College Late Departure in the United States: Exploring the Scope and Cause of Dropout Among Students Who Are Close to Earning a Degree

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Zachary Mabel

Bridget Terry Long, Saris Professor or Education and Economics, HGSE
David J. Deming, Professor of Public Policy, Education and Economics, HKS & HGSE
Christopher Avery, Roy E. Larsen Professor of Public Policy, HKS

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Abstract

Although many U.S. college students drop out after their second year of school, research on withdrawal has mostly focused on early departure. As a result, late departure–the phenomenon whereby students leave after making considerable academic progress–has been understudied. This dissertation is comprised of two studies that examine the scope and potential cause of dropout among students who are close to earning a degree. In the first study, I conduct descriptive and event history analyses using data from the Florida Department of Education and Ohio Board of Regents to examine dropout as a function of credit attainment. I find that late departure is widespread, particularly at two- and open-admission, four-year institutions. Fourteen percent of all degree-seeking entrants to public institutions in Florida and Ohio and one-third of all dropouts completed at least three-quarters of the credits typically required for graduation before leaving without a degree.

In the second study, I examine the extent to which late dropout is explained by time limits on the availability of need-based financial aid. In 2012-13, a new lifetime limit on Pell Grants eliminated a subset of continuing, income-eligible students from receiving grant aid. Using data from the University System of Georgia and a matched difference-in-differences research design, I compare the outcomes of Pell recipients who were affected and unaffected by the new eligibility rule before versus after the rule change. As a result of the new lifetime limit, students on average borrowed more to continue pursuing their degree and accelerated their time to completion. The rule change increased the probability of re-enrollment and bachelor's degree completion within 8 years by 2-3 percentage points. However, I find no evidence that the new lifetime limit decreased the probability of degree attainment overall. These findings suggest that aid exhaustion is not a major cause of dropout among low-income students who enroll for at least five full-time equivalent years, although decisions over how to allocate late-stage financial aid are consequential for this group.

I. PREFACE

Over the last two decades, improvements in data quality have shown that college dropout is widespread, and this has raised concerns over low completion rates at U.S. colleges and universities. In particular, the likelihood of degree attainment among those who attend has not responded to the large and increasing economic return to completing college (Autor, 2014; Avery & Turner, 2012; Carnevale, Jayasundera, & Gulish, 2016): 49.5 percent of degree-seeking entrants to college in 1996 completed an associates or bachelor's degrees within six years of entry compared to 47.1 percent of the 2003 entering cohort.[1]

To date, the majority of efforts to address low completion rates have focused on supporting students before or soon after they enter college. For example, several interventions have focused on helping students apply to college, complete the cumbersome application for federal student aid, and overcome procedural obstacles to matriculation that arise before students arrive on campus (Bettinger, Long, Oreopoulos, & Sanbonmatsu, 2012; Carrell & Sacerdote, 2017; Castleman & Page, 2015; Hoxby & Turner, 2013; Pallais, 2015). Considerable attention has also been devoted to improving the effectiveness of remediation policies for students who enter college academically underprepared (Bettinger & Long, 2009; Martorell & McFarlin, 2011; Scott-Clayton, Crosta, & Belfield, 2014).

Despite these investments, patterns of college dropout suggest that addressing the completion problem may also require supporting students long after they arrive on campus. For example, more than 40 percent of college students who do not earn degrees

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[1] Author's calculations using the National Center for Education Statistics (NCES), 1996/2001 and 2004/2009 Beginning Postsecondary Students Longitudinal (BPS) Studies. Statistics were calculated in the NCES DataLab using the online PowerStats tool.

leave after their second year of college (Bowen, Chingos, & McPherson, 2009; Shapiro et al., 2014). In an era in which the returns to completion are large for most students but public funding for higher education is limited (Baum, Ma and Payea, 2013; Baum and Ma, 2015; Oreopoulos and Petronijevic, 2013), targeting at-risk students who are approaching graduation may offer a cost-effective strategy for increasing degree attainment. Recent initiatives have begun to focus on this population of students. For example, with support from the Bill & Melinda Gates and Great Lakes Foundations, the 11-college University Innovation Alliance (UIA) is offering completion grants to students within two semesters of graduation who encounter financial challenges to finishing their studies. However, because most studies and policy efforts have targeted students at the start of their college careers, more analysis is needed to understand how many students are withdrawing close to graduation, which students are at risk of leaving late, and what is causing them to drop out.

This dissertation is comprised of two studies that together examine the scope and one potential cause of dropout among upper-division college students. In the first study, I conduct an event history analysis of dropout as a function of credit attainment using longitudinal, student-level data at public colleges in Florida and Ohio to investigate the incidence of college late departure, which I define to be non-completion or enrollment six years after entry among students who earn at least three-quarters of the credits typically required for graduation. Although a large literature has documented that students withdraw at multiple points along the path to completion, the majority of studies to date have modeled dropout as a function of time enrolled (Desjardins, Ahlburg, & McCall, 1999; Ishitani, 2006; Stratton, O'Toole, & Wetzel, 2008). Yet as I show, enrollment duration obscures proximity to completion because many students accumulate credits slowly due to the prevalence of remediation policies and discontinuous and part-time enrollments in college (Attewell, Lavin, Domina, & Levey, 2006; O'Toole, Stratton, & Wetzel, 2003; Scott-Clayton, 2012). The number of students leaving college after making considerable academic progress is not well known for this reason. I investigate dropout explicitly as a function of credit progress to fill this gap in the literature, although the approach I pursue is not without limitations. In particular, excess credit completion among graduates is common (Complete College America, 2011), and in my analysis I am unable to identify course-specific graduation requirements at the program level. Total credit completion will overstate progress to completion for many students as a result. To address this issue in part, I investigate dropout solely as a function of college-level credit completion, which in prior work has been shown to reduce overestimation of credit progress to completion by approximately two-thirds for students pursuing associates degrees (Complete College America, 2011; Zeidenberg, 2015).

The results from the first study indicate that many students withdraw after completing most of the credits that are typically required for graduation. I estimate that 14 percent of all degree-seeking entrants to college and 33 percent of all dropouts completed at least three-quarters of the credits typically required to graduate before withdrawing. Moreover, my results indicate that the probability of withdrawal spikes near the finish line. For example, the probability of dropout once students have completed three-quarters of their college-level credits is 21 percent, which is 1.5 times greater than the probability of dropout when students have completed at least half, but fewer than three-quarters of their credits to graduate. These results equate to approximately 420,000 degree-seeking entrants per cohort nationwide who are late dropouts, with substantial costs to individuals and to taxpayers. On average, college enrollees pay $11,500 per year in out-of-pocket expenses (Horn & Paslov, 2014), while state appropriations and grants subsidize the cost of attendance at public institutions by $10,000 per year on average (Schneider, 2010). As a result, nearly $32,000 and $40,000 in public and private dollars, respectively, are invested in the educations of degree-seeking students who earn substantial college credits but no degree.

In the second study, I examine the extent to which late departure is driven by lifetime financial aid eligibility limits that cause some students to exhaust their receipt of need-based aid towards the end of college. Because the majority of bachelor's degree recipients take longer than four years to finish (Bound, Lovenheim, & Turner, 2012), exhausting aid eligibility may make college suddenly unaffordable for students who have invested considerably towards earning a degree. Alternatively, decisions to persist in college may stabilize over time.[2] The effect of financial aid on attainment may therefore diminish as students progress in school and justify the front-loading aid disbursement policies that many institutions practice (Pratt, 2015; Sharpe, 2016). While causal research finds that generous and simple aid programs can increase access, completion, and post-schooling earnings (Angrist, Autor, Hudson, & Pallais, 2016; Bettinger, Gurantz, Kawano, & Sacerdote, 2016; Castleman & Long, 2016; Dynarski, 2003; Goldrick-Rab, Kelchen, Harris, & Benson, 2016), little is known about how tuition subsidies or grants affect students after they have enrolled in college. In particular, it is unclear whether aid

[2] For example, the "sunk cost fallacy" suggests that individuals are more likely to continue investing in domains where they have previously invested (Arkes & Blumer, 1985). Likewise, learning models of human capital accumulation assume that enrollment decisions will stabilize over time as uncertainty declines with experience (Manski, 1989; Stange, 2012; Stinebrickner & Stinebrickner, 2014).

that gets disbursed beyond the second year of college affects whether students will graduate and how quickly they do so.

Millions of college students also lose financial aid each year (Schudde & Scott-Clayton, 2016; Suggs, 2016), yet evidence on whether aid loss affects attainment is inconclusive and has only examined the effects of losing aid due to poor academic performance early in college (Carruthers & Özek, 2016; Schudde & Scott-Clayton, 2016). Therefore, in addition to examining a potential determinant of college late departure, this study informs more broadly how aid dollars can be allocated to best support college student success by investigating whether the effects of aid vary over time and how students respond when aid is taken away late into college.

I shed light on these questions by exploiting a recent change to federal Pell Grant eligibility rules that reduced the lifetime cap on aid from 9 to 6 full-time-equivalent (FTE) years beginning in 2012-13. Because it immediately eliminated a subset of continuing students from receiving need-based aid and reduced award amounts for others, the rule change provides a source of plausibly exogenous variation to estimate the effects of exhausting Pell Grant eligibility on several outcomes, including how much students borrow to pay for college, their investments in academic effort, and the probability of bachelor's degree attainment and time to completion. Using longitudinal data from the University System of Georgia and matched difference-in-differences (DD) and difference-in-difference-in-differences (DDD) research designs, I compare these outcomes before versus after the rule change for Pell recipients who were affected and unaffected by the new lifetime limit.

I find that Pell recipients affected by the new lifetime limit lost one-third of their grant aid per term after the new rule took effect. Students compensated for this loss by borrowing 15 percent more per term to pay for college and by increasing their academic effort. The eligibility change increased the probability of term-over-term re-enrollment and bachelor's degree completion within 8 years by 2-3 percentage points. Students who had at least one year to adjust to the new rule before exhausting their eligibility were also much more likely to graduate before experiencing any loss of aid. Importantly, I find no evidence that the rule change decreased the probability of degree completion overall.

