Community College Transfer Student Pathways in Virginia

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APPROVAL OF THE DISSERTATION

This dissertation, *Community College Transfer Student Pathways in Virginia,* has been approved by the Graduate Faculty of the Curry School of Education and Human Development in partial fulfillment for the degree of Doctor of Philosophy.

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TABLE OF CONTENTS

DEDICATION

I dedicate this dissertation to my wife, Clarissa, and my parents, Kathy and Chuck. None of this would be possible without your continued support. Thank you for always being there for me.

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LIST OF TABLES

LIST OF FIGURES

LINKING DOCUMENT

Community colleges are the starting point to higher education for approximately 35 percent of American college students, many of whom are from underrepresented racial/ethnic minority groups and/or low-income backgrounds (Ginder, Kelly-Reid, & Mann, 2018). In addition to being more affordable, community colleges offer open access admissions policies and provide a pathway to four-year colleges. Although only 30 percent of students who start at a community college eventually transfer to a four-year institution, this group makes up approximately two million students annually (Ginder, Kelly-Reid, & Mann, 2018).

Despite a substantial body of research on community college transfer student experiences and outcomes, very little work has examined the relationship between the selectivity of the four-year transfer destination and graduation outcomes (Bowen, Chingos, & McPherson, 2009; Hilmer, 2002). Ample research focusing on native students (those who begin their post-secondary studies in the four-year sector) overwhelmingly finds that higher quality colleges, defined by some combination of selectively and institutional resources, are related to better graduation outcomes (Bowen, Chingos, & McPherson, 2009; Cohodes & Goodman, 2014; Hoekstra, 2009; Zimmerman, 2017). However, there are several reasons why the same patterns may not hold for transfer students. Transfer students spend approximately half as much time at the four-year college and routinely experience "transfer shock," which is commonly defined as a temporary drop in grades the semester after transferring (Hills, 1965; Ishitani, 2008). They also enter four-year colleges after many students have already established social groups and relationships with faculty members, which are important predictors of success (Mayhew et al., 2016).

Community college transfer students are a particularly important part of higher education in Virginia, where the state has made specific commitments to facilitate their success. For example, in 2007, Virginia established a transfer grant that provides eligible community college transfer students with $1,000 to help with their transition into a four-year college in the state (SCHEV, 2019). Each year, approximately 11,000 students transfer from one of 24 community colleges to a four-year college in Virginia (SCHEV, 2019). Virginia is also home to a robust set of Guaranteed Admissions Agreements (GAAs) that provide formal pathways between community colleges and four-year institutions for students who earn an academic associate degree and a specified GPA prior to transfer. Additionally, Virginia has seen an increase in transfer students over the past decade, particularly for students from underrepresented racial/ethnic minority (URM) backgrounds, with the number of URM transfer students almost doubling between 2010 and 2017 (from 2,606 to 5,034, SCHEV, 2019).

The goal of this dissertation is to add to the literature on college selectivity and transfer student graduation outcomes in three valuable ways. The first chapter lays out a rich descriptive analysis of transfer patterns in Virginia and addresses the extent to which students who transfer to more selective colleges have more favorable graduation outcomes. The second chapter discusses how rurality and the distance between community colleges and four-year institutions of various levels of selectivity plays a role in enrollment and graduation outcomes. The third chapter aims to eliminate the problem of self-selection inherent in the first and second chapters and identifies the causal effect of attending a more selective college on bachelor's degree completion, bachelor's degree completion in 6 years, and time-to-degree.

The first chapter uses logistic and ordinary least squares (OLS) regressions and shows descriptive evidence that, for the most part, students who transfer to colleges at higher levels of

selectivity relative to non-selective institutions are significantly more likely to earn a bachelor's degree, earn a bachelor's degree in 6 years, and take significantly less time to complete that degree, controlling for background characteristics (race, gender, parents' income, and age at the time of transfer), community college experiences (credits earned before transfer, transfer GPA, and associate degree status), and an indicator for transferring multiple times across four-year institutions. The first chapter also explores how these independent variables are related to graduation outcomes. Many common patterns found in the native student literature are confirmed by presented analyses. Most notably, students from underrepresented racial/ethnic minority (URM) and low-income backgrounds are significantly less likely to earn their bachelor's degree and take significantly more time to earn that degree than students from non-URM and higher income backgrounds. The first chapter also contributes to the discussion on the relationship between earning an associate degree prior to transfer and bachelor's degree completion. Whereas previous research has found mixed results across different states (Jenkins & Fink, 2016), students in Virginia who earn an academic associate degree are significantly more likely to complete a bachelor's degree than students who do not earn an associate degree, controlling for background characteristics and other community college experiences.

However, several patterns stand out as unique in comparison to students who begin their postsecondary studies at a four-year college. First, community college transfer students across different income quartiles are approximately equally likely to transfer to the most selective colleges in Virginia. Among native students, those from higher income quartiles are considerably more likely to attend the most selective colleges (NCES, 2019). Second, a majority of transfer students who are qualified to attend the most selective colleges, based on their GPA, choose to transfer to less selective colleges. While these patterns generally resemble those noted in

research on enrollment patterns across different institutional types (Black & Smith, 2004; Bowen, Chingos, & McPherson, 2009; Smith, Pender, & Howell, 2013), scholars have yet to investigate undermatching among community college transfer students. Third, underrepresented racial/ethnic minority (URM) students graduate at statistically indistinguishable rates compared to their non-URM peers at the most selective colleges in the state, which is not the case among native students (Massey, 2006; IPEDS, 2019).

There are also important findings related to differential benefits associated with selectivity across various sociodemographic groups. Some examples include the finding that URM students benefit significantly less compared to their non-URM peers by attending selective and very selective colleges relative to non-selective institutions in terms of bachelor's degree completion, and that females benefit significantly more than males in terms of bachelor's degree completion in 6 years and time-to-degree by attending selective and very selective institutions relative to non-selective ones. At the same time, interaction terms between parents' income quartiles and selectivity are generally not statistically significant.

The second chapter of the dissertation investigates transfer patterns as they pertain to geographic considerations. In particular, I examine whether rural compared to suburban community college transfer students (a) are equally likely to attend four-year colleges at varying levels of selectivity, (b) have different graduation outcomes (bachelor's degree completion, bachelor's degree completion in 6 years, and time-to-degree), and (c) benefit differentially from attending colleges at various levels of selectivity. Rural transfer students are particularly important to study in Virginia for several reasons. First, there are significantly more rural transfer students in Virginia compared to the national average (31 percent in Virginia vs. approximately 18 percent nationally) (Wells, Manly, Kommers, & Kimball, 2019). Second, the lack of

representation of rural students at the most selective colleges in the state is fairly well documented (i.e., UVa Enrollment Map, 2019). Third, rural students often face more difficulty adjusting to college than students from suburban areas (Hillman, 2016) and thus may not experience the same benefits of attending more selective colleges as students from suburban communities.

The findings in this chapter reveal a significant disadvantage in terms of both enrollment and graduation outcomes for rural community college students compared to their suburban peers. On a descriptive level, significantly fewer rural community college students transfer to the most and very selective colleges in the state compared to suburban students. Both of these differences are also large in magnitude: 4 percent of rural students enroll at the most selective colleges compared to 6 percent of suburban students; and 25 percent or rural students enroll at very selective colleges compared to 33 percent of suburban students. Additionally, a multinomial logistic regression model shows that rural students continue to be disadvantaged in enrollment at the most and very selective colleges even after controlling for background characteristics, community college experiences, and multiple transfer. With regards to graduation outcomes, both descriptive and regression estimates indicate that rural community college transfer students graduate at significantly lower rates than their peers from suburban areas. Additionally, among students who complete a bachelor's degree, those from rural areas take significantly longer compared to their peers from suburban areas. Finally, rural community college transfer students overall benefit significantly less than suburban students from attending institutions at higher levels of selectivity compared to attending non-selective colleges.

Despite the value of these descriptive chapters, it is possible that the benefits to graduation outcomes associated with attending a more selective college are driven by self-

selection and not institutional selectivity. It may be that students who transfer to more selective colleges are more likely to graduate anyways. To account for the problem of self-selection, the third chapter leverages GPA thresholds in Guaranteed Admissions Agreements (GAAs) between community colleges and four-year institutions in Virginia to identify the causal effect of attending a more selective college on bachelor's degree completion, bachelor's degree completion in 6 years, and time-to-degree. Using a multiple cut-point regression discontinuity design (RDD), it is possible to compare the graduation outcomes for students who just missed a GAA GPA threshold against students who just made the threshold to estimate the causal effects of attending a more selective college. This methodology has gained popularity in recent years in higher education research (Cohodes & Goodman, 2014; Hokestra, 2016; Goodman, Huriwitz, & Smith, 2017) and is widely considered one of the most compelling quasi-experimental methods in econometric design (Angrist & Pischke, 2015).

In a standard RDD framework (known as sharp RDD), treatment and control groups are determined based on a sharp threshold with no non-compliance. This means that all observations on and to the right of the threshold are assigned to the treatment group and all observations to the left of the threshold are assigned to the control group. However, in the case I study, students on the left of the threshold may still earn acceptance to a more selective college without guaranteed admission through the traditional application review process. Similarly, some students are eligible for a more selective college based on the GAA requirements, but choose to nonetheless attend a less selective college. To account for this non-random non-compliance with the GAA GPA thresholds, I adjust the RDD model to leverage the offer of guaranteed admission as an instrument for transferring to a more selective college. This "fuzzy" RDD specification allows

me to estimate the causal effects of transferring to a more selective college on graduation outcomes, accounting for students who did not enroll using the GAAs.

Although there are several major thresholds that determine guaranteed transfer eligibility to almost all four-year colleges in Virginia, only the highest GPA threshold generates strong exogenous variation in the probability of enrolling in a more selective college. Given these circumstances, this chapter estimates the causal effect for attending a more selective college at the 3.4 GPA threshold. These estimates reveal that students who just make the 3.4 GPA threshold are 18 percentage points more likely to complete a bachelor's degree and 47 percentage points more likely to complete a bachelor's degree in 6 years. Despite results that are large in magnitude, these estimates are not statistically significant because of a very small treatment group at the 3.4 GPA threshold (only 7 percent of the sample around this threshold transfers to a more selective college), which leads to large standard errors. Explanations for the lack of strong exogenous variation at other thresholds are also explored in further detail in the chapter.

Overall, this dissertation contributes to the existing body of literature on college selectivity and transfer student outcomes in the following ways. The first chapter provides a descriptive understanding of how background characteristics and community college experiences are related to enrollment at colleges of varying levels of selectivity, and how all of those factors (selectivity, background characteristics, and community college experiences) are associated with graduation outcomes. Previous research has focused primarily on examining these relationships for students who begin college in the four-year sector. The second chapter explores rurality as it relates to both enrollment patterns and graduation outcomes, which adds to the limited body of research on rural community college transfer students. Finally, the third chapter aims to

eliminate the problem of self-selection and adds causal evidence to the discussion on college selectivity and graduation outcomes for community college transfer students.

College Selectivity and Transfer Patterns in Virginia

By: Matt Ericson

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Chapter 1 of Dissertation

Abstract

This chapter relies on a longitudinal data set that contains enrollment information for all community college students who began their postsecondary studies between 2001 and 2012 and subsequently transferred to a four-year institution in Virginia. Previous research on transfer students has demonstrated that various factors from sociodemographic characteristics to specific community college experiences are associated with graduation outcomes. However, this research has rarely examined how the selectivity of the four-year transfer destination may be related to graduation outcomes. Results suggest that students who attend more selective colleges are more likely to complete a bachelor's degree and take fewer years to earn their degree, controlling for background characteristics and community college experiences. The results also show differential benefits across all three outcome measures on a variety of background characteristics.

Introduction

Community colleges are the access point to higher education for approximately 35 percent of undergraduate students in the United States, many of whom are from underrepresented racial/ethnic minority groups and/or low-income backgrounds (Ginder, Kelly-Reid, & Mann, 2018). Although one of the principle goals of community colleges is to prepare students for transfer to a four-year institution (Alfonso, 2006), and as many as 80 percent of community college students intend to transfer, only 30 percent actually do so (Jenkins & Fink, 2016). Nevertheless, students who do make the transition from a two- to a four-year college account for a sizable group in the postsecondary education system: approximately one million students transfer from a two-to four-year institution annually (Shapiro et al., 2018).

On average, community college transfer students earn bachelor's degrees (BA) at significantly lower rates than their native peers (i.e., students who begin in four-year institutions). In 2016, 42 percent of transfer students earned a BA within six years relative to 60 percent of native students (Shapiro et al., 2017). There are myriad factors that help explain this gap. Some scholars have argued that community colleges are not suited to those hoping to pursue a BA degree and potentially reduce educational aspirations (Clark, 1960; Brint & Karabel, 1989). Others have pointed out that transfer students generally arrive at four-year colleges with lower levels of academic preparation (Reynolds, 2012), which can lead to transfer shock (Hills, 1965). Additionally, some research has suggested that students fail to transfer a significant percentage of their credits earned at the community college, which leads to delayed or even forgone graduation (Cullinane, 2014; West, 2015). There is also some indication that earning an associate degree before transfer is related to BA completion, but the relationship varies across states (Kopko & Crosta, 2016; Jenkins & Fink, 2016).

Despite the growing scholarly research on transfer students, studies have yet to dedicate much attention to examining how a student's decision of where to transfer is related to BA completion and time-to-degree. Extensive research on native four-year students indicates that the selectivity of the institution is important for degree completion (Cohodes & Goodman, 2014; Hoekstra, 2009; Zimmerman, 2014), but very few studies of transfer students have examined how selectivity of four-year institutions is related to transfer student outcomes (Hilmer, 2000; Bowen, Chingos, & McPherson, 2009). Moreover, studies have not examined whether students from different racial/ethnic, gender, and income backgrounds transfer to similar types of four-year institutions and whether that is related to their educational outcomes. In this chapter, I aim to fill that gap in the literature by exploring the relationship between four-year college selectivity and graduation outcomes as well as variation in those relationships for students from different racial/ethnic, gender, and income backgrounds.

Literature Review

Inequality in Higher Education

Underrepresented racial/ethnic minority (URM) and low-income students are less likely to enroll in college relative to their non-URM and higher income peers (Bowen, Chingos, & McPherson, 2009; Cahalan et al., 2018; Carnevale & Strohl, 2010; Deane et al., 2017; Jenkins & Fink, 2016; McFarland et al., 2019; and Taylor & Cantwell, 2019). In 2017, 41 percent of White and 65 percent of Asian students between 18- and 24-years-old were enrolled in college compared to 36 percent of Black, 36 percent of Hispanic, and 20 percent of American Indian students (McFarland et al., 2019). There is also a strong positive correlation between parents' income quartile and college enrollment. Approximately 80 percent of students in the highest

income quartile enrolled in college in 2016 compared to 70 percent in the third quartile, 59 percent in the second quartile, and 47 percent in the first quartile (Cahalan et al., 2018).

Moreover, when URM and low-income students enter higher education, they are more likely to do so through community colleges. For example, among students who began their postsecondary studies in 2010, 48 percent of Hispanic, 46 percent of Native American, and 39 percent of African-American undergraduate students are enrolled in community colleges compared to 33 percent of white undergraduates (McFarland et al., 2019). Furthermore, 55 percent of low-income students attend community colleges, compared to only 23 percent of high-income students (Hill, Smith, Wilson, & Wine, 2016).

Acquiring a BA for these students necessitates transferring to a four-year institution and students from racial/ethnic minority and low-income backgrounds are less likely to make this transition. A recent national study showed that 34 percent of students from the top income quintile transferred relative to 26 in the bottom quintile (Shapiro et al., 2017). Moreover, 49 percent of higher-income transfer students earned a BA within six years compared to 35 percent of lower-income transfer students (Shapiro et al., 2017). Research also finds that White community college students are between 45 to 70 percent more likely to transfer to a four-year college than Black or Latinx students (Crisp & Nuñez, 2014; Wood et al., 2012). Although IPEDS doesn't track graduation rates for transfer students, some studies have reported that URM transfer students are less likely to earn BA degrees than their non-URM peers (Alfonso, 2006).

Although it has received less attention until recently, gender is another important background characteristic to consider. Thirty years ago, there was a wide gap in graduation outcomes between men and women, with men having the edge. However, this pattern has changed dramatically, with the reversal in the gender gap in both college entry and degree

completion now favoring women (DiPrete & Buchman, 2013). However, less has been written about these trends for transfer students as gender is typically only used as control variable in a broader analysis of transfer outcomes. To the extent that certain groups, whether related to gender, race/ethnicity or family income, have differential college success rates is crucial to examine as college education is correlated with economic success, health, family stability, and social connections (Card, 1999; Goldin & Katz, 2007; and Hout, 2012).

Community Colleges and Bachelor's Degree Outcomes

Previous research typically finds a penalty associated with beginning at a community college for BA completion and time-to-degree (Dietrich & Lichtenberger, 2017; Terry Long & Kruelander, 2009). There are myriad factors that contribute to these less favorable outcomes, including lower levels of academic preparation (e.g., GPA, test scores, rigor of high school curriculum, etc.), whether students earn an associate degree before transfer, and credits earned (and lost) during the transfer process, each of which is considered in turn.

Students who begin their post-secondary studies at community colleges are generally less academically prepared than students who begin in the four-year sector. Given the open access admissions policies at community colleges, students entering these institutions often have lower levels of academic preparation. One indication of this is the extent of developmental coursework, which is negatively correlated with transferring to a four-year institution (Bettinger, & Terry Long, 2005; Roksa & Calcagno, 2010; Wang, 2009). Research repeatedly shows that the majority of students who do successfully transfer are more academically prepared (Bowen, Chingos, & McPherson, 2009; Dougherty & Kienzl, 2006; Melguizo, 2009; and Terry Long & Kurlaender, 2009). In addition, community college students also have lower grade point

averages (GPAs) coming out of high school, which are highly predictive of graduation outcomes (Stange, 2012).

There is mixed evidence as to whether earning an associate degree prior to transfer increases the probability of earning a BA (Jenkins & Fink, 2016; Kopko & Crosta, 2016; Turk, 2018; Wang, Chuang, & McCready, 2017). Within a single community college system, Kopko and Crosta (2016) found a positive relationship between earning an AA prior to transfer and BA completion. However, using a national sample, Jenkins & Fink (2016) showed that these results vary by state. Wang, Chuang, and McCready (2017) and Turk (2018) both analyzed national datasets and did not find a statistically significant effect between earning an AA prior to transfer and BA completion.

Moreover, research finds that students frequently lose previously earned credits during the transfer process and that this contributes to their lower likelihood of BA completion relative to their native peers (Doyle, 2009; Goldrick-Rab, 2010; Hodara, Martinez-Wenzl, Stevens, & Mazzeo, 2017; Monaghan & Attewell, 2015). Hodara, Martinez-Wenzl, Stevens, and Mazzeo (2017) found that students commonly lose credits when they transfer because they fail to decide on a major early enough, which causes them to take unnecessary courses at the community college that do not go toward their degree at the four-year institution. Excess credits have also been discussed in the state-level context where researchers reported that transfer students who earn a BA complete eight more credits than their native peers in Texas (Cullinane, 2014); nine more in Kentucky (Kentucky Council on Postsecondary Education, 2008); and four more in Washington (West, 2015). Additionally, qualitative research from Indiana showed that many credits transfer as elective credits rather than degree program credits (Kadlec & Gupta, 2014).

Students who do complete a similar amount of credits at the community college and successfully transfer them to a four-year institution earn BAs at similar rates to their native peers. For example, Doyle (2009) found that 82 percent of students who were able to transfer all of their community college credits earned a BA within six years, while only 42 percent of students who lost any amount of credit earned a BA within six years. Similarly, Monaghan & Attewell (2015) reported that students who were able to transfer most of their credits had a 2.5 times better chance of completing a BA within six years relative to students who had less than half of their credits transfer. While a range of factors, from academic preparation to earning an AA and not losing credits, have been discussed in the relationship to transfer student outcomes, less attention has been paid to four-year college factors, particularly the quality (or, selectivity) of the four-year college to which the students transfer.

College Selectivity

There are several reasons why attending a more selective college might lead to better graduation outcomes. More selective colleges generally invest more institutional resources in each student, they have more academically prepared students with better standardized test scores and high school GPAs, and they have more distinguished faculty members and robust alumni networks (Bound & Turner, 2007; IPEDS, 2018; Smith & Stange, 2016). On the surface, these patterns hold in Virginia. For example, the three colleges in the state with a 90 percent graduation rate or higher (University of Virginia, the College of William and Mary, and Washington and Lee University) also have the highest average SAT scores and instructional spending per student (IPEDS, 2018). Similarly, the colleges with the lowest graduation rates are home to students with the lowest SAT scores and spend the fewest on instructional expenses per student (IPEDS, 2018).

A substantial body of literature exists on the effects of college selectivity on outcomes of students attending four-year institutions. These studies almost exclusively find that attending a higher quality college (as measured by some combination of selectivity and/or institutional resources) leads to higher BA completion rates and annual earnings (Bowen, Chingos, & McPherson, 2009; Cohodes & Goodman, 2014; Goodman, Hurwitz, & Smith, 2017). For example, Bowen, Chingos, and McPherson (2009) show a strong positive relationship between the selectivity of the four-year college and six-year graduation rates. They note that much of this is due to incoming characteristics, including SAT and GPA, as well as demographic variables, such as race, gender, residency status, and parents' income. However, even after controlling for these variables, they still find a strong positive relationship.

The primary difficulty in addressing the question of the relationship between college selectivity and student outcomes is accounting for self-selection into different types of colleges. However, a number of recent studies using various analytical strategies to address self-selection, confirm these positive relationships (Hoekstra 2009; Cohodes and Goodman 2014; Zimmerman 2014; Goodman, Hurwitz, & Smith 2017). Cohodes and Goodman (2014), for example, estimated the effects of attending a public college in Massachusetts based on eligibility to the Adam's Scholarship, which was designed to keep the most academically prepared students in public colleges in MA. The authors found that the quality of these public colleges was lower than those the students otherwise would have attended, and that the decision to attend a MA public college ultimately led to lower BA completion rates. The effects of attending a more selective college tend to be more pronounced for students from underrepresented racial / ethnic and low-income backgrounds; studies rarely find differences across gender (Goodman, Hurwitz, & Smith, 2017).

Despite extensive research on college selectivity and graduation outcomes for students who begin postsecondary education in four-year institutions, very little scholarship has examined this relationship for transfer students, particularly those from URM and low-income backgrounds (Bowen, Chingos, & McPherson, 2009; Crisp & Nunez, 2014; Hilmer, 2000 & 2002). Studies on transfer students to date corroborate findings for four-year native students: selectivity is positively related to educational outcomes. Bowen et al. (2009) reported that transfer students who attended flagship universities were approximately 10 percent more likely to graduate than students who attended the next best institutions in the state, controlling for observable characteristics. Similarly, Hilmer (2000, 2002) showed that the quality of a transfer students four-year college had a significant positive relationship with probability of graduating and future earnings. The present study aims to extend this literature by providing additional evidence about the relationship between four-year college selectivity and transfer student outcomes as well as by exploring how those relationships vary by race/ethnicity, gender, and family income.

Data and Methods

This project is situated in the state of Virginia, which is home to 24 public community colleges, 15 public four-year colleges, and 44 private non-profit four-year colleges. As of 2018, the undergraduate enrollment in each of these sectors was 163,945, 174,795, and 86,208, respectively (SCHEV, 2019). Each year, approximately 11,000 community college students transfer to public four-year colleges and 2,500 transfer to private non-profit four-year institutions (SCHEV, 2019).

Virginia's public and private non-profit colleges vary widely in terms of selectivity. Some colleges, including the University of Virginia and the College of William and Mary, are among the top 40 colleges in the U.S., according to US News and World Report (2020). On the

other end, many others are open-access institutions. Barron's Profiles of American Colleges provides a competitiveness index that makes comparisons across various institution types relatively easy. Specifically, Barron's ranks colleges into three primary categories: most competitive, very competitive, and competitive. Among Virginia's four-year colleges, 4 are considered most competitive, 10 are very competitive, 19 are competitive, and the rest of the colleges are unranked (Barron's, 2018). These unranked colleges are predominately small private colleges with low enrollment; almost 95 percent of the students transferring in Virginia are attending colleges listed in the Barron's Rankings.[1]

The data for this research was provided by the Virginia Longitudinal Data System (VLDS). Established in 2009, the VLDS combines longitudinal data from some of the most prominent agencies in the state, including the Virginia Department of Education (VDOE), the State Council for Higher Education in Virginia (SCHEV), and the Virginia Employment Commission (VEC) to allow researchers to more effectively collaborate with the state agencies and help improve student outcomes. This paper relies on the SCHEV data from the VLDS.

Sample

For this project, I began with a VLDS dataset including all students who initially enrolled at a Virginia college between fall 2001 and 2017 and then transferred to a different college anytime between spring 2002 and 2018. This dataset defines "transfer" as any movement across institutions and thus captures any student who went to more than one college at any point during their post-secondary studies in Virginia. However, the focus of this project is on students who transferred between community colleges and four-year institutions, which includes

[1] Although Barron's refers to these categories as "competitive," I will refer to them as selective (i.e., most selective, very selective, selective, and non-selective for unranked colleges) to reflect the terminology common in previous research.

approximately 130,000 students. I restrict the analytical sample to students who took at least 12 credits in a community college before transferring to a four-year institution, which is commonly considered one semester in college and the minimum requirement to receive full-time federal aid (FAFSA, 2019). Students could complete 12 credits over several years or just a single semester. Students are followed through the end of the 2017-18 academic year. Since students who entered college prior to 2013 would have limited graduation outcome data, I also restrict the sample to include only students who started at a community college no later than the fall semester of 2012, which would allow everyone up to 6 years to complete a degree. Additionally, I restrict the sample to include only students who started at the community college during a fall semester, which is when most students initially enroll in college, and allows for more uniform comparisons across cohorts. Finally, the sample is restricted to students who started at a four-year college no later than the fall semester of 2014, which would provide all students 4 years to complete a degree after transfer. The final analytic sample includes 54,512 students who initially enrolled at a Virginia community college during a fall semester between 2001 and 2012 and then transferred to a four-year college in Virginia between spring 2002 and fall 2014.

Variables

There are three primary outcome variables: bachelor's degree (BA) completion, bachelor's degree (BA) completion within 6 years, which is a commonly used metric in education research (i.e., 150% completion time; IPEDS, 2018), and time-to-degree. Throughout the text, for simplicity, I refer to all bachelor's degrees (either a Bachelor of Arts or a Bachelor of Science degree) as BA. BA completion and BA within 6 years are coded as binary indicators (1 = BA completed (or completed in 6 years); 0 = BA not completed (or not completed within 6 years)). Students with a value of 1 for BA completion in 6 years are those who earned a BA and

their final class at the four-year college occurred within 6 years of their initial class at the community college.[2] Both BA completion variables capture all students in the sample. Time-to-degree is coded as number of years from community college start to four-year graduation among those who completed a BA.

It is important to note that students in the analytic sample have different amounts of time to complete their BA's, depending on the year in which they entered community colleges as well as transferred to four-year institutions. The most recent student cohorts (those who entered a community college in in the fall semester of 2012 and 2011) are tracked for only 6 or 7 years. However, students who entered community colleges in the fall semester of 2002 are tracked for up to 16 years. Despite this variation, the average amount of time students spent in higher education (i.e., the time between their first community college enrollment and final four-year enrollment) is 6.63 years.

