	-0.021	-0.139	-0.025
	(0.080)		(0.088)		(0.078)	
2,501-5,000 FTE undergraduates	**-0.552**	-0.104	**-0.478**	-0.080	**-0.483**	-0.086
	(0.090)		(0.098)		(0.087)	
More than 5,000 FTE undergraduates	**-0.769**	-0.145	**-0.771**	-0.129	**-0.730**	-0.130
	(0.095)		(0.105)		(0.092)	
Proportion FTE minority undergraduates	**-0.746**	-0.141	**-0.812**	-0.136	**-0.758**	-0.135
	(0.142)		(0.169)		(0.143)	
Proportion FTE part-time undergraduates	**-0.774**	-0.146	**-0.712**	-0.120	-0.198	-0.035
	(0.227)		(0.244)		(0.273)	
Proportion FTE female undergraduates	**-2.580**	-0.487	**-2.695**	-0.453	**-1.787**	-0.318
	(0.377)		(0.356)		(0.391)	
Interaction term: more than 50 percent of female					-0.023	-0.004
Percent FTE part-time undergraduate					(0.088)	
Proportion part-time faculty	0.053	0.010	-0.136	-0.023	**0.282**	0.050
	(0.090)		(0.100)		(0.060)	
Institution awards more certificates than associate degrees	**0.286**	0.054	**0.328**	0.055	**-0.807**	-0.144
	(0.063)		(0.066)		(0.220)	
In-state tuition[a]	-0.067	-0.013	-0.044	-0.007	-0.058	-0.010
	(0.038)		(0.043)		(0.037)	
Instructional expenditures[b]	**0.053**	0.010	**0.091**	0.015	**0.071**	0.013
	(0.021)		(0.022)		(0.020)	
Academic support[b]	0.041	0.008	0.008	0.001	0.035	0.006
	(0.051)		(0.056)		(0.049)	
Student services[b]	-0.068	-0.013	-0.084	-0.014	-0.065	-0.012
	(0.044)		(0.046)		(0.042)	
Administrative expenditures[b]	-0.029	-0.005	-0.063	-0.011	-0.053	-0.009
	(0.039)		(0.041)		(0.037)	
Federal aid (Pell Grants)[b]	0.004	0.001	0.112	0.019	0.034	0.006
	(0.073)		(0.083)		(0.072)	
Constant	0.042		0.226		-0.025	
	(0.639)		(1.136)		(0.929)	
Number of observations	822		813		825	
Adjusted R squared	0.60		0.64		0.64	

Notes: [a] in $1,000s.
[b] in $1,000s per FTE undergraduate.
Bolded coefficients are significant at the 5% level. Regressions also include fixed effect state dummies.
Coefficients for these variables are available from authors on request.

APPENDIX B: INDIVIDUAL OUTCOMES MODELS

Model Specifications

The model, incorporating both individual and institutional characteristics as covariates, for students whose initial postsecondary education was at a community college is as follows:

$$y^{*}_{ic} = X'_{ic}\beta + v_{ic} \qquad i = 1, 2, \ldots, N \text{ and } c = 1, 2, \ldots, C \qquad (1)$$

and

$$y_{ic} = 1 \text{ if } y^{*}_{ic} > 0 \text{ and} = 0 \text{ otherwise}$$

where i denotes each student and c is the cluster, in this case, the community college; y^{*} is the unobservable individual propensity to graduate; y is the observed outcome; X is a vector of exogenous individual and institutional characteristics which affect the outcome; and v_{it} is the unobserved component. Under the usual assumption for the error component (mean of zero, normalized variance σ^2_v equal to one), we can pool the data to obtain unbiased estimates using basic discrete response models.[25] This *pooled probit model* is used for our Models 1 and 2.

