

The Effect of Earning an Associate Degree on Community College Transfer Students'

Performance and Success at Four-Year Institutions

Xueli Wang

Email: xwang273@wisc.edu

Phone: 608-263-5451

Address: 270-H Education Building, 1000 Bascom Mall
University of Wisconsin-Madison
Madison, WI 53706-1326

Yating Chuang

Email: ychuang@holycross.edu

Phone: 508-792-3517

Address: Stein 521, College of the Holy Cross
1 College Street, Worcester, MA 01610

Bo McCready

Email: bmccready@madison.k12.wi.us

Phone: 608-663-4948

Address: 205A, Doyle Administration Building
Department of Research, Accountability, & Data Use
Madison Metropolitan School District
Madison WI 53718

Biographical Statement

Dr. Xueli Wang is an assistant professor in the Department of Educational Leadership and Policy Analysis at the University of Wisconsin-Madison. Her research deals with community college students' access to, transitioning into, and attainment at 4-year institutions, as well as students' participation in STEM fields of study. Wang's recent work includes studies such as "Baccalaureate Expectations of Community College Students: Socio-Demographic, Motivational, and Contextual Influences," published in *Teachers College Record*, and "Pathway to a Baccalaureate in STEM fields: Are Community Colleges a Viable Route and Does Early STEM Momentum Matter?" published in *Educational Evaluation and Policy Analysis*.

Dr. Yating Chuang is a visiting assistant professor in the Department of Economics and Accounting at the College of the Holy Cross. She is an applied microeconomist with research interests in development economics, behavioral economics, and environmental economics. Her most recent work is "Stability of experimental and survey measures of risk, time, and social preferences: A review and some new results," published in *Journal of Development Economics*.

Dr. Bo McCready is Quantitative Research Supervisor for the Madison Metropolitan School District in Madison, Wisconsin. His research interests include program evaluation, college access, and data visualization. His recent work can be found at mmsd.org/research.

Description of the Article

Drawing upon national data and two quasi-experimental methods, this study investigates the effect of earning an associate degree prior to transfer on community college transfer students' success at four-year institutions. The findings indicate an overall null effect of earning an associate degree on post-transfer success.

Structured Abstract

Background/Context

As the cost of postsecondary education continues to rise, more students begin their postsecondary careers at a community college with the ultimate goal of upward transfer. However, there is limited evidence regarding how earning an associate degree prior to transfer shape transfer students' eventual success at baccalaureate institutions. The existing literature on this topic either draws on data from single states or does not address self-selection.

Purpose

In this study, we seek to understand whether transfer students' performance and attainment at four-year institutions vary based on whether they achieved an associate degree prior to pursuing a baccalaureate degree. This study attempts to provide clearer evidence by using national data and robust quasi-experimental designs to investigate the effect of pre-transfer associate degree attainment on post-transfer success.

Research Design

We drew upon data from the Beginning Postsecondary Students Longitudinal Study (BPS:04/09) and its supplementary Postsecondary Education Transcript Study (PETS:09) to answer our research question. To address self-selection, we employed two complementary quasi-experimental approaches in our study: propensity score matching (PSM) and instrumental

variable (IV). The results were compared with baseline analyses using ordinary least squares (OLS) and probit regression.

Findings

In the baseline analyses that did not deal with potential selection, we found that, compared to their counterparts who did not earn an associate degree prior to transfer, transfer students who had an associate degree showed no statistically significant differences in bachelor's degree attainment, retention, or GPA, but earned significantly fewer credits at four-year institutions. The results from the PSM are substantively similar to those from the baseline models. Using an IV approach, we found no impact of earning an associate degree on any of the educational outcomes at four-year institutions. Our study suggests that, based on a national dataset, students transferring upward to a four-year institution from a community college are likely to have similar outcomes regardless of whether they earned an associate degree pre-transfer.

Conclusions

The uncovered null effect may not mean that earning an associate degree has no impact within specific state contexts; instead, it may mean that the impact varies across contexts, but aggregates to be null. Given that earning an associate degree at least does not hurt later transfer success, community colleges may wish to encourage pre-transfer credential attainment as a way to better capture their success with these students and illustrate their contribution to the growing national effort to increase degree completion.

Executive Summary

Background/Context

As the cost of postsecondary education continues to rise, we can expect more students to begin their postsecondary careers at a community college with the ultimate goal of upward transfer. Since upward transfer is a desirable step toward increasing baccalaureate attainment, it is important to not only develop systems intended for transfer, but also understand factors that facilitate post-transfer success. However, there is limited evidence regarding how earning an associate degree may or may not shape transfer students' eventual success at baccalaureate institutions. Therefore, we seek to understand whether transfer students' performance and attainment at four-year institutions vary based on whether they achieved that highest possible credential prior to pursuing a baccalaureate degree. From a policy perspective, it is critical to understand the relationship between pre-transfer associate degree attainment and post-transfer success for community colleges wishing to prepare their students transferring upward.

Purpose

The existing literature draws on data from single states instead of national data, and in some cases, does not address self-selection, i.e., the identified positive relationship between associate degree attainment and transfer students' outcomes at four-year institutions might be due to other factors that drive both associate degree attainment and post-transfer success. To date, there is no clear, nationally generalizable empirical evidence on the effect of earning an associate degree pre-transfer, and we have yet to understand fully whether pre-transfer associate degree attainment facilitates post-transfer success. This study attempts to provide clearer evidence by using data from a nationally representative cohort of students to investigate the effect of earning an associate degree pre-transfer on post-transfer success. Specifically, we ask the following

question: What is the effect of earning an associate degree on the academic performance and success of community college transfer students, measured by their GPA, credits earned, retention, and degree completion at four-year institutions?

Research Design

We employed data from the Beginning Postsecondary Students Longitudinal Study (BPS:04/09) and its supplementary Postsecondary Education Transcript Study (PETS:09) to answer our research question. For the purpose of our study, we included students who started at community colleges as their first postsecondary institution and transferred to four-year institutions during the 6-year BPS study period. We further restricted our sample to respondents with complete transcript and attainment data in PETS:09, which allowed us to examine post-transfer educational outcomes, such as attainment, retention, credits earning, GPA, of community college transfer students with or without earning an associate degree prior to transfer. To address the issue of self-selection, we employed two complementary quasi-experimental approaches in our study: propensity score matching (PSM) and instrumental variable (IV). Earning an associate degree prior to transfer is the key “treatment” variable in PSM analysis. We also compared different matching methods: stratification matching and nearest neighbor matching. The results were compared with baseline analyses using ordinary least squares (OLS) and probit where the potential selection bias is not addressed.

Findings

Without dealing with selection bias, we found that compared to their counterparts who did not earn an associate degree prior to transfer, transfer students who had an associate degree showed no statistically significant differences in bachelor’s degree attainment, retention, or GPA, but earned significantly fewer credits at four-year institutions. The results from the PSM largely

show that earning an associate degree pre-transfer did not lead to better post-transfer educational outcomes when controlling for observed covariates and possible selection-bias. Only in one specification (i.e., PSM with stratification matching) did earning an associate degree have a slightly positive impact on the retention rate. Otherwise, the results from the PSM are substantively similar to those from the baseline models. After accounting for the unobservable and unobserved factors using an IV approach, we found no impact of earning an associate degree on any of the educational outcomes at four-year institutions. Therefore, our study suggests that, based on a national dataset, generally speaking, students transferring upward to a four-year institution from a community college are likely to have similar outcomes regardless of whether they earned an associate degree before they transfer.