The findings therefore indicate that aid exhaustion was not a major determinant of late dropout for this sample. However, the results imply that decisions over how to allocate financial aid are consequential. For students who have demonstrated a sustained commitment to finishing college, setting time limits on the availability of need-based aid can accelerate time to completion. Applying estimates from Castleman & Long (2016), who use a regression discontinuity design to estimate that offering students $1,300 in additional need-based aid at the start of college increased bachelor's degree attainment in Florida by 4.6 percentage points, suggests that completion rates could have increased overall by 2-3 percentage points if the savings generated by the new lifetime limit had been used to offer first-year Pell recipients more generous awards. In short, the findings from the second study indicate that disbursement policies can be designed with attention towards accelerating time to degree and can impact the cost-effectiveness of financial aid expenditures.

I structure the remainder of the dissertation as follows. In Section II, I present the first study, "Leaving Late: Understanding the Extent and Predictors of College Late

Departure", in its entirety. In Section III, I present the second study, "Aiding or Dissuading? The Effects of Exhausting Eligibility for Need-based Aid on Bachelor's Degree Attainment and Time to Completion", in its entirety. I conclude in Section IV with a discussion of the findings from both studies and directions for future research to continue investigating why students drop out late and the types of policy interventions that can help them finish.

II. Study 1–Leaving Late: Understanding the Extent and Predictors of College Late Departure[3]

1. INTRODUCTION

The economic return to completing college is large and increasing (Autor, 2014; Avery & Turner, 2012; Carnevale, Jayasundera, & Gulish, 2016), yet improvements in data quality over the last two decades have shown that college dropout rates are high. Approximately two-thirds of degree-seeking students who first attend community colleges withdraw before earning an associate or bachelor's degree within six years of initial enrollment, while nearly 40 percent of undergraduates who first attend four-year institutions do not graduate within six years.[4] Data sources also suggest that more than 40 percent of college students who do not earn degrees leave after their second year of school (Bowen, Chingos, & McPherson, 2009; Shapiro et al., 2014). These rates have policymakers, school leaders, and the public concerned over institutional performance at U.S. colleges and universities.

In an era in which the returns to college completion are large for most students but public funding for higher education is limited, targeting students who are near graduation but remain at risk of dropout may offer a cost-effective strategy for increasing degree attainment. However, because much of the research and policy attention on the dropout issue has focused on early departure (Adelman, 2006; Chemers, Hu & Garcia, 2001; Kuh, Cruce, Shoup, Kinzie & Gonyea, 2008; Stinebrickner & Stinebrickner, 2012;

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[3] A version of this paper has been published in the journal *Social Science Research* and is the version that should be cited. The suggested citation is: Mabel, Z. & Britton, T. (2018). Leaving late: Understanding the extent and predictors of college late departure. *Social Science Research*, *69*(1), 34-51. I conceived of the study and research design and I executed all aspects of the empirical work. I am indebted to my co-author, Tolani Britton, for preparing the Ohio data for analysis and for contributing to portions of the introduction.

[4] Author's calculations using the NCES, 2004/2009 BPS Study. Statistics were calculated in the NCES DataLab using the online PowerStats tool.

Zajacova, Lynch, & Espenshade, 2005), less is known about how close to degree attainment non-completers are at the time of dropout and which students are at risk of leaving late.

In this paper, I offer new evidence on the scope and predictors of college late departure. Building on previous research, which has traditionally modeled dropout as a function of time enrolled and demonstrated that the likelihood and predictors of withdrawal are dynamic (Desjardins, Ahlburg, & McCall, 1999; Ishitani, 2006; Stratton, O'Toole, & Wetzel, 2008), I examine dropout instead as a function of credit progress towards degree completion. Using administrative data on first-time, degree-seeking students attending public institutions in Florida and Ohio, I conduct an event history analysis of dropout as a function of credit attainment seven years after students first entered college. As I describe in more detail in the following section, enrollment duration can obscure progress to completion because many students accumulate college credits slowly, which prolongs time to degree completion (Bound, Lovenheim, & Turner, 2012). Investigating dropout as a function of credit accumulation therefore provides a more precise approach to estimating the scope of late departure, which in this study I define to be non-degree completion among students who earned at least three-quarters of the credits typically required for graduation.

To preview my results, I find that many students withdraw after completing most of the credits that are typically required for graduation. I estimate that 14 percent of all degree-seeking students who enrolled in college and 33 percent of all dropouts completed at least three-quarters of the credits typically required to graduate before leaving college without a degree seven years following initial entry. Moreover, I find that the probability of withdrawal spikes near the finish line. For example, the probability of dropout among students who reach the three-quarter credit threshold is nearly 1.5 times greater than the probability of dropout among students who completed at least half, but fewer than three-quarters of their credit requirements.

Although unpacking the causes of late departure is beyond the scope of this study, I descriptively examine which students are in jeopardy of leaving just shy of degree attainment and investigate how dropout predictors vary with proximity to completion. The results suggest that well-established predictors of early dropout, including poor academic preparation and non-sequential enrollment histories (Adelman, 2006; Attewell, Heil, & Reisel, 2012), also predict late departure. However, I also document relationships that have received less attention in the research literature. In particular, the spike in late departure signals that the relationship between credit accumulation and dropout is not constant through college. I also find suggestive evidence that the transition to more rigorous, upper division coursework may present a crucial barrier to completion for many students who are capable of passing introductory coursework. Students who dropout late appear to maintain their academic effort in terms before exiting, as measured by their term credits attempted/earned and term GPA, yet experience increasing rates of course failure as they progress in school. These findings, coupled with the fact that the magnitude of many dropout predictors varies with credit progress, suggests the student dropout profile is dynamic along the pathway to degree completion.

I structure the remainder of this paper into three sections. In Section 2, I discuss the barriers to completing college and what is currently known about college dropout from the research literature. In Section 3, I describe the data, study sample, key measures, and methods for empirical analysis. I present my results in Section 4 and conclude in Section 5 by discussing the implications of the findings for research and policy.

2. BACKGROUND

2.1 Theoretical Models of College Attrition

Scholars have theorized about the process of college persistence for decades, with three models motivating much of the research on the topic. In economics, the human capital model pioneered by Becker (1964) and Mincer (1958) assumes that individuals make enrollment decisions by evaluating the costs and benefits of attending school and choosing the level of education that maximizes their return on investment. The standard model assumes that decisions over schooling are fixed over time, but several scholars have augmented the traditional model to capture the sequential decision-making process that many students undertake each term (Bettinger, 2004; Heckman, Lochner & Todd, 2006; Manski, 1989; Stange, 2012).

Whereas economists have focused primarily on the individual determinants of educational investment, higher education scholars have also paid attention to the role of institutional factors. The student integration model developed by Tinto (1987) posits that retention is primarily a function of the robustness of the social and intellectual life of a college, while Bean's student attrition model (1980) adds environmental factors, such as institutional selectivity and level of bureaucracy, to the equation. Cabrera, Nora, and Castaneda (1993) later integrated these models to demonstrate the connectedness of individual, institutional, and environmental factors associated with departure.

2.2 Empirical Models of College Attrition

To account for the dynamic nature of investments in human capital, Willett and Singer (1991) proposed using discrete time survival analysis. Following this convention, Desjardins, Ahlburg, and McCall (1999) used event history modeling to shed light on when students are at greatest risk of dropping out of school, as measured by time since initial enrollment. Employing variables from the structural model of Cabrera, Nora, and Castaneda (1993), such as high school records, demographic information, and current student achievement and financial aid, the authors find that predictors often treated as static are actually time-varying. Several studies over the last two decades have followed this same methodological approach to study predictors of dropout and when departure occurs (Calcagno, Crosta, Bailey & Jenkins, 2006; Desjardins, Ahlburg, & McCall, 2002; Ishitani, 2006; Stratton, O'Toole, & Wetzel, 2008).

However, because most studies have focused on the temporal dimension of dropout, less empirical work has explored dropout as a function of credit accumulation. Of the work that has examined credit completion as a metric of progress, most studies have investigated how credits earned in the first year predict subsequent persistence and graduation (Adelman, 2006; Kuh, Cruce, Shoup, Kinzie, Gonyea, 2008; Zajacova, Lynch, & Espenshade, 2005). Furthermore, longitudinal studies that include credit attainment as a predictor typically follow the conventional approach to modeling progress as a function of time (Calcagno, Crosta, Bailey & Jenkins, 2006). Within this setup, it has been shown that credit accumulation increases the probability of graduation, but prior research has stopped short of examining how many students drop out after completing many of their credit requirements. Evaluating proximity to graduation may be difficult to parse out for this reason unless the dropout process is modeled explicitly as a function of credit attainment.

This raises an important question: is time since initial enrollment a suitable proxy for degree progress? In Figure 1, I explore this empirically by plotting the distributions of credits earned one, three, and five years into college among undergraduates of public institutions in Florida and Ohio. The results show that while average credit attainment increases with enrollment duration, the variation in accumulated credits is large and increasing over time. By year 3, the standard deviation of completed credits (22.6) is equal to almost one full-time-equivalent year of credit attainment. For students who make it to a 5th year of college, the standard deviation is comparable to approximately 1.3 years of academic progress. This wide variation in credit completion indicates that time is a noisy measure of degree progress, especially as enrollment duration increases.

Several facets of the college student experience help to explain why credit attainment is a better proxy for academic progress than enrollment duration. First, roughly one-third of students are required to take developmental or remedial courses, which do not count towards a degree, but must be completed prior to taking credit-bearing courses (Attewell, Lavin, Domina, & Levey, 2006). Discontinuous enrollment, whereby students take time off from college but later return, is also widespread (O'Toole, Stratton, & Wetzel, 2003), as is working while in college (Scott-Clayton, 2012), which hinders full-time enrollment and has been shown to cause students to complete fewer credits per term (Darolia, 2014). In light of this evidence, and as I discuss in greater detail in section *3.4*, in this study I model dropout as a function of college-level credit accumulation to examine the scope of the late departure phenomenon. This approach is not without limitations, however, as graduates of associate and bachelor's degree programs respectively complete 32 percent and 14 percent more credits on average than is required to graduate (Complete College America, 2011). I investigate dropout solely as a function of college-level credit completion to more closely approximate dropout as a function of credit progress to completion. In my sample, graduates who earned associates and bachelor's degrees completed fewer excess credits on average (23 percent and 11 percent among associate and bachelor's degree completers, respectively) because remedial coursework accounts for a large share of excess credit completion, particularly at community colleges (Complete College America, 2011; Zeidenberg, 2015).