The focus of our research is on the effect of institutional characteristics on community college student outcomes (a subset of coefficients within the vector β). However, researchers often argue that estimations of aggregate covariates on individual level outcomes might be misleading due to the presence of correlated disturbance within clustered data (Moulton, 1990, Wooldridge 2003). To account for this effect or other unobservable effects at the community college level, we specify the error term in (1) as follows:

$$v_{ic} = \alpha_c + u_{ic} \qquad (2)$$

where α_c is the unobserved institution specific effect and u_{ic} is the usual idiosyncrasy term. Standard practice assumes that α_c and u_{ic} are independent and identically distributed random variables with mean zero and variance σ^2_c and σ^2_u, respectively. Similarly, error terms are independent of the vector of covariates X. If we assume a standard normal distribution for u_{ic}, we obtain a *random effect probit model* for the outcome:

$$P\left(y_{ic} = 1 \mid X_{ic}, \alpha_c\right) = \Phi\left(X'_{ic}\beta + \alpha_c\right) \qquad (3)$$

Consistent estimates for β and σ^2_c are available without further assumptions, in particular with large populations of small clusters (Wooldridge, 2003). Results of this specification are referred to as Model 3.[26]

[25] However, standard errors will be misleading and need a fully robust variance-covariance matrix to account for serial correlation. See Guilkey and Murphy (1993) or Wooldridge (2002).

[26] A detailed discussion of the model and estimation can be found in Wooldridge (2002) or Hsiao (2003).

Comparison of the Models

By construction, the random effect probit model (Model 3) provides information about the proportion of the total variance contributed by the unobserved heterogeneity[27]

$$\rho = \text{corr}(v_{ic}, v_{is}) = \frac{\sigma_c^2}{\sigma_c^2 + 1}.$$

The estimated Rho is reported in the last row of the tables in Appendix C Model 3. Only 9 percent of the variance in the unexplained outcome of community college students can be explained by the unobserved institution specific effect. The unobserved component seems to be more important in the more homogenous population of students enrolled in associate degree programs, where 33 percent of their unexplained outcome can be attributed to unobserved community college level effects. Similarly, this result becomes evident when one observes the improvement in fit for each sample, measured as Pseudo R^2. Therefore, it is straightforward to specify a likelihood ratio (LR) hypothesis test for Rho as $H_0: \rho = 0$. LR statistic values of 5.35 and 15.35 with one degree of freedom for the community college and associate degree students provide strong statistical evidence at the 1 percent level against the null hypothesis. We conclude, therefore, that the random effect probit model is the appropriate specification.[28] An unobservable institution specific effect or omitted variable problem exists and is highly important for explaining the unexplained outcome of associate degree students.

[27] After normalization $\sigma_u^2 = 1$.

[28] Given this important evidence, it is relevant to analyze the behavior of the likelihood function during the maximization process. Estimation requires a Gauss-Hermite quadrature formula to approximate the integral. The accuracy of the estimation decreases as the cluster size or rho increases, and the number of points at which the integrand must be evaluated become an important factor to achieve convergence. Our standard estimation uses 12 points and we also test the sensitivity of the results with 8 and 16 points as provided by the STATA command quadchk. Results show that the quadrature technique is stable, as expected, since our sample contains around 400 community colleges with an average sample size of 4 students. Rho in both samples is low values. In addition, we also follow Rabe-Hesketh, Skrondal, & Pickles (in press) by estimating the same models using GLLAMM and an adaptive quadrature as recommended by the authors. Results echo our previous estimates and are available from the authors upon request.