Students in earlier cohorts also have considerably more time to complete their 12 credits at a community college to be included in the sample. Exploratory analyses indicate that students who entered the sample in earlier cohorts are considerably less likely to complete their degrees in 6 years since, on average, they spent more time in the community college before transferring to a four-year college. Across all cohorts, students in the sample spent on average 3.68 years in a community college and 2.95 years in a four-year institution, although this varies notably across cohorts (from 1.7 to 7.8 years for time in community college and from 2.3 to 3.7 years for time in a four-year institution). If the sample was restricted to include only students who spent less than 4 years at the community college, overall BA completion would remain similar but BA in 6 would increase notably. Moreover, if the sample was restricted to students who spent less than 3

[2] The results are substantively similar if the timing of the last four-year enrollment is not considered, and the variable is instead defined simply as 6 years since the initial enrollment at the community college.

years at a four-year institution, overall BA completion would remain similar but BA in 6 would markedly increase.

The key independent variable of interest is four-year college selectivity. I use Barron's Profiles of American Colleges to assign four-year institutions in Virginia one of four labels: most selective, very selective, selective, and non-selective.[3] Other key variables include a dummy variable for race/ethnicity (Black, Hispanic, and Native American students are defined as under-represented racial/ethnic minorities (URM) while white and Asian students are used as a refence category), parents' income quartile, and gender (1 = female and 0 = male).[4] In addition, I consider several variables that capture students' experience in community college: associate degree (AA) status, which distinguishes between different degree types (having an academic associate degree, having a technical associate degree, and having no associate degree), transfer GPA (on a 4.0 scale), and number of credits earned at the community college. Transfer GPA is divided into categories (less than 2.0, 2.0-2.49, 2.5-2.99, 3.0-3.49, 3.5+, and not reported) to account for students who do not have a valid value for this independent variable. Community college credits are divided into categories (less than 24, 24-47, 48-59, 60+) to account for non-linearities in relation to the outcome variables of interest. Akin to the BA, I refer to all associate degrees, whether Associate of Art or Associate of Science, as AA degrees.

Although not considered key variables of interest, I also control for age and whether a student transferred more than once during their postsecondary studies in Virginia. Prior research indicates that older students tend to have different educational outcomes than traditional-age students (Graham & Donaldson, 1999) and that students who move across institutions are less

[3] Unranked colleges in Barron's Profiles of American Colleges are labeled as non-selective.
[4] Due to a substantial number of missing cases for race and parents' income, I also control for students who have "unknown" values for those variables in the regression models.

likely to complete their degrees (Goldrick-Rab, 2006). Age reflects students' age in years at the time of transfer to a four-year institution. Multiple transfer is a binary measure reflecting whether students transferred multiple times across four-year institutions (1= transferred multiple times, 0 = transferred only once). Students who transfer from a four-year college to a community college, known as "reverse transfers," are not captured in the data. Descriptive statistics for all variables are presented in Table 1.

Methods

The primary relationships of interest are those between the selectivity of the transfer destination and graduation outcomes (BA completion, BA completion in 6 years, and time-to-degree), which are examined through logistic and ordinary least squares (OLS) regression models. Before modeling those relationships in the multivariate context, I present descriptive relationships between key background characteristics (race/ethnicity, gender, and parents' income quartile) and the selectivity of the transfer destination as well as community college experiences (transfer GPA, credits earned, and AA degree type) and selectivity of the four-year institution. Those are presented as figures with supporting statistical results based on Chi-square or ANOVA analyses (depending on the variable), with accompanying post-hoc tests, reported in the text. In addition, I present descriptive results examining relationships between the key background characteristics, community college experiences, and each of the graduation outcomes. Those are presented in tables with supporting statistical results discussed in the text (Chi-square tests for BA completion outcomes and ANOVA for time-to-degree). Presented descriptive patterns provide the foundation for the subsequent multivariate regression models.

Regression analyses of BA completion and time-to-degree begin with simply estimating a bivariate relationship between selectivity and those outcomes. Subsequent models add different

blocks of variables to examine the extent to which various factors identified in the literature contribute to the relationship between selectivity and graduation outcomes, as well as the extent to which selectivity is a predictor of degree completion and time-to-degree net of other confounding factors. Since background characteristics are related to educational pathways and college outcomes, the second model adds race/ethnicity, gender, parents' income quartile, and age. The third model introduces community college experiences (transfer GPA, community college credits, and AA degree type). Furthermore, while not discussed in the community college literature, one of the factors important to consider is whether students transfer multiple times as that can alter their odds of BA completion as well as time to degree, which is also included in the third model.

In addition to examining the relationship between selectivity and graduation outcomes, this study investigates whether students from different backgrounds (as represented by race/ethnicity, gender, and parental income) benefit differentially from attending institutions at various levels of selectivity. The final set of analyses thus reports interactions between background characteristics and selectivity for each of the graduation outcomes, with interaction terms tested separately for each background characteristic. To facilitate interpretation of results, I include figures that show the average predicted probabilities for the background characteristics of interest, along with 95% confidence intervals. Although the presented findings are primarily descriptive, they portray the overall relationship between college selectivity and transfer student outcomes in Virginia, and set the stage for further analysis into these patterns.

Results

While previous research has shown that college selectivity contributes to graduation outcomes for students who begin their postsecondary education in four-year colleges, very few

studies have examined these relationships for transfer students (Bowen, Chingos, & McPherson, 2009; Milner, 2000, 2002). Descriptive results from VLDS indicate that there is a strong relationship between selectivity and all graduation outcomes (BA completion, BA completion in 6 years, and time-to-degree). For example, 89 percent of transfer students at the most selective colleges in Virginia earn a BA; 54 percent complete a BA in 6 years; and these students earn their degrees in 6.44 years. By way of comparison, 81 percent of transfer students at very selective colleges in Virginia complete a BA; 48 percent complete a BA in 6 years; and these students earn their degrees in 6.63 years. These results, as well as those for lower selectivity groups, are presented in Table 2. All of the differences between selectivity categories are statistically significant for each of the graduation outcomes examined.

While these results indicate strong differences in each of the outcome measures across colleges selectivity, those differences may in part reflect selection of students into colleges. With respect to transfer students, there are two important sets of factors that might be related to students attending different types of four-year institutions: background characteristics and community college experiences. The next section explores how those factors are related to college selectivity as well as graduation outcomes.

Descriptive Results for Relationships between Background Characteristics, Four-Year College Selectivity, and Graduation Outcomes

As noted in the literature review, background characteristics play a role in both college enrollment decisions and graduation outcomes. VLDS data similarly reveal large and statistically significant differences in transfer patterns between URM and non-URM students for all selectivity categories (Figure 1). For example, almost 17 percent of URM students attend non-selective colleges compared to only 6 percent of non-URM students; and only 20 percent of

URM students attend very selective colleges compared to approximately 31 percent of non-URM students. Differences between URM and non-URM students are less pronounced at most selective and selective colleges, although still statistically significant. These patterns are similar to those found across four-year colleges for native students in the United States (IPEDS, 2019).

Another factor commonly associated with college enrollment is parents' income quartile. Typically, students who come from higher-income families have greater access to more selective colleges (Bowen, Chingos, & McPherson, 2009). Among community college transfers in Virginia, students from higher income quartiles are more likely to attend very selective colleges, while students from lower income quartiles are more likely to attend non-selective and selective colleges, with all differences being statistically significant (Figure 2). However, students from each income quartile are approximately equally likely to transfer to the most selective colleges in the state. These patterns differ from those reported for native students, which show linear increases in selectivity based on parents' income (Bowen, Chingos, & McPherson, 2009; IPEDS, 2019) and will be explored in more detail in the second chapter of the dissertation.

Figure 3 reports differences between males and females in terms of the selectivity of their transfer destination. The largest differences in enrollment patterns between males and females are at very selective and non-selective categories, with a higher proportion of males attending very selective colleges than females, and on the other hand, a higher proportion of females attending non-selective institutions than their male peers. Although smaller, the differences in enrollment patterns at other types of college are also statistically significant. These findings deviate from national enrollment patterns for native four-year students, where males and females are distributed relatively equally across various levels of college selectivity (IPEDS, 2019).

Students from different backgrounds may not only attend different types of institutions but may also have different graduation outcomes. Descriptive relationships between background characteristics and graduation outcomes are reported in Table 2. The results reveal wide differences across student groups. First, differences between URM and non-URM students are statistically significant for all outcome measures. Although males and females are equally likely to earn a BA, males are significantly more likely to earn a BA in 6 years and graduate in significantly less time than females (almost half a year). Furthermore, differences across income quartiles are statistically significant for all three outcome measures. Each of these patterns are linear with the exception of time-to-degree, where students from the lowest income quartile complete their degrees in less time than students in the second income quartile.

Descriptive Results for Relationships Between Community College Experiences, Four-year College Selectivity, and Graduation Outcomes

Although background characteristics are related to transfer destinations and graduation outcomes, previous research has also shown that community college experiences play a considerable role in college choice and graduation outcomes (e.g., Shapiro et al., 2017). The primary factors examined in the literature are whether a student completed an associate degree (AA), the student's transfer GPA, and the number of credits the student earned at the community college. In this section, I examine the relationship between each of these factors and the selectivity of the four-year institution students transferred to as well as bachelor's degree completion outcomes and time-to-degree. These results provide insights into how various community college experiences contribute to both transfer destination decisions and graduation outcomes.

With regards to the relationship between having an AA prior to transfer and college selectivity, the results vary depending on the type of AA. Academic AAs are generally associated with studies in liberal arts, social and natural sciences, engineering, and business. On the other hand, technical AAs are typically awarded for more focused vocationally-specific classes, such as welding, culinary arts, and many nursing-related programs. The results indicate that a statistically significantly higher proportion of students with a technical AA attend a non-selective institution compared to either students with no AA or an academic AA (Figure 4). Although differences in enrollment patterns are only marginally statistically significant at the most selective and selective colleges, a smaller proportion of students who earn technical AAs attend very selective colleges than either of the other two groups.

Unsurprisingly, there is a very strong relationship between college selectivity and transfer GPA (Figure 5). Almost all students in the sample who transferred to the most selective colleges in Virginia earned a 3.5 or higher GPA at the community college. Similarly, the majority of students who transferred to the non-selective colleges earned a GPA below 2.5. A post-hoc analysis shows that the significant results are attributed to all cells in the Chi-squared test other than the group composed of students with a 3.5+ GPA at selective colleges. Since the relationship between transfer GPA and college selectivity is not completely linear, showing that many students attend less selective colleges than may be expected based on their GPA, it suggests that factors other than academic preparation (as reflected in GPA) are influencing transfer decisions. The second chapter of the dissertation will explore one possible factor that may contribute to these patterns.

Very small differences emerge with regards to college selectivity and number of credits completed at the community college. Although differences displayed in Figure 6 are statistically

significant, they are small in terms of magnitude. A post-hoc analysis reveals that these results reflect significant contributions to the Chi-squared test across all groups other than the lowest credit group / selective college and the highest credit group / most selective college.

Community college experiences are not only related to where students transfer but also their graduation outcomes. Each of the variables has some statistically significant association with at least one of the outcome measures, which are examined using Chi-squared tests for the BA completion outcomes and ANOVA analyses for the time-to-degree (Table 2). First, there is a statistically significant relationship between transfer GPA and all three graduation outcomes, and all relationships follow a linear pattern. Relationships between community college credits and the outcome variables of interest are much less linear than those found for GPA. For example, time-to-degree is practically identical across the three lowest credit groups; meanwhile, students who complete 60+ credits at the community college prior to transfer take almost a full-year longer to complete a BA than students from each of the other groups.

The results also reveal a strong relationship between associate degree type (academic, technical, and no degree) and various outcomes. Although students who earn an academic AA and no AA have relatively similar outcomes with regards to BA completion in 6 years and time-to-degree, the differences are more pronounced for overall BA completion: 80 percent of students with an academic AA earn a BA compared to 73 percent of students with no AA. In comparison, only 67 percent of students who complete a technical AA earn a bachelor's degree and, among those who do earn a BA, they take approximately 2.5 years longer than students who earned an academic AA or no AA. A smaller proportion of students who earn a technical AA complete a BA in 6 years compared to the other two groups: Only 18 percent of students with a

technical AA complete a BA in 6 years compared to 45 and 43 percent for academic AA holders and no AA holders, respectively.

Regression Analyses Predicting Graduation Outcomes

This section examines relationships between college selectivity and various outcomes in a multivariate context. Given that background characteristics and community college experiences are related to both selectivity and graduation outcomes, the question remains whether college selectivity is related to BA completion (Table 3), BA completion in 6 years (Table 4), and time-to-degree (Table 5) after controlling for those confounding factors. The first model in Table 3 simply confirms the descriptive results, indicating that the likelihood of degree completion increases across selectivity categories. After adding students' background characteristics in Model 2, the odds ratios for selectivity do not change much, implying that differences in background characteristics measured in this study do not substantially contribute to explaining the relationship between selectivity and BA completion. Model 3, which includes community college experiences as well as the indicator for multiple transfers, shows some decrease in odds ratios from Model 1 (especially for the most selective category), but overall the results for selectivity remain strong. Even net of all of the variables, students attending most selective institutions are 2.9 times as likely to complete a BA as students attending non-selective institutions.

The background characteristics show the expected patterns: net of other variables, racial/ethnic minority students are less likely to complete a BA, and students from higher income quartiles are more likely to complete a BA than those in the bottom quartile. For example, students in the top quartile are almost 2 times as likely to complete a BA than those in the bottom

quartile. Women are also more likely to complete degrees than men, although the difference is small: women have only 10% higher odds of completing a BA than men, net of other variables.

Similarly, the community college characteristics follow the expected patterns: in Model 3, students with higher GPA's and more credits earned in a community college are more likely to complete a BA, although the differences for credits earned are much less pronounced and the odds ratios for students earning 48-59 and 60+ credits are of similar magnitudes. Students who earn an academic AA degree have higher odds of completing a BA than those who transfer without an AA degree. At the same time, those who complete a technical AA have lower odds of completing a BA than those without an AA degree.

The results for BA completion in 6 years presented in Table 4 are very similar to those for overall BA completion. For example, after controlling for background characteristics, community college experiences, and multiple transfer, students who attend the most selective colleges are approximately 2.2 times as likely to complete a BA as students who attend non-selective colleges. However, the patterns for overall BA completion and BA completion in 6 years differ for number of credits and multiple transfer. While students from each credit group are significantly more likely to complete a BA than the reference group (students who completed between 12-24 community college credits), students who take between 27 – 47 and 48 – 59 community college credits are approximately equally likely to complete a BA in 6 years as the reference group. Meanwhile, students who complete 60+ credits at the community college are significantly less likely to complete a BA in 6 years compared to the reference group. Additionally, while multiple transfer is associated with significantly higher odds of completing a BA, multiple transfers are significantly less likely to complete a BA in 6 years compared to students who only transferred once, controlling for other factors in the model.

Results for the final outcome of interest, time-to-degree (measured in years), which is conditional on having completed a BA, are presented in Table 5. The first model confirms the descriptive results indicating that selectivity is related to time to degree. Model 2 accounts for background characteristics and Model 3 adds community college experiences and an indicator for multiple transfer. The coefficients from Model 3 indicate that students attending institutions at each selectivity level complete their degrees in a shorter amount of time than those who attend non-selective colleges. For example, students who transfer to the most selective colleges complete their degrees more than one semester earlier (.66 fewer years) than students who attend non-selective colleges.

In line with the BA completion models, background characteristics are related to time-to-degree. In contrast to national trends (McFarland et al., 2019) and the BA completion outcome measures, URM students who complete a BA do not take longer to complete their degrees than non-URM students, controlling for other background characteristics in Model 2. After adding community college experiences in Model 3, the coefficient for URM students becomes more negative and statistically significant at the 0.1 level, suggesting that URM students complete their BA's in slightly less time than non-URM students (although this difference in very small in magnitude and only marginally statistically significant). In line with national trends (Kena et al., 2016), students from the highest income quartile complete their degree in significantly less time (a full semester) than students from the lowest income quartile, all else equal.

Community college experiences are also related to time-to-degree. As in the previous models, transfer GPA is highly predictive of time-to-degree: students who transfer with a GPA of 3.5 or above graduate in 1.24 fewer years than students who transfer with a GPA below 2.0, controlling for background characteristics, other community college experiences, and

transferring more than once. Among students who completed a BA, the coefficients for community college credits in Model 3 suggest that students who complete 60 or more credits at the community college take more than a full-year longer to graduate than students who transferred with fewer than 24 credits. In terms of AA degrees, students who transfer with an academic AA graduate in significantly less time than students who transfer without an AA, controlling for all variables in the model, but this difference is very small in magnitude (.07 fewer years). However, students who earn a technical AA prior to transfer take an additional 1.3 years to complete their BA compared to students who do not earn an AA, controlling for other variables in the model. Finally, students who transfer more than once take approximately 2.5 more years to complete their degrees compared to students who only transferred once, net of other factors.

Do All Demographic Groups Benefit Equally from Four-Year College Selectivity?

Based on previous research, it is possible that different student groups, defined by race, gender, and parents' income quartile, experience differential benefits from attending more selective institutions (Dale & Krueger, 2002; Goodman, Hurwitz, & Smith, 2017). I thus re-estimate Model 3, which includes all background characteristics, community college experiences, and an indicator for multiple transfer, for each outcome with interactions between selectivity and background characteristics, one at the time. The results for these models are found in Tables 6-8. Each of these tables uses non-selective colleges as the reference group. I also present Figures 7, 8, and 9, which show the predicted values for each outcome variable for different demographic groups and specific selectivity categories.

The first interaction of interest is between race and college selectivity, controlling for background characteristics, community college experiences and multiple transfer (Table 6;

Figure 7). This interaction model includes only students with valid data for race (90 percent of the sample). Results reveal statistically significant interactions for the BA completion and time-to-degree outcome measures. In terms of BA completion, URM students benefit less compared to their non-URM peers by attending selective and very selective colleges relative to non-selective institutions; however, with regards to BA completion in 6 years, there are no statistically significant interactions between race and college selectivity. In addition, URM students benefit significantly more by attending selective and very selective colleges as opposed to non-selective institutions relative to their non-URM peers in terms of time-to-degree, although the interaction term for selective colleges is statistically significant only at the 0.1 level. The results for the most selective colleges are not statistically significant for any outcome measures, suggesting that URM students gain similar benefits compared to non-URM students by attending those institutions as opposed to non-selective colleges.

Interactions between gender and college selectivity indicate large and significant differences for two of the outcome measures (Table 7 and Figure 8). Females benefit more than males from attending selective and very selective colleges relative to non-selective institutions with respect to BA completion in 6 years and time-to-degree. These differences are particularly large in the time-to-degree models: women gain approximately half a year more than males by attending selective and very selective colleges compared to non-selective institutions. Interaction patterns for these two levels of selectivity relative to non-selective colleges are not statistically significant for BA completion. However, females benefit more than males from attending most selective relative to non-selective colleges in terms of overall BA completion, though this difference is only marginally statistically significant at $p<.10$.

Interaction effects between parents' income quartiles and college selectivity reveal only very small differences across a couple of groups (Table 8; Figure 9). Specifically, only four interaction terms are statistically significant (one only marginally at $p<.10$) and all of those are negative and observed for the highest income quartile. Students from the highest income quartile benefit significantly less than students from the lowest income quartile by attending very selective and most selective colleges relative to non-selective institutions in terms of BA completion in 6 years and time-to-degree. None of the interaction terms between income quartiles and selectivity categories are statistically significant in the BA completion model. Overall, these results suggest that community college students from different income quartiles benefit to a relatively similar extent regardless of their transfer destination.

Discussion and Conclusion

Much has been written about the relationship between college selectivity and graduation outcomes for students who initially enroll in four-year colleges. However, there is very little research on this relationship among community college transfer students. This project adds to that body of literature by examining the patterns for transfer students in Virginia. As expected, many of the findings corroborate those found among native students who begin their postsecondary studies in the four-year sector: transfer students who attend more selective colleges are more likely to complete a BA, complete a BA in 6 years, and take fewer years to earn their degrees than students who attend less selective colleges. Additionally, students from higher income quartiles are more likely to earn a BA degree than students from lower income quartiles; and URM students are less likely to earn a BA compared to their non-URM peers. All of these differences remained statistically significant at the .01 level after controlling for background characteristics, community college experiences, and multiple transfer.

However, several patterns stand out as unique for the population under study. First, students from higher income quartiles are not more likely to transfer to the most selective colleges in the state relative to students from lower income quartiles, which differs from the patterns observed among native students (Buddin, 2014). Second, a large proportion of students with high GPAs transfer to less selective colleges than may be expected based on their GPA. Although these patterns generally resemble those found in prior research pertaining to enrollment patterns across different institutional types (Black & Smith, 2004; Smith, Pender, & Howell, 2013), previous work has not yet examined undermatching among community college transfer students. Third, URM students graduate at statistically indistinguishable rates compared to their non-URM peers at the most selective colleges in the state, which differs from prior research (Massey, 2006) and descriptive statistics (IPEDS, 2019). Fourth, students who earn an academic associate degree prior to transfer are significantly more likely to complete a BA compared to students who do not earn an AA, all else equal. These findings add to a body of literature that commonly finds mixed results for the relationship between AA degrees and BA degree completion across states (Jenkins & Fink, 2016).

Moreover, interaction analyses indicate that different sociodemographic groups benefit to varying extents by transferring to colleges at specific levels of selectivity. Overall, interaction coefficients at the most selective college are not statistically significant, except for students from the highest income quartile who benefit significantly less (in terms of BA completion in 6 years and time-to-degree) by attending these colleges as opposed to non-selective institutions compared to students from the lowest income quartile. This suggests that attending most selective colleges in the state benefits most sociodemographic groups equally. Institutions at other selectivity levels have variable benefits for different groups. Attending very selective

colleges as opposed to non-selective colleges, benefits females significantly more than males in terms of BA completion in 6 years and time-to-degree. Although attending very selective colleges compared to non-selective ones benefits URM students less than non-URM students in terms of BA completion, URM students gain significantly more from attending those institutions in terms of time-to-degree. Similarly, females benefit more than males from attending selective as opposed to non-selective colleges with respect to BA completion in 6 years and time-to-degree, while URM students benefit significantly less than non-URM students in terms of BA completion, but significantly more in terms of time-to-degree (although this coefficient is only significant at the .1 level). Given these divergent patterns across different levels of selectivity as well as different sociodemographic groups, future research is needed to further explore these patterns and potential mechanisms.

In addition, future studies would benefit from examining the potential process of undermatch in the transfer process. While prior studies have examined the patterns of academic undermatch for overall enrollment, wherein students attend less selective institutions than they are academically qualified to attend (Bowen, Chingos, & McPherson, 2009; Smith, Pender, & Howell, 2013; Roderick, Coca, & Nagaoka, 2011), presented results imply that students may also undermatch in the transfer process. This study only reported the relationship between GPA and selectivity, showing that many students attend less selective institutions than may be expected based on their GPA, and future research is needed to further examine this process and explore factors related to undermatch of transfer students.

Moreover, future research would benefit from looking into the causal nature of the relationship between college selectivity and community college transfer student graduation outcomes. While this chapter provides descriptive evidence showing that community college

transfer students are more likely to graduate if they attend colleges at higher levels of selectivity instead of non-selective institutions, and previous research on native students has found similar patterns (Goodman, Hurwitz, & Smith, 2017; Zimmerman, 2017), more rigorous work is needed to better understand this relationship and establish whether this link is causal.

Overall, this chapter provides descriptive evidence in favor of expanding opportunities for community college transfer students to attend institutions at higher levels of selectivity, particularly the most selective colleges in the state. Currently, only 300-400 community college students in Virginia transfer to one of the most selective colleges annually, despite several thousand being qualified based on their transfer GPA and completion of an academic associate degree. The limited transfer to the most selective institutions could reflect a number of different factors, from resources available during the transfer process to perceived cultural and social barriers (Melguizo and Dowd, 2006). Policy-makers in Virginia could work with leaders at the most selective colleges in the state to expand opportunities for these students. Furthermore, administrators at community colleges and the most selective colleges in Virginia could work together to more effectively convey the viability of this option, potential benefits in terms of graduation outcomes, and the steps involved in transferring to the most selective institutions, possibly through transfer workshops or focused advising.

Table 1: Descriptive statistics for the variables examined in this study, by selectivity category

	All Students	Most Selective	Very Selective	Selective	Non-Selective	Significance
Demographics						
Race (percent)						***
Non-URM	71	76	78	69	52	
URM	19	12	14	19	35	
Unknown	11	12	8	12	14	
Gender (percent)						***
Female	57	54	49	59	72	
Male	43	46	51	41	28	
Age at Time of Transfer (years)	26.2	26.7	24.1	26.7	28.9	
Parents' Income Quartile (percent)						***
Q1	21	23	18	20	28	
Q2	21	19	18	21	29	
Q3	21	19	21	22	24	
Q4	21	22	26	20	14	
Unknown	16	17	17	17	5	
Community College Experiences						***
Transfer GPA	3.11	3.65	3.13	3.09	2.88	
Community College Credits	65.6	66.2	64.7	66.5	62.2	
Associate Degree (percent)						***
Academic	48	57	47	51	33	
Technical	10	7	7	11	20	
No Degree	41	36	46	39	48	
Four-Year-Level Factors						***
Multiple Transfer (percent)	22	25	24	19	30	
N	54,512	2,780	15,182	31,812	4,738	

***<0.01, **p<0.05, $^{+}$p<0.10.

Note: The final column, Significance, indicates whether the differences in attending institutions at different levels of selectivity are statistically significant for categories of each independent variable using a Chi-square test. Significance values are adjusted using a Bonferroni correction for multiple comparisons. Parents' income was reported at the time of college entry and adjusted for inflation to represent value in 2018. Percentages in the table are rounded to the nearest whole number and thus may not add up to 100.

Table 2: Graduation outcomes by selectivity, key background characteristics, and community college experiences

	Bachelor's Degree (%)	Significance	Bachelor's Degree in 6 Years (%)	Significance	Time-to-degree (years)	Significance
All Students	76		41		6.93	
Barron's Selectivity Categories		***		***		***
Most Selective	89		54		6.44	
Very Selective	81		48		6.63	
Selective	74		40		6.99	
Non-Selective	62		24		8.14	
Demographics						
Race		***		***		***
Non-URM	78		44		6.74	
URM	69		35		7.21	
Unknown	76		32		7.8	
Gender		NS		***		***
Female	76		39		7.11	
Male	76		44		6.69	
Parents' Income Quartile		***		***		***
Q1	69		32		7.29	
Q2	73		34		7.48	
Q3	79		40		7.24	
Q4	83		51		6.47	
Unknown	77		51		6.04	
Community College Experiences						
Transfer GPA		***		***		***
Less than 2.0	60		23		8.1	
2.0 - 2.49	63		27		7.66	
2.5 - 2.99	72		35		7.25	
3.0 - 3.49	78		43		6.88	
3.5+	85		52		6.47	
Not Reported	76		41		6.93	
Community College Credits		***		***		***
Less than 24	68		41		6.45	
24 - 47	73		45		6.43	
48 - 59	79		50		6.41	
60 +	78		38		7.31	
Associate Degree		***		***		***
Academic	80		45		6.83	

Technical	67		18		9.12	
No Degree	73		43		6.6	
Four-Year-Level Factors		***		***		***
Multiple Transfer						
Transferred 1 time	75		47		6.38	
Transferred 2+ times	80		22		8.74	
N	54,512		54,512		41,499	

***<0.01, **p<0.05, $^{+}$p<0.10, NS=Not Significant.
Note: The columns labeled "Significance" pertain to the results of the associated statistical tests, examining the association between each independent variable and a specific outcome, including Chi-square tests for the two bachelor's degree completion outcomes and ANOVA for time-to-degree. The sample in the time-to-degree column is conditional on bachelor's degree completion. Parents' income was reported at the time of college entry and adjusted for inflation to represent value in 2018. Percentages in the table are rounded to the nearest whole number.