It is important to note that many of the aforementioned characteristics of the student experience are common to students throughout their time in school. However, the influence of these characteristics on the likelihood of dropout is likely to vary with proximity to graduation. For example, as students age they are likely to take on additional work and family commitments that may make completing college more challenging. Furthermore, because perceptions of belonging in college influence the likelihood of stop out but typically stabilize over time (Walton and Cohen, 2007; Robbins et al., 2004), the relationship between prior enrollment behavior and the likelihood of degree completion may diminish as students progress in college. I thus hypothesize that the influence of student characteristics will vary with the number of credits completed and I examine evidence for this empirically.

2.3 Leaving College in the Ninth Hour

Although proximity to graduation is an understudied topic in the dropout literature, aspects of the traditional college experience suggest that many students may be susceptible to leaving late. At large, open access colleges and universities students are often required to navigate complex bureaucracies and receive minimal advising to chart their course. Student-to-counselor ratios at those institutions, which frequently exceed 1,000:1, create environments in which many students are unaware of whom to contact if they need support (Gallagher, 2010; Center for Community College Student Engagement, 2009). Furthermore, because students typically have an abundance of choice when deciding which courses to take, they may delay progress to completion by avoiding required classes that are demanding and unpleasant (Bailey, Jeong, & Cho, 2010).

The road to completion also becomes increasingly self-directed because colleges frequently assume that students can navigate through school independently after the first year. Support programs primarily target first-year students for this reason, even though initial impacts of first-year interventions, such as learning communities and student success courses, typically fade out in subsequent semesters when students lose access to structured supports (Rutschow, Cullinan & Welbeck, 2012; Visher, Weiss, Weissman, Rudd, & Wathington, 2012). In this isolated environment, the risk of departure may loom large for students who have made substantial academic progress. Unanticipated obstacles, including changes in financial aid, experiencing hardship such as a family member's job loss, or even failing a required course, may derail advanced undergraduates who are committed to graduating and capable of doing so.

These features of the college landscape may explain why a large portion of dropout during the first two years of college is attributed to what students learn about the expectations of college and their own academic performance, whereas these factors play a much smaller role in later dropout decisions (Stinebricker & Stinebricker, 2014).

Furthermore, because per-student resources are most limited at broad-access institutions where student needs are greatest, the challenges to finishing college after making substantial progress are likely to vary across institutions and be most acute at two- and non-selective four-year institutions where graduation rates are lowest.

In spite of the documented challenges encountered by college-goers, the number of students leaving college after making considerable academic progress is not well known. Estimates suggest that nearly 25 percent of traditional-age students from the high school graduating class of 1992 entered college and completed at least 75 percent of their academic degree requirements before leaving without a degree (Institute for Higher Education Policy, 2011). However, this two-decade old estimate may no longer reflect the current postsecondary landscape. For example, the growing shift of financial aid from grants to loans in recent decades has increased both the percentage of students that take-on debt to pay for college and average loan amounts (Baum, Elliot and Ma, 2014). If students are less willing to invest in additional schooling as debt accumulates, then the rate of late departure may be increasing over time. Alternatively, the problem may be less severe today now that technology innovations offer students more ways to balance school with other responsibilities. In short, more analysis is needed to understand if many students are withdrawing near graduation because much has changed in higher education over the last two decades.

This paper contributes to the literature on college persistence and attainment by examining three research questions: 1) how many of the credits typically required for graduation do non-completers earn, 2) which students are at risk of dropping out after completing most of these credits, and 3) do the predictors of late departure differ from the predictors of withdrawal at earlier points along the path to degree completion? By focusing on proximity to degree completion as a function of academic progress instead of enrollment duration, which I measure by the percentage of credits typically required for graduation that students have completed, I provide a more detailed picture of when students are dropping out and which students are at risk of leaving late. As I discuss in my concluding remarks, my findings offer policymakers and institutional leaders new avenues for increasing degree attainment by targeting supports to this oft-overlooked population of students.

3. DATA, SAMPLES, AND METHODS

3.1 Data

The data in this study are from the Florida Department of Education K-20 Data Warehouse (KDW) and the Ohio Board of Regents (OBR), which maintain longitudinal student-level records at all public colleges and universities in Florida and Ohio, respectively. From these systems I have high school and college application records, including demographic and transcript data on students. These data are then linked to term-by-term college enrollment, course transcript, and degree award records at all public two- and four-year institutions in both states. I am therefore able to observe students' credit accumulation in remedial and college-level courses and can track progress to degree completion by the number of credits completed over time.

This rich dataset captures enrollment and completion records for the census of students at Ohio public colleges and for the majority of college-bound, Florida high school graduates.[5] However, a limitation of the data is that I cannot differentiate between students who dropped out and those who transferred to private or out-of-state institutions. My results will overstate the extent of dropout for this reason, although the magnitude of upward bias is likely small given that only 6 percent of students first attending public institutions in Florida and Ohio subsequently transfer to private or out-of-state colleges according to National Student Clearinghouse enrollment records (Shapiro, Dundar, Wakhungu, Yuan, & Harrell, 2015), whereas 44 percent of the students in my data withdrew before earning a degree.

3.2 Samples

I explore the scope and determinants of college late departure among a sample of first-time, degree-seeking undergraduates who enrolled at public institutions in Florida and Ohio between the fall 2000 and fall 2001 academic terms. I condition the sample on traditional college entrants, which comprise approximately 80 percent of all first-time college-goers, in order to observe both pre-entry characteristics and the complete enrollment trajectories of students in the data. Specifically, I restrict the sample to include students who: a) were between the ages of 17-19 at the time of high school graduation, and b) enrolled at least half-time (attempted 6 or more credits) as a degree-seeking student within 16 months of high school completion. I also condition the sample on students with complete demographic, prior achievement and college experience data, given that one objective of this study is to examine the predictors of late departure. These restrictions yield a sample of 54,012 unique students, of which 22,499 first attended two-

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[5] KDW records capture the census of Florida public high school graduates, not the census of college-bound students as in Ohio. In the 2000-01 academic year, 85 percent of all first-time freshmen at public institutions in Florida were in-state residents (authors' calculations using IPEDS). I therefore observe most, though not all students who first attended public colleges and universities in Florida.

year college, 12,318 first attended an open-admission four-year institution, and 19,195 first attended a selective four-year university.[6] I separately examine my research questions by the type of institution students first attended to allow the magnitude and risk factors of late departure to vary by college sector.[7]

To examine dropout as a function of credit progress, I follow the convention in the discrete event history modeling literature and construct a student-period dataset. However, whereas most event history analyses use a student-by-time dataset to examine *when* dropout occurs, I construct a student-by-credit category dataset to examine *the share of college-level* credits students complete upon exiting school for the last time. This dataset contains one observation per credit category for each student, with each student contributing as many observations to the sample as the number of credit thresholds they surpassed.[8] The student-period sample is comprised of the same 54,012 unique students but yields 177,331 student-by-credit category observations.

In Table 1, I present descriptive statistics for three samples of students: all first-time, degree-seeking undergraduates who attended public postsecondary institutions in the United States in fall 2003 (column 1), the sample of public college entrants in Florida and Ohio ages 17-19 at high school graduation who enrolled in college within 16 months of high school completion (column 2), and the subset of those students in the analytic

[6] I classified four-year universities as selective if Barron's Profiles of American Colleges categorized the institution as "very", "highly" or "most competitive" in the 2000-01 school year. Nine of the 24 public universities in Florida and Ohio met this criterion.
[7] As a robustness check, I also conducted analyses on a sample in which I assigned students to their last institution attended. The results presented throughout the paper are robust to whether I assign students to the first or last school that they attended.
[8] For example, a student who earned 20 of the 120 credits typically required to earn a bachelor's degree would contribute a single observation to the student-period dataset, corresponding to the interval when fewer than one-quarter of the requisite credits to graduate had been earned. Another student who earned 90 credits would contribute four observations to the dataset, given that they completed three-quarters of the credits typically required for a bachelor's degree.

sample (column 3).[9] There are some important differences between all first-time public undergraduates nationwide and those in the analytic sample as a result of the sample restrictions I impose. Because of the age restriction, the students in the study sample are younger at entry (18.5 versus 21.3 years old) and a significantly larger share entered college immediately following high school graduation (91 percent versus 65 percent). Students who first attended four-year institutions are also overrepresented in my sample (58 percent in my sample versus 43 percent nationally). However, on gender, race, and high school GPA, the students in the analytic sample closely mirror the profile of all incoming undergraduates nationwide.

The students in the analytic sample also closely mirror the full population of traditional public college entrants in Florida and Ohio on observable demographic characteristics. In terms of college performance, the students in the analytic sample are slightly higher performing than the statewide sample. Average credit attainment is 8 units (9 percent) higher and the dropout rate is 3.6 points (7.6 percent) lower in the analytic sample compared to the statewide population. However, these differences largely reflect the overrepresentation of students who first attended four-year colleges in the analytic sample (58 percent versus 52 percent statewide). Differences within sector are considerably smaller, which is notable because I stratify by institution type in all of my analyses. Furthermore, the late departure rate (i.e. the dropout rate among students who completed three-quarters of the credits typically required for graduation) is nearly equivalent in both the statewide and analytic samples. I take this as evidence, in addition to the size and diversity of the Florida and Ohio postsecondary systems, that my findings

[9] The statistics in column 1 draw on data from the National Center for Education Statistics, 2003-04 Beginning Postsecondary Students Longitudinal Study.

likely generalize to traditional students in other large public postsecondary systems across the country.