Conclusions

The uncovered null effect may not mean that earning an associate degree has no impact within specific state contexts; instead, it may mean that the impact varies across contexts, but aggregates to be null. Considering political realities that are likely to encourage the completion of associate degrees pre-transfer and that earning an associate degree at least does not hurt later transfer success, in the face of public scrutiny, community colleges may wish to encourage pre-transfer credential attainment as a way to better capture their success with these students and illustrate their contribution to the growing national effort to increase degree completion.

The Effect of Earning an Associate Degree on Community College Transfer Students’ Performance and Success at Four-Year Institutions

Introduction

A prominent part of the historical mission of the community college is to facilitate upward transfer, defined as students transferring from a community college to a baccalaureate-granting institution (Brint & Karabel, 1989; Cohen, Brawer, & Kisker, 2014; Roksa & Calcagno, 2008). Community colleges often are more affordable and accessible than their four-year counterparts, offering an appealing alternative venue for the initial years of postsecondary coursework for students aspiring to complete a baccalaureate degree. As the cost of postsecondary education continues to rise, we can expect more students to begin their postsecondary careers at a community college with the ultimate goal of upward transfer, particularly given the overall relative academic success of students transferring upward (College Board, 2013; Melguizo, Kienzl, & Alfonso, 2011; Shapiro et al., 2013).

Since upward transfer is a desirable step toward increasing baccalaureate attainment, it is important to not only develop systems intended for transfer, but also understand factors that facilitate post-transfer success. Scholars have investigated community college transfer for decades (e.g., Arbona & Nora, 2007; Best & Gehring, 1993; Lee, Mackie-Lewis, & Marks, 1993; Roksa & Keith, 2008; Townsend & Barnes, 2001; Wang, 2009; for a comprehensive review, see Bahr, Toth, Thirolf, & Massè, 2013). While this body of work has uncovered a variety of individual, academic, and institutional characteristics associated with transfer student outcomes at four-year colleges and universities, there is limited evidence regarding how earning an associate degree may or may not shape transfer students’ eventual success at baccalaureate institutions. This is an important topic given the prominent role of associate degree completion in a

community college education. Although increasingly the “community colleges baccalaureates” or “workforce baccalaureates” are being offered and conferred by some authorized community colleges (Floyd, Felsher, & Falconetti, 2012), an associate degree generally still is the highest degree that can be conferred by a community college, often signifying the highest level of attainment that a student can achieve while still enrolled at a community college. From 2002-03 to 2012-13 alone, associate degree attainment increased by about 59%, compared to 36% for bachelor’s degrees (Kena et al., 2015). Also, associate degree completion rates are used as one of the most critical measures of student success at community colleges (Calcagno, Bailey, Jenkins, Kienzl, & Leinbach, 2008). Therefore, we should seek to understand whether transfer students’ performance and attainment at four-year institutions vary based on whether they achieved that highest possible credential prior to pursuing a baccalaureate degree.

There may be several explanations for why earning an associate degree might enhance post-transfer success. For example, students attaining an associate degree should be familiar with the steps needed to fulfill degree requirements and complete a postsecondary credential, as they have successfully done so at their two-year institution. This may add to their ability to navigate the four-year institution successfully. Also, the pursuit of the associate degree might help them ensure that the classes they are taking fit as part of a cohesive whole and, if the associate degree is designed to indicate readiness for transfer, that their credits earned really will transfer to a four-year institution. Finally, attaining an associate degree might provide valuable momentum during a student’s postsecondary career, signaling progress and encouraging students to continue on.

On the other hand, it might be possible to imagine ways that an associate degree completion may hinder post-transfer success. Students attaining the associate degree may have

had to take additional coursework at their community college to fulfill associate degree requirements that did not transfer to a four-year institution (Crosta & Kopko, 2014). Articulation agreements between two-year and four-year institutions are often not in place, with four-year institutions evaluating transfer credits on a case-by-case basis, and course acceptance can vary greatly across institutions and disciplines (Cohen et al., 2014). The time spent in courses that ultimately do not transfer could perhaps have been spent in courses that did transfer, or students could simply have saved time and money and not taken them in the first place. This potentially inefficient use of time and resources could result in both financial hardship and educational fatigue, factors that in turn could lead students to disengage from their postsecondary institutions, which makes them more likely to drop out (Tinto, 1975). Students with an associate degree also might be more likely to leave school before completing a bachelor's degree, because they have already attained a postsecondary credential, reducing their incentive to attain another one, especially if they perceive the attained skillsets meeting labor market demands. Stuart, Rios-Aguilar, and Deil-Amen (2014) suggest a persistence model for community college students based in part on the expected value of their future credential in the labor market; using this model, if the associate degree offers an adequate credential for students' aspirations, their cost-benefit analysis of completing the bachelor's degree is likely to be unfavorable.

Understanding the potential impact of pre-transfer associate degree attainment on post-transfer success has implications for program design across postsecondary institutions. Community colleges may want to structure academic programs for transfer-aspiring students to culminate in the awarding of an associate degree; baccalaureate-granting institutions may need to reflect on the supports offered for upward transfers (with and without an associate degree) to ensure they all have the best chance to succeed. Therefore, from a policy perspective, it is critical

to understand the relationship between pre-transfer associate degree attainment and post-transfer success for community colleges wishing to prepare their students transferring upward.

Baccalaureate-granting institutions hoping to serve these students as effectively as possible should work to understand how the support may vary based on their pre-transfer attainment status. Also, students aspiring to transfer upward must decide whether completing an associate degree prior to transfer is an efficient use of their time.

Despite the prominence of the associate degree and the increased interest in upward transfer, we still have very limited empirical knowledge about whether pre-transfer attainment of an associate degree appears to have any impact on students' post-transfer success. Some research already has addressed this topic, with promising early findings associated with pre-transfer degree attainment (e.g., Belfield, 2013; Belfield & Bailey, 2011; Crook, Chellman, & Holod, 2012; Crosta & Kopko 2014). In particular, based on data from the National Student Clearinghouse, Shapiro et al. (2013) found that, among students who transferred from community colleges, 62% earned a bachelor's degree or higher within six years after transfer. Transfer students with an associate degree or certificate attained a bachelor's degree at a 72% rate, which is much higher than the 56% rate for those who transferred without a credential.

Through this work, we have some preliminary findings pointing to potential benefits of earning an associate degree for transfer students' longer-term success. Notwithstanding the value of this small line of research, existing literature draws on data from single states instead of national data, and in some cases, does not address self-selection, i.e., the identified positive relationship between associate degree attainment and transfer students' outcomes at four-year institutions might be due to other factors that drive both associate degree attainment and post-transfer success. To date, there is no clear, nationally generalizable empirical evidence on the

effect of earning an associate degree pre-transfer, and what we have yet to understand fully is whether pre-transfer associate degree attainment facilitates post-transfer success. This study attempts to provide clearer evidence by using data from a nationally representative cohort of students to investigate the effect of earning an associate degree pre-transfer on post-transfer success.

Background of the Study

Numerous empirical studies have addressed factors influencing the educational success of community college transfer students at four-year institutions (e.g., Arbona & Nora, 2007; Best & Gehring, 1993; Calcagno et al., 2008; Chrystal, Gansemer-Topf, & Laanan, 2013; Lee & Frank, 1990; Lee, Mackie-Lewis, & Marks, 1993; Roksa & Keith, 2008; Townsend & Barnes, 2001; Townsend & Wilson, 2006; Wang, 2009). Despite the wealth of our knowledge on the topic, we do not know much about the impact of earning an associate degree pre-transfer, as few rigorous studies are designed to illuminate relationships between associate degree attainment and post-transfer success. In this section, we describe the limited amount of prior research that focuses on the relationship between earning an associate degree and various outcomes of community college transfers and discuss how our study is situated within and contributes to this line of work.