Figure 1: Percentage of transfer students enrolled at each level of college selectivity, by race

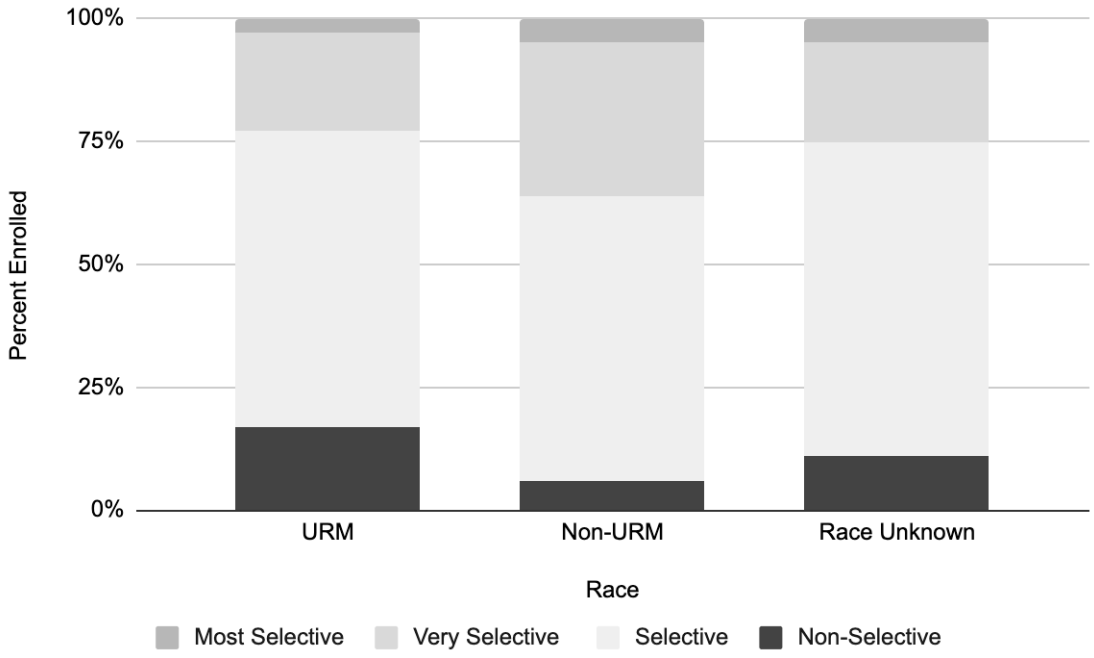


Figure 2: Percentage of transfer students enrolled at each level of college selectivity, by parents' income quartile

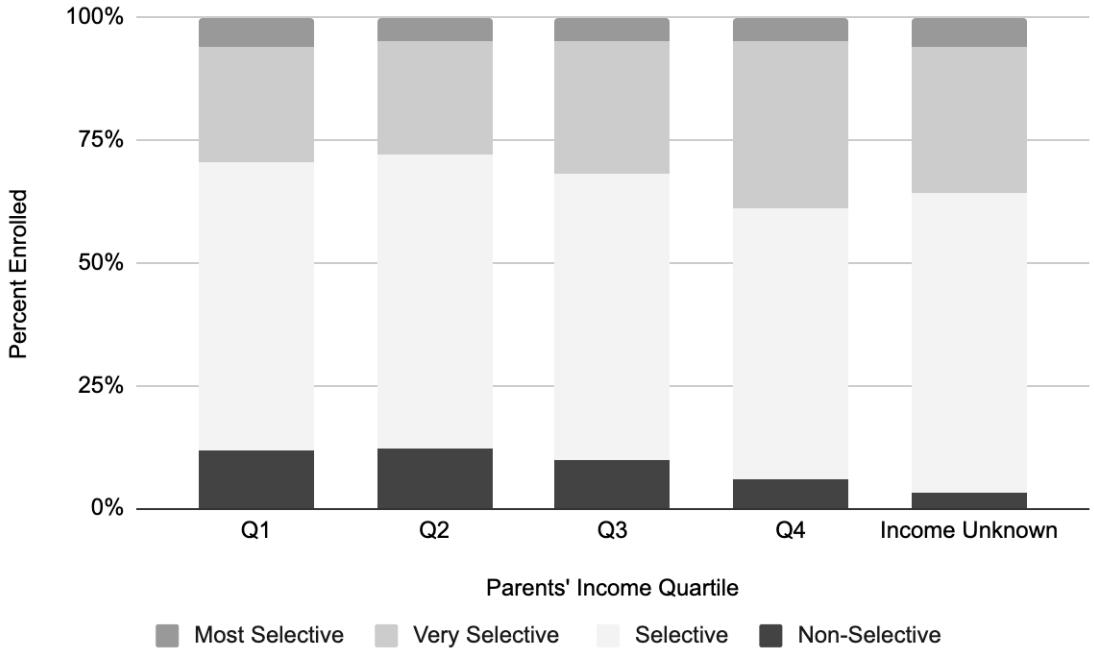


Figure 3: Percentage of transfer students enrolled at each level of college selectivity, by gender

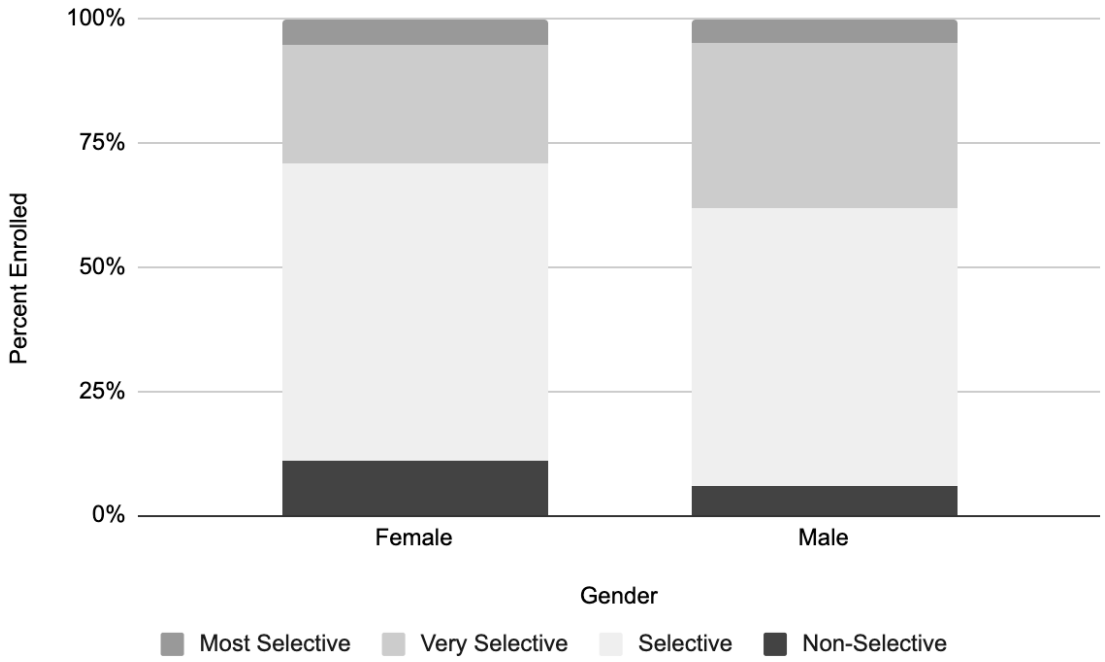


Figure 4: Percentage of transfer students enrolled at each level of college selectivity, by type of associate degree

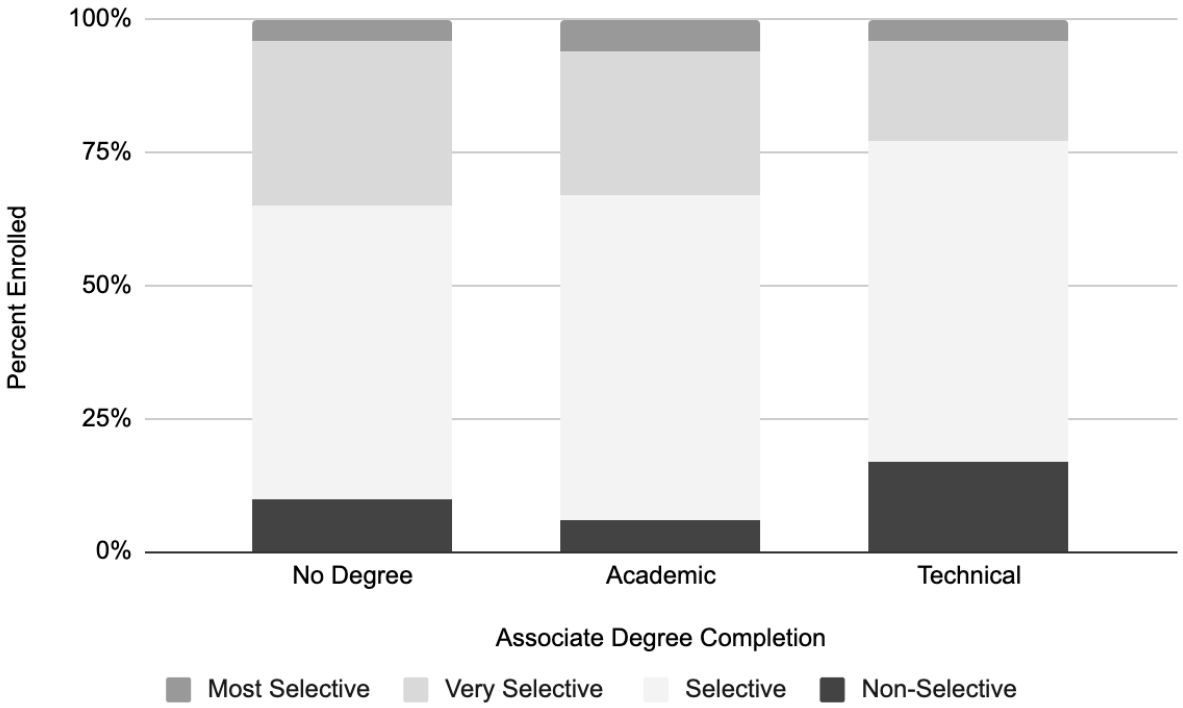


Figure 5: Percentage of transfer students enrolled at each level of college selectivity, by transfer GPA

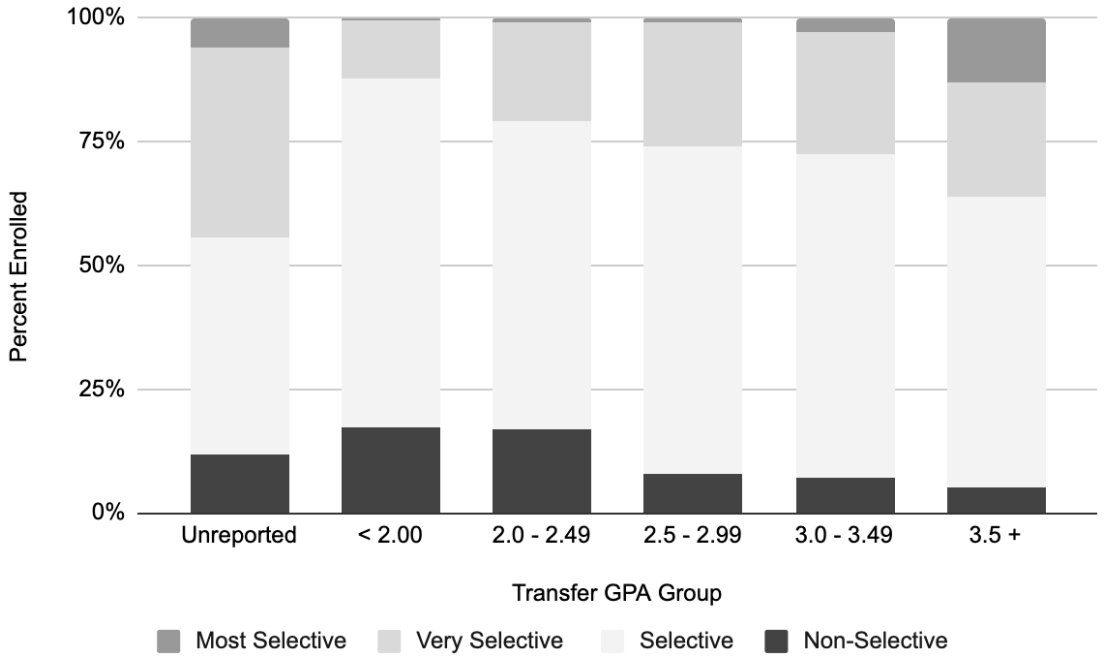


Figure 6: Percentage of transfer students at each level of college selectivity, by number of community college credits

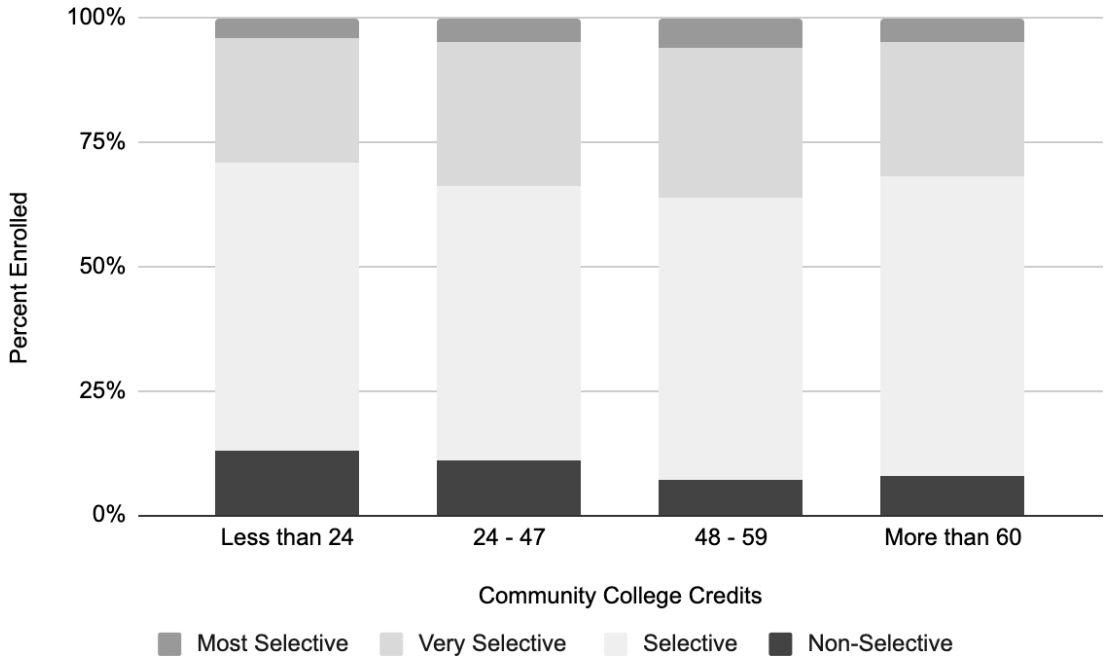


Table 3: Logistic regression models predicting bachelors' degree completion

	Model 1 Odds Ratio	Model 2 Odds Ratio	Model 3 Odds Ratio
Barron's Selectivity Categories			
Selective	1.803***	1.616***	1.432***
	(0.059)	(0.055)	(0.050)
Very Selective	2.638***	2.148***	1.882***
	(0.096)	(0.082)	(0.074)
Most Selective	4.743***	4.295***	2.931***
	(0.317)	(0.291)	(0.204)
Gender			
Female		1.144***	1.100***
		(0.024)	(0.024)
Race			
URM		0.753***	0.827***
		(0.020)	(0.022)
Unknown		0.985	0.975
		(0.033)	(0.034)
Parents' Income			
Quartile 2		1.251***	1.245***
		(0.038)	(0.038)
Quartile 3		1.541***	1.527***
		(0.048)	(0.048)
Quartile 4		1.867***	1.917***
		(0.062)	(0.064)
Unknown		1.316***	1.341***
		(0.044)	(0.046)
Age at Time of Transfer		0.975***	0.976***
		(0.001)	(0.001)
Transfer GPA			
2.0 – 2.49			1.000
			(0.084)
2.5 – 2.99			1.368***
			(0.110)
3.0 – 3.49			1.914***
			(0.154)
3.5 +			2.850***
			(0.234)
Unknown			1.688***

			(0.136)
Community College Credits			
25 – 47			1.236***
			(0.049)
48 – 59			1.540***
			(0.069)
60 +			1.452***
			(0.057)
Associate Degree			
Academic			1.282***
			(0.033)
Technical			0.787***
			(0.030)
Multiple Transfer			1.341***
			(0.036)
Observations	54,512	54,512	54,512

Standard errors in parentheses.
*** p<0.01, ** p<0.05, $^{+}$ p<0.10.
Note: Reference groups: non-selective colleges, male students, non-URM students, parents' income quartile 1, transfer GPA below 2.0, less than 24 community college credits, no associate degree, and single transfer.

Table 4: Logistic regression models predicting bachelor's degree completion in 6 years

	Model 1 Odds Ratio	Model 2 Odds Ratio	Model 3 Odds Ratio
Barron's Selectivity Categories			
Selective	2.068***	1.698***	1.408***
	(0.074)	(0.063)	(0.056)
Very Selective	2.846***	1.963***	1.650***
	(0.107)	(0.077)	(0.069)
Most Selective	3.689***	3.115***	2.194***
	(0.188)	(0.165)	(0.126)
Gender			
Female		0.996	1.054***
		(0.018)	(0.021)
Race			
URM		0.901***	0.949**
		(0.022)	(0.025)
Unknown		0.665***	0.768***
		(0.021)	(0.025)
Parents' Income			
Quartile 2		1.060**	1.122***
		(0.031)	(0.034)
Quartile 3		1.192***	1.283***
		(0.034)	(0.039)
Quartile 4		1.665***	1.815***
		(0.048)	(0.055)
Unknown		2.000***	1.842***
		(0.062)	(0.059)
Age at Time of Transfer		0.942***	0.931***
		(0.001)	(0.002)
Transfer GPA			
2.0 – 2.49			1.085
			(0.108)
2.5 – 2.99			1.487***
			(0.141)
3.0 – 3.49			2.164***
			(0.205)
3.5 +			3.216***
			(0.306)
Unknown			2.234***
			(0.213)

Community College Credits			
25 – 47			1.012
			(0.039)
48 – 59			1.036
			(0.043)
60 +			0.705***
			(0.027)
Associate Degree			
Academic			1.144***
			(0.027)
Technical			0.458***
			(0.020)
Multiple Transfer			0.261***
			(0.007)
Observations	54,512	54,512	54,512

Standard errors in parentheses.
*** p<0.01, ** p<0.05, $^{+}$ p<0.10.
Note: Reference groups: non-selective colleges, male students, non-URM students, parents' income quartile 1, transfer GPA below 2.0, less than 24 community college credits, no associate degree, and single transfer.

Table 5: Ordinary least squares regression models predicting time-to-degree (in years) among students who completed a bachelor's degree

	Model 1 Coefficient	Model 2 Coefficient	Model 3 Coefficient
Barron's Selectivity Categories			
Selective	-1.153***	-0.714***	-0.295***
	(0.060)	(0.058)	(0.054)
Very Selective	-1.513***	-0.767***	-0.356***
	(0.063)	(0.062)	(0.057)
Most Selective	-1.694***	-1.264***	-0.662***
	(0.084)	(0.081)	(0.075)
Gender			
Female		0.111***	-0.0487*
		(0.030)	(0.027)
Race			
URM		-0.0231	-0.0648*
		(0.040)	(0.037)
Unknown		0.845***	0.457***
		(0.047)	(0.043)
Parents' Income			
Quartile 2		0.239***	0.134***
		(0.047)	(0.042)
Quartile 3		0.158***	0.0578
		(0.046)	(0.042)
Quartile 4		-0.385***	-0.412***
		(0.046)	(0.042)
Unknown		-1.040***	-0.761***
		(0.050)	(0.046)
Age at Time of Transfer		0.108***	0.117***
		(0.002)	(0.002)
Transfer GPA			
2.0 – 2.49			-0.15
			(0.136)
2.5 – 2.99			-0.450***
			(0.130)
3.0 – 3.49			-0.816***
			(0.129)
3.5 +			-1.241***
			(0.130)

Unknown			-0.997***
			(0.130)
Community College Credits			
25 – 47			0.318***
			(0.056)
48 – 59			0.523***
			(0.060)
60 +			1.124***
			(0.055)
Associate Degree			
Academic			-0.0689**
			(0.033)
Technical			1.271***
			(0.054)
Multiple Transfer			2.497***
			(0.032)
Constant	8.143***	4.909***	3.825***
	(0.057)	(0.088)	(0.156)
Observations	41,499	41,499	41,499
R-squared	0.015	0.109	0.262

Standard errors in parentheses.
*** p<0.01, ** p<0.05, $^{+}$ p<0.10.
Note: Reference groups: non-selective colleges, male students, non-URM students, parents' income quartile 1, transfer GPA below 2.0, less than 24 community college credits, no AA degree, and single transfer. This sample only includes students who completed a bachelor's degree.

Table 6: Regression models estimating interactions between race and college selectivity

	Bachelor's Degree	Bachelor's Degree in 6 Years	Time-to-Degree
Barron's Selectivity Categories			
Selective	1.589***	1.470***	-0.292***
	(0.075)	(0.075)	(0.070)
Very Selective	2.072***	1.633***	-0.238***
	(0.105)	(0.086)	(0.072)
Most Selective	3.126***	2.152***	-0.609***
	(0.261)	(0.149)	(0.091)
Race			
URM	0.985	0.879	0.208^{+}
	(0.067)	(0.072)	(0.109)
Interaction Terms			
URM x Selective	0.800***	1.026	-0.226^{+}
	(0.060)	(0.090)	(0.118)
URM x Very Selective	0.782***	1.136	-0.383***
	(0.070)	(0.110)	(0.130)
URM x Most Selective	1.052	1.262	-0.13
	(0.208)	(0.196)	(0.198)

Standard errors in parentheses.
*** p<0.01, ** p<0.05, $^{+}$ p<0.10.
Note: All models include other independent variables from Tables 3-5. Models 1 and 2 are based on logistic regression analyses and report odds ratios; Model 3 reports OLS regression coefficients.

Table 7: Regression models estimating interactions between gender and college selectivity

	Bachelor's Degree	Bachelor's Degree in 6 Years	Time-to-Degree
Barron's Selectivity Categories			
Selective	1.396***	1.249***	-0.0119
	(0.088)	(0.085)	(0.095)
Very Selective	1.864***	1.473***	-0.0212
	(0.124)	(0.103)	(0.097)
Most Selective	2.549***	2.192***	-0.672***
	(0.269)	(0.199)	(0.121)
Gender			
Female	1.038	0.852**	0.422***
	(0.072)	(0.067)	(0.107)
Interaction Terms			
Female x Selective	1.055	1.263***	-0.500***
	(0.078)	(0.105)	(0.113)
Female x Very Selective	1.013	1.198**	-0.488***
	(0.082)	(0.104)	(0.117)
Female x Most Selective	1.283^{+}	0.98	0.0845
	(0.180)	(0.114)	(0.151)

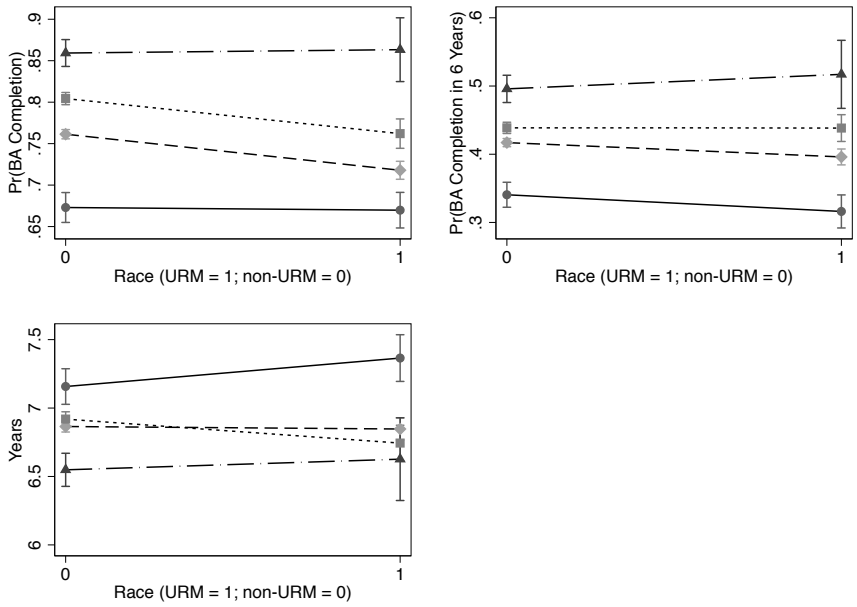
Standard errors in parentheses.
*** p<0.01, ** p<0.05, $^{+}$ p<0.10.
Note: All models include other independent variables from Tables 3-5. Models 1 and 2 are based on logistic regression analyses and report odds ratios; Model 3 reports OLS regression coefficients.

Table 8: Regression models estimating interactions between parents' income quartile and college selectivity

	Bachelor's Degree	Bachelor's Degree in 6 Years	Time-to-Degree
Barron's Selectivity Categories			
Selective	1.436***	1.513***	-0.474***
	(0.091)	(0.123)	(0.107)
Very Selective	2.035***	1.733***	-0.353***
	(0.151)	(0.152)	(0.116)
Most Selective	3.248***	2.934***	-0.991***
	(0.423)	(0.339)	(0.151)
Parents' Income			
Quartile 2	1.251***	1.077	0.221+
	(0.100)	(0.111)	(0.134)
Quartile 3	1.521***	1.197+	0.260+
	(0.132)	(0.126)	(0.137)
Quartile 4	1.730***	1.726***	-0.234
	(0.181)	(0.200)	(0.155)
Interaction Terms			
Quartile 2 x Selective	0.988	0.98	0.0927
	(0.088)	(0.109)	(0.145)
Quartile 2 x Very Selective	0.988	0.968	0.0787
	(0.094)	(0.109)	(0.147)
Quartile 2 x Most Selective	1.092	0.921	0.202
	(0.123)	(0.112)	(0.164)
Quartile 3 x Selective	0.913	0.963	0.00447
	(0.095)	(0.115)	(0.157)
Quartile 3 x Very Selective	0.895	0.973	-0.0796
	(0.097)	(0.117)	(0.157)
Quartile 3 x Most Selective	0.939	0.896	0.0555
	(0.115)	(0.115)	(0.172)
Quartile 4 x Selective	1.007	0.908	0.145
	(0.200)	(0.150)	(0.212)
Quartile 4 x Very Selective	0.84	0.683**	0.374+
	(0.172)	(0.114)	(0.214)
Quartile 4 x Most Selective	1.064	0.601***	0.546**
	(0.240)	(0.103)	(0.221)

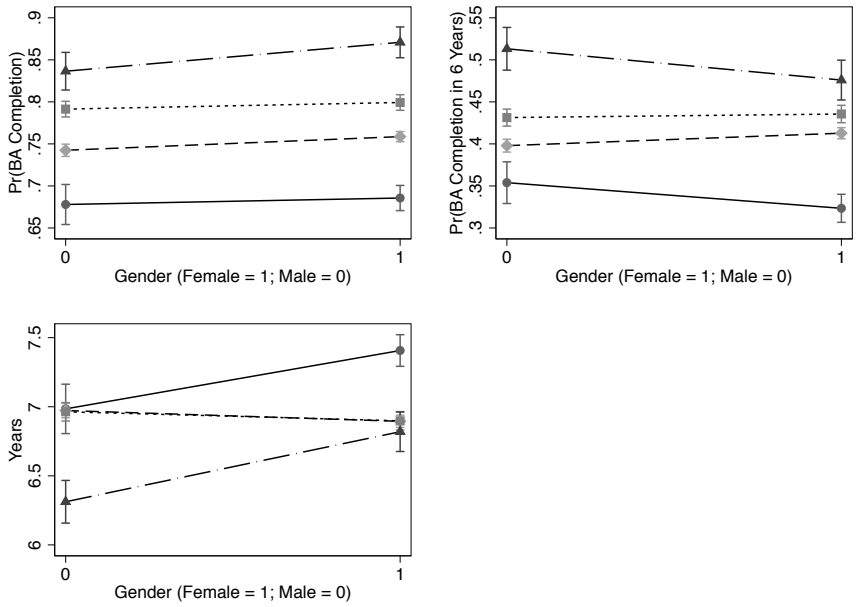
Standard errors in parentheses.
*** p<0.01, ** p<0.05, + p<0.10.
Note: All models include other independent variables from Tables 3-5. Models 1 and 2 are based on logistic regression analyses and report odds ratios; Model 3 reports OLS regression coefficients.