3.3 Dependent and Independent Measures

In my empirical work, I examine the probability of withdrawal by the proportion of college-level credits cumulatively earned. This allows me not only to examine whether a student left college without earning their degree, but also how much academic progress they made towards degree completion at the time of departure. For this investigation, I constructed the categorical variable $CRED\_CAT$, which captures the share of credits completed, in quarter increments, typically required for degree completion (i.e. $\mathrm{X} < 0.25$; $0.25 \leq \mathrm{X} < 0.5$; $0.5 \leq \mathrm{X} < 0.75$; and $0.75 \leq \mathrm{X}$).[10]

To investigate predictors of dropout by credit progress, I leverage a rich set of pre- and post-entry measures that capture many of the demographic, incoming preparation, enrollment momentum, and college performance factors shown to correlate strongly with degree progress in the research literature (Adelman, 2006; Attewell, Heil, & Reisel, 2011; Nora, Barlow, & Crisp, 2005). These include indicators for gender and race, whether the student entered college immediately following high school graduation, whether the student took remedial coursework, and a continuous measure of high school GPA. I also examine time-varying enrollment and academic performance factors, including indicators for having previously stopped out from college and transferred institutions, age in years, and the student's average term GPA, number of credits

[10] Because I do not observe programs of study for most students in the data, I assume associate and bachelor's degree-seeking students must earn 60 and 120 college-level credits to graduate, respectively. These thresholds are consistent with the graduation requirements for most majors published on institutional websites in Florida and Ohio. I assigned students to either the 60 or 120 credit threshold according to the degree type they first pursued.

attempted, and the proportion of attempted credits that were earned in each credit period.[11]

My outcome measure is an indicator equal to "1" if a student did not earn an associate or bachelor's degree within six years of initial enrollment in college, or was not enrolled in college at the start of their seventh year. By construction, all students assigned a value of "0" had therefore either graduated within six years or were still enrolled in their seventh year and presumed to be working towards their degree. Because the data is right-censored at year 7, some students coded as dropouts will have stopped out but later re-enrolled and graduated beyond the time horizon I observe. This will also lead to overestimation of late dropout rates, although the definition of dropout I employ likely results in a minimal amount of upward bias due to censoring.[12] I count all students who completed an associate or bachelor's degree, regardless of which credential they initially pursued, as degree earners. This ensures that the departure rates I estimate are not inflated by changes to degree intentions over time.[13]

[11] A clear omission from this list is financial aid, which a large body of research has shown can increase the probability of enrollment, persistence, and degree completion (see Dynarski & Scott-Clayton, 2013 for a summary of this literature). Unfortunately, I do not observe complete aid packages for students in the data and therefore do not examine the relationship between financial aid and credit progress to graduation.

[12] To examine this issue, I turned to an administrative dataset from the University System of Georgia, which maintains longitudinal student-level records at public, four-year colleges and universities in the State of Georgia and allows me to track students over a longer time horizon (i.e., through 10 years following initial enrollment). I find that only 14 percent of USG students who completed 90 or more credits (i.e., 75 percent of the credits typically required for bachelor's degree completion) and who were not still enrolled in year 7 completed a bachelor's degree within 10 years. This suggests that the vast majority of students coded as dropouts in the study sample did not return to college after the data is censored and subsequently graduate.

[13] Students not enrolled in year 7 who completed a college certificate are counted as dropouts, although most dropouts did not earn certificates. Fewer than 5 percent of dropouts who first sought associate degrees and 3 percent of dropouts who first sought bachelor's degrees completed a certificate within six years of entry.

3.4 Empirical Strategy

I begin my empirical work by calculating sample departure rates within each credit category and institution type. I then examine dropout rates by pre- and post-entry characteristics for students who reach the three-quarter credit threshold to shed light on which students are at risk of dropping out after completing most of their credit requirements. Next, to allow for population inferences that extend beyond the study sample, I turn to event history modeling using the student-period dataset. For this analysis, I estimate a single risk discrete-time hazard model using a logistic regression specification of the following form:[14]

(1) $$\Pr(Y_{idc} \mid X_{idc}) = P(\theta_{idc} + Z_{idc} + \omega_s), \text{ where } P(j) = \frac{1}{1+e^{-(j)}}.$$

Because the student-period dataset contains one observation for each credit category a student surpasses, in this specification I model the conditional risk of dropout, also called the "hazard" in event history analysis, for student i who first pursued degree *d* in credit interval *c*. To test whether the probability of dropout varies both by the share of credits completed and the type of degree sought, I include indicator variables for twelve (4 credit categories x 3 institution types) credit-by-institution type categories (θ_{icd}). By including this set of dummy variables, an attractive feature of this regression model is that I make no assumption as to the functional form of the underlying relationship between credit attainment and dropout. To account for factors that may influence the progress students make towards degree completion and their risk of dropout, in some

[14] In addition to estimating logistic hazard models, I also fit random intercept logistic and complementary log-log hazard models and estimated models that account for parametric and non-parametric representations of unobservable factors affecting student dropout behavior (i.e. "unobserved heterogeneity" or "frailty" in event history modeling nomenclature). The substantive conclusions are unaltered by these modeling decisions, and I therefore present results from the logistic models for simplicity and computational efficiency.

models I also include the full set of pre- and post-entry student characteristics (Z_{idc}) and an indicator of whether the student attended college in Florida or Ohio (ω_s). In those models, the vector Z_{idc} also includes a measure of time between the term students reached each credit period and initial enrollment, which partials out the correlation between credit attainment and enrollment duration so that my results do not conflate dropout as a function of academic progress and as a function of time.

To formally test whether the risk of departure differs by progress to degree completion and institution type, I carry out post-estimation General Linear Hypothesis (GLH) tests of whether the coefficients on the credit-by-institution type indicators are equivalent. Likewise, to examine heterogeneity in dropout risk factors by proximity to degree completion, I augment equation (1) with interactions of θ_{idc} and Z_{idc} and then conduct GLH tests of whether the coefficients on the interaction terms are equal in magnitude. In all analyses, I report inference statistics that account for both the correlation of outcomes among students attending the same schools and for multiple testing by controlling the False Discovery Rate.[15]

4. RESULTS

4.1 The Probability of Departure by College-Level Credit Completion

I begin the results section with a graphical presentation of enrollment outcomes through six years following college entry. Figure 2 shows the share of entrants that dropped out and completed a degree or remained enrolled by institution type. To highlight the scope of late departure, I define two groups of dropouts in the figure: those

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[15] The FDR controls the proportion of rejections that are Type I errors, i.e. false discoveries. It reduces the penalty to multiple hypothesis testing when some Type I error is acceptable, as is the case for exploratory analyses like this one.

who withdrew prior to earning three-quarters of the credits typically required to graduate, which I define as "early" dropouts, and those who surpassed the three-quarter credit threshold, which I define as "late" dropouts. Across all institutions, late dropouts represent 14 percent of all students who ever enrolled in college and one-third of all dropouts. Figure 2 also shows that late departure is especially prevalent at two- and open-admission four-year institutions, representing 20 percent and 14 percent of all students who respectively began their college careers in those sectors.

In Figure 3, I disaggregate rates of late departure at two-year institutions by race, which shows that the phenomenon is widespread among students of different backgrounds. Approximately 20 percent of White, Black, and Hispanic/Latino students left college without a degree after accumulating three-quarters of their college-level credits. Analogous results in Figure A1 of Appendix A also reveal small differences by race at four-year institutions. In Table A1 of Appendix A, I present more detailed departure rates by credit category and show that late dropouts represent the largest share of withdrawals in each sector.

The fact that late dropouts represent a large share of all college entrants implies that the probability of departure spikes late into college. To show that this is the case, I turn to the results of the event history analysis. In Figure 4, I present graphical results of conditional dropout probabilities estimated from a logit hazard model that includes the twelve credit-by-institution type categories. Across all institution types, the probability of withdrawal is constant or declines in each of the first three credit categories. For students who first attended two- and open-admission four-year colleges, the probability of departure respectively declines from 0.19 to 0.10 and from 0.13 to 0.11 between the first and third credit intervals. For students who first attended four-year selective institutions, the probability of dropout is approximately .06 in each of the first three credit intervals.

In contrast, the probability of departure increases substantially for all students after they have completed three-quarters of their college-level credits. This spike is largest at non-selective institutions, with conditional dropout probabilities of 0.34 and 0.21 among students first attending two- and open-admission four-year students, respectively. However, students attending four-year selective admissions institutions also experience a large increase in the probability of late departure in relative terms, rising from 0.6 to 0.10 between the third and fourth credit interval.

To examine if the spike in late departure is explained by the changing composition of students along the pathway to degree completion or the cumulative amount of time students enrolled in college, in Table A2 of Appendix A I report estimates of the hazard model with the inclusion of pre- and post-entry student characteristics. Notably, most of the departure estimates in the first three credit periods attenuate slightly after the inclusion of covariates, whereas the probability of departure in the fourth period spikes even higher. This suggests that enrollment duration and dynamic selection are unlikely to explain the increase in dropout risk late into college. In fact, because unobserved dropout factors are expected to lead to monotonically decreasing departure rates (Singer and Willett, 2003), which I do not observe, the spike in late departure is not likely attributable to omitted variable bias. As shown in the bottom of Table A1 of Appendix A, I also reject that the risk of departure is equal across credit categories and institution types. The p-values from all GLH tests are less than 0.01, indicating that both the spike in late departure and the differences in its pervasiveness by sector are substantively and statistically significant.

4.2 Predictors of Late Departure

To explore which students are at risk of late departure, I begin by reporting dropout rates in the fourth credit interval by student demographic, prior achievement, and college enrollment characteristics.[16] For ease of interpretation, I present results separately by incoming attributes and enrollment experiences during college in Tables 2 and 3, respectively. Unlike the unconditional dropout rates in Figure 3, the results in Table 2 point to large differences in the conditional probability of late departure on several dimensions, including by race and high school GPA.[17] For example, the probability of late dropout is approximately 1.5 times greater for Black and Latino students relative to Whites, while students with high school GPAs in the bottom quartile are 3 times more likely than top-quartile students to drop out late.

I also find large differences in dropout risk by the experiences of students in college. Consistent with previous work that has linked early academic momentum to increases in the likelihood of graduating (Adelman, 2006; Attewell, Heil, & Reisel, 2012), the largest contrasts in Table 3 emerge when I compare rates by whether or not students previously stopped out and by the proportion of attempted credits students

[16] Given that the relationships I document in this section are purely correlational, the findings should not be mistaken by the reader for determinants of dropout. Indeed, much as a student's race or ethnicity is not the direct cause of their departure, it is likely that some of the enrollment factors I examine are not the underlying reason for a student's decision to leave school (although they may signal warning of a student's decision to drop out). For this reason, I use the terms predictor and risk factor interchangeably, but only in reference to documenting observable characteristics that can help diagnose the types of students at risk of leaving late. Neither term, nor any of the findings in this section, are intended to imply causality.

[17] The divergent findings between Figure 3 and Table 2 can be explained by differences in the size of the initial enrollment cohort across student subgroups. For example, for every Black student that first attended a two-year institution in our sample, nearly four white students enrolled. Because the share of late dropouts among all college entrants is similar for Blacks and Whites, it must therefore be the case that the probability of dropout is higher for the subset of Black students that reached the three-quarter credit mark.

earned once they reached the three-quarter credit mark. Students who withdrew from college and later returned are three times more likely than continuously enrolled students to dropout late, and students who failed to earn 20 percent or more of their attempted credits each semester, on average, are more than five times as likely to withdraw without earning a degree relative to students who failed no more than 10 percent of their course load each term. Taken together, these results suggest that enrollment momentum and early performance in upper division courses may play important roles in diagnosing which students are at greatest risk of late departure.