APPENDIX C: INDIVIDUAL OUTCOMES REGRESSION TABLES

Table C1. Individual Level Effect on Community College Student Outcomes

	Model 1 Pooled Probit		Model 2 Pooled Probit Multiple institution		Model 3 Random effect Probit	
Variable	Coeff (std err)	dy/dx	Coeff (std err)	dy/dx	Coeff (std err)	dy/dx
Female	0.136	0.054	0.139	0.055	0.117	0.046
	(0.110)		(0.115)		(0.077)	
Black	**-0.517**	-0.205	-0.473	-0.187	**-0.431**	-0.169
	(0.242)		(0.290)		(0.190)	
Hispanic	0.039	0.015	0.511	0.202	**0.364**	0.144
	(0.225)		(0.303)		(0.183)	
Asian	0.333	0.132	0.335	0.132	**0.419**	0.165
	(0.382)		(0.415)		(0.193)	
SES: Second Quartile	0.189	0.075	0.212	0.084	-0.619	-0.244
	(0.160)		(0.164)		(0.568)	
SES: Third Quartile	0.223	0.088	0.231	0.091	0.082	0.032
	(0.162)		(0.162)		(0.116)	
SES: Fourth Quartile	**0.730**	0.289	**0.740**	0.292	0.214	0.084
	(0.198)		(0.217)		(0.116)	
Test scores: Second Quartile	0.037	0.015	0.067	0.027	**0.532**	0.210
	(0.180)		(0.182)		(0.133)	
Test scores: Third Quartile	0.197	0.078	0.169	0.067	**0.287**	0.113
	(0.186)		(0.186)		(0.115)	
Test scores: Fourth Quartile	0.350	0.138	0.398	0.157	**0.590**	0.232
	(0.212)		(0.215)		(0.119)	
Received any financial aid	**0.309**	0.122	**0.329**	0.130	**0.730**	0.287
	(0.107)		(0.109)		(0.142)	
Occupational Major	**-0.352**	-0.139	**-0.287**	-0.113	**0.246**	0.097
	(0.119)		(0.133)		(0.084)	
No major declared	**-0.389**	-0.154	-0.288	-0.114	**-0.306**	-0.120
	(0.168)		(0.174)		(0.082)	
Took remedial courses	**-0.346**	-0.136	**-0.375**	-0.147	**-0.439**	-0.174
	(0.109)		(0.115)		(0.133)	
Delayed enrollment	**-0.511**	-0.201	**-0.416**	-0.165	**-0.810**	-0.312
	(0.158)		(0.157)		(0.110)	
Interrupted enrollment	**-0.368**	-0.145	**-0.298**	-0.118	**-0.450**	-0.177
	(0.107)		(0.113)		(0.082)	
Full-time enrollment	**0.555**	0.209	**0.480**	0.182	**0.629**	0.232
	(0.146)		(0.153)		(0.118)	
Unweighted observations	1464		1380		1414	
Number of institutions					391	
Pseudo R^2	0.184		0.172		0.194	
Estimated rho					0.086	

Source: Authors' estimates based on NELS:88.
Notes: Bolded coefficients are significant at the 5% level.

Table C2. Institutional Level Effect on Community College Student Outcomes

	Model 1 Pooled Probit		Model 2 Pooled Probit Multiple institution		Model 3 Random effect Probit	
Variable	Coeff (std err)	dy/dx	Coeff (std err)	dy/dx	Coeff (std err)	dy/dx
College is located in urban area	-0.035	-0.014	-0.075	-0.030	-0.070	-0.028
	(0.116)		(0.121)		(0.092)	
College is located in rural area	0.036	0.014	-0.073	-0.029	0.324	0.123
	(0.195)		(0.191)		(0.245)	
Certificate degree oriented	-0.086	-0.034	-0.192	-0.076	-0.115	-0.045
	(0.141)		(0.154)		(0.143)	
1,001-2,500 FTE undergraduates	-0.201	-0.079	-0.193	-0.076	-0.140	-0.055
	(0.208)		(0.197)		(0.241)	
2,501-5,000 FTE undergraduates	**-0.505**	-0.200	**-0.436**	-0.172	-0.446	-0.176
	(0.210)		(0.189)		(0.250)	
More than 5,000 FTE undergraduates	-0.235	-0.093	**-0.389**	-0.154	-0.258	-0.102
	(0.204)		(0.198)		(0.253)	
Percent part-time faculty	-0.171	-0.068	-0.106	-0.042	-0.118	-0.046
	(0.222)		(0.229)		(0.186)	
Percent FTE minority undergraduates	**-0.994**	-0.394	**-0.579**	-0.229	**-0.530**	-0.209
	(0.439)		(0.232)		(0.174)	
Percent FTE female undergraduates	-0.196	-0.078	-1.028	-0.406	-0.565	-0.222
	(0.798)		(0.837)		(0.778)	
Percent FTE part-time undergraduates	-0.353	-0.140	-0.807	-0.319	0.238	0.094
	(0.628)		(0.661)		(0.472)	
Federal aid (Pell Grants)[a]	0.102	0.040	-0.125	-0.049	0.126	0.050
	(0.253)		(0.255)		(0.189)	
In-state tuition[b]	-0.116	-0.046	-0.083	-0.033	-0.053	-0.021
	(0.063)		(0.059)		(0.050)	
Instructional expenditures[a]	0.044	0.017	0.051	0.020	0.074	0.029
	(0.071)		(0.072)		(0.054)	
Academic support[a]	**-0.545**	-0.216	**-0.642**	-0.254	-0.236	-0.093
	(0.227)		(0.223)		(0.189)	
Student services[a]	-0.062	-0.025	-0.002	-0.001	0.264	0.104
	(0.236)		(0.246)		(0.186)	
Administrative expenditures[a]	**0.194**	0.077	0.115	0.045	-0.009	-0.004
	(0.098)		(0.136)		(0.111)	
Constant	0.863		**1.516**		0.145	
	(0.589)		(0.526)		(0.576)	
Unweighted observations	1464		1380		1414	
Number of institutions					391	
Pseudo R^2	0.184		0.172		0.194	
Estimated rho					0.086	