A few studies have examined the relationship between holding an associate degree and transfer students' academic performance. For example, Graham and Hughes (1994) found that receipt of an Associate of Arts degree positively predicts transfer students' GPA. Similarly, a study by Keeley and House (1993) revealed that during transfer students' first semester at a four-year university, those holding an associate degree do not experience as much of a dip in their GPA compared to their counterparts who transferred without an associate degree. These studies suffer several limitations that may inhibit their generalization. The population in Graham and

Hughes's (1994) study was limited to traditional-age students. Keeley and House (1993) indicated that their findings could be attributed to the type of students who earn an associate degree rather than the value of the degree itself. In addition, both studies focus on single institutions, and their results may or may not be generalizable to other settings.

More recently, Shapiro et al. (2013) demonstrated that community college transfer students who earned an associate degree or certificate showed higher rates of bachelor's degree attainment than their peers who transferred with no credential. This study provides descriptive comparisons between these two groups of students, but does not take any steps toward causality, with no focus on comparing similar students or accounting for selection bias in pre-transfer credential attainment. In addition, the authors focus on community college credentials broadly rather than explicitly on associate degrees.

There also has been some recent empirical evidence indicating that students would receive more economic benefit if they attain an associate degree before transferring to four-year institutions (Belfield, 2013; Belfield & Bailey, 2011). Comparing college costs with labor market benefits in the state of North Carolina, Belfield argued that students who attained an associate degree before transferring had, on average, higher net benefits than those who did not. Although transfer students who bypassed the associate degree and later attained a bachelor's degree had net benefits nearly as high as students who attained an associate and bachelor's degree and higher net benefits than those earning an associate degree but no bachelor's degree, Belfield concluded that more North Carolina Community College System (NCCCS) students should complete their associate degree before transfer because few students who transfer before earning an associate degree ever earn their bachelor's degree and thus leave college with no credential at all.

Crook and colleagues (2012) used data from the CUNY system to test the effect of earning an associate degree pre-transfer for students who transferred upward. They found that students earning an Associate of Arts (AA) or Associate of Science (AS) degree had slightly higher probabilities of bachelor's degree completion, but found no such effect for the Associate of Applied Science (AAS) degree. They argued that, from a policy standpoint, encouraging upward transfers to complete an associate degree pre-transfer is beneficial not just because of the increased probability of graduation, but because of the labor market benefits of the associate degree itself.

Crosta and Kopko (2014) conducted a study that focused explicitly on the effect of earning an associate degree pre-transfer for upward transfers. To estimate this effect, they focused on students from a single state who transferred from a community college to a four-year institution and had earned between 50 and 90 community college credits pre-transfer. They conducted separate analyses for students in transfer-oriented (AA/AS) and workforce-oriented (AAS) programs and found that among students in transfer-oriented programs, those who attained an associate degree pre-transfer were significantly more likely to complete a bachelor's degree than those who did not, while students in workforce-oriented programs showed no variation in outcomes based on associate degree attainment.

Crosta and Kopko's decision to restrict their sample to students who had earned between 50 and 90 community college credits before transferring strengthens the internal validity of their study by facilitating the creation of similar comparison groups. In addition, this restriction ensures that the authors are working with a student population that conceivably could have earned an associate degree. However, this approach limits the generalizability of their study to the larger population of community college students who transfer with fewer than 50 credits or

more than 90 credits. Crosta and Kopko argued that students earning more credits pre-transfer likely are more motivated than those earning fewer. This assumption, however, may not hold, as in practice, students can transfer from a community college to a four-year institution after a single semester and a fairly small number of credits. Arguably, students earning many credits pre-transfer might actually be less transfer-focused, particularly if those credits are earned toward an AAS degree, so this attempt to account for motivation is not entirely successful. In addition, Crosta and Kopko noted that the state where they conducted their research had a guaranteed transfer policy for AA and AS students but none for AAS students; therefore, their findings likely are most applicable to states with similar transfer contexts, and their study essentially functions as a effective assessment of the impact of an articulation policy instead of associate degree attainment per se.

In summary, current evidence on the effect of earning an associate degree pre-transfer is limited. Some strong recent studies have shown a likely positive impact of pre-transfer associate degree attainment (Crook et al., 2012; Belfield, 2013; Crosta & Kopko, 2014), but these studies draw on datasets from single states and, although illuminating, may not be generalizable beyond those states. In addition, these studies do not all deal effectively with selection bias, meaning that their estimates of the effect of earning an associate degree may not be identified due to stronger motivation or higher aspirations among associate degree-earning students that are unobserved in their data. Extending this line of work, our study draws upon a national sample of students, which distinguishes our work on this topic from those mentioned above which use localized samples, and two quasi-experimental approaches, namely propensity score matching and instrumental variable to address selection bias, approaches that go beyond previous work to strengthen causal inferences. As such, this study represents a clear and important contribution to

the literature on the role of earning an associate degree in shaping community college transfer students' success at four-year institutions. Specifically, we ask the following question: What is the effect of earning an associate degree on the academic performance and success of community college transfer students, measured by their GPA, credits earned, retention, and degree completion at four-year institutions? We adopt multiple measures of transfer students' performance and success, as they each speak to a distinct aspect of academic progress and attainment and have been each used in the college success literature. Including multiple outcomes thus reflects the complex nature of college success and could potentially gauge the influence of earning an associate degree on each of these measures, lending nuanced empirical insights into the topic.

Empirical Strategies and Procedures

Data and Sample

We employed the Beginning Postsecondary Students Longitudinal Study (BPS:04/09) and its supplementary Postsecondary Education Transcript Study (PETS:09) to answer our research question. The target population for BPS:04/09 was first-time postsecondary students beginning at any college or university in the United States and Puerto Rico in the 2003-2004 academic year. Data collection occurred at three points in time for the same cohort during a six-year time window after students first started postsecondary education, with the baseline study completed during the first year (2003-2004), the first follow-up during the third year (2005-2006), and the final follow-up in the sixth year (2008-2009). There were 18,640 eligible respondents in BPS:04/09, and among them nearly 15,000 students either partially or fully completed the interview. As part of the BPS:04/09 data collection, PETS:09 gathered student transcripts from eligible institutions attended by BPS cohort members between July 1, 2003 and

June 30, 2009. In total, PETS:09 contained transcript data for 16,960 sample members of the BPS:04/09 cohort.

For the purpose of our study, we included students who started at community colleges (defined as public two-year institutions) as their first postsecondary institution and transferred to four-year institutions during the study period. We further restricted our sample to respondents with complete transcript and attainment data in PETS:09, which allowed us to examine educational outcomes of community college transfer students with or without earning an associate degree prior to transfer, accounting for important course-taking information. After applying these criteria, our final analytical sample consisted of 1,140 students.

Measures

Definition of earning an associate degree prior to transfer. The key “treatment” variable of interest was *whether the respondent had earned an associate degree prior to transferring into a four-year institution*. With transcript data, we were able to identify the date by which students had earned an associate degree, and the date by which they transferred into four-year institutions.¹ Drawing upon this information, we coded earning an associate degree, $ASSOCIATE_{ij}$ for student i in region j , as 1 if the sampled students had ever earned an associate degree prior to their transfer date, and 0 if they had never earned an associate degree or earned it later than their transfer date.²

¹ For students who earned multiple associate degrees, we defined their associate degree status prior to transfer based on the first associate degree they obtained; similarly, for those who transferred multiple times, we based our coding on the first four-year institution students transferred into.