In Table 4, I examine the role of academic momentum in more detail by comparing how credit loads, credit attainment, and grade performance evolve over time. For this analysis, I again restrict the sample to students who completed three-quarters of their credits and then compare the academic progression of late dropouts to college graduates and students still enrolled seven years after entry. The results in panel A indicate that many students attempted fewer credits later in their college careers than at the outset, although the decline is larger on average for students who dropped out. For example, in column 7, I find that graduates and late persisters attempted 13.9 credits per semester before completing one-quarter of their credits versus 12.3 credits per semester once they exceeded the three-quarter credit mark, an 11.6 percent decline in relative terms. By comparison, in column 8 I find that late departers experienced an average credit load decline of 18.1 percent between the first and fourth credit interval.

I observe an even larger discrepancy between late dropouts and graduates/enrollees in year 7 in panel B of Table 4, which examines the average share of attempted credits that students earned per term in each credit period. Graduates and late persisters not only passed a greater fraction of their early courses compared to late dropouts (0.93 versus 0.87 in column 7), but they also continued to earn nearly all of their attempted credits in the fourth interval as well. On the other hand, late dropouts earned just 76 percent of their attempted credits each semester, on average, once they reached the three-quarter credit threshold. Between the first and fourth credit interval, the proportion of credits completed per semester by late dropouts thus declined 11.9 percent, while among graduates and active enrollees the proportion increased 0.4 percent. The evolution of college grades between late dropouts and their peers is less informative, as the results in panel C suggest. Both groups improved their GPAs over time, with late dropouts who first attended four-year institutions gaining nearly as much in relative terms as their peers who graduated or remained enrolled. However, late dropouts earned lower grades compared to non-dropouts each semester at both the beginning and end of college.

The divergent patterns of academic performance between graduates and late dropouts in Table 4 could be the result of many factors. For instance, it is possible that late dropouts experience increasing academic difficulty as course rigor intensifies in later years. Alternatively, late dropouts might reduce their academic effort preemptively as they begin to consider the decision to withdraw. Although I am unable to identify the root cause(s) of their academic declines in the data, the evidence suggests that late dropouts reduced their effort little before their final term. In Table A3 of Appendix A, I show how academic performance evolved for late dropouts in their last three terms. In their final semester, late dropouts decreased their enrollment intensity by 1.2 credits compared to only 0.3 fewer credits in the previous term. The number of credits late dropouts completed also declined considerably more in their final term (-1.7 credits) compared to the previous one (-0.5), and I find no evidence that late dropouts earned lower grades in their courses until their final semester. Flagging effort preceding the decision to withdraw is therefore an unlikely explanation for the academic performance declines I document among late dropouts.

To explore the potential sources of late dropout further, I also examined the extent to which the phenomenon is associated with credit accumulation in required coursework.[18] Although neither the Florida nor Ohio data allow me to track completion of major-specific requirements precisely, I constructed a proxy measure of major requirements in the three most popular majors in Florida (i.e., Business, Psychology, and Education) by identifying common courses completed by bachelor's degree recipients in those programs. I then compared the number and share of credits completed in those courses between graduates and late dropouts. The results of this analysis indicate that graduates completed just under half (49 percent) of their credits in common courses, while late dropouts completed only a slightly smaller share (41 percent) of their credits in those courses. On average, late dropouts completed 13.5 fewer credits in those courses than graduates, indicating that many late dropouts may have only needed to pass 3-4 additional courses to fulfill their major requirements to graduate. These results provide additional indication that academic challenges in major-specific courses may explain much of the late dropout phenomenon.

Because many observable characteristics of students are correlated, the simple mean differences reported in Tables 2-4 may mask which factors predict dropout over

[18] This analysis is limited to students at four-year colleges and universities in Florida for whom I observe majors of study. To make this analysis tractable, I also restricted the sample to students in the top three majors in Florida where sample sizes were sufficiently large to identify course-taking patterns by program of study.

and above others. To obtain a more nuanced portrait of the late departure risk profile and to examine how the dropout profile varies along the pathway to degree completion, I turn once again to the event history modeling framework. Specifically, I interact the credit-by-institution type indicators with the pre- and post-entry characteristics to examine whether dropout risk factors vary by proximity to degree completion. To simplify this analysis, I collapse the student-period dataset into two periods: before and after students earned three-quarters of the credits typically required for graduation.

In columns 1, 3, and 5 of Table 5, I report differences in the probability of late departure for each predictor (in percentage points), which I evaluate at the average values of all other covariates in the model. Whereas the unadjusted differences in Table 2 revealed that minority students faced greater risk of late departure, in Table 5 those gaps are fully explained by other observable characteristics of students. Across all sectors, the point estimates on the race dummies are generally negative or near zero when they are positive. I also find that the relationship between the timing of initial college enrollment and late departure flips signs after I account for student attributes and other enrollment experiences. In column 8 of Table 3, I report that students who delayed attendance following high school graduation were 10 percentage points more likely than seamless enrollees to dropout late; yet after controlling for other observables, students who took time off between high school and college were 3 – 8 points *less* likely to dropout late into college.

In column 7 of Table 5, I also report the results of GLH tests that examine whether the conditional risk factors of late departure are equal across sectors. On most dimensions I reject that the risk profile is the same across institution type. In general, where I find differences by sector, the associations are strongest for students who first attended two-year institutions. Whether students transferred institutions is one notable exception to this pattern, however. Students who attended multiple institutions are no more likely than non-transfer students to dropout late if they first attended a two-year college, whereas transfer students who first attended four-year institutions are more likely than their non-transferring peers to leave college without earing an associate or bachelor's degree after completing 90 college-level credits.

The results in Table 5 also reveal that incoming achievement and academic momentum in college remain strong predictors of late departure. All else equal, I find that students with high school GPAs one standard deviation above the mean are 1-5 percentage points less likely to drop out in the fourth credit interval relative to students with mean high school GPAs. Students who enrolled in remedial coursework at two-year institutions are also 11 percentage points more likely than non-remedial students to drop out late. Students who withdrew from college and later returned are at particularly high risk of late departure, ranging from 5 points at selective four-year universities to 19 points at two-year colleges, as are students who struggled to earn passing grades in their late-stage coursework.

On several dimensions I also find that the late departure risk profile is distinct from the predictors of dropout at earlier points along the credit continuum. In columns 2, 4, and 6 of Table 5, I compare the conditional risk of dropout in the fourth credit interval to the risk of withdrawal in the first three intervals. Three results stand out in particular from these comparisons, all of which hold across sectors. First, the relationship between initial enrollment timing and dropout changes direction as students accumulate three-quarters of their credits. For example, among students who first attended two-year colleges, those who matriculated immediately following high school graduation were 16 (7.8 – 23.5) percentage points *less* likely than delayed enrollees to dropout before completing three-quarters of their credits, but 8 percentage points *more* likely to exit without a degree relative to delayed matriculants once they completed three-quarters of their credits.[19] Second, I find that while students who previously stopped out experienced high risk of late departure, non-sequential enrollment is a much stronger predictor of earlier dropout. Differences in the probability of dropout between continuous and discontinuous enrollees are approximately twice the magnitude before students complete three-quarter of their credits compared to afterwards. Lastly, high course failure rates more strongly predict late departures than earlier dropouts. A one-half standard deviation increase from the average proportion of credits earned per term is associated with 14 and 10 percentage point declines in the probability of dropout in the fourth interval at two- and open-admission four-year institutions, respectively, versus declines of less than 5 percentage points when students earned fewer than three-quarters of their credits to degree completion. Taken together, these results reveal that the risk profile for departure varies in meaningful ways with proximity to degree completion.

4.3 Policy Application: Using Predictive Modeling to Target Students for Intervention

Although the results in Table 5 identify characteristics that differentiate late dropouts from other students, they do not reveal how well prediction models distinguish between students who are and are not at risk of dropping out late. Yet the answer to this question is particularly policy-relevant because it can help policymakers and higher

[19] The relationship I document between enrollment timing and early departure is consistent with previous research. See, for example, Bozick and DeLuca (2005).

education leaders pinpoint which students on campus may stand to benefit from late-stage intervention. I therefore evaluate the performance of candidate prediction models and present the results in Table 6. For this analysis, I conditioned the sample on students who completed at least three-quarters of the credits typically required to graduate. After running logistic regression models separately by institution type and predicting the probability of late departure for each student, I derived probability cut-offs to categorize students as either at-risk or not at-risk of late dropout.[20] I then calculated the percentage of students correctly assigned to the risk group that matched their observed outcome. To evaluate how well the cut-offs generalize out-of-sample, I randomly split the sample into development and validation subsamples. I estimated all models on the development subsample and present results for both the development (columns 1-3) and validation (columns 4-6) subsamples in Table 6. I also report results from two prediction models. Because some institutions may not observe prior enrollment histories for transfer students, I test a parsimonious model in panel A that contains only predictors that most colleges are likely to observe for all students.[21] In panel B, I present results from a model that includes the full set of student-level predictors for point of comparison.

The results in Table 6 show that the prediction models correctly classify the majority of students in the development and validation subsamples. Across both models and subsamples, the percent of students assigned to the risk group that matched their observed enrollment behavior ranges from 70 percent to 83 percent. In addition, no fewer

[20] I established the cut-offs as the probability (rounded to the nearest point) that equated the percentage of late dropouts classified as at-risk (i.e. model sensitivity) and the percentage of graduates/active enrollees classified as not at-risk (i.e. model specificity).

[21] These predictors are indicators for gender and race; age at the time the student reached the three-quarter credit threshold; whether the student entered as a transfer student; and mean academic performance in the fourth credit period (i.e. the average term GPA, average number of credits attempted per term; and the average proportion of credits earned per term).

than 68 percent of late dropouts are classified as at-risk and the same is true of graduates/active enrollees assigned to the non-risk group. Comparing the results in columns 1-3 to those in columns 4-6 also indicates that the predictive models perform well out-of-sample. For example, in columns 1 and 4 of panel A, the percent of students correctly classified is nearly identical across the two subsamples (67.6 percent versus 67.8 percent among late dropouts and 71.3 percent versus 70.8 percent among non-late dropouts).

I also find that institutions can identify most students at risk of dropping out late using just a few basic demographic variables and their recent past performance in school. The model in panel B leads to only small improvements in correctly classifying students, ranging from 0.5 percent (column 1) to 2.4 percent (column 3). The concordance statistic, which reports the probability that a randomly selected late dropout has a higher predicted probability of withdrawal than a randomly selected graduate/active enrollee, is also near 0.8 or 0.9 in panel A and increases by no more than 5 percent in panel B. Both of the models I tested therefore exhibit strong predictive power.