Source: Authors' estimates based on NELS:88.
Notes: [a] in $1,000s per FTE undergraduate.
[b] in $1,000s.
Bolded coefficients are significant at the 5% level.

Table C3. Individual Level Effect on Associate Degree Student Outcomes

	Model 1 Pooled Probit		**Model 2** Pooled Probit Multiple institution		**Model 3** Random effect Probit	
Variable	Coeff (std err)	dy/dx	Coeff (std err)	dy/dx	Coeff (std err)	dy/dx
Female	**0.386**	0.153	**0.506**	0.199	0.218	0.086
	(0.127)		(0.130)		(0.133)	
Black	-0.035	-0.014	-0.078	-0.031	-0.573	-0.226
	(0.302)		(0.278)		(0.299)	
Hispanic	0.238	0.095	0.101	0.040	0.400	0.158
	(0.294)		(0.241)		(0.326)	
Asian	0.492	0.196	0.629	0.249	-0.102	-0.040
	(0.287)		(0.327)		(0.236)	
SES: Second Quartile	0.192	0.076	0.053	0.021	-0.883	-0.348
	(0.209)		(0.200)		(0.930)	
SES: Third Quartile	0.405	0.161	0.095	0.038	0.346	0.137
	(0.210)		(0.189)		(0.192)	
SES: Fourth Quartile	**0.953**	0.379	**0.475**	0.188	**0.422**	0.167
	(0.267)		(0.234)		(0.191)	
Test scores: Second Quartile	0.225	0.090	**0.418**	0.166	**0.776**	0.306
	(0.224)		(0.210)		(0.230)	
Test scores: Third Quartile	0.164	0.065	0.305	0.121	**0.720**	0.284
	(0.223)		(0.214)		(0.206)	
Test scores: Fourth Quartile	**0.587**	0.233	**0.706**	0.280	**0.903**	0.356
	(0.259)		(0.247)		(0.219)	
Received any financial aid	**0.300**	0.119	0.141	0.056	**1.141**	0.450
	(0.133)		(0.138)		(0.258)	
Occupational Major	**-0.367**	-0.145	**-0.316**	-0.125	**0.445**	0.176
	(0.144)		(0.146)		(0.145)	
No major declared	**-0.445**	-0.175	**-0.624**	-0.242	-0.250	-0.098
	(0.209)		(0.234)		(0.137)	
Took remedial courses	-0.222	-0.088	-0.209	-0.083	-0.494	-0.195
	(0.138)		(0.148)		(0.262)	
Delayed enrollment	**-0.806**	-0.308	**-0.491**	-0.194	**1.557**	0.558
	(0.197)		(0.206)		(0.158)	
Interrupted enrollment	**-0.535**	-0.211	**-0.317**	-0.126	**-0.296**	-0.117
	(0.136)		(0.130)		(0.142)	
Full-time enrollment	**0.458**	0.177	**0.347**	0.135	**0.548**	0.206
	(0.169)		(0.170)		(0.191)	
Unweighted observations	892		801		777	
Number of institutions					252	
Pseudo R^2	0.237		0.338		0.460	
Estimated rho					0.326	

Source: Authors' estimates based on NELS:88.
Notes: Bolded coefficients are significant at the 5% level.