² This was a stringent definition for $ASSOCIATE_{ij}$ because we only considered the “associate degree treatment” valid if it happened earlier than transfer. In reality, some students might have technically fulfilled all requirements for earning an associate degree prior to transfer, but did not apply for the degree until after transfer. To account for this possibility, we explored an alternative definition of $ASSOCIATE_{ij}$ by relaxing the criteria: We coded $ASSOCIATE_{ij}$ as 1 if students had ever earned an associate degree prior to transfer *or within the first six months* of their transfer date and 0 otherwise, and subsequently estimated and compared our models based on the two definitions. Analysis using this more flexible definition of $ASSOCIATE_{ij}$ did not produce substantively different results; hence we only report findings based on the more stringent definition of variable $ASSOCIATE_{ij}$.

Outcome measures. We adopted the following outcome variables to measure community college transfer students' later success at four-year institutions: (1) *BACHELOR_{ij}*—whether students had completed a bachelor's degree as of 2009; (2) *RETENTION_{ij}*—whether students were still enrolled at a four-year institution or had already completed a bachelor's degree as of 2009; (3) *CREDITS_{ij}*—number of credits earned at four-year institutions; and (4) *GPA_{ij}*—cumulative GPA at four-year institutions as of 2009. Variables *BACHELOR_{ij}* and *RETENTION_{ij}* represented outcome measures often referenced in the college success literature, while credits earned and cumulative GPA allowed us to more holistically capture aspects of students' academic performance at four-year institutions.

Covariates. Given our interest in the impact of earning an associate degree on later education outcomes of community college transfer students at four-year institutions, it was critical to account for background influences that may create potential selection between students with different associate degree attainment status. Thus, we controlled for a set of demographic, family, academic preparation, and college experience variables that could affect students' educational decision or performance. Based on prior literature, these covariates included demographic background characteristics such as age, gender, race, family income, and parental educational and linguistic backgrounds that often shape community college students' educational pathways and attainment (e.g., Bailey, Alfonso, Scott, & Leinbach, 2004; Velez & Javalgi, 1987; Perna & Titus, 2005; Wang, 2012). As educational attainment also depends on academic preparation (Bailey et al., 2004; Wang, 2012), we accounted for this factor by including measures such as students' GPA and attempted number of remedial courses as these variables are among the most salient indicators of academic preparation and performance. Also, we controlled for students' postsecondary degree expectations, given that educational expectations are close

correlates to eventual attainment (Laanan 2003; Wang, 2013). There is also empirical ground for the potential link between college integration and community college students' outcomes (Barnett, 2011; Deil-Amen, 2011), so we took into consideration student interaction with faculty, academic advisors, and study groups during the first year of college. Also, we controlled for the “risk index,” a constructed measure in the BPS dataset based on the sum of seven possible characteristics that may adversely affect student persistence and attainment. The seven characteristics are: delayed enrollment, no high school diploma, part-time enrollment, financial independence, having dependents, being a single parent, and working full-time while enrolled. Finally, when estimating the effect of associate degree attainment on post-transfer outcomes at four-year institutions, we took into consideration the percentage of credits transferred as both a covariate in the naïve (i.e., baseline) estimates and a form of robustness check in later specifications. Table 1 presents a detailed description of variables used in the study.

[Insert Table 1 about here.]

Analytic Strategies

Baseline analysis. We first conducted ordinary least squares (OLS) analyses for the continuous outcome variables and probit estimation for the dichotomous outcome variables. These two approaches yielded baseline estimates that compared the outcomes of students with different associate degree attainment status prior to joining four-year institutions, while controlling for a set of observable characteristics outlined in Table 1. We estimated the following equation:

$$OUTCOME_{ij} = \alpha_1 ASSOCIATE_{ij} + \alpha'_2 \mathbf{X}_{ij} + REGION_j + \varepsilon_{ij} \quad (1)$$

where $OUTCOME_{ij}$ for student i in region j is each of the following outcomes in separate estimations: $BACHELOR_{ij}$, $RETENTION_{ij}$, $CREDIT_{ij}$, and GPA_{ij} . $ASSOCIATE_{ij}$ indicates

whether the student had earned an associate degree prior to transfer, \mathbf{X}_{ij} is a vector of relevant covariates, α'_2 is a row vector of coefficients, $REGION_j$ represents the region fixed effects,³ and ε_{ij} is the error term. We should note that we also explored institution and state fixed effects. However, because most of the institutions represented in the sample we selected had only one or two observations, we did not have enough variation in the data to control for institution fixed effects. In addition, the complex survey design of BPS already adjusts for state-level stratification in the sampling process. Therefore, we used regional fixed effects instead of state or institution fixed effects to account for any additional regional differences. We should also point out that, by accounting for regional fixed effects, we also addressed the multi-level nature of our data (i.e., institutions nested within regions), given that the fixed effects model allowed us to compare the observations within a region by controlling for regional-level unobservable factors that might be correlated with the observed explanatory variables (Wooldridge, 2010).

Accounting for self-selection. To address the issue of self-selection, we employed two complementary quasi-experimental approaches in our study: propensity score matching (PSM) and instrumental variable (IV). A few scholars (e.g., Long & Kurlaender, 2009) have resorted to multiple strategies, such as using PSM and IV together to address selection issues, when studying community colleges, as this approach helps triangulate the impact of the “treatment” under study. In the following, we discuss these approaches and how using them in combination helps strengthen the study’s casual inferences. First, we employed the PSM approach (Rubin, 1974, 1976), which helps balance the “treatment” and “control” groups (transfer students with an

³ We conducted fixed effects models based on the following regions where the community colleges students attended are located: New England (CT, ME, MA, NH, RI, VT), Mid East (DE, DC, MD, NJ, NY, PA), Great Lakes (IL, IN, MI, OH, WI), Plains (IA, KS, MN, MO, NE, ND, SD), Southeast (AL, AR, FL, GA, KY, LA, MS, NC, SC, TN, VA, WV), Southwest (AZ, NM, OK, TX), Rocky Mountains (CO, ID, MT, UT, WY), Far West (AK, CA, HI, NV, OR, WA), and other jurisdictions (PR).

earned associate degree prior to transfer and those who transferred without an associate degree) based on a set of student characteristics and academic variables prior to transfer. By creating balancing scores from possibly observed covariates, the PSM technique adjusts for statistical settings to be more similar to randomized experiments to reduce the influence of self-selection (Steiner & Cook, 2013).

More formally, let $z_i = 1$, or 0 where z_i is assigned to the treatment (with an associate degree) or control group (without an associate degree) respectively. The propensity score (PS) is the conditional probability of selection into a particular treatment ($z_i = 1$) versus non-treatment ($z_i = 0$) given a vector of observed covariates, \mathbf{x}_i , and is formally written as,

$$PS_i = Pr(z_i = 1 | \mathbf{x}_i) = p(z_i) \quad (2)$$

To obtain propensity scores, a logistic or probit model can be estimated using a binary dependent variable indicating whether a student transferred with or without an associate degree, and a set of relevant covariates as the independent variables. Propensity scores can be obtained by calculating the fitted value from the logistic or probit model. In this study, we selected a number of background and early college variables that could predict students' decision to earn an associate degree (Table 1). Then, we used a probit model to estimate the propensity of the students to be in the treatment group (earning an associated degree prior to transfer) given the selected covariates. Figure 1 presents the histogram of the estimated propensity scores for transfer students who had an associate degree, compared with those for students who did not earn an associate degree prior to transfer. Based on the visual displays, the common support (i.e., the overlapping in the propensity score ranges between the treatment and control groups) is sufficient.