One caveat to these generally promising results is that a large share of students assigned to the at-risk group did not drop out. This largely reflects the fact that most students who reach the three-quarter credit threshold do not drop out, even though the conditional dropout rate spikes late in college. As a result, predictive models that generate a large number of “false positives” will lead to targeting many inframarginal students for intervention. However, in Figure A2 of Appendix A I show that the share of inframarginal students decreases considerably as the predicted probability of late departure rises. Among students who first attended two-year colleges, more than two-thirds of students with predicted probabilities greater than or equal to 0.5 actually dropped out late and nearly three-quarters of students with predicted probabilities of 0.6 or higher did so. Resource-constrained institutions can therefore ensure that investments reach students most in need by establishing more stringent cut-offs for intervention.

5. CONCLUSIONS AND IMPLICATIONS

In this study, I provide a new perspective on college dropout by examining how many credits students have completed when leaving school without a degree. The results suggest that late departure is widespread, especially at two- and open-admission four-year institutions, where nearly 20 percent and 14 percent of students respectively began their college careers but dropped out after earning three-quarters of the credits typically required to graduate. At greatest risk of late departure are students poorly prepared for the academic rigor of college and those who struggle to maintain enrollment and academic momentum. The strong relationship between momentum and late departure that I document reinforces that many students may stand to benefit from more robust guidance and support throughout their time in school, especially as the rigor of upper division coursework escalates. Importantly, because there is considerable variation in the returns to college degrees, it is possible that late departure is an optimal human capital investment decision for some students. Nevertheless, given the extent of the phenomenon and the high returns to degree completion for most college-goers, I believe efforts to mitigate late departure are likely to benefit many who dropout late.

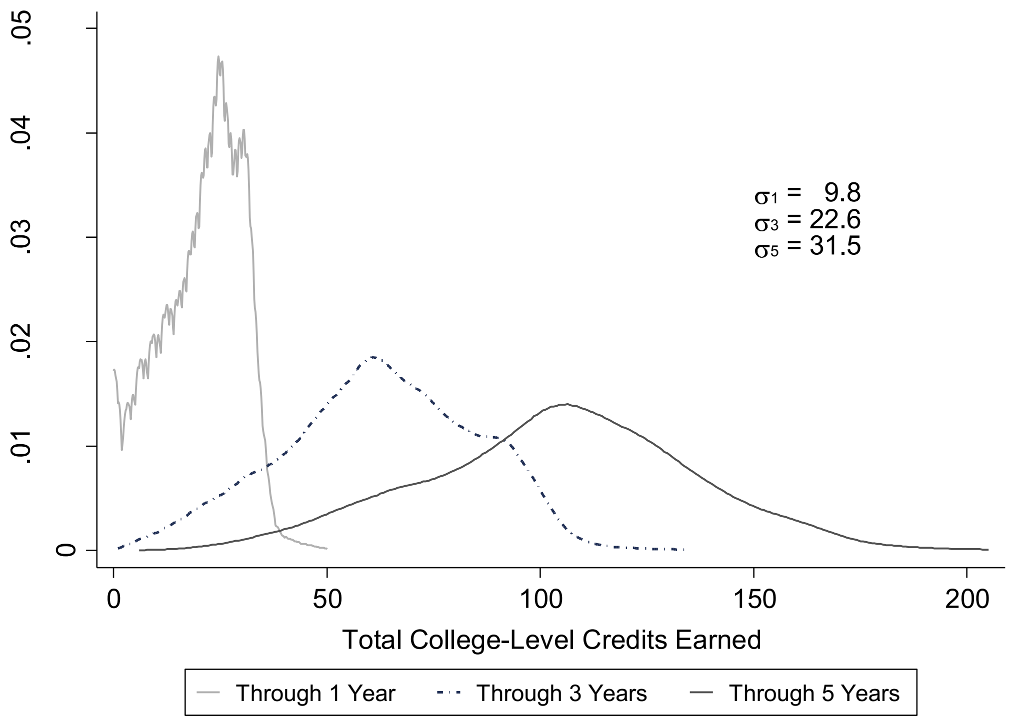
Initiatives undertaken in recent years to mitigate late departure have focused almost exclusively on re-engaging individuals after they have withdrawn from school. For instance, through Project Win-Win, a partnership between the Institute for Higher

Education Policy and the State Higher Education Executive Officers, sixty postsecondary institutions attempted to contact individuals who needed 9 or fewer credits to earn an associate degree and provide them with templates for finishing their degree (Institute for Higher Education Policy, 2013). Unfortunately, efforts to retroactively support late departers have achieved only modest success because they require labor-intensive investments to identify and contact eligible individuals (Adelman, 2013).

Alternative strategies have also emerged to simplify the decision environment for students by changing the structure of degree programs. Some four-year institutions have begun to award associate degrees to students en route to a bachelor's degree, either by acquiring associate degree-granting authority or by establishing new partnerships with community colleges (Bragg, Cullen, Bennett, & Ruud, 2011). Other institutions are offering structured programs that constrain student choices in order to increase completion rates and accelerate time to degree receipt (Weinbaum, Rodriguez, & Bauer-Maglin, 2013). Early evidence suggests these efforts can substantially increase credit and credential attainment (Zeidenberg, Cho, & Jenkins, 2010; Scrivener, Weiss, Ratledge, Rudd, Sommo & Fresques, 2015). However, all of these interventions are quite radical in the context of higher education, and as a result, the majority of students at risk of late departure are not receiving support during the most promising time to intervene: while they are still enrolled.

My findings suggest that colleges may be able to substantially increase degree attainment by targeting interventions to students who have made considerable academic progress but remain at risk of dropping out. While it is too soon to know which interventions are most effective and the contexts in which they work best, one thing is clear. Helping more students complete their final steps to a degree requires paying more attention to the late departure phenomenon and further investigating its origins and consequences.

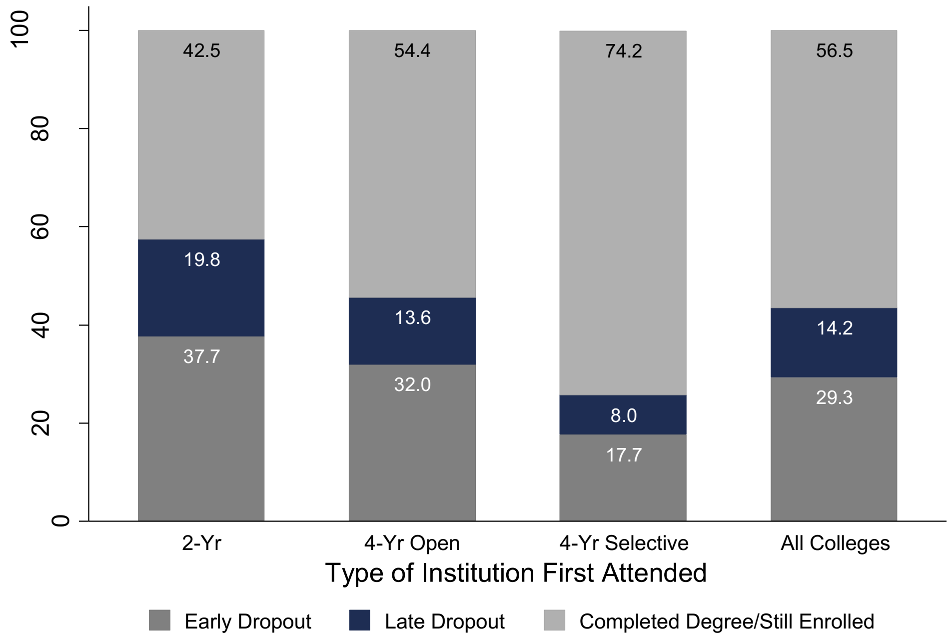
Figure 1. Distributions of total college-level credits earned by year of attendance



Notes: The sample is comprised of all degree-seeking undergraduates ages 17-19 at high school graduation who enrolled at least half-time at public postsecondary institutions in Florida and Ohio within 16 months of high school completion. See column 2 of Table 1 for descriptive statistics of the sample.

Sources: Florida Department of Education and Ohio Board of Regents.

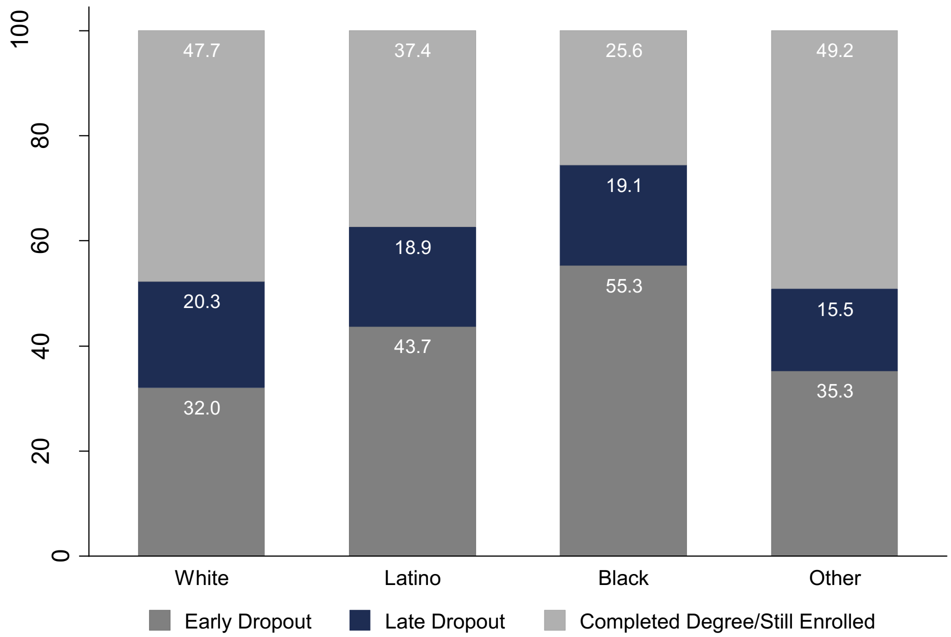
Figure 2. The share of college entrants that are late dropouts, by institution type



Notes: The sample is comprised of all degree-seeking undergraduates ages 17-19 at high school graduation with non-missing pre-and post-entry data who enrolled at least half-time at public postsecondary institutions in Florida and Ohio within 16 months of high school completion. Outcomes are reported through six years following initial college enrollment. Early dropouts capture students who withdrew prior to earning three-quarters of the college-level credits typically required to graduate. Students who surpassed the three-quarter credit threshold before dropping out are captured as late dropouts. Students who graduated within six years of entry or who were actively enrolled in year 7 are captured in the completed degree/still enrolled category.