Figure 7: Predicted probabilities of bachelor's degree completion, bachelor's degree completion in 6 years, and time-to-degree, with 95% confidence intervals, by race at each level of college selectivity



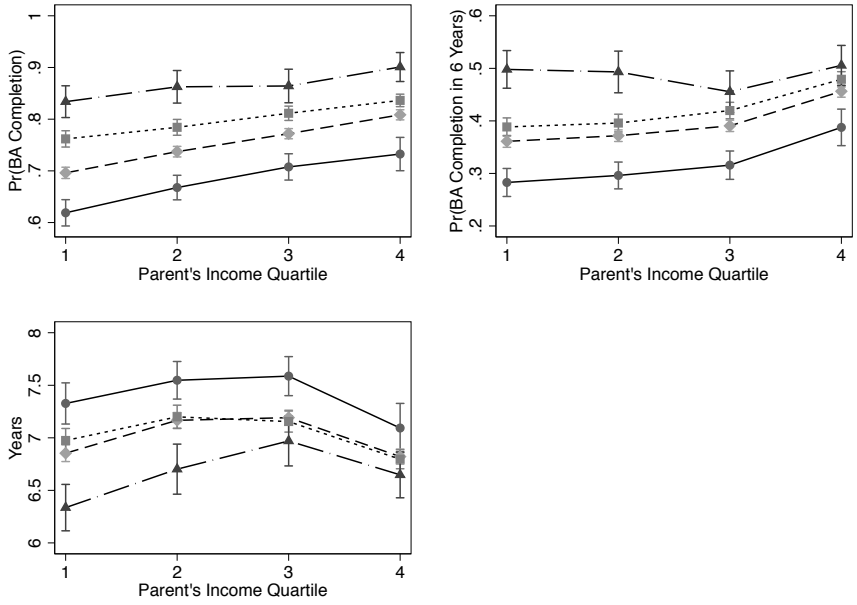
Note: The long-dashed line represents most selective institutions, the dotted line very selective, the short-dashed line selective, and the solid line non-selective.

Figure 8: Predicted probabilities of bachelor's degree completion, bachelor's degree completion in 6 years, and time-to-degree, with 95% confidence intervals, by gender at each level of college selectivity



Note: The long-dashed line represents most selective institutions, the dotted line very selective, the short-dashed line selective, and the solid line non-selective.

Figure 9: Predicted probabilities of bachelor's degree completion, bachelor's degree completion in 6 years, and time-to-degree, with 95% confidence intervals, by parents' income quartile at each level of college selectivity



Note: The long-dashed line represents most selective institutions, the dotted line very selective, the short-dashed line selective, and the solid line non-selective.

The Role of Rurality in Community College Transfer Student Pathways

Chapter 2 of Dissertation

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Abstract

This chapter explores the relationship between rurality and community college transfer student enrollment and graduation outcomes. The first question addresses the extent to which rural community college transfer students attend more selective colleges compared to their suburban peers. Next, I examine the relationship between rurality and bachelor's degree completion, bachelor's degree completion in 6 years, and time-to-degree, controlling for observable background characteristics and community college experiences. Finally, I explore whether the benefits of attending institutions of varying selectivity levels are the same for rural and suburban students. Overall, presented findings suggest that rural community college transfer students are significantly less likely to attend more selective colleges and have worse graduation outcomes than their suburban peers. There are also differential benefits across levels of selectivity between rural and suburban students. These findings expand our understanding of rural community college transfer student enrollment and graduation outcomes and highlight the need for future research into this relationship.

Introduction

According to the National Student Clearinghouse (2016), high school graduates from rural communities are less likely to attend college than their suburban peers (59% vs. 67%). These students are also less likely to return for their second year of college and less likely to complete a bachelor's degree in 6 years compared to their suburban peers (NSC, 2016). These patterns persist for community college transfer students. Using a national sample, Jenkins and Fink (2016) showed that students who transferred to a four-year college were more likely to be enrolled in community colleges that were located in suburban compared to rural communities. In addition, rural students who made the transition from a two- to a four-year college were less likely to earn a bachelor's degree within in 6 years relative to their suburban peers (28% vs 38%).

Prior literature has identified several factors that contribute to lower rates of college attendance for rural than suburban students. For example, rural students tend to come from disproportionally lower-income backgrounds (Lichter & Johnson, 2007), have parents with fewer years of education (Provasnik et al., 2007), and attend less rigorous high schools with fewer college preparation resources (Griffin, Hutchins, & Meece, 2011; Irvin et al., 2011). Additionally, rural students generally live farther away from four-year colleges (Hillman, 2016), which is related to the probability of attending college (Turley, 2009; Terry Long & Kurelander, 2009). In terms of graduation outcomes, one factor that may contribute to differential outcomes is institutional selectivity: rural students are less likely to attend highly selective colleges compared to their non-rural peers (Byun, Irvin, Meece, 2015; Byun, Meece, & Agger, 2017), and institutional selectivity is related to the likelihood of degree completion (Bowen, Chingos, & McPherson, 2009; Goodman, Hurwitz, & Smith, 2017).

Understanding outcomes of rural transfer students is crucial for several reasons. First, disadvantages of rural students with respect to college enrollment and graduation outcomes are gaining national attention (National Public Radio, 2018; The Atlantic, 2017) and are becoming an increasingly important policy topic (The New York Times, 2017). Second, community colleges are often the nearest college for students from rural communities, making transfer an especially appealing option for those students who are interested in earning a bachelor's degree (Hillman, 2016; Terry Long & Kurlaender, 2009). Moreover, the role of rurality is particularly important to consider in Virginia given the disproportionately high number of college students residing in rural areas. On a national level, rural and suburban students account for approximately 58 percent of students attending higher education (18 and 39 percent, respectively). In Virginia, rural and suburban students make up 70 percent of the overall college student body (25 and 45 percent, respectively) and 75 percent of the community college student body (31 and 44 percent, respectively) (NCES, 2014).

While prior literature has examined rural college student enrollment and graduation outcomes, it has rarely considered rural community college transfer students (for recent exceptions, see Byun, Meece, & Agger, 2017; Jaeger, Dunstan, & Dixon, 2015). Furthermore, previous research has not examined how the selectivity of the transfer destination is related to graduation outcomes for rural students. Using a rich longitudinal data set from Virginia, this chapter aims to fill those gaps by addressing three research questions: First, is the likelihood of transfer to more selective colleges related to rurality? Second, do graduation outcomes differ between rural and suburban students? Third, do rural compared to suburban community college transfer students benefit differentially by attending colleges at various levels of selectivity?

Literature Review

Rural Students in Higher Education

Scholars routinely point to a set of factors that contribute to the gaps in college-going and graduation outcomes between rural and non-rural students. For example, rural students tend to come from disproportionally lower-income and/or racial/ethnic minority backgrounds and have parents with fewer years of education compared to their non-rural peers (Lichter & Johnson, 2007; Turley, 2009). Additionally, since the labor markets in rural areas generally favor technical skills over a college degree, many of the high schools in rural communities are less academically rigorous and do not offer Advanced Placement courses or well-resourced college counselors (Provasnik et al., 2007). Lower property taxes in rural areas further exacerbate the problem by limiting the school districts' abilities to hire high-quality teachers and spend more money per student compared to schools in non-rural communities (Theobald & Siskar, 2008). These factors also contribute to higher dropout rates at rural high schools and lower average test scores (Licher, Roscigno, & Condron, 2003; Roscigno & Crowle, 2001).

Furthermore, colleges are not distributed uniformly across states; many geographic areas have rich concentrations of colleges while others, particularly rural areas, might be hundreds of miles away from a very selective college (Hillman, 2016). Since the proximity of a student's home relative to college is one of the primary factors in the college-choice process (Turley, 2009), and more than 50 percent of college students in the U.S. attend colleges that are within 20 miles of their homes (Sponsler & Hillman, 2016), rural students are likely at a disadvantage relative to their non-rural peers in terms of college-going.

Even once they enroll in college, rural students generally perform less well (Molefe et al., 2017), which is related in part to academic and socioeconomic inequalities noted above (Byun,

Meece, & Irvin, 2012). In addition, rural students are less likely to attend very selective colleges (Byun, Irvin, Meece, 2015), which has consistently been linked to bachelor's degree completion (Bowen, Chingos, & McPerson, 2009; Goodman, Hurwitz, & Smith, 2017).

Rural Transfer Students

Few studies have examined transfer pathways for college students from rural backgrounds (Byun, Meece, & Agger, 2017; Jaeger, Dunstan, & Dixon, 2015). One study based in North Carolina found that rural students commonly used community colleges as a starting point prior to attending a four-year college (Byun, Meece, & Agger, 2017). Specifically, the authors reported that 24 percent of rural community college students in North Carolina who began their post-secondary studies in 2008 transferred to a four-year college. These results suggest that, at least in some states, rural students take advantage of transferring from a two- to a four-year college. However, previous research has not addressed differences in transfer patterns among rural vs. non-rural community college students.

Transferring from a two- to a four-year college is an attractive option for rural students because it affords them the opportunity to attend a nearby community college before making the commitment to a four-year college or university. This pathway to a bachelor's degree is also traditionally viewed as a less expensive option than directly attending a four-year college in terms of both tuition and housing expenses (IPEDS, 2019). This is particularly true given the increased expenses associated with attending a college that is farther away from a student's home and the high percentage of rural students that come from lower-income and/or racial/ethnic minority backgrounds (Lichter & Johnson, 2007; Turley, 2009).

In addition to being scant, prior literature on transfer students from rural areas has not examined the extent to which selectivity of the four-year institution may contribute to differential

educational attainment between rural students and those from other areas. Extensive literature focusing on students who enter four-year institutions has shown a positive relationship between selectivity and graduation outcomes (see chapters 1 and 3 for a full review of the literature). The overarching finding from this literature is that attending a more selective college is associated with better graduation outcomes (Bowen, Chingos, & McPherson, 2009). Causal evidence shows similar results, with particularly strong effects for students from lower-income and underrepresented racial/ethnic minority backgrounds (Goodman, Hurwitz, & Smith, 2017; Zimmerman, 2017). A few studies also show that selectivity of the four-year institution is related to graduation outcomes for transfer students (Bowen, Chingos, & McPherson, 2009; Hilmer, 2000, 2002).

Although rural high school graduates are less likely to attend very selective colleges compared to their non-rural peers (Byun, Irvin, & Meece, 2015), research is limited on whether those patterns hold for transfer students and whether selectivity of the four-year institution is related to their outcomes. This chapter aims to fill those gaps by relying on a rich data set from Virginia to examine four-year destinations of rural vs. suburban transfer students as well as their graduation outcomes.

Data and Methods

This chapter uses restricted-access data from the Virginia Longitudinal Data System (VLDS). The original data set contains rich administrative data for all students who initially enrolled at a Virginia college between fall 2001 and 2017 and then transferred to a different college anytime between spring 2002 and 2018. Students in this data set represent all 24 public community colleges, 15 public four-year colleges, and 44 private non-profit colleges in Virginia. The sample for this study is restricted to students who transferred from community colleges to

four-year institutions, and who completed at least 12 credits at a Virginia community college prior to transferring to a four-year college. Students could complete 12 credits over several years or just a single semester. I restrict the analytical sample to students who took at least 12 credits prior to transfer because this is commonly considered one semester and is the minimum requirement to receive full-time federal aid (FAFSA, 2019). I further restrict the sample to students who began their studies at a community college during the fall semester no later than 2012 to make sure I have at least 6 years to track their graduation outcomes. I focus on those who began their post-secondary studies during a fall semester because this is when most students enter college and this approach allows for more uniform comparisons across cohorts. Additionally, I restrict the sample to only include students who started at a four-year college no later than the fall semester of 2014, which provides all students at least 4 years to complete their bachelor's degrees after transfer. Finally, I drop the students in the sample who are from towns and cities, per the explanation below. The final analytic sample includes 39,448 students who initially enrolled at a Virginia community college during a fall semester between 2001 and 2012 and then transferred to a four-year college between spring 2002 and fall 2014.

Variables

There are three primary outcomes of interest: bachelor's degree (BA) completion, bachelor's degree (BA) completion in 6 years, and time-to-degree. I use BA to refer to all bachelor's degrees, including a Bachelor of Arts and a Bachelor of Science. BA completion and BA completion in 6 years are binary indicators (1 = completed BA / completed BA in 6 years; 0 = did not complete BA / did not complete BA in 6 years).[5] Time-to-degree is a continuous

[5] In line with the methodology used in chapter 1, students with a value of 1 for BA in 6 are those who completed a BA degree and their last date of enrollment in a four-year college was less than or equal to 6 years after they first enrolled in a community college. Since students in earlier cohorts have considerably more time to complete their 12 credits at the community college, these students, on average, take longer to complete their degrees.

measure indicating the number of years that it took students to earn their degrees, which is conditional on having completed a BA. I also use college selectivity as an outcome variable in the first model to examine the relationship between rurality and the probability of transfer to institutions at various levels of selectivity.

The two key independent variables are rurality (rural vs. suburban) and college selectivity. Rurality indicators are derived from the National Center for Education Statistics (NCES) Common Core of Data (CCD). These categories follow the pattern of the U.S. Census, dividing geographic areas into four primary categories: rural, suburban, city, town. Although I do not have student's addresses, I merge VLDS data with the county where the student lived during their first semester in community college using these rurality indicators.

This analysis compares rural with suburban students. Geographic areas are labeled rural if they fall outside of urban territories. Suburban areas are those that are located inside of an urbanized area, but outside of a principle city (Geverdt, 2015). Preliminary analyses indicated that rural vs. non-rural comparisons would not be appropriate because students in towns and cities were often positioned closer to rural than suburban students with respect to transfer patterns and graduation outcomes. Combining all non-rural students into one category would thus introduce unnecessary noise into the comparison. Moreover, students from towns and cities represent only 6 percent and 18 percent of community college transfer students in the sample, respectively. Given their small numbers and unique patterns of transfer destinations and graduation outcomes, town and city students are excluded from analysis.

The second key independent variable is the selectivity of the four-year institutions that students transferred to. College selectivity categories for four-year colleges are taken from

Barron's Profiles of American Colleges (2018 edition). There are four primary categories used in this analysis: most selective, very selective, selective, and non-selective.[6]

Other independent variables include background characteristics and community college experiences identified in previous literature and chapter 1 as being related to transfer student outcomes. Background characteristics include a dummy variable for underrepresented racial/ethnic minority (URM) students (1 if Black, Hispanic, and Native American; 0 if white or Asian); gender (1 if female; 0 if male), parents' income quartile, and age at time of transfer (in years).[7]

Community college experiences include associate degree (AA) degree status, which is one of three categorical indicators (academic associate degree, technical associate degree, or no associate degree, which is used as a reference), transfer GPA (on a 4.0 scale), and number of community college credits. Similar to the BA variable, I use AA to refer to all associate degrees, including an Associate of Arts or an Associate of Science. Transfer GPA is divided into groups (less than 2.0, 2.0-2.49, 2.5-2.99, 3.0-3.49, 3.5+, and not reported) to account for students who do not have a valid value for this independent variable. Community college credits are divided into groups (less than 24, 24-47, 48-59, 60+) to account for non-linearities in relation to the outcome variables of interest. I also include a dummy variable for students who do not have a valid transfer GPA. Additionally, I include a binary indicator to identify whether a student transferred more than one time during their post-secondary studies in Virginia, which was found to a play a significant role in all three primary outcomes of interest in chapter 1.

[6] Barron's uses the terminology competitive rather than selective. However, for the purposes of this project, I refer to these as selectivity categories. I consider all unranked colleges in Barron's guide "non-selective."
[7] Due to a substantial number of missing cases for race and parents' income, I also control for students who have "unknown" values for those variables in the regression models.

Methods

This analysis focuses on the differences in four outcome measures (one enrollment and three graduation outcomes) between community college transfer students from rural and suburban communities. First, I present descriptive statistics to convey differences in both background characteristics and community college experiences between these student groups. Next, I examine descriptive differences in four-year enrollment patterns for rural and suburban community college transfer students. After looking into these descriptive differences, I turn my attention to a set of regression models that help eliminate some of the bias by controlling for observable background characteristics and community college experiences. The first of these is a multinomial logistic regression model that examines whether community college transfer students from rural communities have the same probability of attending colleges at different levels of selectivity relative to non-selective colleges compared to their suburban peers. This multinomial logistic regression model also provides insights into differences in enrollment patterns between various student groups, defined by background characteristics and community college experiences.

Next, I look at the graduation outcomes of interest (BA completion, BA completion in 6 years, and time-to-degree). First, I present the descriptive differences in each of these graduation outcomes for rural compared to suburban community college transfer students. Following, I estimate logistic regressions for BA completion variables and an ordinary least squares (OLS) regression for the time-to-degree variable. Regression analyses include three models, which sequentially add control variables. Model 1 shows the bivariate relationship between rurality (rural vs. suburban) and the graduation outcome of interest. Subsequent models add different blocks of variables to examine the extent to which factors identified in the literature may

contribute to explaining differences between rural and suburban community college transfer students. Specifically, Model 2 adds the selectivity of the four-year college and background characteristics (gender, race, parents' income quartile, and age at time of transfer). Model 3 includes variables from Models 1 and 2 and adds community college experiences (transfer GPA, community college credits, AA degree status) and an indicator for whether a student transferred more than once during their postsecondary studies in Virginia.

After presenting logistic and OLS regression results for graduation outcomes, I examine whether there are differential benefits to attending institutions at various levels of selectivity for rural compared to suburban students. These interaction models are estimated by running the regressions from Model 3 for each of the graduation outcomes and including an interaction between rurality and college selectivity. To facilitate the interpretation of these interaction results, I include figures that show the average predicted probabilities for rural compared to suburban community college transfer students for each of the outcome measures of interest, along with 95% confidence intervals.

Finally, I examine the relationship between distance and college selectivity. First, I report the distance to the nearest college at each level of selectivity for rural compared to suburban community college transfer students. Additionally, I include the average distance to the set of colleges at each level of selectivity for these two groups of students. To enhance the interpretations of these differences, I present a population density map that shows all of Virginia's community colleges as well as the 30 biggest four-year colleges in the state.[8] Collectively, presented analyses describe relationships between rurality and community college

[8] All colleges in Virginia are not included in this map for the sake of clarity. However, there is at least one college of each level of selectivity in each geographic area to represent the spread of colleges in the state.

transfer students' enrollment and graduation outcomes and provide valuable insights into a previously understudied topic.

Results

Background Characteristics, Community College Experiences, and Transfer Patterns of Rural and Suburban Students

Rural and suburban community colleges transfer students in Virginia are relatively similar on most background characteristics and with respect to examined community college experiences. While many differences reported in Table 1 are statistically significant (based on t-tests with a Bonferroni correction for multiple comparisons), they are mostly of very small magnitude. However, a few differences have larger magnitudes. There are considerably more females from rural than suburban communities (60 vs. 53 percent). A significantly higher percentage of rural than suburban students come from the second- and third- income quartiles and fewer rural than suburban students come from the fourth and unknown income quartiles.[9] Additionally, significantly more rural than suburban students transfer from a community college with a technical AA (12 vs. 7 percent) and transfer more than once during their post-secondary studies (26 vs. 20 percent).

While most of the differences pertaining to background characteristics are relatively small, the patterns of transfer to institutions at different selectivity levels are more pronounced. Table 2 indicates that significantly fewer students from rural communities transfer to the most selective and very selective colleges in the state and significantly more transfer to selective and non-selective colleges compared to their suburban peers (based on a t-test comparing rural and suburban students at each level of selectivity, with a Bonferroni correction for multiple

[9] Income data is derived from each student's financial aid applications. Given that very high-income students are not eligible for need-based aid, these students most likely do not fill out those applications.

comparisons). These differences are particularly large in magnitude at the most selective, very selective, and non-selective colleges. For example, while 6 percent of suburban students transfer to most selective institutions only 4 percent (or 50 percent fewer) rural students do the same. The biggest gap between rural and suburban students is observed at non-selective colleges, which are attended by twice as many rural as suburban students (4 percent of suburban students compared to 9 percent of rural students).

Regression Analysis

Although the descriptive data shows significant differences between rural and suburban students in terms of selectivity of the transfer destination, it is possible that these results are attenuated by differences in background characteristics and community college experiences. A multinomial logistic regression analysis in Table 3 indicates that rural students are significantly less likely to transfer to selective, very selective, and most selective colleges as opposed to less selective colleges than their suburban peers, controlling for observable background characteristics and community college experiences. Model 1 indicates that rural students are .62 times as likely to attend a selective college vs. a non-selective college compared to suburban students. Similarly, rural students are .42 times as likely to attend a very selective college and .39 times as likely to attend a most selective college compared to their suburban peers.

There are also significant differences in terms of enrollment at institutions at each level of selectivity relative to non-selective colleges across virtually every independent variable in the analysis. For example, female students and URM students are significantly less likely than male students and non-URM students to attend selective, very selective, and most selective colleges compared to non-selective colleges, controlling for other background characteristics and community college experiences. There is also a positive statistically significant relationship

between the highest parents' income quartile and selectivity, with students in the highest income quartile being notably more likely to attend institutions at each selectively level than non-selective institutions relative to students in the bottom income quartile. However, there are no differences in terms of enrollments between students in the first- and third-income quartile at selective and very selective colleges compared to non-selective colleges. Additionally, odds ratios for the second and third quartiles are below 1 for most selective colleges, which suggests that students from the lowest parents' income quartile are significantly more likely to attend the most selective colleges in the state relative to attending non-selective institutions, compared to students from the second- and third-income quartiles.

With regards to community college experiences, students with higher transfer GPAs are generally significantly more likely to attend colleges at higher levels of selectivity than non-selective institutions. This relationship is particularly pronounced in the 3.5+ GPA group at the most selective colleges in Virginia. Although there are only small enrollment differences with regards to students who complete fewer than 25 credits compared to students who complete 25-47 credits, students who complete between 48-59 credits and 60+ credits are significantly more likely to attend colleges at each level of selectivity relative to non-selective institutions than students who complete fewer than 25 credits. Additionally, students who earn an academic AA are significantly more likely to attend colleges at higher levels of selectivity relative to a non-selective college compared to students who earned no AA. Meanwhile, students who earned a technical AA are significantly less likely to attend institutions at higher levels of selectivity relative to a non-selective college compared to those who did not earn an AA prior to transfer. Finally, Table 3 shows that, compared to students who only transferred once, students who transfer more than once during their post-secondary studies in Virginia are significantly less

likely to attend selective and very selective colleges, but equally likely to attend the most selective colleges, relative to attending non-selective institutions.

Graduation Outcomes for Rural and Suburban Students

While the difference between rural and suburban community college transfer students with respect to background characteristics are relatively small, descriptive results reveal large gaps in graduation outcomes (Table 4). There are three outcome variables of interest: BA completion, BA completion in 6 years, and time-to-degree. On a descriptive level, rural students perform significantly worse on each of the three outcome variables compared to suburban students. These descriptive results are corroborated by logistic and OLS regression analyses. Even after controls, community college transfer students from rural communities perform significantly worse across all three graduation outcomes compared to their suburban peers.

Tables 5-7 present a series of sequential regressions for each of the outcomes, wherein the first model shows the bivariate relationship between outcome of interest and rurality, the second model accounts for the level of college selectivity and background characteristics (race, gender, parents' income quartile, and age at time of transfer), and the third model adds community college experiences (transfer GPA, community college credits, and AA degree type) and an indicator for whether a student transferred more than once during their post-secondary studies in Virginia. In terms of BA completion, controlling for all observable characteristics in Model 3, community college transfer students from rural communities are .86 times as likely to complete a BA compared to students from suburban communities, which is virtually identical to the coefficient in Model 1 (Table 5).

The second outcome measure shows a similar pattern in Table 6. Rural community college transfer students are .85 times as likely to complete a BA in six years compared to

suburban community college transfer students, even after considering all of the controls. The coefficient for rurality changes only slightly between Model 1 and Model 3. The change across models is more pronounced for time-to-degree outcome measure, shown in Table 7. The first model indicates that rural community college students take approximately half a year longer to complete the BA than their suburban peers. The gap drops to less than half of that in the final model. Net of controls, rural students complete their degrees in 0.2 years more than suburban students, which is statistically significant at the .01 level, although of relatively low magnitude (approximately half a semester).

Interactions Between Rurality and College Selectivity

Given findings from prior research on differential outcomes by sociodemographic background and college selectivity (Dale & Krueger, 2002; Goodman, Hurwitz, & Smith, 2017), as well as the interaction patterns presented in chapter 1 of this dissertation, it is possible that students from rural vs. suburban communities benefit to different extents by attending colleges at various levels of selectivity.

Descriptive results in Table 8 indicate that rural and suburban community college transfer students complete their BA degrees at a statistically indistinguishable rate at most and very selective colleges. However, rural students graduate at significantly lower rates at selective colleges and significantly higher rates at non-selective colleges compared to their suburban peers. The biggest gaps in graduation outcomes between rural and suburban community college transfer students are at the most selective colleges and pertain to BA completion in 6 years and time-to-degree. While 57 percent of suburban students complete their BA in 6 years at the most selective colleges in Virginia, only 48 percent of rural students do so. Additionally, suburban students complete their degrees almost a full year earlier than rural students at the most selective

colleges (.81 years). Similar differences are also found at selective colleges, where rural students have significantly worse outcomes on all three graduation measures. For example, at selective colleges, 44 percent of suburban students complete their BA in 6 years compared to only 37 percent of rural students. In addition, rural students take half a year longer to complete their degrees at selective colleges compared to suburban students.

These descriptive differences could be in part related to differences in students' background characteristics and community college experiences. Therefore, I re-estimate each of the regression models (controlling for all observable characteristics noted in previous models) while including interaction terms between rurality and college selectivity. In general, rural students gain significantly fewer benefits compared to their suburban peers by attending colleges at higher levels of selectivity compared to non-selective institutions. The first two columns of Table 9 show the odds ratio from a logistic regression for the BA completion models and the third column of Table 9 shows the OLS estimate for the time-to-degree model.

With regards to BA completion, attending selective and very selective colleges relative to non-selective colleges benefits rural students significantly less than their suburban peers. However, there are no differential benefits of attending most selective institutions compared to non-selective institutions between rural and suburban students in the BA completion model. In contrast to the BA completion model, all of the interactions between rurality and selectivity are negative and statistically significant for BA completion in 6 years, with the largest differences observed at the most selective colleges. This suggests that rural students benefit significantly less compared to their suburban peers at selective, very selective, and most selective colleges in the state in terms of completing a BA in 6 years relative to non-selective colleges. The final column of Table 9 shows that rural community college transfer students compared to suburban students

gain significantly less by attending selective and the most selective institutions relative to non-selective institutions in Virginia with regards to time-to-degree. However, there are no differential effects in the time-to-degree model at very selective colleges relative to non-selective colleges. To accompany Table 9, Figure 1 shows the average predicted probabilities for rurality for each of the outcome variables of interest, including 95% confidence intervals.

Distance Between Community Colleges and Four-Year Institutions

Part of the disadvantage of rural students' transfer to institutions at higher levels of selectivity may be related to the distance from various types of institutions. In the sample examined in this study, rural students are particularly disadvantaged relative to suburban students in terms of access to more selective institutions (Table 10). Overall, rural transfer students attend community colleges that are significantly farther away from selective, very selective, and most selective four-year colleges in Virginia. For example, the distance to the nearest most selective institution in the state is 77 miles from a rural transfer student's community college compared to 64 miles from a suburban transfer student's community college. Furthermore, the average distance of all the most selective institutions to a rural transfer student's community college is 112 miles compared to 90 miles from a suburban transfer student's community college. In addition to being statistically significant, both of these differences are quite large in magnitude based on national college-going patterns (Hillman, 2016). Although statistically significant, the rural/suburban gaps in distance to selective and very selective colleges are much smaller in magnitude.