[Insert Figure 1 about here.]

We then applied several different matching methods to find relevant control observations. In general, with large sample sizes and a sufficient overlap in the distribution of the propensity scores, most matching algorithms will yield similar results (Dehejia & Wahba, 2002). Given that our study's sample size is not particularly large as a whole as well as specifically for both the treatment and control groups, we compared different matching methods, namely, stratification matching and nearest neighbor matching, both common procedures in PSM. This approach helps ensure that the result is not sensitive to the specific matching method being used.

Stratification matching is used to first partition the sample into strata based on the values of propensity scores (Rosenbaum & Rubin, 1983). The initial sample was sorted and split into multiple equal intervals based on the propensity scores. Within each interval, the average propensity score of the treated and the untreated should not statistically differ. If there is significant difference of the propensity scores between the treatment and control group within a certain interval, the interval would be split into half until the two groups are balanced, meaning that there are no longer statistical differences in the covariates between those who earned an associate degree and those who did not. This matching method can be viewed as estimating the average treatment effect within each stratum, and the covariate distribution should be similar within a stratum. In our case, we created six strata/blocks in order to find balanced propensity scores between treatment and control groups within each stratum. Table 2 shows the comparison of the mean propensity scores. The *p*-values in Table 2 indicate that there were no significant differences in the means of propensity scores between those who earned an associate degree prior to transfer and those without one. After making sure that each stratum was balanced, we could thereby test the average treatment effect on educational outcomes within each stratum.

[Insert Table 2 about here.]

To ensure that these results are consistent, we also conducted nearest neighbor matching that helps pair each treatment observation with a control observation that has the closest characteristics. We adopted this matching approach with replacement because we can reduce bias by finding more similar control cases to the treated ones (Dehejia & Wahba, 2002). We first sorted the sample based on their estimated propensity scores, and then for each treated case (a student who transferred with an earned associated degree), we searched forward and backward for a closest control case. After finding all appropriate nearest neighbors, the subsequent average treatment effect of the treated was estimated.

While the PSM approach excels at balancing the two groups of students based on observable characteristics, it cannot account for systematic group differences in characteristics that are not observed in the available data. Although we controlled for many observable characteristics in the regression and PSM models, earning an associate degree can still be endogenous because there may exist theoretically relevant but unobserved and unobservable variables that were not included in our data.

Therefore, to help strengthen our study's causal inference, we adopted another quasi-experimental strategy, instrumental variable (IV), to mitigate this limitation. IV is crucial in modern econometrics, and was first discussed by Philip G. Wright (1928). The major contribution of IV was its ability to estimate the effect of an endogenous regressor, which standard OLS or PSM analysis cannot achieve. In our context, the instrument has to be related with earning an associate degree, but unrelated with the unobservable factor (ε_{ij}) that can predict the outcome variables. We could then estimate:

$$ASSOCIATE_{ij} = \beta_1 INSTRUMENT_{ij} + \beta_2' \mathbf{X}_{ij} + REGION_j + \varepsilon_{ij} \quad (3)$$

where *INSTRUMENT* is exogenous and not correlated with the error term (ε_{ij}) after controlling

for the observable covariates (\mathbf{X}_{ij}) and regions. Then we could use the predicted value ($\widehat{ASSOCIATE}_{ij}$) to estimate the original equation (1).

In this study, we used the number of non-transferred, non-remedial credits students earned at community colleges, *conditional upon credit transfer rate*, as our instrument, where $CREDITS_NT_{ij}$ was defined as the total non-remedial credits⁴ students earned at community colleges, their original institutions, minus credits students transferred from community colleges to four-year institutions. The number of non-transferred, non-remedial credits would be highly related to whether students would earn an associate degree or not because those who earned more community college credits would be more likely to fulfill the associate degree requirement. Meanwhile, the decision that these credits were nontransferable was made by four-year institutions and would seem to be independent from students' characteristics. (There are a number of assumptions underlying the adoption of an IV approach. To conserve space, we provide a detailed discussion of these assumptions and how we addressed them in the Appendix.)

Adopting an IV approach, we estimated the following two-stage least squares (2SLS) regression:

$$ASSOCIATE_{ij} = \beta_1 CREDITS_NT_{ij} + \boldsymbol{\beta}'_2 \mathbf{X}_{ij} + REGION_j + \varepsilon_{ij} \quad (4)$$

$$OUTCOME_{ij} = \gamma_1 \widehat{ASSOCIATE}_{ij} + \boldsymbol{\gamma}'_2 \mathbf{X}_{ij} + REGION_j + \mu_{ij} \quad (5)$$

In the first stage, we used $CREDITS_NT_{ij}$ to instrument the probability of earning an associate degree, controlling for regional fixed effects and a variety of background characteristics.

$CREDITS_NT_{ij}$ is not correlated with μ_{ij} , and the coefficient β_1 in the first stage is not zero.

Therefore, γ_1 can be consistently identified. In addition, because the endogenous variable,

⁴ Based on the data, transfer students in general took few remedial courses, indicating that this student population represents an academically advantaged group among community college students.

$ASSOCIATE_{ij}$, is a binary variable, we estimate probit models in the first stage as recommended by Wooldridge (2010).

For all our analyses, we adjusted for the complex survey designs of BPS and PETS by accounting for the multi-stage sampling and sampling weight (WTD000). To deal with the singleton primary sampling unit (PSU) in a stratum, we applied the scaled option⁵ in STATA because some of the PSUs were not chosen with certainty. This approach would increase the standard error, but would give us a more conservative estimate. We used listwise deletion and did not impute missing values because the missing values almost all occurred in the transcript data, likely due to random administrative errors, and are uncorrelated with students' educational decisions or performance.

Results

Table 3 presents the baseline OLS and probit estimation results. Without dealing with selection bias, we found that compared to their counterparts who did not earn an associate degree prior to transfer, transfer students who had an associate degree showed no statistically significant differences in bachelor's degree attainment, retention, or GPA, but earned significantly fewer credits at four-year institutions. However, these estimates are limited in their utility because students can self-select into the treatment (earning an associate degree).

[Insert Table 3 about here.]

We present the results from the PSM in Table 4. The first row shows the coefficients of the effect of earning an associate degree after controlling for the propensity scores. The second and third rows present estimates of the average treatment effect on the treated (ATT) using stratification matching and nearest neighbor matching respectively. The results largely show that

⁵ The scaling factor comes from using the average of the variances from the strata with multiple sampling units for each stratum with one PSU.

earning an associate degree pre-transfer did not lead to better post-transfer educational outcomes when controlling for observed covariates and possible selection-bias. Only in one specification (i.e., estimating average treatment effect on the treated using stratification matching) did earning an associate degree have a slightly positive impact on the retention rate. However, this result was not observed in other specifications. In addition, associate degree attainment prior to transfer still seems to negatively influence the number of credits students earned at four-year institutions. The results from the PSM are substantively similar to those from the baseline models.

[Insert Table 4 about here.]