Sources: Florida Department of Education and Ohio Board of Regents.

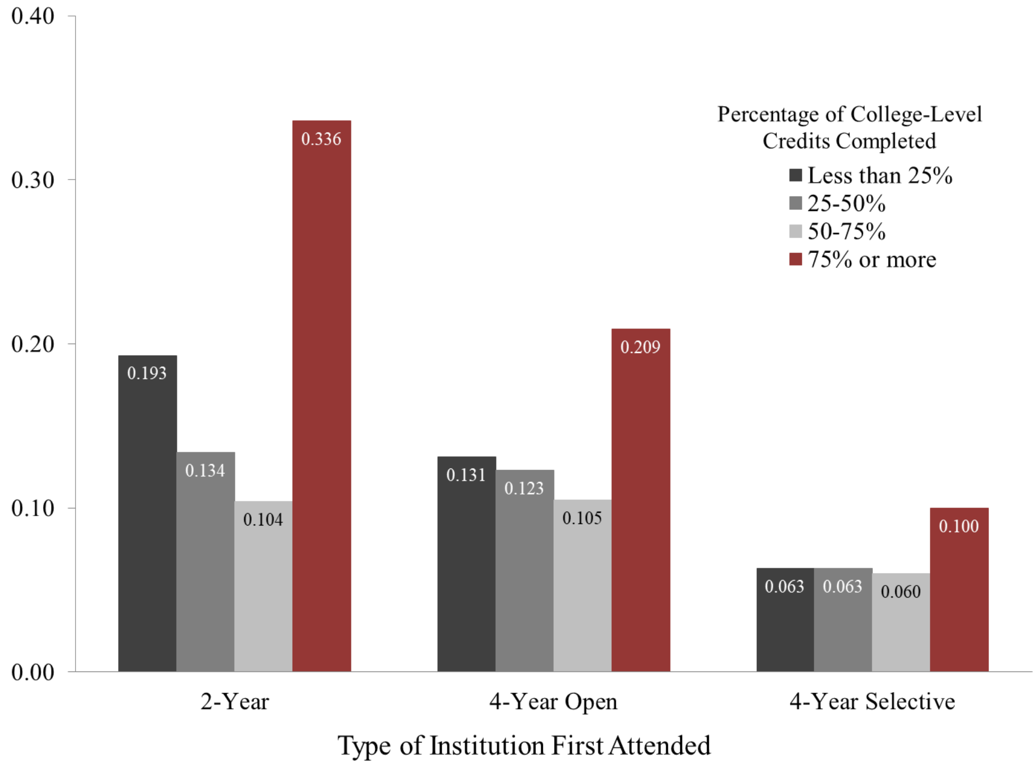
Figure 3. The share of college entrants that are late dropouts at two-year institutions, by race/ethnicity



Notes: The sample is comprised of all degree-seeking undergraduates ages 17-19 at high school graduation with non-missing pre-and post-entry data who enrolled at least half-time at public postsecondary institutions in Florida and Ohio within 16 months of high school completion. Outcomes are reported through six years following initial college enrollment. Early dropouts capture students who withdrew prior to earning three-quarters of the college-level credits typically required to graduate. Students who surpassed the three-quarter credit threshold before dropping out are captured as late dropouts. Students who graduated within six years of entry or who were actively enrolled in year 7 are captured in the completed degree/still enrolled category.

Sources: Florida Department of Education and Ohio Board of Regents.

Figure 4. Fitted probabilities of dropout, by credits completed and college sector



Note: The sample is comprised of all degree-seeking undergraduates ages 17-19 at high school graduation with non-missing pre-and post-entry data who enrolled at least half-time at public postsecondary institutions in Florida and Ohio within 16 months of high school completion. Fitted probabilities are shown from a single-risk, discrete-time logit hazard model that includes twelve credit-by- degree categories and a constant.

Sources: Florida Department of Education and Ohio Board of Regents.

Table 1. Descriptive statistics for national, state, and analytic samples

	(1)	(2)	(3)
	National Sample	State Sample	Analytic Sample
	First-time degree-seeking undergrads	*Enrolled in college w/in 16 months of hs graduation*	*Subset of students from column 2 with complete data*
Female	0.562	0.563	0.595
White	0.651	0.760	0.718
Black	0.124	0.125	0.157
Latino	0.126	0.084	0.094
Other Race	0.099	0.031	0.030
		[99,648]	
Age at college entry	21.300	18.508	18.481
	(0.140)	(0.489)	(0.480)
HS GPA	3.105	3.019	3.016
	(0.786)	(0.613)	(0.617)
		[60,868]	
Seamless enrollee	0.654	0.887	0.909
First attended:			
2-Yr college	0.572	0.481	0.417
4-Yr open admissions college		0.191	0.228
4-Yr selective admissions college		0.328	0.355
Cumulative college-level credits earned		87.948	96.436
		(61.379)	(61.777)
Dropout and completed > 0.75 of credits		0.136	0.142
Ever dropout	0.522	0.471	0.435
Number of students	16,100†	101,103	54,012

† Sample size is estimated

Notes: Column 1 reports sample-weighted statistics computed with NCES PowerStats for undergraduates attending public colleges in fall 2003. The samples in columns 2 and 3 are comprised of degree-seeking undergraduates ages 17-19 at high school graduation who enrolled at least half-time at public postsecondary institutions in Florida and Ohio within 16 months of high school completion. Unweighted means are reported in columns 2 and 3 with standard deviations in parentheses and the number of observations in brackets if less than the full sample. HS GPA is on a 4.0 scale. Seamless enrollees first entered college in the same year as their graduation from high school.

Sources: U.S. ED, NCES, 2003-04 Beginning Postsecondary Students Longitudinal Study (col 1); Florida Department of Education and Ohio Board of Regents (cols 2 and 3).

Table 2. Sample departure rates conditional on completing 75% or more of college-level credits, by college sector and student attributes

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
College sector first attended	2-Yr		4-Yr Open Admissions		4-Yr Selective		All	
	%	N	%	N	%	N	%	N
A. Gender								
Female	0.316	8,223	0.200	4,648	0.088	9,349	0.196	22,220
Male	0.371	5,005	0.231	3,252	0.123	5,801	0.236	14,058
B. Race								
White	0.315	9,707	0.191	5,678	0.094	12,229	0.192	27,614
Black	0.463	1,628	0.295	1,342	0.142	1,552	0.303	4,522
Latino	0.364	1,584	0.244	634	0.136	740	0.281	2,958
Other	0.249	309	0.187	246	0.107	629	0.160	1,184
C. High School GPA (cumulative)								
Top Quartile	0.185	1,416	0.169	734	0.068	2,720	0.117	4,870
3rd Quartile	0.250	2,567	0.146	2,646	0.075	6,333	0.130	11,546
2nd Quartile	0.330	4,296	0.217	2,506	0.130	4,286	0.227	11,088
Bottom Quartile	0.432	4,949	0.311	2,014	0.176	1,811	0.351	8,774

Notes: The sample is comprised of degree-seeking undergraduates ages 17-19 at high school graduation with non-missing pre-and post-entry data who enrolled at least half-time at public postsecondary institutions in Florida and Ohio within 16 months of high school completion and completed 75 percent of more of the college-level credits typically required for graduation. Upper bound points for GPA quartiles (on 4.0 scale) are: Q1 =2.5; Q2 = 3.0; Q3 = 3.44.

Sources: Florida Department of Education; Ohio Board of Regents.

Table 3. Sample departure rates conditional on completing 75% or more of college-level credits, by college sector and experiences in college

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
College sector first attended	2-Yr		4-Yr Open Admissions		4-Yr Selective		All	
	%	N	%	N	%	N	%	N
A. Initial Enrollment Timing								
Immediately after high school	0.339	11,691	0.211	7,687	0.102	14,960	0.207	34,338
Delayed 1 or more semesters	0.326	1,537	0.254	213	0.111	190	0.297	1,940
B. Remediation Status								
Enrolled in remedial coursework	0.416	6,775	0.276	2,237	0.190	1,629	0.352	10,641
Did not enroll	0.254	6,453	0.188	5,663	0.091	13,521	0.154	25,637
C. Number of Schools Attended								
One	0.380	6,096	0.166	5,387	0.065	10,784	0.175	22,267
Two or more	0.300	7,132	0.313	2,513	0.194	4,366	0.269	14,011
D. Number of Stopouts								
None	0.251	8,681	0.152	6,371	0.074	13,196	0.146	28,248
One or more	0.501	4,547	0.466	1,529	0.292	1,954	0.443	8,030
E. Age at Time of Completing 75% of credits								
Less than 23	0.297	6,991	0.136	2,922	0.048	8,486	0.157	18,399
23 and older	0.382	6,237	0.258	4,978	0.171	6,664	0.268	17,879
F. Average Credits Attempted per Term								
Less than 12 credits	0.360	8,268	0.272	3,206	0.126	6,311	0.261	17,785
12 or more credits	0.299	4,960	0.172	4,694	0.084	8,839	0.164	18,493
G. Proportion of Credits Completed per Term								
Less than 0.80	0.614	3,549	0.579	1,165	0.466	1,470	0.572	6,184
0.80 to 0.90	0.350	2,471	0.293	1,097	0.150	1,826	0.270	5,394
0.90 to 1.0	0.196	7,208	0.121	5,638	0.049	11,854	0.109	24,700
H. Term GPA in College								
Top Quartile	0.262	2,814	0.170	1,885	0.069	4,370	0.150	9,069
3rd Quartile	0.213	3,318	0.171	1,795	0.066	3,957	0.141	9,070
2nd Quartile	0.295	3,246	0.184	2,048	0.090	3,775	0.184	9,069
Bottom Quartile	0.534	3,850	0.311	2,172	0.210	3,048	0.372	9,070

Notes: The sample is comprised of degree-seeking undergraduates ages 17-19 at high school graduation with non-missing pre-and post-entry data who enrolled at least half-time at public postsecondary institutions in Florida and Ohio within 16 months of high school completion and completed 75 percent of more of the college-level credits typically required for graduation. The number of schools, stopouts, and age at enrollment are calculated through the term in which students reached the 75 percent credit completion threshold. College academic measures are calculated as per-term averages over all terms following the completion of 75 percent of credits. Upper bound points for college GPA quartiles (on 4.0 scale) are: Q1 =2.06; Q2 = 2.61; Q3 = 3.28.