On the other hand, rural transfer students attend community colleges that are much closer to non-selective colleges, which likely helps to partially explain the wide gap in enrollment at these types of colleges between rural and suburban students (9 percent of rural vs. 4 percent of

suburban). For example, the nearest non-selective institution is 18 miles closer to a rural transfer student's community college compared to a suburban transfer student's community college.

To better illustrate these differences, Figure 2 shows a population density map in Virginia, including all community colleges and the 30 largest four-year transfer destinations.[10] Population data is gathered through the U.S. Census Bureau (2018). The figure illuminates descriptive distance data and shows a few notable patterns. The most selective colleges in the state are located in central and eastern Virginia, the nearest of which is hundreds of miles away from the west-most point of the state. Additionally, there are several community colleges in the southwest and south of the state that are very close to non-selective and selective colleges, but very far away from the most selective colleges. Although students from northern Virginia are similarly far away from the most selective colleges compared to students in the western part of the state, these students generally live in suburban areas.

Given these differences, I considered using distance from the nearest most selective college as an instrumental variable (IV) to estimate the causal effect of attending a more selective college on community college transfer student graduation outcomes. The theory behind this approach is that distance to a nearest college is associated with the probability of attending that college, since students traditionally attend colleges that are closer to their homes (Hillman, 2016; Turley, 2009), but not associated with the probability of graduating from college. Scholars have used such an approach to estimate the community college penalty on graduation outcomes. For example, Long and Kurlaender (2009) found that students who initially begin at a community college are 14.5 percent less likely to complete a BA within 9 years compared to similarly qualified students who began at a four-year college. Their argument rested on the

[10] At least one college at each level of selectivity is shown in any given geographic area. All colleges are not included to ease the interpretation of the map.

assumption that students who lived closer to community colleges were more likely to attend community colleges, but not more likely to eventually earn a bachelor's degree based simply on their distance from the nearest college.

In this study, it was theoretically possible to use distance as an instrument to estimate the causal effect of attending a more selective college on community college transfer students. A perfect data set would contain addresses of students, which could then be converted to distance from the nearest most selective four-year college. However, the data set utilized in this study provided only county-level data and did not include students' home addresses. I thus had two options: (A) use the distance from centroid of the county or (B) use the distance from the student's community college.

Option A would be desirable if counties in Virginia were relatively small and uniform in size. However, this is not the case: the largest counties in Virginia are almost 1,000 square miles and the smallest counties are less than 3 square miles. Additionally, the average county in Virginia is 299 square miles with a standard deviation of 227 square miles. These large differences are due in part to county designations in the state, wherein many cities, including Charlottesville and Richmond, are considered independent and do not form part of a larger local government entity. Therefore, measuring the distance from the centroid of the county to the nearest most selective four-year college would lead to considerable noise that would severely limit the validity of the results.

The alternative option (B) would be to use the distance from the student's community college to the nearest college at each level of selectivity. Since there are only 24 community colleges in Virginia, this would lead all students to have 1 of 24 values for the instrument in the analysis. While previous studies have used only binary instruments, such as winning a charter

school lottery (Angrist, Pathak, & Walters, 2013), using the distance from a student's community college would effectively translate to community college fixed effects. For example, all students at community college X would have the same value for the instrument, regardless of where they actually lived. Therefore, this approach was ruled out as a possible means to use distance as an instrument to estimate the causal effect of attending a more selective college.

Discussion and Conclusion

While previous research has noted differences in graduation outcomes between rural and suburban students (e.g., Byun, Meece, & Irvin, 2012; Adelman, 2002), it has infrequently addressed outcomes of community college transfer students. Using longitudinal data from Virginia, this chapter extends our understanding of community college transfer student enrollment and graduation outcomes, primarily as they relate to college selectivity. Descriptive results indicate that significantly fewer rural community college transfer students enroll in selective, very selective, and most selective institutions compared to their suburban peers. Additionally, significantly more rural students transfer to non-selective colleges, which are located significantly closer to their community colleges, compared to suburban students. These patterns hold in a regression analysis controlling for observable background characteristics and community college experiences: rural students are significantly less likely to transfer to colleges at each level of selectivity relative to non-selective institutions compared to their suburban peers.

With regards to graduation outcomes, rural community college students are significantly less likely to complete a BA and complete a BA in 6 years compared to their suburban peers, controlling for selectivity of the four-year institution, background characteristics and community college experiences. Rural students are approximately .86 times as likely to complete a BA and

.85 times as likely to complete a BA in 6 years relative to their suburban peers, net of controls. Students from rural communities also take significantly longer to complete their degrees compared to their peers from suburban communities: among community college transfer students who complete a BA, rural students take approximately half a year longer to do so compared to their suburban peers. This difference is much smaller (approximately less than half a semester) after controlling for selectivity of the four-year institution, background characteristics and community college experiences, implying that these factors explain a substantial proportion of the relationship between rurality and time-to-degree.

Finally, interactions between rurality and college selectivity suggest that rural community college transfer students in general benefit significantly less compared to their suburban peers by attending colleges at all levels of selectivity relative to non-selective colleges. For example, rural students benefit significantly less than their suburban peers in terms of BA completion in 6 years and time-to-degree at the most selective colleges, BA completion and BA completion in 6 years at very selective colleges, and all three outcome measures at selective colleges relative to non-selective colleges. There are no differential benefits for rural and suburban student for only two comparisons: BA completion at the most selective colleges and time-to-degree at selective colleges compared to non-selective colleges.

The findings in this chapter are consistent with previous research on the relationship between rurality and graduation outcomes for college students who begin their post-secondary studies at a four-year college or university (Molefe, Proger, & Burke, 2017; Byun, Meece, & Irvin, 2012), showing that rural community college transfer students have significantly less desirable graduation outcomes compared to their suburban peers. Although these results are not causal, they provide further evidence of a gap in enrollment and graduation outcomes between

rural and suburban college students. Future research could expand on this study, particularly as it pertains to community college transfer students, by addressing the relationship between rurality and college enrollment and graduation outcomes through more rigorous quasi-experimental methods in order to establish whether the patterns observed herein are causal or largely reflect self-selection.

Additionally, university administrators and policy-makers would benefit from reflecting on whether all students in Virginia have the same opportunities. Presented results indicate that rurality and distance to the nearest most selective and very selective colleges play some role in the college-choice process for community college transfer students, evidenced by disparate enrollment patterns for rural and suburban students at those types of institutions. In order to help rural community college transfer students gain access to most selective and very selective colleges, these institutions could more actively recruit in rural areas as well as make their institutions more welcoming to students from those areas. Moreover, rural community college students overall benefit less than their suburban peers from attending institutions at higher levels of selectivity relative to non-selective colleges, implying the need for more selective institutions in Virginia to develop better ways to support students from rural communities.

Table 1: Descriptive statistics for independent variables used in analysis, by rurality

	Total	Rural	Suburban	Difference	Significance
Demographics					
Race (percent)					
Non-URM	72	73	72	1	NS
URM	17	16	18	-2	+
Unknown	11	11	11	0	NS
Gender (percent)					
Female	56	60	53	7	**
Male	44	40	47	-7	**
Age at Time of Transfer (years)	25.63	25.7	25.6	0.1	NS
Parents' Income Quartile (percent)					
Q1	19	19	19	0	
Q2	20	23	19	4	**
Q3	21	24	19	5	**
Q4	23	22	24	-2	+
Unknown	16	12	19	-7	**
Community College Experiences					
Transfer GPA	3.12	3.12	3.12	0	NS
Community College Credits	65.4	66.7	64.4	2.3	NS
Associate Degree (percent)					
Academic	49	49	49	0	
Technical	9	12	7	5	**
No Degree	42	39	44	-5	**
Four-Year-Level Factors					
Multiple Transfer (percent)	22	26	20	6	***
N	39,448	16,855	22,593		

*** p<0.01, ** p<0.05, + p<0.10, NS=Not Significant.
Note: The final column, Significance, indicates whether the differences between rural and suburban community college transfer students are statistically significant for categories of each independent variable using a t-test. Significance values are adjusted using a Bonferroni correction for multiple comparisons. Parents' income was reported at the time of college entry and adjusted for inflation to represent value in 2018. Percentages in the table are rounded to the nearest whole number and may not add up to 100.

Table 2: Percentage of community college transfer students enrolled at institutions at various levels of selectivity, by rurality

	Total	Rural	Suburban	Difference	Significance
Barron's Selectivity Categories					
Most Selective	5	4	6	-2	***
Very Selective	29	25	33	-8	***
Selective	59	61	57	4	***
Non-Selective	6	9	4	5	***
Total	39,448	16,855	22,593		

*** $p<0.01$, ** $p<0.05$, $^{+}$ $p<0.10$.

Note: The final column, Significance, indicates whether the differences between rural and suburban community college transfer students are statistically significant for each level of selectivity using a t-test. Significance values are adjusted using a Bonferroni correction for multiple comparisons. Percentages in the table are rounded to the nearest whole number and may not add up to 100.

Table 3: Multinomial logistic regression models predicting the probability of attending institutions at various levels of selectivity (reference: non-selective)

	Model 1	Model 2	Model 3
	Selective	Very Selective	Most Selective
Rurality			
Rural	0.623***	0.417***	0.393***
	(0.028)	(0.020)	(0.025)
Gender			
Female	0.710***	0.552***	0.519***
	(0.034)	(0.027)	(0.034)
Race			
URM	0.654***	0.489***	0.497***
	(0.034)	(0.028)	(0.043)
Unknown	0.976	0.548***	0.811**
	(0.066)	(0.041)	(0.078)
Parents' Income			
Quartile 2	0.982	0.981	0.828**
	(0.061)	(0.065)	(0.075)
Quartile 3	1.034	1.088	0.808**
	(0.065)	(0.073)	(0.074)
Quartile 4	1.478***	1.724***	1.246**
	(0.103)	(0.125)	(0.119)
Unknown	3.498***	3.491***	2.554***
	(0.360)	(0.370)	(0.318)
Age at Time of Transfer (years)	0.995**	0.946***	0.991**
	(0.003)	(0.003)	(0.004)
Transfer GPA			
2.0 – 2.49	0.877	1.848***	1.867
	(0.125)	(0.341)	(1.160)
2.5 – 2.99	1.821***	4.215***	2.4
	(0.252)	(0.756)	(1.456)
3.0 – 3.49	2.233***	5.261***	13.72***
	(0.309)	(0.942)	(8.163)
3.5 +	1.933***	5.045***	63.39***
	(0.273)	(0.916)	(37.620)
Unknown	0.632***	4.348***	14.75***
	(0.085)	(0.765)	(8.744)
Community College Credits			
25 – 47	0.93	1.176^{+}	1.146

	(0.073)	(0.099)	(0.143)
48 – 59	1.291***	1.614***	2.006***
	(0.118)	(0.156)	(0.271)
60 +	1.462***	1.731***	1.966***
	(0.116)	(0.147)	(0.242)
Associate Degree			
Academic	1.364***	1.126**	1.389***
	(0.077)	(0.066)	(0.107)
Technical	0.556***	0.466***	0.380***
	(0.039)	(0.036)	(0.046)
Multiple Transfer	0.605***	0.815***	0.993
	(0.030)	(0.042)	(0.070)
Observations	39,448	39,448	39,448

Standard errors in parentheses.
*** p<0.01, ** p<0.05, $^{+}$ p<0.10.
Note: Reference groups: suburban students, male students, non-URM students, parents' income quartile 1, transfer GPA below 2.0, less than 24 community college credits, no associate degree, and single transfer.

Table 4: Community college transfer student graduation outcomes, by rurality

	Total	Rural	Suburban	Difference	Significance
Graduation Outcomes					
Bachelor's degree (percent)	77	75	79	-4	***
Bachelor's degree in 6 years (percent)	42	38	45	-7	***
Time-to-degree (years)	6.9	7.2	6.7	-0.5	***

*** p<0.01, ** p<0.05, $^{+}$ p<0.10.
Note: The final column, Significance, indicates whether the differences between rural and suburban community college transfer students are statistically significant for categories of each outcome variable using a t-test. Significance values are adjusted using a Bonferroni correction for multiple comparisons. Percentages in the table are rounded to the nearest whole number. The sample in the time-to-degree row is conditional on bachelor's degree completion.
N (Bachelor's degree models) = 39,448.
N (Time-to-degree model) = 30,454.

Table 5: Logistic regression models predicting bachelor's degree completion

	Model 1 Odds Ratio	Model 2 Odds Ratio	Model 3 Odds Ratio
Rurality			
Rural	0.841***	0.871***	0.863***
	(0.020)	(0.022)	(0.022)
Barron's Selectivity Categories			
Selective		1.678***	1.494***
		(0.077)	(0.071)
Very Selective		2.012***	1.781***
		(0.100)	(0.091)
Most Selective		4.006***	2.786***
		(0.323)	(0.230)
Gender			
Female		1.172***	1.126***
		(0.029)	(0.029)
Race			
URM		0.798***	0.870***
		(0.025)	(0.028)
Unknown		1.002	0.984
		(0.040)	(0.040)
Parents' Income			
Quartile 2		1.230***	1.234***
		(0.045)	(0.046)
Quartile 3		1.512***	1.510***
		(0.057)	(0.058)
Quartile 4		1.791***	1.863***
		(0.069)	(0.074)
Unknown		1.241***	1.271***
		(0.049)	(0.051)
Age at Time of Transfer (years)		0.973***	0.974***
		(0.002)	(0.002)
Transfer GPA			
2.0 – 2.49			0.915
			(0.091)
2.5 – 2.99			1.280***
			(0.120)
3.0 – 3.49			1.818***

			(0.171)
3.5 +			2.663***
			(0.255)
Unknown			1.590***
			(0.150)
Community College Credits			
25 – 47			1.194***
			(0.057)
48 – 59			1.523***
			(0.081)
60 +			1.438***
			(0.068)
Associate Degree			
Academic			1.251***
			(0.038)
Technical			0.799***
			(0.037)
Multiple Transfer			1.306***
			(0.042)
Observations	39,448	39,448	39,448

Standard errors in parentheses.
*** p<0.01, ** p<0.05, $^{+}$p<0.10.
Note: Reference groups: suburban students, non-selective colleges, male students, non-URM students, parents' income quartile 1, transfer GPA below 2.0, less than 24 community college credits, no associate degree, and single transfer.

Table 6: Logistic regression models predicting bachelor's degree completion in 6 years

	Model 1 Odds Ratio	Model 2 Odds Ratio	Model 3 Odds Ratio
Rurality			
Rural	0.755***	0.801***	0.852***
	(0.016)	(0.018)	(0.020)
Barron's Selectivity Categories			
Selective		1.700***	1.422***
		(0.085)	(0.075)
Very Selective		1.836***	1.590***
		(0.096)	(0.087)
Most Selective		2.974***	2.138***
		(0.197)	(0.152)
Gender			
Female		1.031	1.096***
		(0.022)	(0.025)
Race			
URM		0.935**	0.984
		(0.027)	(0.030)
Unknown		0.657***	0.760***
		(0.024)	(0.029)
Parents' Income			
Quartile 2		1.048	1.099***
		(0.036)	(0.040)
Quartile 3		1.209***	1.298***
		(0.041)	(0.047)
Quartile 4		1.691***	1.829***
		(0.057)	(0.065)
Unknown		1.904***	1.787***
		(0.069)	(0.068)
Age at Time of Transfer (years)		0.939***	0.928***
		(0.002)	(0.002)
Transfer GPA			
2.0 – 2.49			1.08
			(0.123)
2.5 – 2.99			1.429***
			(0.155)
3.0 – 3.49			2.104***
			(0.227)

3.5 +			3.115***
			(0.338)
Unknown			2.190***
			(0.238)
Community College Credits			
25 – 47			1.001
			(0.046)
48 – 59			1.047
			(0.052)
60 +			0.708***
			(0.032)
Associate Degree			
Academic			1.158***
			(0.032)
Technical			0.463***
			(0.024)
Multiple Transfer			0.257***
			(0.008)
Observations	39,448	39,448	39,448

Standard errors in parentheses.
*** p<0.01, ** p<0.05, $^{+}$p<0.10.
Note: Reference groups: suburban students, non-selective colleges, male students, non-URM students, parents' income quartile 1, transfer GPA below 2.0, less than 24 community college credits, no associate degree, and single transfer.

Table 7: Ordinary least squares regression models predicting time-to-degree (in years) among students who completed a bachelor's degree

	Model 1 Coefficient	Model 2 Coefficient	Model 3 Coefficient
Rurality			
Rural	0.514***	0.373***	0.201***
	(0.036)	(0.034)	(0.032)
Barron's Selectivity Categories			
Selective		-0.702***	-0.316***
		(0.077)	(0.071)
Very Selective		-0.692***	-0.359***
		(0.081)	(0.074)
Most Selective		-1.177***	-0.634***
		(0.101)	(0.093)
Gender			
Female		0.0607*	-0.100***
		(0.034)	(0.031)
Race			
URM		-0.0403	-0.0746*
		(0.047)	(0.043)
Unknown		0.818***	0.429***
		(0.055)	(0.050)
Parents' Income			
Quartile 2		0.231***	0.148***
		(0.055)	(0.050)
Quartile 3		0.110**	0.0241
		(0.054)	(0.049)
Quartile 4		-0.417***	-0.418***
		(0.053)	(0.048)
Unknown		-0.960***	-0.721***
		(0.058)	(0.053)
Age at Time of Transfer		0.114***	0.121***
		(0.002)	(0.002)
Transfer GPA			
2.0 – 2.49			-0.284*
			(0.154)
2.5 – 2.99			-0.532***
			(0.145)
3.0 – 3.49			-0.871***

			(0.144)
3.5 +			-1.293***
			(0.145)
Unknown			-1.057***
			(0.145)
Community College Credits			
25 – 47			0.305***
			(0.065)
48 – 59			0.477***
			(0.069)
60 +			1.089***
			(0.064)
Associate Degree			
Academic			-0.103***
			(0.038)
Technical			1.263***
			(0.064)
Multiple Transfer			2.481***
			(0.037)
Constant	6.695***	4.656***	3.828***
	(0.023)	(0.110)	(0.180)
Observations	30,454	30,454	30,454
R-squared	0.007	0.111	0.263

Standard errors in parentheses.
*** p<0.01, ** p<0.05, $^{+}$ p<0.10.
Note: Reference groups: suburban students, non-selective colleges, male students, non-URM students, parents' income quartile 1, transfer GPA below 2.0, less than 24 community college credits, no associate degree, and single transfer. This sample only includes students who completed a bachelor's degree.

Table 8: Community college transfer student graduation outcomes, by rurality and selectivity of transfer destination

	Total	Rural	Suburban	Difference	Significance
Bachelor's Degree (percent)					
Most Selective	88	89	88	1	NS
Very Selective	81	81	81	0	NS
Selective	76	74	78	-4	***
Non-Selective	64	66	61	5	***
Bachelor's Degree in 6 Years (percent)					
Most Selective	53	48	57	-9	***
Very Selective	47	45	48	-3	***
Selective	41	37	44	-7	***
Non-Selective	25	26	25	1	NS
Time-to-Degree (years)					
Most Selective	6.51	7.03	6.22	0.81	***
Very Selective	6.6	6.82	6.59	0.23	+
Selective	6.97	7.28	6.74	0.54	***
Non-Selective	8.08	8.14	8	0.14	NS
Total	39,448	16,855	22,593		

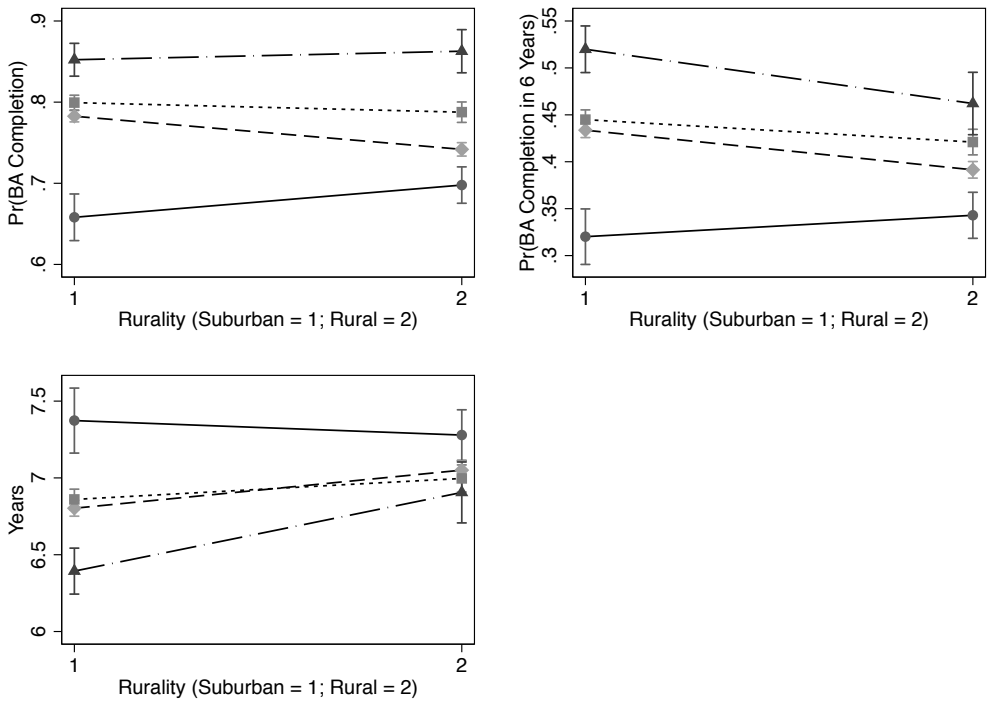
*** p<0.01, ** p<0.05, + p<0.10, NS = Not Significant.
Note: Selectivity groups reflect Barron's Selectivity Categories. The final column, Significance, indicates whether the differences between rural and suburban community college transfer students are statistically significant for each level of selectivity using a t-test. Significance values are adjusted using a Bonferroni correction for multiple comparisons. Percentages in the table are rounded to the nearest whole number.

Table 9: Regression models estimating interactions between rurality and college selectivity

	Bachelor's Degree	Bachelor's Degree in 6 Years	Time-to-Degree
Rurality			
Rural	1.213**	1.128	-0.0943
	(0.108)	(0.117)	(0.136)
Barron's Selectivity Categories			
Selective	1.935***	1.779***	-0.571***
	(0.140)	(0.148)	(0.111)
Very Selective	2.152***	1.880***	-0.513***
	(0.163)	(0.160)	(0.113)
Most Selective	3.162***	2.706***	-0.980***
	(0.347)	(0.276)	(0.133)
Interaction Terms			
Rural x Selective	0.651***	0.720***	0.342**
	(0.061)	(0.077)	(0.141)
Rural x Very Selective	0.765***	0.789**	0.231
	(0.078)	(0.088)	(0.147)
Rural x Most Selective	0.902	0.670***	0.606***
	(0.153)	(0.097)	(0.185)

Standard errors in parentheses.
*** p<0.01, ** p<0.05, $^{+}$ p<0.10.
Note: All models include other independent variables from Tables 3-5. Models 1 and 2 are based on logistic regression analyses and report odds ratios; Model 3 reports OLS regression coefficients.

Figure 1: Predicted probabilities of bachelor's degree completion, bachelor's degree completion in 6 years, and time-to-degree with 95% confidence intervals, by rurality



Note: The long-dashed line represents most selective institutions, the dotted line very selective, the short-dashed line selective, and the solid line non-selective.

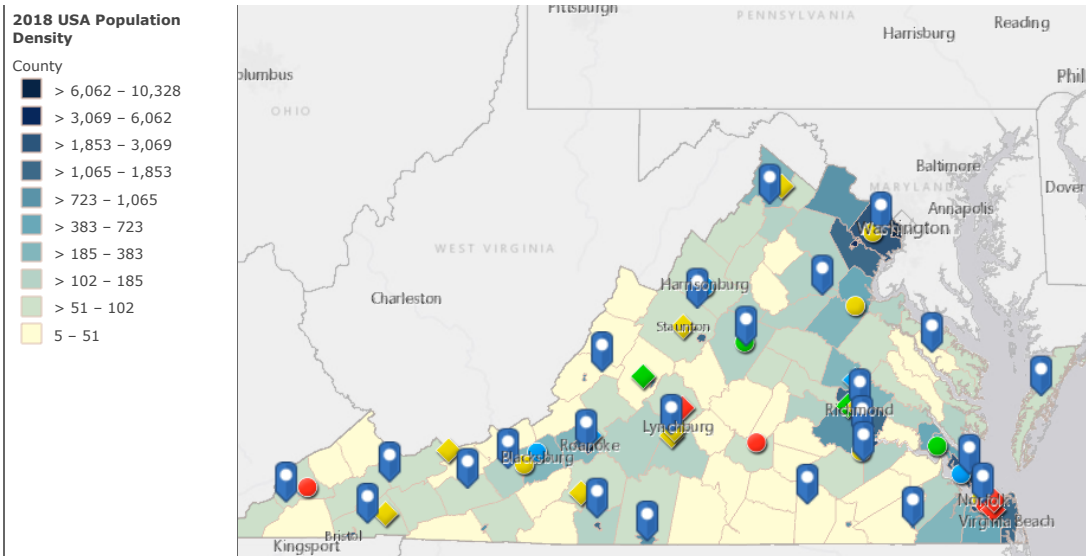
Table 10: Distance to four-year colleges in the state for community college transfer students, by rurality

	Total	Rural	Suburban	Difference	Significance
Distance to Nearest (miles):					
Most Selective	69	77	64	13	***
Very Selective	34	36	32	4	**
Selective	11	14	8	6	**
Non-Selective	79	69	87	-18	***
Average Distance (miles):					
Most Selective	100	112	90	22	***
Very Selective	117	121	113	8	**
Selective	124	127	122	5	**
Non-Selective	151	147	153	-6	***
N	39,448	16,855	22,593		

*** $p<0.01$, ** $p<0.05$, $^{+}$ $p<0.10$.

Note: Distances reflect the distance from the student's community college to the four-year colleges in Virginia. The final column, Significance, indicates whether the differences between rural and suburban community college transfer students are statistically significant for each selectivity category using a t-test. Significance values are adjusted using a Bonferroni correction for multiple comparisons. Miles in the table are rounded to the nearest whole number.

Figure 2: Population density map including Virginia's public and private non-profit colleges and universities



Note: Most selective colleges are green; very selective colleges are blue; selective colleges are yellow; and non-selective colleges are red. Circles indicate public universities; diamonds indicate private universities. Community colleges are represented by the blue arrows. Map includes all 24 community colleges and the 30 biggest colleges in the state. At least one college at each level of selectivity is included in each geographic area.

Estimating the Causal Effects of Attending a More Selective Four-Year College on Community College Transfer Student Graduation Outcomes

Chapter 3 of Dissertation

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Abstract

Using a fuzzy regression discontinuity design and a rich longitudinal data set in Virginia, this chapter estimates the causal effects of attending a more selective four-year college on community college transfer student graduation outcomes. Specifically, I leverage institutional GPA thresholds that define guaranteed admission for community college transfer students who earn an academic associate degree prior to enrolling at a four-year college. Results suggest that students are significantly more likely to take advantage of guaranteed transfer admission at the most selective colleges with the highest threshold. Additionally, students who earn guaranteed transfer admission and attend the most selective colleges in the state are approximately 18 percentage points more likely to complete a bachelor's degree and 47 percentage points more likely to complete a bachelor's degree in 6 years compared to similarly qualified students who just missed the threshold and attended a less selective college. Despite estimates that are large in magnitude, these results are not statistically significant because of a very small treatment group at the highest threshold, which leads to large standard errors in the estimates.