Table 5 describes results from the IV approach. The instrument had high predictive power in explaining our main variable of interest – earning an associate degree – with all F statistics larger than 10.0. After accounting for the unobservable and unobserved factors using an IV approach, we found no impact of earning an associate degree on any of the educational outcomes at four-year institutions.

[Insert Table 5 about here.]

Discussion

Our baseline estimates show no apparent impact of earning an associate degree prior to transfer, other than a smaller number of credits earned among students who transferred with an associate degree compared to those without it. After we applied the PSM and IV approaches to account for self-selection bias, the results still by and large point to no statistically significant association between earning an associate degree prior to transfer and most of the post-transfer outcomes we examined, except a negative effect on credits earned in one of the PSM estimations. Therefore, our study suggests that, generally, students transferring upward to a four-

year institution from a community college are likely to have similar outcomes regardless of whether they earned an associate degree before they transfer.

This largely null effect of earning an associate degree on post-transfer success is perhaps unexpected, given that earning this degree has significant implications for students' future earnings and career success, among other things. However, considering the national dataset from which we drew our sample of students, this null finding may not be surprising. We know that transfer and articulation policies vary across institutions, systems, and states. Therefore, an aggregate null effect may not mean that earning an associate degree has no impact within specific state contexts; instead, it may mean that the impact varies across contexts, improving outcomes in some while worsening outcomes in others. Our findings differ from the positive impact of a transfer-oriented degree on bachelor's degree completion identified by recent research (e.g., Crosta & Kopko, 2014). However, we should note that datasets used by Crosta and Kopko included students from a single state, while ours includes a national sample. Their sample is entirely appropriate for what we argue is a study that reveals the impacts of an articulation policy; however, it is possible that the postsecondary environment and system in the state from which they drew their data is one where earning an associate degree pre-transfer is particularly beneficial. On a national level, though, our data suggest that it is not.

Our work also builds on recent research while contributing new ideas that encourage reflecting on conclusions from other scholars. In particular, Bailey, Jaggars, and Jenkins (2015) and Jenkins and Cho (2013) discussed the benefits of guided pathways for community college students as opposed to a self-service cafeteria model (Bailey et al., 2015). They argue that colleges can and should redesign programs around the concept of guided pathways to enhance student success. Our findings suggest that pathways designed to help students transfer upward

and earn a bachelor's degree do not necessarily need to culminate in the attainment of an associate degree; instead, perhaps strong collaboration with four-year institutions to ensure the completion of needed entry requirements and facilitate bachelor's degree completion are better points of focus than completion of the associate degree. It is, of course, a rather large assumption that this would be feasible in many cases, as uncoordinated or nonexistent state higher education systems, as well as differences between public and private institutions, could stand in the way of the strong collaboration we suggest. Future research should delve into these nuanced policy implications by engaging in more in-depth case studies to further enrich this line of work.

The overall estimated null effect of earning an associate degree on post-transfer success suggests that in the United States, this degree has not evolved into one that leads to a seamless transfer pathway. However, we should reflect on whether this is a problem. To be sure, the associate degree is not meant only to encourage seamless transfer. Instead, perhaps this degree serves another fundamental purpose, signaling completion of a significant milestone in a student's educational career, and any effects of the degree on the post-transfer outcomes we measured are incidental. There is significant empirical evidence that the associate degree leads to meaningful benefits for students who do not earn a bachelor's degree (Abel & Deitz, 2014; Pew Research Center, 2014), so it is not as if students earning an associate degree pre-transfer are wasting their time in doing so, especially given that many will not complete their bachelor's degree post-transfer. In this sense, transfer students with an earned associate degree may still end up in a better position due to the earned credential that may lead to additional education and economic benefits. In addition, while not consistent across all estimations, the result indicating that transfer students who earned an associate degree prior to transfer accumulated fewer credits at four-year institutions could suggest that transferring with an associate degree may help avoid

excessive amount of coursework and alleviate financial burdens associated with higher tuition at four-year institutions.

Still, it seems only logical that institutions should seek to design associate degree programs that confer significant benefits and help prepare students for post-transfer success. These two aims of an associate degree are not necessarily in conflict with each other. A strong associate degree program that allows seamless transfer between two- and four-year institutions for those students seeking a higher credential while preparing other students for success in their careers and in the community may be the ideal to which institutions should aspire.

Limitations of the Study and Future Research

Like any empirical work, our research has several limitations. First, the IV approach we used, although extremely promising for accounting for selection bias in earning an associate degree, removes our ability to distinguish between the various types of associate degrees. Students earning an AA, AS, and AAS pre-transfer may well have different post-transfer outcomes. Even if we had chosen an approach that allows distinguishing between these degrees, the PETS data do not contain complete information on the type of associate degree earned that would allow us to make reliable distinctions between degree types. In addition, although BPS is the best possible dataset to answer our research question, students included in this dataset began in postsecondary education during 2003-04, a full decade ago. It is possible that significant changes in the American postsecondary landscape mean that the impact of the associate degree has changed over the past 10 years. Finally, although we believe the IV approach we used successfully accounts for selection bias, we still face the limitation that no variables in our dataset deal with student motivational attributes that explicitly speak to their interest and intent regarding credit accumulation in light of degree attainment.

While our study advances the literature on earning an associate degree pre-transfer, more research on this topic is necessary. On the quantitative side, future research could conduct separate analyses for students based on the type of associate degree earned. Other research has pointed to differential outcomes for students earning the AA, AS, and AAS, and it is possible that our findings might differ as well given a study designed explicitly to answer this question. Similarly, perhaps transfer outcomes vary depending on students' academic majors post-transfer. It is worth investigating whether the impact of earning an associate degree pre-transfer varies by field or discipline. In addition, research on this topic has been almost entirely quantitative to this point. Although the quantifiable outcomes related to earning an associate degree pre-transfer are important, there may be qualitative outcomes as well. Even if students are not more likely to complete a degree or earn more credits post-transfer, they may feel better about their experience at their four-year university or experience other benefits that are not easily observed and quantified but are nonetheless important. Finally, there also are political realities that are likely to encourage the completion of associate degrees pre-transfer. Degree attainment rates at two-year institutions appear very low, especially relative to four-year institutions, and students who transfer pre-credential likely will appear the same as a dropout when calculating a graduation rate for their two-year institution, even if attaining a bachelor's degree post-transfer. In the face of public scrutiny, community colleges may wish to encourage pre-transfer credential attainment as a way to better capture their success with these students and illustrate their contribution to the growing national effort to increase degree completion.