Table C4. Institutional Level Effect on Associate Degree Student Outcomes

Variable	Model 1 Pooled Probit		Model 2 Pooled Probit Multiple institution		Model 3 Random effect Probit	
	Coeff (std err)	dy/dx	Coeff (std err)	dy/dx	Coeff (std err)	dy/dx
College is located in urban area	0.129	0.051	0.177	0.070	0.154	0.061
	(0.145)		(0.152)		(0.171)	
College is located in rural area	0.458	0.182	0.087	0.034	0.036	0.014
	(0.277)		(0.250)		(0.463)	
Certificate degree oriented	-0.344	-0.137	-0.135	-0.054	0.053	0.021
	(0.198)		(0.241)		(0.271)	
1,001-2,500 FTE undergraduates	-0.318	-0.127	-0.267	-0.106	-0.742	-0.289
	(0.280)		(0.321)		(0.448)	
2,501-5,000 FTE undergraduates	**-0.748**	-0.297	-0.320	-0.127	**-1.393**	-0.509
	(0.294)		(0.302)		(0.474)	
More than 5,000 FTE undergraduates	-0.478	-0.190	0.133	0.053	**-1.115**	-0.422
	(0.285)		(0.307)		(0.488)	
Percent part-time faculty	-0.246	-0.098	**-0.812**	-0.322	-0.696	-0.275
	(0.309)		(0.341)		(0.360)	
Percent FTE minority undergraduates	**-1.130**	-0.450	-0.862	-0.342	-0.029	-0.011
	(0.518)		(0.471)		(0.503)	
Percent FTE female undergraduates	0.619	0.246	1.876	0.744	-0.150	-0.059
	(1.011)		(1.305)		(1.414)	
Percent FTE part-time undergraduates	-1.010	-0.402	**-5.137**	-2.038	-0.037	-0.015
	(0.764)		(0.821)		(0.923)	
Federal aid (Pell Grants)[a]	-0.280	-0.111	**-0.855**	-0.339	-0.280	-0.110
	(0.266)		(0.278)		(0.373)	
In-state tuition[b]	-0.086	-0.034	-0.052	-0.021	0.115	0.046
	(0.082)		(0.082)		(0.098)	
Instructional expenditures[a]	0.109	0.044	0.048	0.019	-0.015	-0.006
	(0.095)		(0.112)		(0.103)	
Academic support[a]	-0.437	-0.174	-0.479	-0.190	0.034	0.013
	(0.270)		(0.302)		(0.344)	
Student services[a]	**0.631**	0.251	**0.877**	0.348	0.357	0.141
	(0.310)		(0.336)		(0.348)	
Administrative expenditures[a]	-0.011	-0.004	0.077	0.031	-0.150	-0.059
	(0.142)		(0.169)		(0.154)	
Constant	0.266		0.840		-0.383	
	(0.789)		(0.925)		(1.094)	
Unweighted observations	892		801		777	
Number of institutions					252	
Pseudo R^2	0.237		0.338		0.460	
Estimated rho					0.326	

Source: Authors' estimates based on NELS:88.
Notes: [a] in $1,000s per FTE undergraduate.
[b] in $1,000s.
Bolded coefficients are significant at the 5% level.

Table C5. Measures of Fit Analysis, Individual versus Institutional Characteristics[a]

Model	Community College Students		Associate Degree Students	
	Block 1[b]	Block 2[c]	Block 1[b]	Block 2[c]
Model 1	0.133	0.184	0.196	0.237
Model 2	0.133	0.172	0.196	0.338
Model 3	0.178	0.194	0.415	0.460

Source: Authors' estimates based on NELS:88.
Notes: [a] Fit of the model is measures as McFadden Pseudo-R^2.
[b] Block 1 corresponds to models only with individual level characteristics.
[c] Block 2 adds to Block 1 the institutional level variables.