Introduction

Much has been written about the relationship between college selectivity and graduation outcomes for students who begin their postsecondary studies at a four-year college or university. This research indicates that attending a more selective college increases graduation rates (Bowen, Chingos, & McPherson, 2009; Hoekstra 2009, Cohodes and Goodman 2014, Zimmerman 2014). Additionally, these positive effects of selectivity are more pronounced for lower-income and underrepresented racial/ethnic minority students (Goodman, Hurwitz, & Smith 2017). This work points to factors such as academic preparation of peers, institutional resources, and environmental factors as potential contributors to higher success rates at more selective colleges (Bowen, Chingos, & McPherson, 2009; Taylor & Cantwell, 2019).

However, notably absent from this line of research are discussions about community college transfer students, with few exceptions (Bowen, Chingos, & McPherson, 2009; Dills & Hernández-Julián, 2006; Hilmer, 2000). Bowen, Chingos, & McPherson (2009) find a positive relationship between college selectivity and transfer student outcomes as part of a broader discussion of graduation outcomes, and Dills & Hernández-Julián (2006) show that attending higher quality community colleges leads to better grades at four-year colleges in South Carolina. Hilmer (2000) finds mixed results for the relationship between college quality and graduation outcomes across various levels of quality between community college transfer students and those who begin their post-secondary studies in the four-year sector. Although each of these studies provides valuable information, prior research has not focused on the causal relationship between college selectivity and graduation outcomes for community college transfer students.

There are several reasons why the effects of college selectivity may differ for transfer as opposed to native students: community college transfer students are typically less academically

prepared compared to their native peers, spend approximately half as much time at the four-year college, and routinely experience "transfer shock" (Cejda, 1997; Hills, 1965; Ishitani, 2008; Reynolds, 2012). Furthermore, community college transfer students arrive at the four-year campus later in their academic careers, and thus have less time to develop strong social circles with peers and relationships with faculty members, which research suggests are important for success in college (for a review see Mayhew et al., 2016).

The present study aims to fill this gap in the literature by examining the relationship between college selectivity and graduation outcomes for community college transfer students. Specifically, using a rich administrative state-level data set and a fuzzy regression discontinuity design (RDD) with multiple thresholds, this chapter estimates the causal effects of transferring to a more selective college on bachelor's degree completion and time-to-degree. Moreover, the study estimates whether the benefits of selectivity differ by race/ethnicity, gender, and parents' income. This work is particularly timely for several reasons: first, the cost of college continues to rise and beginning at a community college is often perceived as an approach to save money (NCES, 2017; U.S. Department of Education, 2018); second, an increasing proportion of underrepresented racial/ethnic minority students are using transfer as a pathway to enrolling in a four-year college, particularly in Virginia (SCHEV, 2019); and third, a majority of transfer students come from lower-income backgrounds compared to students who begin their post-secondary studies at a four-year college (SCHEV, 2019; NSC, 2016).

Literature Review

College Selectivity

There are several reasons why attending a more selective college might lead to better student outcomes. For example, more selective colleges generally invest more institutional

resources in each student, have more academically prepared students with better standardized test scores and high school GPAs, and have more distinguished faculty members and robust alumni networks (Bound & Turner, 2007; IPEDS, 2018; Smith & Stange, 2016).

A substantial body of literature exists on the effects of college selectivity on outcomes of native students attending four-year institutions. These studies overwhelmingly find that attending a higher quality college (as measured by some combination of selectivity and/or institutional resources) leads to higher bachelor's degree completion rates and annual earnings (Bowen, Chingos, & McPherson, 2009). However, these results may in part reflect student self-selection into colleges. On the surface, more selective colleges boast higher graduation rates and median starting salaries for their graduates. For example, according to U.S. News and World Report, the three colleges that report the highest median starting salary for graduates are California Institute of Technology ($78,400), Massachusetts Institute of Technology ($76,900), and Stanford University ($70,300). Similarly, these three schools have exceptionally high graduation rates at 91.5%, 91.3%, and 94.6%, respectively (US News and World Report, 2017). These are also three of the most elite higher education institutions with the most competitive admissions standards in the world. The factors that helped students earn admission (high GPA, SAT/ACT, etc.) are also highly predictive of college success. Furthermore, many of the students enrolled at these institutions come from affluent backgrounds and were provided with substantial resources to succeed in high school.

In order to account for self-selection in the admissions process, scholars have implemented various quasi-experimental techniques to estimate the causal effects of attending a more selective college. Most of these studies find a positive relationship between selectivity and student outcomes. Black and Smith (2004, 2006) used ordinary least squares (OLS) regression,

propensity score matching (PSM), and instrumental variables (IV) techniques (using multiple proxies for college quality as instruments) with data from the NLSY and found positive increases in labor market earnings using all three methods. Long (2008) used a novel approach to the distance IV where he used the average quality of the nearest institutions instead of just the quality of the closest college, and also found positive returns on both bachelor's degree completion rates and earnings for students who attended more selective colleges. Another study used a fixed-effects model by exploiting the college-going decisions of twins and found that attending a college with a median SAT score 100 points higher than an alternative is associated with a five-percentage point increase in the probability of completing a bachelor's degree within four years (Smith, 2013).

More recently, a number of scholars have used a regression discontinuity design (RDD) to estimate causal effects and reported that attending a more selective college is associated with higher bachelor's degree completion rates and/or labor market earnings (Hoekstra 2009; Cohodes and Goodman 2014; Zimmerman 2014; Goodman, Hurwitz, and Smith 2017). Cohodes and Goodman (2014), for example, estimated the effects of attending a public college in Massachusetts based on eligibility to the Adam's Scholarship, which was designed to keep high-achieving students in public colleges in MA. The authors found that the quality of these public colleges was lower than those the students otherwise would have attended, and that the decision to attend a MA public college ultimately led to lower bachelor's degree completion rates. Similarly, Zimmerman (2014) used administrative data from Florida and found evidence that attending a more selective college for marginal students led to substantially more years of educational attainment and similar bachelor's degree completion rates. He also found that

students admitted to the more selective college earned approximately $1,500 per year more 8 to 14 years after graduation than students who just missed eligibility for that same institution.

Another important aspect of the college selectivity literature looks at heterogeneity in selectivity effects across different sociodemographic groups with respect to both graduation (Smith 2013) and labor market outcomes (Dale & Krueger, 2002, 2014; Andrews, Li & Lovenheim, 2016; Zimmerman, 2014). Smith (2013) noted that the relationship between college selectivity and four-year graduation probability was nearly twice as large for males compared to females. Although Dale and Krueger (2002, 2014) did not find a statistically significant association between college selectivity and student outcomes in general, they did find evidence that lower-income and underrepresented racial/ethnic minority students experienced more positive returns in terms of earnings from attending a more selective college compared to their higher income and non-underrepresented peers. Zimmerman (2014) similarly showed strong heterogeneous treatment effects by gender and free-lunch status among a large sample of college students in Florida. Specifically, he reported that males who were just over the GPA threshold and enrolled in a more selective college earned more than $1,000 per quarter relative to male peers who were just shy of the threshold; he found no differences among female students in terms of earnings. Furthermore, students who were eligible for free lunch earned more than $700 per quarter relative to free-lunch status peers who were just shy of the threshold.

Andrews, Li, and Lovenheim (2016) paid specific attention to heterogeneity in selectivity effects in their study on the effects of graduating from a flagship college relative to a non-flagship university on earnings. Using rich administrative data with almost 100,000 observations from Texas and quantile treatment effects, the authors found that the expected return to college selectivity varied considerably across both student groups and institutional selectivity. Their

study was particularly informative because it made estimates based on specific institutions in Texas, including the flagship University of Texas (UT) in Austin and Texas A&M, in addition to all other four-year public universities, and all public two-year colleges. Specifically, the authors found that Black and Hispanic graduates of UT benefited less than White and Asian students. However, they found that the earnings premium of attending A&M was the same across all races. Part of these differences are likely due to the focus of the colleges. For example, more than 44 percent of A&M students major in engineering compared to 19 percent at UT, which are commonly seen as more valuable in the labor market. These findings demonstrate the importance of examining heterogeneity in the benefits of selectivity across sociodemographic groups if the sample is big enough to make reliable estimates.

Community College Transfer Students

Although there is a strong positive relationship between college selectivity and graduation outcomes for students who begin their studies in the four-year sector, it seems possible that community college transfer students might have different experiences. First, community college transfer students typically arrive at the four-year college with less academic preparation relative to their native peers. This is likely the case for two reasons: (1) underprepared students are more likely to attend community colleges than their more academically prepared peers in the first place (Reynolds, 2012); and (2) introductory community college coursework is generally less rigorous than similar classes at four-year colleges, in large part due to open admissions and a more general audience (Laanan, 1996).

Second, community college transfer students commonly arrive at the four-year college at the beginning of their junior year, which gives them half as much time to become acquainted with fellow students, faculty members, and campus resources. Since prior literature indicates that

interactions with faculty and peers are important for student success (Carrell, Fullerton, & West, 2009; Sacerdote, 2011), community college transfer students might not reap the same benefits as their native peers. Additionally, Laanan (2007) points out that community college transfer students often miss out on joining clubs and social organizations, as well as developing strong relationships with the academic counselors at the four-year college.

Third, lower levels of academic preparation and difficulties adjusting to the new environment contribute to what is commonly referred to in the literature as "transfer shock" (Hills, 1965), which is a temporary drop in GPA after the first year of transfer to a four-year college. Early research has reported a drop in GPA after transfer (Peng and Bailey 1977), especially for students from less advantaged socioeconomic backgrounds (Porter 1999). Some research has only found evidence of transfer shock in more rigorous majors, such as math, business, and physical sciences (Cejda, 1997; Cejda, Kaylor, & Rewey, 1998), or a more pronounced transfer shock at highly competitive institutions (Pennington 2006). Part of transfer shock is likely attributed to more difficult coursework at the four-year institution: transfer students report experiencing higher academic standards and faster-paced courses that placed more emphasis on writing skills than at the community college (Laanan 2007; Townsend 2007). At the very least, transfer shock poses some unnecessary burden on transfer students that native students do not experience in their third year of college.

Data and Methods

This analysis uses student-level data from the Virginia Longitudinal Data System (VLDS), which is a statewide administrative data set that combines longitudinal data from several agencies around the state. The primary data of interest within the VLDS come from the State Council for Higher Education in Virginia (SCHEV). These data contain records of

background characteristics, enrollment dates, program details, GPA, and graduation outcomes. The original sample included all students who initially enrolled at a Virginia college between fall 2001 and 2017 and then transferred to a different college anytime between spring 2002 and 2018. In the original sample, transfer was defined as having attended more than one post-secondary institution. This meant that any student who attended more than one college at any point in their academic career was labeled a transfer student.

Since this analysis is primarily interested in students who completed an academic associate degree at a community college prior to transfer, it is necessary to restrict the sample in the following ways: First, I remove all students who did not attend a community college; second, I restrict the sample to include only students who began their post-secondary studies during a fall semester, because this is when most students first attend college and the approach allows for more uniform comparisons across cohorts; third, I remove all students who did not earn an academic associate degree; fourth, I remove all students who began their studies at a four-year college prior to spring 2007 (the first year that the GAAs took full effect) and later than fall 2014 (to make sure I can follow students for at least four years once they arrive at the four-year college). Overall, the presented analysis focuses on students who earned an academic associate degree at a Virginia Community College prior to fall 2014 and then transferred to a four-year college in the state between spring 2007 and fall 2014. 16,564 students meet these criteria.

I focus the analysis on three outcome variables: bachelor's degree (BA) completion, bachelor's degree (BA) completion in 6 years, and time-to-degree. Throughout the remainder of the text, for simplicity, I refer to all bachelor's degrees (either a Bachelor of Arts or a Bachelor of Science degree) as a BA. The BA completion variables are binary and indicate whether a student completed a BA or completed a BA in 6 years (1 = completed BA or completed BA in 6

years; 0 = did not complete BA or did not compete BA in 6 years).[11] Both BA completion variables capture all students in the sample. Time-to-degree variable is conditional on BA completion and reflects the number of years between initial community college enrollment and graduation from the four-year college.

The independent variables of interest are the sociodemographic characteristics typically related to educational success and include an indicator for race (Black, Hispanic, and Native American students are defined as underrepresented racial/ethnic minority (URM) students while White and Asian students are used as the reference group; I also include a dummy variable for students who did not report race/ethnicity); a binary indicator for gender (1 if female; 0 if male); a continuous measure of age at the time of transfer; a categorical variable indicating parents' income quartile (1 to 4 correspond to each quartile; I also include a dummy variable for students who did not report family income);[12] a categorical variable for rurality (suburban, rural, town, city); and a continuous measure of time spent at the community college (measured in years), which was found to play an important role in the BA completion in 6 years and time-to-degree outcome variables through supplemental analysis in chapter 1. I also include a binary indicator for whether a student transferred more than once during their post-secondary studies (1 if multiple transfer; 0 if single transfer), which was found to be related to all three graduation outcomes (see chapter 1). Finally, all models include fixed effects for the year in which the students transferred and the community college where they earned their associate degree.

[11] As a sensitivity check, I also ran analyses examining BA completion in 8 years. The results did not substantively differ from the overall BA completion outcome variable and thus are not reported herein.

[12] Since students from high-income backgrounds are not eligible for need-based aid through FAFSA, they oftentimes do not submit the application. These students likely make up a substantial portion of the unknown income category. Despite missing data on parents' income for approximately 20 percent of community college transfer students, this percentage does not fluctuate much across the samples at each GAA threshold.

Methods: Regression Discontinuity Design (RDD)

In Virginia, all community college students are eligible to transfer to almost any in-state four-year college using a Guaranteed Admissions Agreement (GAA).[13] Originally established in 2006, GAAs are intended to develop more formal routes between the Virginia Community College System (VCCS) and four-year colleges in Virginia.[14] GAAs tend to be university-wide with some technical programs being program specific. In order to use a particular GAA, a student must complete an academic associate degree (AA) and graduate with a specified GPA. Since all students are required to complete an AA to use a GAA, the actual course requirements do not differ substantially (in many cases, at all) by institution. Therefore, a community college transfer student with an AA is eligible for any GAA that has a GPA requirement at or below their transfer GPA.[15]

The goal of this analysis is to estimate the causal effect of attending a more selective four-year college on community college transfer student graduation outcomes. In a perfect experiment, one would randomly assign community college transfer students to different institutions and estimate the effects of four-year college selectivity on graduation outcomes. This design would allow one to attribute the differences in graduation outcomes to attending a more selective college if all students complied with the intervention. However, it is not possible (or ethical) to randomly assign students to colleges. In these circumstances, I address the problem of self-selection in college choice by exploiting various thresholds in GAAs for Virginia's four-year colleges. This method, known as a regression discontinuity design (RDD), has become widely

[13] A full list of GAA thresholds, along with descriptive statistics about each college from IPEDS, are included in Appendix A.
[14] The GAAs were first introduced in 2006 but did not take effect across most institutions until 2007. I restrict the sample to include only students who transferred after 2006 to make sure they had exposure to the GAAs.
[15] Additional adjustments were made when necessary to incorporate GAA criteria by institution.

accepted as one of the most compelling quasi-experimental methods in econometric design (Angrist & Pischke, 2015).

Specifically, RDD leverages the GAAs design to identify a comparable treatment and control group. As applied here, it assumes that students just shy of a particular GPA threshold are similar to students just at or above the same threshold. To gain guaranteed admission to the University of Virginia, for example, a student must earn an AA from a Virginia community college and transfer with a 3.4 GPA; a student who earns a 3.38 GPA is not offered guaranteed admission, but is presumably similar to a student with a 3.4 or 3.42 GPA. The difference between these two students might simply be a B+ vs. an A- in one or two classes (out of approximately 20 classes that are necessary to earn an associate degree).

However, GAAs are not the sole way transfer students are able to enroll at a more selective four-year college, and not all students meeting the requirements will take advantage of the offer.[16] For example, some students might fail to reach the GAA GPA threshold, but apply as a traditional transfer student and still earn admission. Similarly, some students might be eligible for guaranteed admission to a more selective college, but choose not to apply or attend for a variety of reasons. To account for this non-random non-compliance with the GAAs GPA thresholds, it is necessary to instrument attending a more selective college with a source of exogeneous variation, i.e., a measure that increases the probability of enrolling in a more selective college but does not affect the outcomes of interest. Given these circumstances, I use GAA eligibility as an instrument because that is a mechanism that should increase the probability of attending a more selective college without on its own affecting the outcomes. For example,

[16] It is also possible that a transfer student might apply to a college without knowing that they are eligible for the GAA. Based on conversations with several university administrators, it is likely that they would automatically admit the student based on the student meeting the GAA criteria.

community college transfer students just to the left and right of the threshold are effectively the same aside from the randomness in their transfer GPA. This "fuzzy" RDD specification will allow me to estimate the causal effects of transferring to a more selective college on graduation outcomes for compliers, accounting for students who did not enroll using a GAA.

Although there are 11 thresholds across the various four-year colleges in Virginia (see table in the Appendix), 4 of them account for the transfer destination of approximately 80 percent of all transfer students in the sample. The remaining 7 thresholds do not have enough observations around each of them to generate reliable estimates. Therefore, I focus my analysis on the following four thresholds: 2.5, 2.85, 3.0 and 3.4. These thresholds account for the biggest transfer destinations in the state, including Old Dominion University (16%), Virginia Commonwealth University (13%), George Mason University (19%) , James Madison University (5%), the University of Virginia (4%) and the Virginia Polytechnic Institute and State University (7%). Overall, the analysis across these 4 thresholds should provide valuable insights into how the effects of college selectivity differ at various levels of selectivity.

Table 1 presents summary statistics for the analytic sample. Column 1 displays results for all transfer students who earned an AA degree and the remaining columns show results for students who earned a transfer GPA within .25 points of the GAA threshold.[17] Besides the transfer GPA and graduation outcome variables, the summary statistics remain fairly similar across each of the samples listed in Table 1.

[17] Since the sample of students who earn an academic associate degree prior to transfer is relatively small over the course of the 6-year sample, I expand the region of inference to increase the power of the analysis. A more detailed discussion of this point is included in the results section.

Estimation Procedures

To account for non-random non-compliance on either side of the threshold, I implement a fuzzy regression discontinuity design (FRDD), which is done using a two-stage least squares approach. The first-stage regression is estimated using the following equation:

$$Selective_i = \alpha_0 + \alpha_1 GAA_i + \alpha_2 Transfer\ GPA_i + \alpha_3 (GAA_i\ x\ Transfer\ GPA_i) + X_i + \alpha_4 Year\ of\ Enrollment\ at\ 4\ Year\ College + \alpha_5 Communtiy\ College + \varepsilon_i$$

Where $Selective_i$ indicates if student i transferred to a college at least as selective as they were qualified to attend. GAA is an indicator for meeting or exceeding the relevant GAA threshold and Transfer GPA is the running variable rule that indicates the number of GPA points each student is from the threshold. For example, a student with a 3.3 GPA would be .1 points away from the 3.4 threshold. I also add a vector of control variables, including race, gender, parents' income quartile, rurality, age at the time of transfer, time spent in a community college, and an indicator to account for students who transferred more than once during their postsecondary studies.[18] Finally, I include fixed effects for the year in which the student initially enrolled at the four-year college and the community college where they earned their associate degree. Since students on either side of the threshold are nearly identical in terms of academic achievement at the community college-level, the coefficient of interest, α_1, estimates the causal effect of meeting GAA eligibility on transferring to a more selective college.

Based on previous literature around college choice (e.g., Hosler, Braxton, & Coopersmith, 1989; Cabrera & La Nasa, 2000), students who are eligible to attend a more selective college based on the GAAs should be more likely to attend more selective colleges for

[18] Each of these variables were found to play a significant role in one or more graduation outcomes in the first and/or second chapter of this dissertation.

several reasons. Cabrera and La Nasa (2002) describe the college choice process as a set of predispositions, search, and choice. Primary considerations within the choice category include, among others, educational aspirations, occupational aspirations, socioeconomic status, and perceived institutional availability. In this case, having the option to attend a more selective college is associated with a student's perceived institutional availability. For example, GAA eligibility signals to students that they are qualified to attend a more selective college and thus could increase their desire and probability to attend such a college.

Additionally, previous research has shown that expanding a student's choice-set, particularly to include more selective colleges, can influence enrollment outcomes (Cullen, Long, & Reback, 2013; Elsner & Isphording, 2017). Cullen, Long, & Reback (2013) estimated the impact of the "Ten Percent Plan" in Texas on the probability of enrolling in a more selective college and graduation outcomes. In Texas, students who graduated from high school in the top ten percent of their class were guaranteed admission to two flagship universities in the state, University of Texas in Austin and Texas A&M. The authors showed that students who were eligible to attend based on their class rank were significantly more likely to attend the flagship universities compared to their similarly qualified peers who did not make the threshold.

To address the impact of GAA eligibility on graduation outcomes, the intent-to-treat effect, I estimate the following reduced form equation:

$$Y_i = \theta_0 + \theta_1 GAA_i + \theta_2 Transfer\ GPA_i + \theta_3 (GAA_i\ x\ Transfer\ GPA_i) + X_i + \theta_4 Year\ of\ Enrollment\ at\ 4\ Year\ College + \theta_5 Communtiy\ College + \varphi_i$$

Here, the outcome variables of interest are BA completion, BA completion in 6 years, and, for students who completed a BA, time-to-degree. This estimate reports whether students have better

outcomes based simply on eligibility for a more selective college, regardless of whether or not they actually attend.

Finally, I use the following second-stage equation to generate the instrumental variables estimate noted in the FRDD framework:

$$Y_i = \rho_0 + \rho_1 Selective_i + \rho_2 Transfer\ GPA_i + \rho_3 (GAA_i\ x\ Transfer\ GPA_i) + X_i + \rho_4 Year\ of\ Enrollment\ at\ 4\ Year\ College + \rho_5 Communtiy\ College + \epsilon_i$$

In this equation, Selective$_i$ is instrumented by GAA eligibility according to the first-stage equation. The coefficient of interest, ρ_1, estimates the causal effect of the impact of transferring to a more selective college on graduation outcomes.

Validity of the Research Design

There are several assumptions that must be met in the FRDD framework to estimate the causal effects of transferring to a more selective college on graduation outcomes. First, the continuity of outcome assumption requires that the outcome can be modeled as a smooth, continuous function of the running variable on both sides of the cut-point. This implies a positive linear relationship between transfer GPA and each of the outcome variables of interest (BA completion, BA completion in 6 years, and time-to-degree), which was shown in chapter one. Second, I checked the functional form assumption by adding higher order terms to the model. These tests reveal that modeling the data using higher order terms does not improve fit, supporting the use of a linear approach.

Third, in line with McCrary (2008), I check for smoothness of the running variable (transfer GPA) around each of the thresholds (the exogeneity of cut-point assumption). Since the GAA thresholds are publicly known, it is possible that students could attempt to manipulate their GPA to meet or exceed certain thresholds. However, such a situation is unlikely to occur because

all students in this sample must have completed an AA, which requires 60 credit hours (approximately 20 classes). In order for a student to manipulate their GPA, it would require that they are extremely close to a specified GPA threshold and are able to convince a professor of a given class to raise their grade. The results for the McCrary test are reported in Table 2 and show that the only threshold that violates the assumption is the 3.0 threshold. Although this coefficient is statistically significant, it seems more likely that this stands alone as a natural clump as opposed to a manipulated threshold. Similar natural clumping is also found at the transfer GPAs of 2.0 and 4.0; however, these GPAs do not represent thresholds of interest and are thus not part of the analysis. Overall, the McCrary tests suggest that students are not manipulating their GPAs to meet certain GAA thresholds.

Additionally, I test for covariate balance on either side of the threshold by estimating a regression using the specification above and the covariate of interest as the outcome variable. The results for these tests are displayed visually in Figures 1 and 2, and are accompanied by statistical tests in Table 3. Inherent in this design is the possibility that students on either side of a particular threshold are more likely to attend one type of college over another. If this were the case, the FRDD results would be biased by self-selection. However, despite small visual differences at some of the thresholds, Table 3 shows that none of the covariate balance tests reveal statistically significant differences on either side of any of the four thresholds.

Results

College Enrollment Effects

In order to meet the requirements of the FRDD, it is necessary to show that GAA eligibility generates exogenous variation in the probability that a student transfers to a more selective college. This is also known as the instrument relevance assumption in an instrumental

variable design and is modeled using the first-stage regression. The first-stage regression shows the extent to which students are using the GAAs to transfer to more selective college and establishes the strength of the instrument for the FRDD analysis. These results are presented for the BA models in Figure 3A and 3B.[19] Only the highest threshold (3.4 GPA) shows a discontinuity in the probability of enrolling in a more selective college. Accompanying statistical tests at the 3.4 threshold are presented in Table 4.[20]

In addition to being statistically significant, it is also necessary to establish that the instrument is strong using an F-test (Lee & Lemieux, 2010). Four of the bandwidths at the 3.4 threshold meet that criteria (samples ranging between .2 and .35 GPA points). Based on previous studies that have used GPA as an assignment variable (i.e., Zimmerman, 2017; Hoekstra, 2009), I chose .25 GPA points. For example, Zimmerman (2017) used a range of .3 GPA points on either side of the cut-off. Although the 3.15 to 3.65 range seems fairly wide, it is a necessary tradeoff to balance both precision and power given the rather small sample size at the 3.4 threshold.[21] Using the .25 bandwidth, the estimate in column 3 of Table 4 suggests that students who are eligible to attend a more selective college at the 3.4 threshold are 5.4 percentage points more likely to attend compared to similar students who just missed the threshold ($F = 15.83$, $p < .01$). Additionally, Table 5 reports the same results for the time-to-degree sample and reveals approximately the same results with the .25 bandwidth.

[19] I only include figures for the BA models; there are no visual differences compared to the time-to-degree model.
[20] Although I tested the first stage regression on each of the four bandwidths, I only include results for the 3.4 threshold since none of the others generated exogenous variation in the probability of attending a more selective college.
[21] Bandwidth selection is something that researchers are given flexibility in choosing (Lee & Lemieux, 2010). A small bandwidth leads to more precise estimates. However, a larger bandwidth provides more power in the analysis. Since the sample of students is relatively small to begin with, I opt for a relatively larger bandwidth than some of the traditional bandwidth algorithms suggest in this case (Imbens & Kalyanaraman, 2012; Calonico et al., 2017).

Another approach to examine whether GAAs significantly altered enrollment outcomes at the highest threshold is to consider a difference between the percentage of qualified transfer students who enrolled before and after the implantation at the GAAs in Virginia. Prior to 2007, 8.8 percent of community college students transferred to one of the colleges that had a 3.4 GPA threshold or higher. However, between 2007 and 2013, 12.9 percent of community college transfer students attended one of these colleges. This difference of 4.1 percentage points (47 percent) is statistically significant at the .01-level. Meanwhile, there were virtually no differences in enrollment patterns for colleges that had lower GAA thresholds over the same time period.

There are several reasons that may explain why lower thresholds do not generate exogenous variation in the probability of attending a more selective college. At the institutional level, less selective colleges need to accept more transfer students to fill the seats of native students who dropped out of college. Since less selective colleges typically have higher attrition rates (see table in Appendix A), they might be willing to relax the standards for transfer admission and admit students who fell short of the GAA threshold. On the other hand, the most selective colleges in the state, particularly the University of Virginia and the College of William and Mary, have very high persistence rates and do not have the same motivations to fill seats with transfer students.

At the student level, several factors play into one's decision of where to transfer. For example, community college transfer students are likely to attend the nearest institution to their home and continue living with their parents during college (Flaga, 2006). Furthermore, these students might be specifically interested in a particular program at a less selective college and attend that institution regardless of other GAA eligibility. It is also possible that less

academically prepared students, defined in this case by having a lower transfer GPA, might not be aware of the agreements with the less selective colleges.