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Table 1

List of Variables

Outcome Variables	Description	Mean	SD
Bachelor's degree attainment	1=earned a bachelor's degree as of 2009; 0=otherwise	0.43	0.50
Retention	1= earned a bachelor's degree, or still enrolled at a 4-year school as of 2009; 0=otherwise	0.74	0.44
Credits	Total credits earned at 4-year institutions	61.53	37.68
GPA	Cumulative GPA at 4-year institutions	2.77	0.85
"Treatment" Variable			
Associate	1=earned an associate degree prior to transfer; 0=otherwise	0.23	0.42
Control Variables			
<i>Demographic background</i>			
Age	Age as of 12/31/03	19.56	4.33
Female	1=female; 0=male	0.57	0.49
Black	1=Black; 0=otherwise	0.14	0.35
Hispanic	1=Hispanic; 0=otherwise	0.12	0.32
Asian	1=Asian; 0=otherwise	0.05	0.23
Other minorities	1=other minorities, 0=otherwise (White is the reference category.)	0.05	0.23
Income group (low middle)	Income group 2003-04: 1=low middle; 0=otherwise	0.27	0.44
Income group (high middle)	Income group 2003-04: 1=high middle; 0=otherwise	0.25	0.43
Income group (high)	Income group 2003-04: 1=high; 0=otherwise (Low-income group is the reference category.)	0.20	0.40
<i>Academic preparation and motivation</i>			
GPA at first institution attended	Grade point average at first institution attended (4.0 scale)	2.96	0.75
Remediation	Transcript: number of remedial courses attempted	0.34	2.22
First-generation	1=Parents' education less than/equal to high school; 0=Parents' education greater than high school	0.34	0.47
English as primary language	1=English is the primary language 2003-04; 0=otherwise	0.88	0.33
Risk index*	Risk index and nontraditional indicators 2003-04	0.99	1.40
First institution distance	log(institution distance from home)	2.49	1.33
Degree expectations	1=expect to earn an associate degree or higher; 0=otherwise	0.96	0.19
Faculty informal meeting	Faculty informal meeting (1=never, 2=sometimes, 3=often)	0.38	0.58
Faculty talk outside class	Faculty talk outside class (1=never, 2=sometimes, 3=often)	0.90	0.62
Meet academic advisor	Meeting academic advisor (1=never, 2=sometimes, 3=often)	0.86	0.66
Study groups	Study groups (1=never, 2=sometimes, 3=often)	0.53	0.63
% of credits transferred	Percentage of credits transferred, first transfer	67.97	38.63

Note. *Risk index represents an index of risk based on the sum of seven possible characteristics that may adversely affect persistence and attainment. The seven characteristics are: delayed enrollment, no high school diploma, part-time enrollment, financial independence, having dependents, being a single parent, and working full-time while enrolled.

Table 2

Mean Propensity Scores for Associate Degree Earners (Treatment) versus Those Who Did Not Earn An Associate Degree (Control)

Blocks	Mean Propensity Scores		<i>P</i> value of t-test between means
	Control	Treatment	
Block 1	0.0395	0.0577	0.4192
Block 2	0.1552	0.1642	0.1131
Block 3	0.2494	0.2542	0.256
Block 4	0.3476	0.3477	0.9827
Block 5	0.4550	0.4564	0.8407
Block 6	0.7047	0.6510	0.4239

Table 3

The Impact of Earning an Associate Degree Prior to Transfer: Baseline Estimates

Variables in the model	Bachelor's degree	Retention	Credits earned at 4-yr institution	GPA at 4-yr institution
	Probit	Probit	OLS	OLS
Associate degree attainment prior to transfer	0.044 (0.200)	0.094 (0.246)	-14.23*** (4.086)	-0.028 (0.069)
Age	-0.002 (0.019)	-0.004 (0.023)	-0.216 (0.469)	-0.007 (0.013)
Female	0.161 (0.183)	0.215 (0.161)	-0.269 (4.209)	0.046 (0.066)
Black	-0.048 (0.303)	0.084 (0.272)	-1.114 (5.063)	-0.184 (0.182)
Hispanic	-0.432 (0.335)	0.159 (0.340)	-5.082 (5.309)	0.155 (0.120)
Asian	-0.428 (0.442)	0.302 (0.350)	6.696 (6.850)	-0.202* (0.121)
Other minorities	-0.077 (0.366)	-0.092 (0.366)	-12.63* (7.022)	-0.104 (0.138)
Income group (low middle)	-0.064 (0.207)	0.131 (0.214)	-2.783 (4.685)	0.002 (0.096)
Income group (high middle)	0.027 (0.247)	0.061 (0.230)	0.989 (6.111)	-0.060 (0.110)
Income group (high)	0.065 (0.250)	0.127 (0.216)	4.809 (5.835)	0.382*** (0.116)
GPA at first institution attended	0.637*** (0.158)	0.365*** (0.109)	15.230*** (3.202)	0.550*** (0.072)
Remediation	-0.010 (0.021)	0.064 (0.041)	0.631 (0.479)	0.007 (0.010)
First-generation	-0.344** (0.161)	0.018 (0.170)	-4.967 (3.293)	-0.046 (0.069)
English as primary language	-0.446 (0.309)	-0.424 (0.374)	-4.370 (5.806)	-0.076 (0.126)
Risk index	-0.127** (0.064)	-0.044 (0.074)	-4.664*** (1.488)	0.012 (0.046)
log(Institution distance from home)	0.012 (0.051)	-0.015 (0.054)	1.386 (1.397)	-0.023 (0.028)
Degree expectations	-0.481 (0.327)	-0.335 (0.304)	-7.234 (8.675)	-0.338 (0.211)
Faculty informal meeting	-0.029 (0.132)	0.020 (0.128)	3.048 (3.196)	0.073 (0.065)
Faculty talk outside class	0.121 (0.147)	-0.074 (0.128)	2.613 (2.880)	-0.081 (0.066)
Meet academic advisor	0.240* (0.137)	0.179 (0.128)	1.619 (2.922)	0.058 (0.053)
Study groups	-0.040 (0.128)	-0.084 (0.137)	-2.291 (2.846)	-0.101* (0.052)
% of credits transferred	0.007*** (0.003)	0.006** (0.003)	0.101* (0.057)	0.002 (0.001)
Region fixed effect	Yes	Yes	Yes	Yes
R-squared			0.263	0.306

Note. Standard errors in parentheses; complex survey design adjusted for in the analyses.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 4

The Impact of Earning an Associate Degree Prior to Transfer (Propensity Score Matching)

	Bachelor's degree	Retention	Credits earned at 4-yr institutions	GPA at 4-yr institutions
1. Associate degree attainment prior to transfer (Coefficient controlling for propensity scores)	0.007 (0.220)	0.072 (0.271)	-13.93*** (4.666)	-0.010 (0.094)
2. Average treatment effect on the treated (using stratification matching)	0.045 (0.042)	0.078*** (0.027)	-14.11*** (2.343)	0.092 (0.067)
3. Average treatment effect on the treated (using nearest neighbor matching)	0.048 0.052	0.070 0.044	-16.07*** (3.882)	0.036 (0.068)
Observations	894	894	893	876
R-squared			0.074	0.056

Note: Standard errors in parentheses; complex survey design was adjusted for in the analyses.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 5
The Impact of Earning an Associate Degree Prior to Transfer (Instrumental Variable)