College Completion Effects

There are three primary outcomes of interest: BA completion, BA completion in 6 years, and time-to-degree. These outcomes are presented graphically in Figures 4A through 6A using a bandwidth of .25 GPA points and in Figures 4B through 6B using the optimal bandwidth, as specified by the Calonico et al. (2017) algorithm, which is approximately .1 GPA points. Since the 3.4 threshold is the only one that generated exogenous variation in the probability of attending a more selective college, the remainder of the analysis focuses on that threshold.

I estimate the outcomes using three different strategies. First, I use the reduced form (RF) equation to estimate the intent-to-treat effect. These results suggest that students who are eligible to attend a more selective college at the 3.4 threshold are 1 percentage point more likely complete a BA and 2.6 percentage points more likely to complete a BA in 6 years compared to similar students who just missed the threshold, neither of which is statistically significant (Table 6, column 1). Similarly, the RF estimate for time-to-degree is not statistically significant.

Next, I estimate a simple ordinary least squares (OLS) regression to examine the relationship between attending a more selective college and graduation outcomes (Table 6, column 2). Each of the OLS estimates are statistically significant and suggest that students who attend more selective colleges are 9 percentage points more likely to complete a BA, 14 percentage points more likely to complete a BA in 6 years, and complete their degrees more than half a year earlier than similarly qualified peers who attended less selective colleges. Although these estimates are biased by self-selection into a more selective college, they help inform the amount of bias removed by using the instrumental variables approach at the 3.4 threshold.

The instrumental variable (IV) estimates presented in the third column of Table 6 are large in magnitude with regards to the BA outcomes. Students who are eligible to attend and transfer to a more selective college are 18 percentage points more likely to complete a BA and 47 percentage points more likely to complete a BA in 6 years compared to similarly qualified students who just missed the cut-off and transferred to less selective colleges. Despite estimates that are large in magnitude for the BA outcomes, these results are not statistically significant. The difference between the two groups in terms of time-to-degree is both statistically insignificant and small in magnitude.

The insignificant findings around the BA outcomes are largely driven by the large standard errors in the estimates, which are a result of an extremely small treatment group in the 3.4 sample. Among the 4,617 students in the sample who transferred with a GPA between 3.15 and 3.65, only 6 percent attended a college that required a GPA at the 3.4 threshold or higher.[22] Although not statistically significant, it is likely that the large point estimates are not entirely due to chance and that students who attend the more selective colleges indeed perform better in terms of BA completion and, particularly, BA completion in 6 years.

Heterogenous Effects

In addition to the main effects presented in preceding analyses, prior literature indicates that various student groups, defined by race, gender, parents' income and rurality, may benefit differently by attending a more selective college. These heterogeneous treatment effects are estimated using the specification from the instrumental variables model in Table 6 and are

[22] Christopher Newport University has a 3.5 threshold, but it did not introduce the agreement until 2013, which is just outside the scope of this analysis. Therefore, the 3.4 and above threshold pertains only to the University of Virginia (3.4), the Virginia Polytechnic Institute and State University (3.4), and the College of William and Mary (3.6).

presented in Table 7.[23] The results indicate that there are virtually no differences across any of the four outcome measures (one enrollment outcome: attending a selective institution; and three graduation outcomes: BA completion, BA completion in 6 years, and time-to-degree) for URM vs. non-URM students, which implies that URM students do not gain any additional benefit by attending a more selective college at the 3.4 GPA threshold compared to similarly qualified non-URM peers.

Turning attention to gender, the only difference found between males and females occurs for the college enrollment outcome, where females are 2.8 percentage points less likely to attend a more selective college compared to the similarly qualified male peers at the 3.4 GPA threshold. Comparisons between low-income (quartile 1) and middle-income students (quartiles 2 and 3) reveal statistically significant differences for three out of four outcomes. Low-income students are 2.7 percentage points more likely to attend a more selective college compared to middle income students at the threshold. However, low-income students are 5.4 percentage points less likely to complete a BA and, among those who do complete a BA, take almost a full-semester longer to complete their degree, than similarly qualified middle-income peers. Finally, rural students are 3.1 percentage points less likely to transfer to a more selective college than non-rural students at the 3.4 GPA threshold, which is statistically significant at the .01-level. There are no differences between rural and non-rural students for any of the graduation outcomes.

Discussion

In this paper, I use a fuzzy regression discontinuity design (FRDD) to estimate the causal effects of transferring to a more selective college on graduation outcomes. Although I set out

[23] I focus these results on the 3.4 threshold because that is the only threshold that generated exogenous variation in the probability of attending a more selective college based on GAA eligibility. Results at other thresholds would be biased by a weak instrument in the first-stage regression.

with the intention of estimating these effects at four different GPA thresholds that define guaranteed admission for community college transfer students to most four-year colleges in Virginia, I was only able to estimate these effects for students at the highest threshold (3.4 GPA). This is because the lower GPA thresholds did not generate exogenous variation in the probability of transferring to a more selective college based on guaranteed eligibility, and therefore failed the instrument relevance assumption required for FRDD analysis.

As previously noted, there are several reasons why one might not see discontinuities at the lower GPA thresholds. At the institutional level, less selective colleges are generally more motivated to admit transfer students to make up for native students who dropped out of college and might be more willing to relax the GPA requirement and admit students who were just shy of meeting the threshold. At the student level, less academically prepared students, indicated by lower transfer GPAs, might not be interested in transferring to a more selective college or might not even be aware that they earned guaranteed admission. Geographic considerations may also play a role, as noted in chapter 2 of the dissertation. Overall, it appears that that the Guaranteed Admissions Agreements (GAAs) do not significantly alter college enrollment patterns for students close to any but the highest GPA threshold in Virginia.

At the 3.4 GPA threshold, students who earn guaranteed admission to a more selective college and attend that college do not have statistically significantly better outcomes in terms of BA completion, BA completion in 6 years, and time-to-degree. However, although not statistically significant, the estimates for the BA completion outcomes are large in magnitude. Specifically, students who just make the 3.4 GPA threshold and transfer to a more selective college are 18 percentage points more likely to complete a BA and 47 percentage points more likely to complete a BA in 6 years compared to similarly qualified students who just miss the

threshold and attend a less selective college. Findings between groups with regards to time-to-degree are neither statistically significant nor large in magnitude.

Presented findings diverge from the previous literature on the relationship between college selectivity and graduation outcomes. Whereas prior research overwhelmingly finds that native students who attend more selective colleges are significantly more likely to graduate compared to similarly qualified students (Cohodes & Goodman, 2014; Goodman, Hurwitz, & Smith, 2017; Zimmerman, 2017), the results of this study suggest that this relationship is not statistically significant for community college transfer students at the most selective colleges in Virginia. Although these results are likely driven by the extremely small treatment group at the 3.4 GPA threshold, it is also possible that community college transfer students do not benefit to the same extent as native students by attending a more selective college or that the effects vary across states.

There are several implications that follow from this research. First, aside from the highest threshold in this study, the GAA thresholds did not significantly alter enrollment patterns across each of the thresholds for community college transfer students in Virginia. Based on previous models of college choice (i.e., Cabrera & La Nasa, 2002), one might expect to see significant differences in the probability of enrolling in a more selective college at each level of selectivity. In light of these results, policymakers and college administrators in Virginia may consider whether one of the goals of the policy is to help more students attend more selective colleges in the state. As it currently stands, GAAs only increase enrollment at the most selective colleges in the state.

Additionally, although the differences between transferring to a more selective college at the 3.4 GPA threshold and graduation outcomes were not statistically significant, the BA

completion and BA completion in 6 years estimates were quite large in magnitude. Future research with larger sample sizes or different estimation strategies is needed to revisit this question, both in Virginia and other states given that the patterns may vary across state contexts. It is also important to examine more carefully why students who were qualified to attend more selective colleges in Virginia based on their GPA did not attend these colleges after GAAs, except at the 3.4 threshold. State policy makers could look more carefully at institutional practices related to GAAs and researchers could consider ways in which these findings inform the college choice models for community college students.

Table 1: Descriptive statistics for variables used in analysis, by GPA thresholds

	All Students	2.5 GAA	2.85 GAA	3.0 GAA	3.4 GAA
Demographics					
Race (percent)					
Non-URM	74	70	70	71	74
URM	17	21	20	19	17
Unknown	10	10	10	10	9
Gender (percent)					
Female	54	50	52	52	57
Male	46	50	48	48	43
Age at Time of Transfer (years)	25.9	25.5	25.1	25.2	25.8
Parents' Income Quartile (percent)					
Q1	22	24	22	21	21
Q2	21	22	21	22	21
Q3	21	20	21	21	22
Q4	19	19	19	19	18
Unknown	18	15	17	18	18
Rurality (percent)					
Suburban	43	44	48	48	44
Rural	31	28	28	29	32
Town	6	5	5	5	5
City	18	22	17	17	17
Community College Experiences					
Transfer GPA	3.2	2.57	2.88	3.01	3.39
Years in Community College	3.9	4.5	4.2	4.1	3.8
Four-Year-Level Factors					
Multiple Transfer (percent)	12	13	11	11	11
Outcomes					
Bachelor's Degree (percent)	81	71	76	78	82
Bachelor's Degree in 6 (percent)	48	34	40	43	52
Time-to-Degree (years)	6.54	7.31	6.95	6.83	6.38
N	16,564	1,952	4,306	4,870	4,617

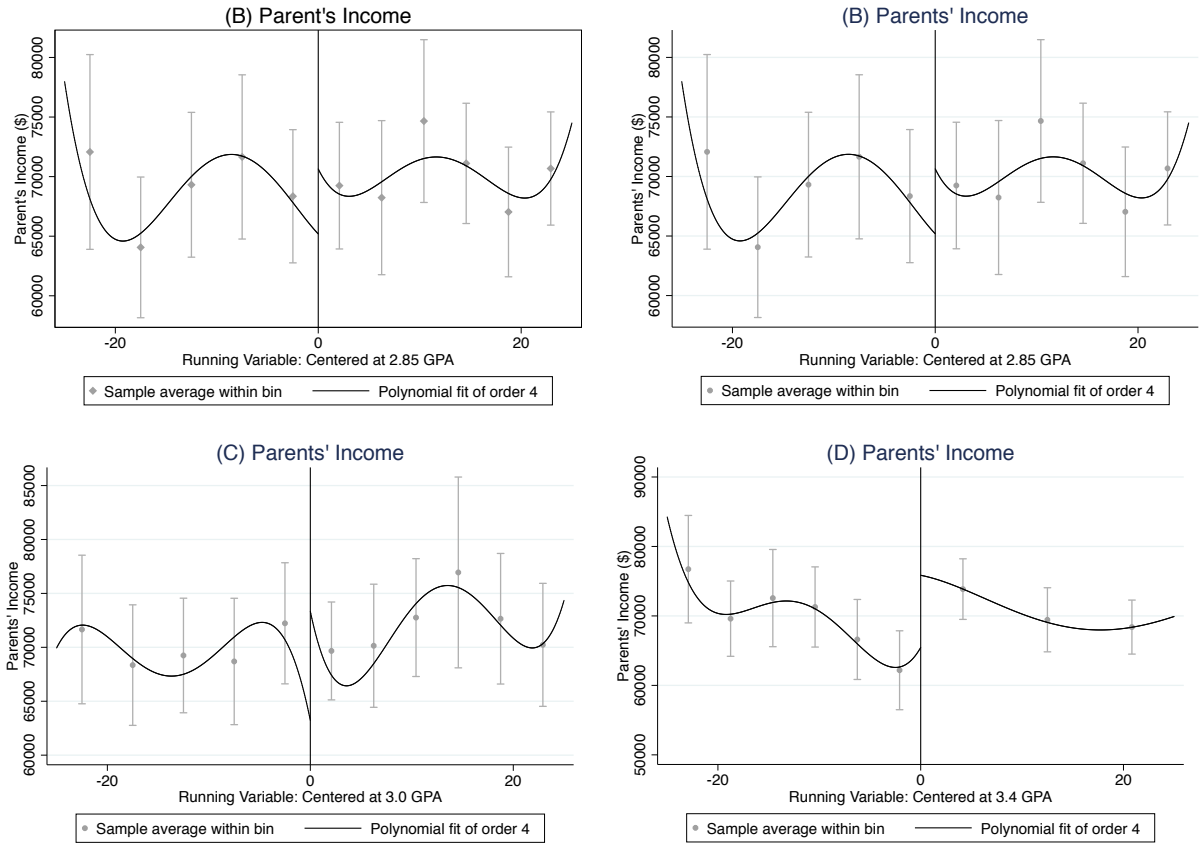
Note: All sample groups are identified using a bandwidth of .25 GPA points. For example, this means that the 3.0 sample includes all students who earned an academic associate degree and transferred with a GPA between 2.75 and 3.25. Parents' income was reported at the time of college entry and adjusted for inflation to represent value in 2018. The final outcome measure, time-to-degree, only represents students who completed a bachelor's degree. Percentages in the table are rounded to the nearest whole number and thus may not add up to 100.

Table 2: McCrary test at each threshold

	(1) BW = .35	(2) BW = .30	(3) BW = .25	(4) BW = .20	(5) BW = .15
Samples					
2.5 GAA	0.3	0.36	0.34	0.37	0.38
2.85 GAA	0.32	0.16	0.84	0.18	0.83
3.0 GAA	0.18	0.02**	0.03**	0.003***	0.001***
3.4 GAA	0.44	0.11	0.59	0.93	0.89

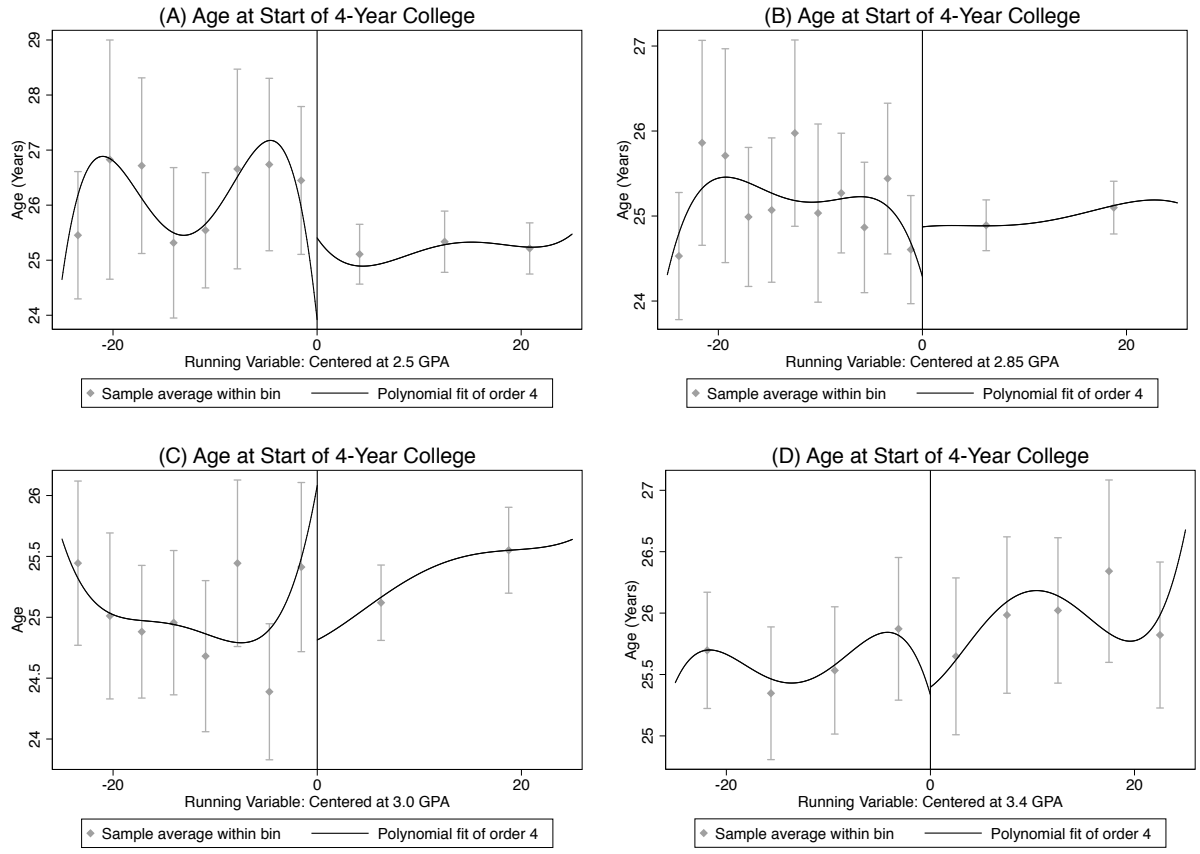
Standard errors in parentheses.
*** p<0.01, ** p<0.05, $^{+}$ p<0.10.
Note: P-values are shown for each Guaranteed Admission Agreement (GAA) sample using 5 different bandwidths (BW). Bandwidth corresponds to GPA points. For example, a bandwidth of .25 means within .25 GPA points on either side of the threshold.

Figure 1: Parents' income and transfer GPA (Bandwidth = .25)



Note: Parents' income by distance to GPA cutoff. Between 3 and 7 bins are selected depending variation in the particular sample group. X-axis labels of -20 and 20 reflect .2 GPA points.
A: 2.5 cutoff; N = 1,660
B: 2.85 cutoff; N = 3,563
C: 3.0 cutoff; N = 3,991
D: 3.4 cutoff; N = 3,777

Figure 2: Age at start of four-year college and transfer GPA (Bandwidth = .25)



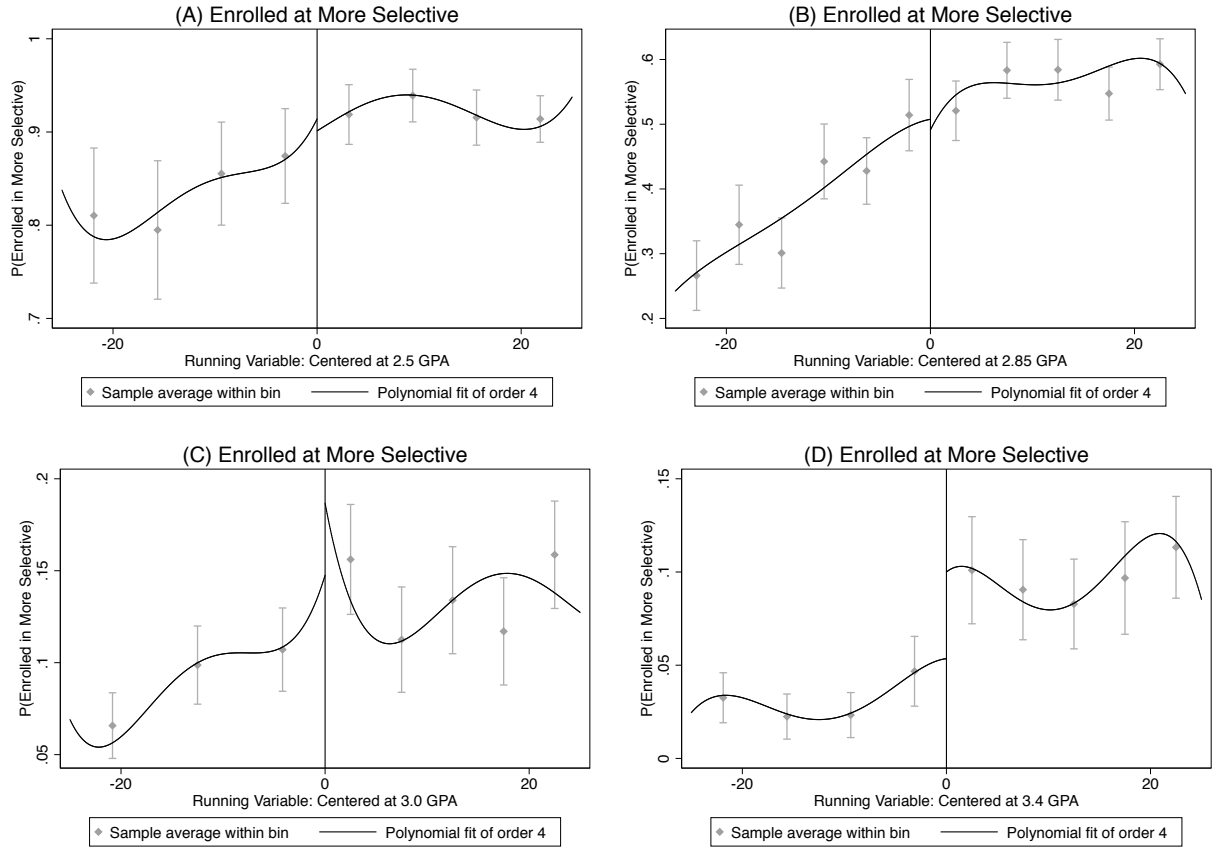
Note: Age at start of four-year college by distance to GPA cutoff. Between 2 and 9 bins are selected depending variation in the particular sample group. X-axis labels of -20 and 20 reflect .2 GPA points.
A: 2.5 cutoff; N = 1,952
B: 2.85 cutoff; N = 4,306
C: 3.0 cutoff; N = 4,870
D: 3.4 cutoff; N = 4,617

Table 3: Covariate balance tests

	Parents' Income ($)	Age at Time of Transfer
Sample		
2.5 GAA	160	-0.71^{+}
	(4,213)	(0.343)
2.85 GAA	-1,789	0.003
	(2,657)	(0.019)
3.0 GAA	-96	0.093
	(2,574)	(0.204)
3.4 GAA	2,902	0.42
	(2,782)	(0.266)

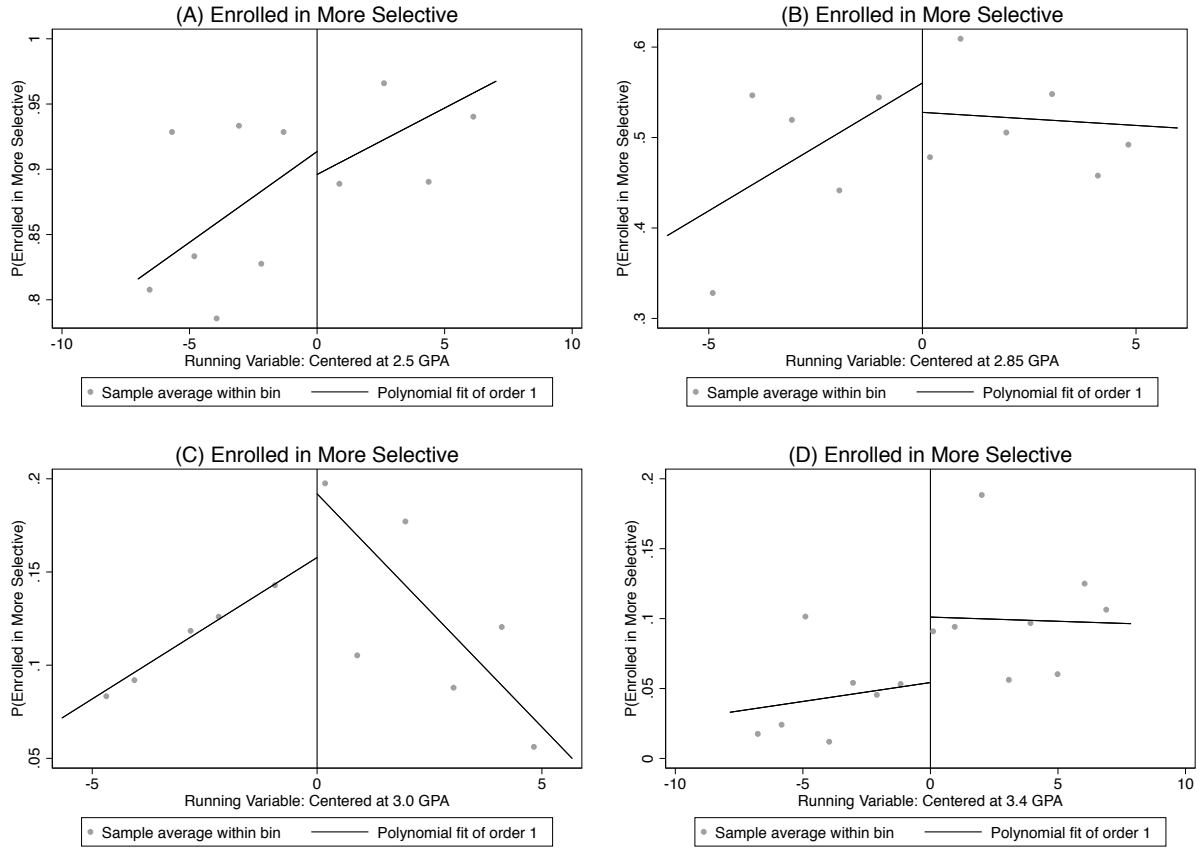
Standard errors in parentheses.
*** p<0.01, ** p<0.05, $^{+}$ p<0.10.
Note: Each estimate comes from the first stage regression, swapping out attended more selective for the covariate of interest (parents' income and age at start of four-year college) as the outcome variable. All regressions use the preferred bandwidth of .25 GPA points (i.e., within .25 GPA points on either side of the threshold).

Figure 3A: Enrollment at more selective institutions and transfer GPA, bachelor's degree models (Bandwidth = .25)



Note: Transferred to a more selective four-year college (i.e., a college at least as selective as a student was qualified to attend) by distance to GPA cutoff. Between 3 and 6 bins are selected depending variation in the particular sample group. X-axis labels of -20 and 20 reflect .2 GPA points.
A: 2.5 cutoff; N = 1,952
B: 2.85 cutoff; N = 4,306
C: 3.0 cutoff; N = 4,870
D: 3.4 cutoff; N = 4,617

Figure 3B: Enrollment at more selective institutions and transfer GPA, bachelor's degree models (Optimal bandwidth)



Note: Transferred to a more selective four-year college (i.e., a college at least as selective as a student was qualified to attend) by distance to GPA cutoff. Each dot reflects the average value at that exact GPA. X-axis labels of -5 and 5 reflect .05 GPA points.
A: 2.5 cutoff; N = 511
B: 2.85 cutoff; N = 1,030
C: 3.0 cutoff; N = 1,087
D: 3.4 cutoff; N = 1,305

Table 4: Probability of attending a more selective college: First-stage regression results for the 3.4 GPA sample (Bachelor's degree models)

	(1)	(2)	(3)	(4)	(5)
	BW = .35	**BW = .30**	**BW = .25**	**BW = .20**	**BW = .15**
P(Attend more selective)	0.039***	0.043***	0.054***	0.050***	0.050***
	(0.012)	(0.012)	(0.014)	(0.015)	(0.018)
F-Test	**11.57**	**11.92**	**15.83**	**10.51**	8.04
N	6,350	5,542	4,617	3,759	2,844

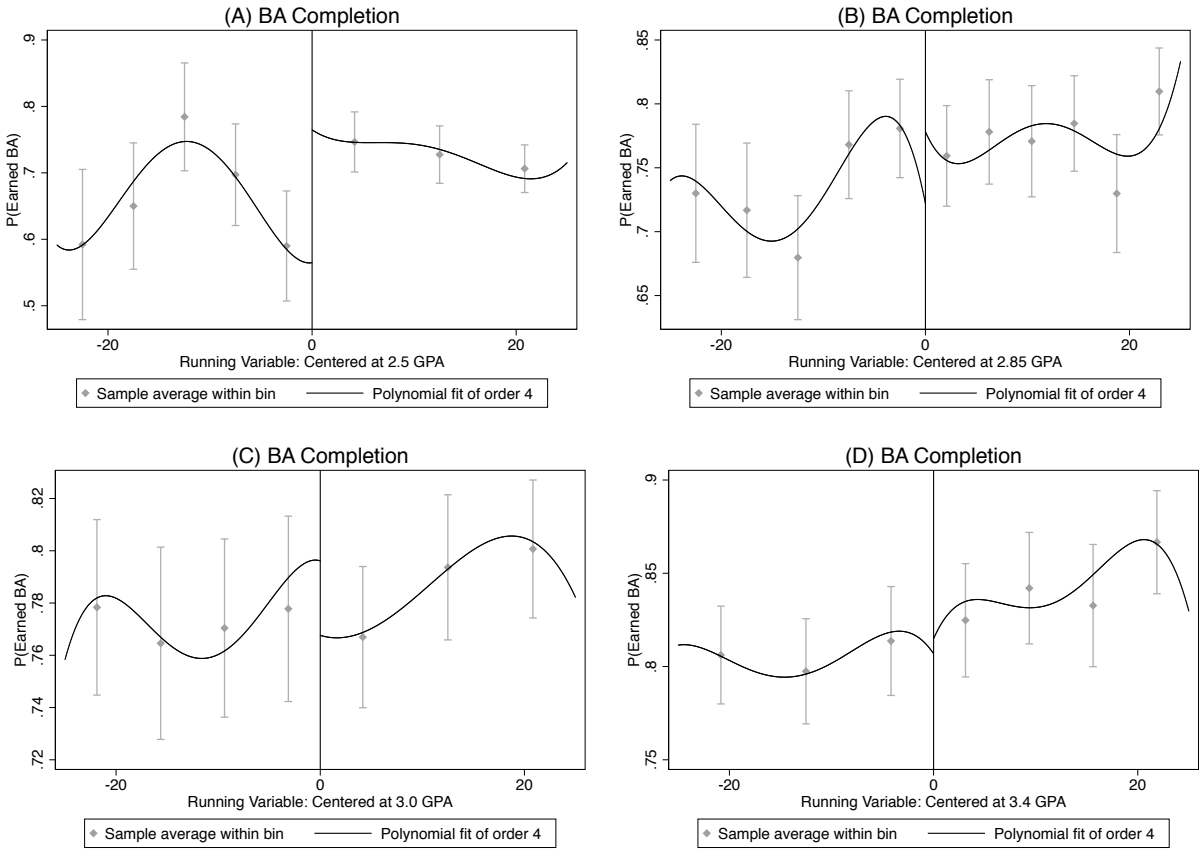
Standard errors in parentheses.
*** p<0.01, ** p<0.05, $^{+}$ p<0.10.
Note: All estimates generated using the first-stage equation specified above. Bandwidth corresponds to GPA points. For example, a bandwidth of .25 means within .25 GPA points on either side of the threshold. Sample sizes at each bandwidth are displayed on the bottom row. Significance values that are bold in row 2 indicate a strong instrument (F > 10.0).