Variables in the model	Bachelor's degree	Retention	Credits earned at 4-yr institutions	GPA at 4-yr institutions
	IV-probit	IV-probit	IV-regress	IV-regress
Associate degree attainment prior to transfer	0.223 (0.974)	0.698 (0.777)	-34.83 (22.46)	-0.447 (0.383)
Age	-0.003 (0.025)	-0.010 (0.027)	-0.031 (0.500)	-0.002 (0.014)
Female	0.165 (0.191)	0.226 (0.166)	-1.071 (4.287)	0.030 (0.072)
Black	-0.064 (0.287)	0.031 (0.292)	0.426 (5.427)	-0.146 (0.180)
Hispanic	-0.464 (0.364)	0.041 (0.343)	-1.146 (7.740)	0.242 (0.156)
Asian	-0.397 (0.467)	0.381 (0.359)	4.013 (7.478)	-0.252* (0.136)
Other minorities	-0.073 (0.375)	-0.075 (0.356)	-13.05* (6.972)	-0.104 (0.143)
Income group (low middle)	-0.061 (0.213)	0.140 (0.209)	-3.178 (5.068)	-0.002 (0.101)
Income group (high middle)	0.023 (0.258)	0.077 (0.229)	0.006 (6.821)	-0.082 (0.116)
Income group (high)	0.0650 (0.257)	0.137 (0.220)	4.215 (6.080)	0.373*** (0.123)
GPA at first institution attended	0.615*** (0.142)	0.281** (0.133)	17.46*** (3.618)	0.597*** (0.074)
Remediation credits attempted	-0.012 (0.023)	0.055 (0.049)	0.880 (0.593)	0.012 (0.009)
First-generation	-0.349** (0.165)	0.019 (0.184)	-5.266 (3.203)	-0.056 (0.069)
English as primary language	-0.448 (0.306)	-0.418 (0.351)	-4.083 (6.677)	-0.068 (0.126)
Risk index	-0.121 (0.081)	-0.0165 (0.079)	-5.468*** (1.924)	-0.010 (0.050)
log(Institution distance from home)	0.0121 (0.052)	-0.010 (0.049)	1.240 (1.559)	-0.027 (0.028)
Degree expectations	-0.523 (0.396)	-0.455 (0.319)	-2.768 (10.21)	-0.245 (0.236)
Faculty informal meeting	-0.025 (0.131)	0.023 (0.126)	3.027 (3.148)	0.074 (0.068)
Faculty talk outside class	0.100 (0.146)	-0.123 (0.121)	3.913 (3.405)	-0.054 (0.076)
Meet academic advisor	0.254* (0.136)	0.204 (0.127)	0.949 (3.176)	0.042 (0.059)
Study groups	-0.046 (0.128)	-0.089 (0.137)	-2.098 (2.954)	-0.098* (0.056)
% of credits transferred	0.007** (0.003)	0.005 (0.003)	0.103* (0.058)	0.002 (0.001)
Region fixed effect	Yes	Yes	Yes	Yes
F-stat of 1st stage	62.80	62.80	62.38	60.40

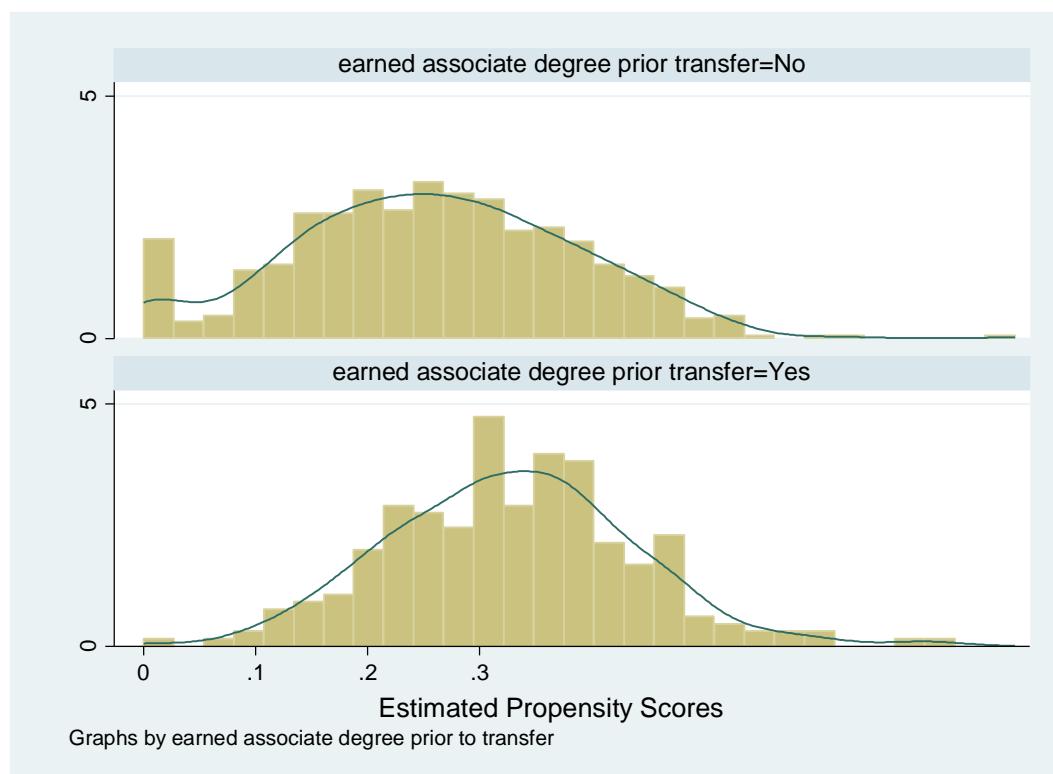
Note. Standard errors in parentheses; complex survey design adjusted for in the analyses.

Associate degree is instrumented using non-transferred, non-remedial credits, conditional upon % of credits transferred.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Figure 1

Histogram of Estimated Propensity Scores for the Associate Degree Earners versus Those Who Did Not Earn An Associate Degree



Appendix: Assumptions Underlying Instrumental Variable (IV)

Several assumptions underlie the application of an IV approach. First, the instrument should be similar to a randomly assigned treatment that had no direct relationship with the outcome variable, after controlling for relevant covariates. In our study, the number of non-transferred credits would be highly related to whether students would earn an associate degree or not because those who earned more community college credits would be more likely to fulfill the associate degree requirement. We removed remedial credits from the calculation of the IV, as remedial credits would not count toward an associate degree. We also eliminated transferred credits earned at community colleges since they would directly affect outcomes at four-year institutions such as baccalaureate completion. In addition, it is likely that non-transferred credits were earned for the express purpose of completing an associate degree rather than with the intent of contributing to post-transfer success among those students who were aware of which courses were likely to transfer. Since students chose and completed their community college courses before transferring to their four-year institution, it is reasonable to assume that after controlling for credit transfer rate, the number of non-transferred credits earned at community colleges was not directly related to later education outcomes other than through the effect of earning an associate degree.

Second, there should be no spillover effects between students with different treatment status. In our case where earning an associate degree was the treatment, we required an instrument that predicted students' treatment status, but the treated students did not have channels to share their treatment and affect un-treated students' later education outcomes. As students in the treatment group gained the attainment status from earning an associate degree, which is not something they would be able to share with the control group, this assumption

should hold.

Third, the instrument would affect the outcome variable only through the endogenous dependent variable of interest, meaning that in our case, our chosen instrument should affect students' outcome variables only through whether they had earned an associate degree and not through other channels. At this point, we should note a potential threat to the validity of our instrument—the percentage of credit loss from transfer. Although they are different concepts, the number of nontransferable credits and the percentage of total community college credits that transfer to four-year institutions may well be correlated. Given the recent literature that community college transfers who had a higher percentage of credits transferred would have higher odds of graduation than those who had lower percentage of credits transferred (Monaghan & Attewell, 2014), we addressed this concern by controlling for percentage of credits transferred, using transcript records. Intuitively, imagine that although the percentage of credits transferred from the original community college could affect later education outcomes (e.g., bachelor's degree attainment and retention), given that the rate of credits transferred was fixed, those non-transferable credits could only reflect the possibility of earning an associate degree and are no longer related to later educational outcome variables. Our instrument would be valid once we controlled for this variable.

Fourth, the instrument should be correlated with the endogenous variable of interest—*ASSOCIATE_{ij}*. To verify this fourth assumption, we tested whether the instrument was strong enough by examining the F-statistic in the first stage of analysis. Our results indicate that all F statistics were much greater than 10.0, which suggest that the maximum bias in IV estimators would be less than 10 % (Staiger & Stock, 1997). Overall, using the IV approach, we were more confident about the causal inferences of our findings.