Table 5: Probability of attending a more selective college: First-stage regression results for the 3.4 GPA sample (Time-to-degree model)

	(1)	(2)	(3)	(4)	(5)
	BW = .35	**BW = .30**	**BW = .25**	**BW = .20**	**BW = .15**
P(Attend more selective)	0.041***	0.045***	0.057***	0.053***	0.051***
	(0.014)	(0.014)	(0.016)	(0.018)	(0.021)
F-Test	9.14	9.89	**12.73**	8.93	6.23
N	5,209	4,558	3,801	3,090	2,332

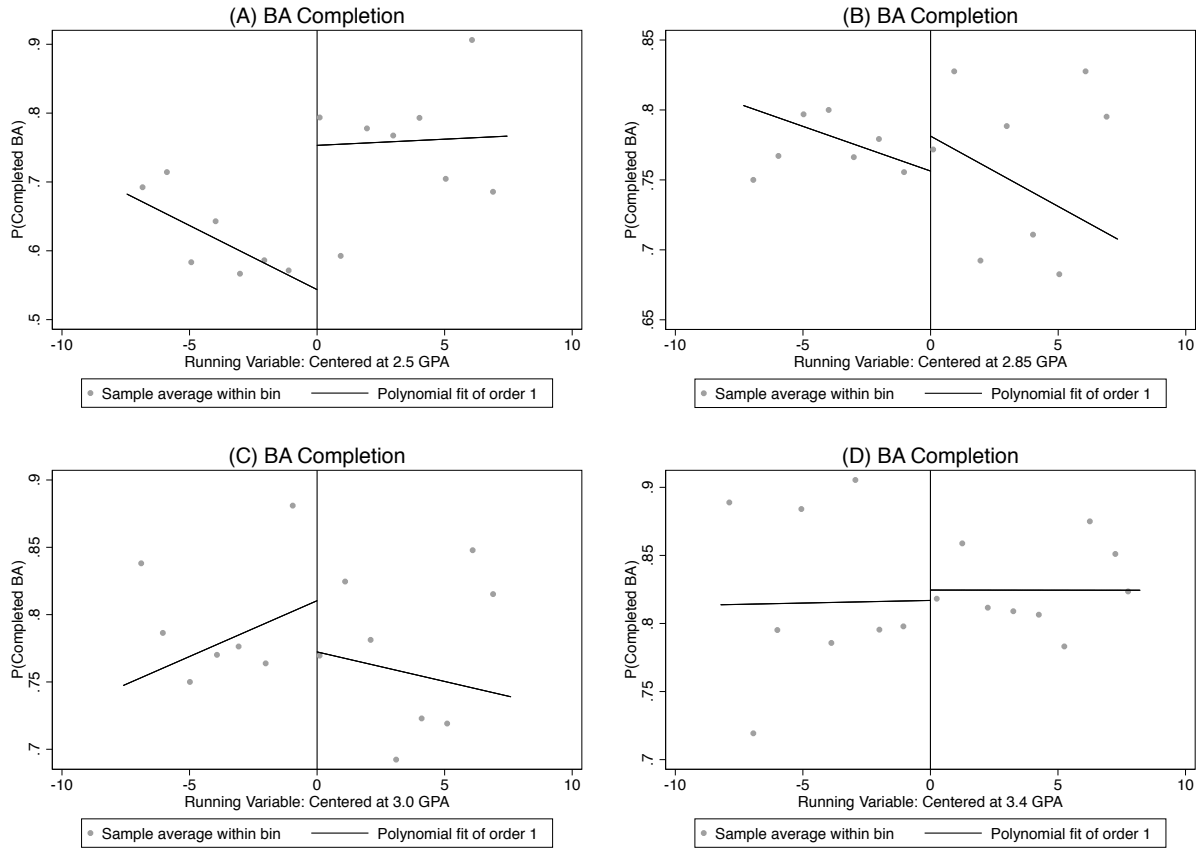
Standard errors in parentheses.
*** p<0.01, ** p<0.05, $^{+}$ p<0.10.
Note: All estimates generated using the first-stage equation specified above. Bandwidth corresponds to GPA points. For example, a bandwidth of .25 means within .25 GPA points on either side of the threshold. Sample sizes at each bandwidth are displayed on the bottom row. Significance values that are bold in row 2 indicate a strong instrument (F > 10.0).

Figure 4A: Bachelor's degree (BA) completion and transfer GPA (Bandwidth = .25)



Note: Bachelor's degree (BA) completion by distance to GPA cutoff. Between 3 and 7 bins are selected depending variation in the particular sample group. X-axis labels of -20 and 20 reflect .2 GPA points.
A: 2.5 cutoff; N = 2,103
B: 2.85 cutoff; N = 4,306
C: 3.0 cutoff; N = 4,870
D: 3.4 cutoff; N = 4,617

Figure 4B: Bachelor's degree (BA) completion and transfer GPA (Optimal bandwidth)



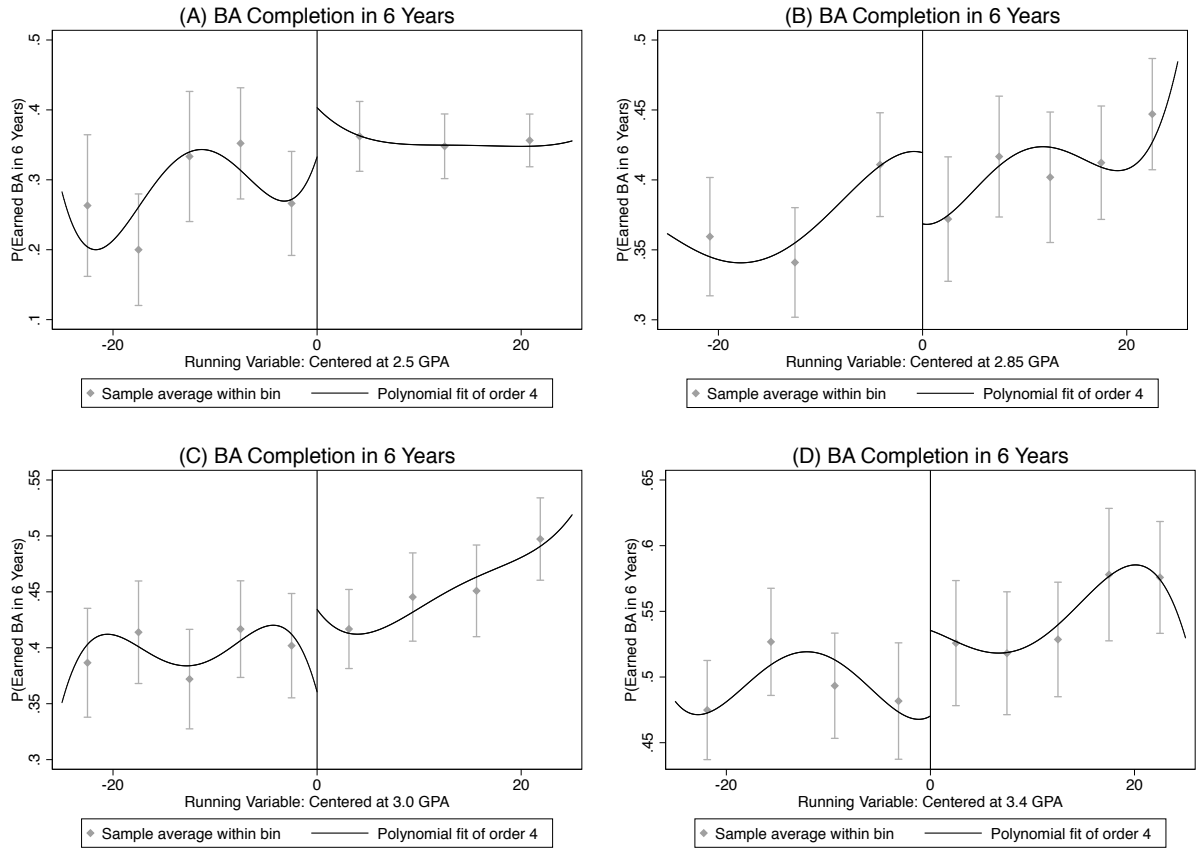
Note: Bachelor's degree (BA) completion by distance to GPA cutoff. Each dot reflects the average value at that exact GPA. X-axis labels of -5 and 5 reflect .05 GPA points.
A: 2.5 cutoff; N = 511
B: 2.85 cutoff; N = 1,357
C: 3.0 cutoff; N = 1,479
D: 3.4 cutoff; N = 1,488

Table 6: Regression estimates for bachelor's degree completion, bachelor's degree completion in 6 years, and time-to-degree at the 3.4 GPA threshold

	(1) RF	(2) OLS	(3) IV
Graduation Outcomes			
Bachelor's degree	0.01	0.086***	0.181
	(0.022)	(0.024)	(0.409)
Bachelor's degree in 6 years	0.026	0.143***	0.471
	(0.024)	(0.025)	(0.442)
Time-to-degree	-0.004	-0.547***	-0.071
	(0.108)	(0.109)	(1.878)
N	4,617	4,617	4,617

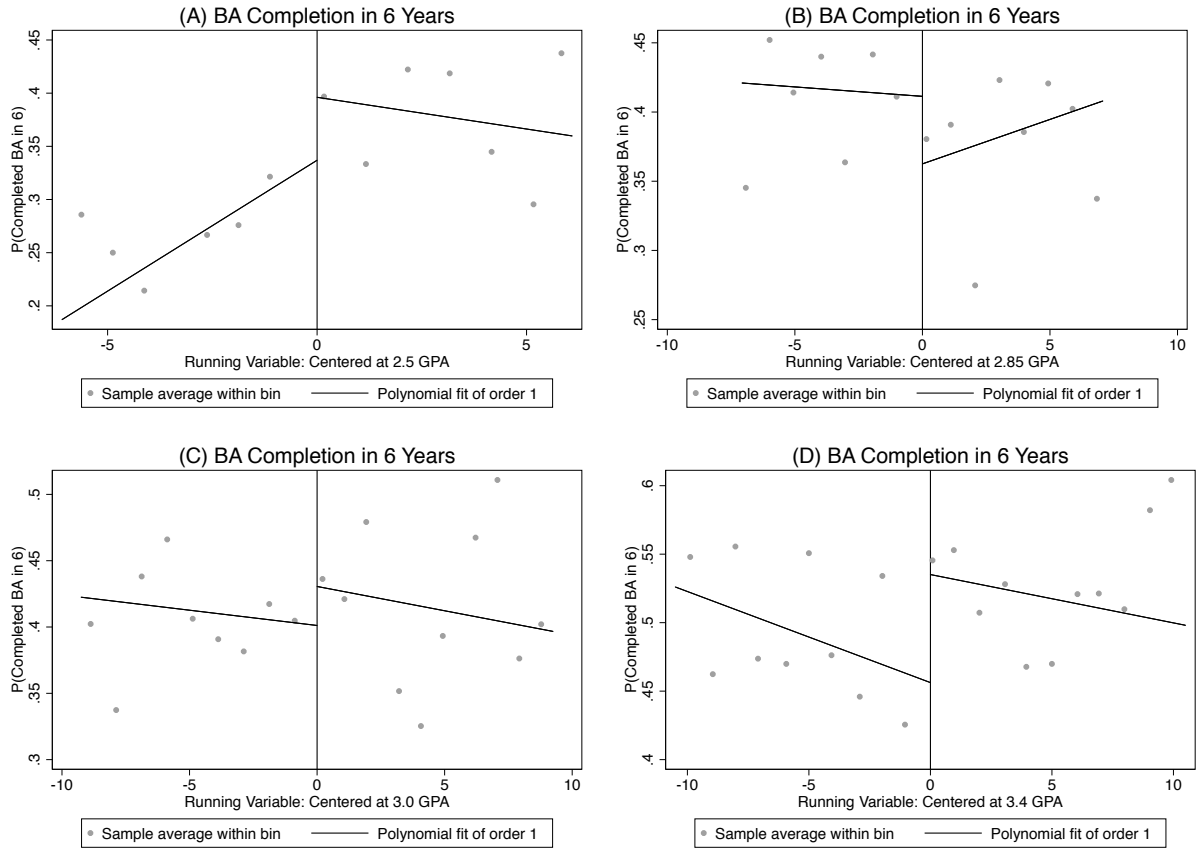
Standard errors in parentheses.
*** p<0.01, ** p<0.05, $^{+}$ p<0.10.
Note: Column 1 presents the reduced form (RF) estimates of the impact of GAA eligibility on the outcome variable of interest. Column 2 presents ordinary least squares (OLS) estimates of the impact of transferring to a more selective college (specified by the 3.4 GPA threshold) on the outcome variables of interest. Column 3 presents the fuzzy RDD (IV) estimates of the impact of transferring to a more selective college (specified by the 3.4 GPA. threshold) on the outcome variable of interest, with attending a more selective college instrumented by GAA eligibility. All regressions use a bandwidth of .25 GPA points and control for race, gender, parents' income quartile, rurality, age at start of four-year college, time spent in community college, multiple transfer, and fixed effects for the year in which students began their studies at the four-year college and the community college where the students earned their associate degree.

Figure 5A: Bachelor's degree (BA) completion in 6 years and transfer GPA (Bandwidth = .25)



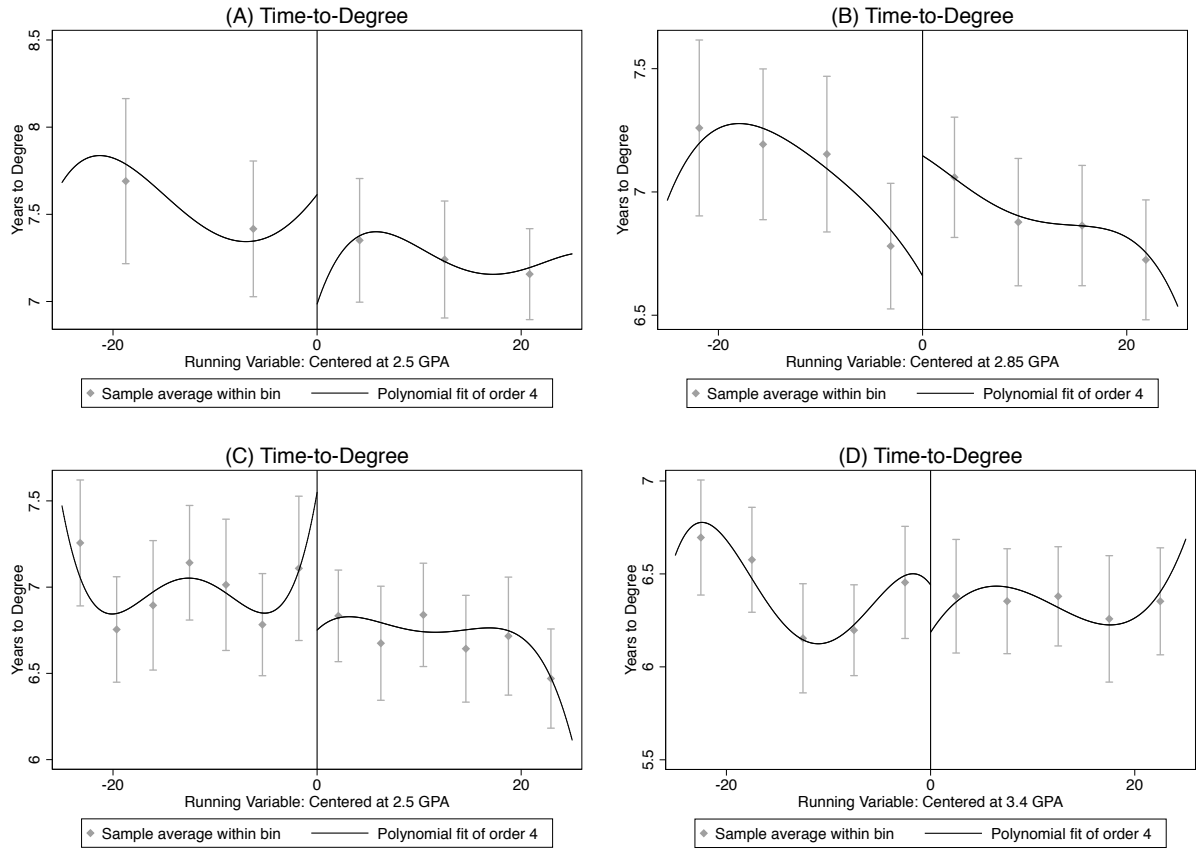
Note: Bachelor's degree (BA) completion in 6 years by distance to GPA cutoff. Between 4 and 6 bins are selected depending variation in the particular sample group. X-axis labels of -20 and 20 reflect .2 GPA points.
A: 2.5 cutoff; N = 2,103
B: 2.85 cutoff; N = 4,306
C: 3.0 cutoff; N = 4,870
D: 3.4 cutoff; N = 4,617

Figure 5B: Bachelor's degree (BA) completion in 6 years and transfer GPA (Optimal bandwidth)



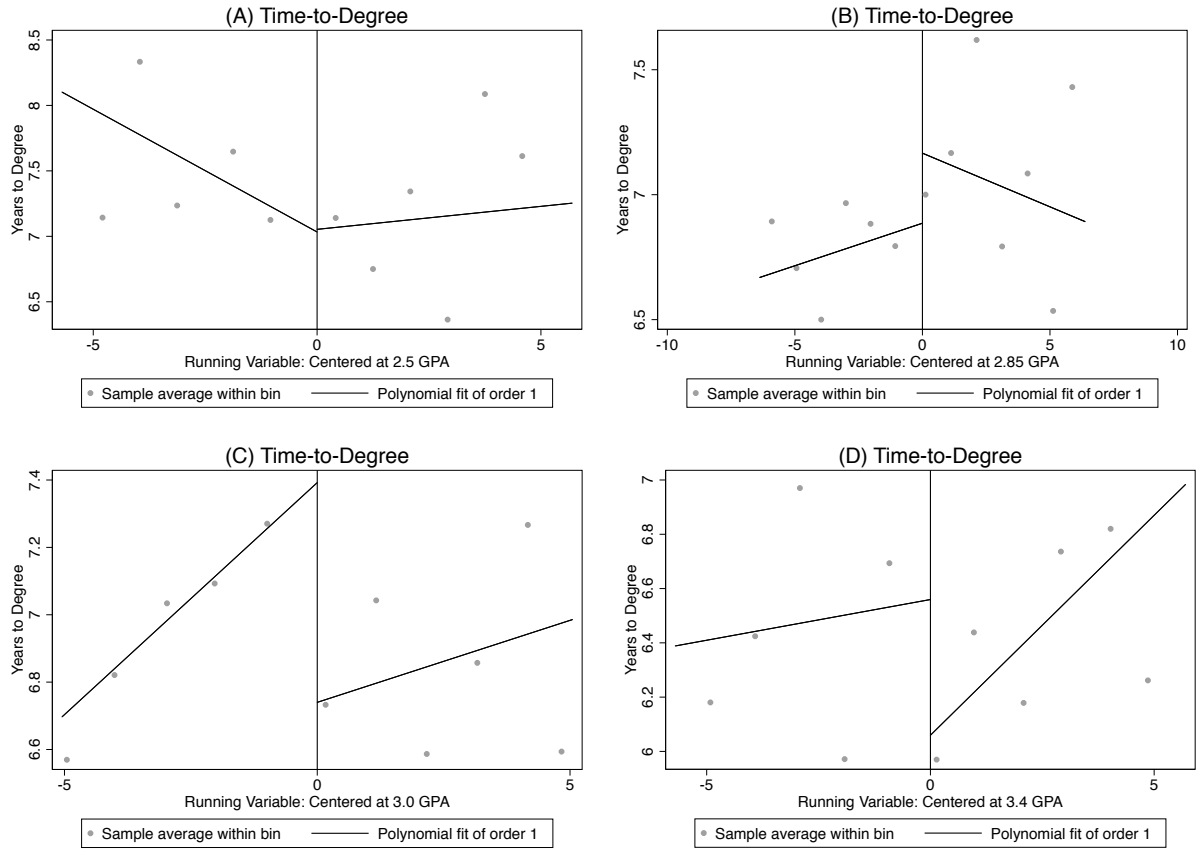
Note: Bachelor's degree (BA) completion in 6 years by distance to GPA cutoff. Each dot reflects the average value at that exact GPA. X-axis labels of -5 and 5 reflect .05 GPA points.
A: 2.5 cutoff; N = 450
B: 2.85 cutoff; N = 1,357
C: 3.0 cutoff; N = 1,847
D: 3.4 cutoff; N = 1,938

Figure 6A: Time-to-degree and transfer GPA (Bandwidth = .25)



Note: Time-to-degree (in years) by distance to GPA cutoff. Between 3 and 7 bins are selected depending variation in the particular sample group. X-axis labels of -20 and 20 reflect .2 GPA points.
A: 2.5 cutoff; N = 1,378
B: 2.85 cutoff; N = 3,273
C: 3.0 cutoff; N = 3,800
D: 3.4 cutoff; N = 3,801

Figure 6B: Time-to-degree and transfer GPA (Optimal bandwidth)



Note: Time-to-degree (in years) by distance to GPA cutoff. Each dot reflects the average value at that exact GPA. X-axis labels of -5 and 5 reflect .05 GPA points.
A: 2.5 cutoff; N = 270
B: 2.85 cutoff; N = 910
C: 3.0 cutoff; N = 824
D: 3.4 cutoff; N = 754

Table 7: Heterogeneous effects in enrollment and graduation outcomes at the 3.4 GPA threshold

	URM vs. Non-URM	Female vs. Male	Low-Income vs. Middle-Income	Rural vs. Non-Rural
Outcomes				
Attended	-0.004	-0.028***	0.027**	-0.031***
	(0.009)	(0.007)	(0.009)	(0.008)
Bachelor's degree	0.018	0.023	-0.054***	-0.007
	(0.015)	(0.016)	(0.018)	(0.019)
Bachelor's degree in 6 years	0.007	0.028	-0.021	-0.004
	(0.017)	(0.017)	(0.020)	(0.021)
Time-to-degree	-0.0001	-0.037	-0.233***	-0.016
	(0.074)	(0.078)	(0.078)	(0.090)
N (Attended model)	785	2,627	957	1,478
N (Bachelor's degree models)	785	2,627	957	1,478
N (Time-to-degree model)	652	2,184	742	1,213

Standard errors in parentheses.
*** $p<0.01$, ** $p<0.05$, $^{+}$ $p<0.10$.
Note: Attended refers to attended a college that was at least as selective as the student was qualified to attend. All estimates are computed using the specification from the instrumental variables model in Table 6.

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Appendix A: Characteristics of Virginia's four-year public and private non-profit colleges and universities that have Guaranteed Admissions Agreements

	GAA GPA Threshold	URM (%)	FTE	BA in 6 (%)	Instructional Spending ($)	Admission (%)	SAT Math (75th)	SAT Reading (75th)	Tuition & Fees ($)
Public Four-Year Colleges									
Christopher Newport University	3.5	13	4,981	75	8,746	60	620	630	12,526
College of William and Mary	3.6	15	8,214	91	14,862	34	730	730	19,372
George Mason University	2.85	21	27,929	70	12,426	80	630	620	10,952
James Madison University	3	11	20,244	82	8,916	73	610	610	10,018
Longwood University	2.5	14	4,400	65	7,897	79	540	550	11,910
Norfolk State University	2	87	4,829	35	11,298	79	450	460	8,366
Old Dominion University	2.5	34	19,692	51	9,338	83	570	570	9,480
Radford University	2.8	21	8,944	58	9,019	83	NA	NA	9,809
University of Mary Washington	3.25	15	4,278	72	7,984	83	590	620	11,130
University of Virginia	3.4	12	22,492	94	18,481	30	740	720	15,192
UVa Wise	2.5	12	1,663	44	10,218	77	510	530	9,220
Virginia Commonwealth University	2.5	24	27,490	62	14,605	79	590	610	12,772
Virginia Tech	3.4	9	31,369	84	12,007	73	680	640	12,485
Virginia State University	2	62	4,396	44	9,818	77	460	480	8,226
Private Four-Year Colleges									
Bluefield College	2.5	26	881	32	3,715	62	560	570	32,300
Bridgewater College	2.5	19	1,878	66	6,408	81	550	570	35,410
Eastern Mennonite University	2.5	13	1,416	62	11,505	93	518	518	23,296
Emory & Henry College	2.5	12	1,130	51	12,065	55	610	620	41,730
Ferrum College	2	40	1,280	30	8,059	49	430	430	15,746
Hollins University	2.5	17	745	53	16,034	76	540	550	30,900
Liberty University	2	19	51,747	51	2,609	97	540	600	30,331
Mary Baldwin University	2.5	23	1,410	46	8,703	NA	NA	NA	24,400
Marymount University	2.8	30	2,937	52	10,254	69	550	570	35,555

Randolph College	2.7	19	666	60	15,687	49	560	565	31,480
Randolph-Macon College	3	12	1,427	59	10,386	31	720	700	48,090
Roanoke College	2.2	10	1,953	63	10,149	69	550	540	23,112
Shenandoah University	2.5	15	3,324	57	9,647	93	540	550	34,428
Sweet Briar College	2.5	19	369	61	40,918	73	500	500	30,835
University of Lynchburg	2	15	2,429	56	11,060	61	510	500	30,900
Virginia Union University	2	95	1,748	33	6,534	82	563	560	30,760
Virginia Wesleyan University	2.5	33	1,341	44	9,260	22	590	600	20,109

Source: Integrated Postsecondary Education Data System (IPEDS), 2018.