Sources: Florida Department of Education; Ohio Board of Regents.

Table 4. The evolution of academic performance among students completing 75% or more of college-level credits, by college sector and late departure status

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	2-Yr		4-Yr Open Admissions		4-Yr Selective Admissions		All	
Outcome	Graduated or Still Enrolled	Dropped Out	Graduated or Still Enrolled	Dropped Out	Graduated or Still Enrolled	Dropped Out	Graduated or Still Enrolled	Dropped Out
A. Average credits attempted per term								
Credit interval 1 (0-25%)	13.228	12.805	14.643	14.261	14.058	13.774	13.931	13.318
Credit interval 4 (75% or more)	11.389	10.321	13.162	11.797	12.524	11.618	12.314	10.904
Percent change from interval 1-4	-13.9%	-19.4%	-10.1%	-17.3%	-10.9%	-15.7%	-11.6%	-18.1%
B. Proportion of credits completed per term								
Credit interval 1	0.916	0.865	0.930	0.866	0.940	0.874	0.930	0.867
Credit interval 4	0.905	0.752	0.939	0.788	0.951	0.773	0.934	0.764
Percent change from interval 1-4	-1.3%	-13.1%	0.9%	-9.0%	1.2%	-11.6%	0.4%	-11.9%
C. Term GPA in college								
Credit interval 1	2.428	2.130	2.273	2.040	2.410	2.041	2.386	2.092
Credit interval 4	2.705	2.250	2.677	2.367	2.813	2.364	2.750	2.299
Percent change from interval 1-4	11.4%	5.7%	17.7%	16.0%	16.7%	15.8%	15.3%	9.9%
Observations	8,769	4,459	6,221	1,679	13,608	1,542	28,598	7,680

Notes: The sample is comprised of degree-seeking undergraduates ages 17-19 at high school graduation with non-missing pre-and post-entry data who enrolled at least half-time at public postsecondary institutions in Florida and Ohio within 16 months of high school completion and completed 75 percent of more of the college-level credits typically required for graduation. Academic performance measures are constructed as per-term averages over all terms following completion of 75 percent of credits.

Sources: Florida Department of Education; Ohio Board of Regents.

Table 5. Conditional risk factors for departure by credit completion status and college sector (N = 89,942)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
College sector first attended	2-Yr		4-Yr Open Admissions		4-Yr Selective Admissions		
	Completed 75% or more credits	Difference (75+ minus 0-75)	Completed 75% or more credits	Difference (75+ minus 0-75)	Completed 75% or more credits	Difference (75+ minus 0-75)	□ □□test: Risk of late departure equal across sectors?
Female	**-0.036**	-0.021	-0.006	0.027	**-0.010**	0.002	**4.526**
	(0.007)	(0.153)	(0.358)	(0.139)	(0.056)	(0.448)	(0.100)
Latino	**-0.052**	**-0.088**	-0.003	-0.018	0.003	0.001	**8.201**
	(0.003)	(0.008)	(0.463)	(0.365)	(0.447)	(0.481)	(0.027)
Black	-0.001	**-0.083**	0.017	0.028	-0.003	0.003	0.624
	(0.481)	(0.001)	(0.318)	(0.264)	(0.424)	(0.444)	(0.410)
Other race	**-0.103**	**-0.134**	-0.033	0.010	-0.002	0.012	**14.31**
	(0.001)	(0.003)	(0.134)	(0.432)	(0.463)	(0.365)	(0.003)
HS GPA (cumulative)	**-0.047**	**-0.025**	**-0.045**	-0.017	**-0.014**	-0.007	**7.555**
	(0.001)	(0.024)	(0.031)	(0.264)	(0.089)	(0.308)	(0.035)
Seamless enrollee	**0.078**	**0.235**	**0.032**	**0.158**	**0.026**	**0.077**	**22.83**
	(0.001)	(0.001)	(0.038)	(0.001)	(0.001)	(0.008)	(0.001)
Took remedial coursework	**0.107**	-0.007	0.020	0.004	**0.017**	0.013	**39.19**
	(0.001)	(0.410)	(0.178)	(0.448)	(0.038)	(0.226)	(0.001)
Attended 2 or more schools	-0.025	**0.047**	**0.067**	-0.001	**0.050**	-0.005	**14.84**
	(0.190)	(0.060)	(0.001)	(0.481)	(0.001)	(0.409)	(0.003)
Stopped out at least once	**0.190**	**-0.155**	**0.164**	**-0.136**	**0.046**	**-0.088**	**37.94**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.016)	(0.038)	(0.001)

Table 5. Conditional risk factors for departure by credit completion status and college sector (N = 89,942)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
College sector first attended	2-Yr		4-Yr Open Admissions		4-Yr Selective Admissions		
	Completed 75% or more credits	Difference (75+ minus 0-75)	Completed 75% or more credits	Difference (75+ minus 0-75)	Completed 75% or more credits	Difference (75+ minus 0-75)	□ □□test: Risk of late departure equal across sectors?
Age	-0.045	-0.067	-0.007	0.001	0.013	0.016	2.585
	(0.112)	(0.041)	(0.463)	(0.483)	(0.357)	(0.318)	(0.216)
Credits attempted	-0.0230	0.003	**-0.049**	-0.024	-0.008	0.004	3.462
	(0.252)	(0.477)	(0.025)	(0.247)	(0.264)	(0.382)	(0.147)
Share of credits completed	**-0.138**	**-0.096**	**-0.103**	**-0.064**	**-0.026**	-0.017	**25.88**
	(0.001)	(0.001)	(0.001)	(0.035)	(0.039)	(0.142)	(0.001)
College GPA (term)	**-0.032**	**-0.030**	**-0.031**	**-0.044**	**-0.011**	-0.009	3.613
	(0.064)	(0.089)	(0.010)	(0.001)	(0.035)	(0.120)	(0.139)

Notes: The sample is comprised of degree-seeking undergraduates ages 17-19 at high school graduation with non-missing pre-and post-entry data who enrolled at least half-time at public postsecondary institutions in Florida and Ohio within 16 months of high school completion. The number of schools, stopouts, and age measures are calculated up to the term in which students reached each credit interval. College academic variables are calculated as the per semester average within each credit interval. All models also control for the number of terms between the time each credit period was reached and initial college entry. Conditional risk factors are reported in percentage points and estimated from a fully interacted logit regression model evaluated at the average values of all covariates in the model. See text for model details. Estimates for high school and college GPA, age, and credits attempted are percentage point differences associated with a standard deviation increase from the mean. Estimates for the proportion of credits completed are percentage point differences associated with a one-half standard deviation increase from the mean. Adjusted p-values that account for multiple hypothesis testing and the clustering of students within schools are reported in parentheses. Point estimates in bold are statistically significant at the .10 level.

Sources: Florida Department of Education; Ohio Board of Regents.

Table 6. Student risk classifications from prediction models of college late departure

	(1)	(2)	(3)	(4)	(5)	(6)
	Development Sample			Validation Sample		
	2-Yr	4-Yr Open Admissions	4-Yr Selective Admissions	2-Yr	4-Yr Open Admissions	4-Yr Selective Admissions
A. Model 1: In absence of cross-institutional tracking						
Percent at-risk | late dropout	67.6	72.3	75.1	67.8	68.0	75.9
Percent not at-risk | not late dropout	71.3	76.6	81.3	70.8	77.5	81.7
Percent late dropout | at-risk	54.5	45.5	31.1	54.2	44.9	32.2
Percent not late dropout | not at-risk	81.3	91.1	96.7	81.2	90.0	96.7
Percent of students correctly classified	70.1	75.7	80.7	69.8	75.5	81.1
Concordance statistic	0.77	0.81	0.85	0.76	0.79	0.86
B. Model 2: In presence of cross-institutional tracking						
Percent at-risk | late dropout	74.9	77.0	81.1	75.0	77.3	76.4
Percent not at-risk | not late dropout	68.1	77.3	82.8	68.9	75.9	83.1
Percent late dropout | at-risk	54.8	48.9	35.7	53.9	44.3	32.6
Percent not late dropout | not at-risk	84.0	92.3	97.4	85.0	93.1	97.1
Percent of students correctly classified	70.4	77.3	82.6	70.9	76.2	82.5
Concordance statistic	0.79	0.84	0.89	0.80	0.84	0.88
Probability cut-off used to assign risk status	0.3	0.2	0.1	0.3	0.2	0.1
Observations	6,614	3,950	7,575	6,614	3,950	7,575

Notes: The sample is comprised of degree-seeking undergraduates ages 17-19 at high school graduation with non-missing pre-and post-entry data who enrolled at least half-time at public postsecondary institutions in Florida and Ohio within 16 months of high school completion and completed 75 percent of more of the college-level credits typically required for graduation. Risk classifications are derived from logit regression models used to predict the probability of late departure. The predictors in Model 1 include: indicators for gender, race and Pell Grant eligibility status; age at the time the student exceeded the three-quarter credit threshold and the square of this term; whether the student transferred schools prior to exceeding the three-quarter credit threshold; and the average term GPA, average number of credits attempted per term; and the average proportion of credits earned per term after reaching the three-quarter credit threshold. Model 2 includes all predictors from Model 1 as well as the full set of prior achievement and college experience predictors specified in Table 5.

Sources: Florida Department of Education; Ohio Board of Regents.

III. Study 2–Aiding or Dissuading? The Effects of Exhausting Eligibility for Need-based Aid on Bachelor's Degree Attainment and Time to Completion

1. INTRODUCTION

For decades financial aid has been a widely utilized strategy to support access to higher education and postsecondary attainment. In the fifty years since the passage of the federal Higher Education Act of 1965, average aid per student has more than tripled in real dollars, from $3,800 (in 2017 dollars) to $14,500, largely due to the expansion of federal aid programs (Baum, Elliott, & Ma, 2014; Dynarski & Scott-Clayton, 2013). Despite this growth in spending, many students who attend college withdraw before earning a certificate or degree. Less than one-third of degree-seeking students who enter community colleges earn an associate's or bachelor's degree within six years of initial enrollment, and nearly 40 percent of students who begin at four-year institutions exit without a degree.[22] The size of aid expenditures and magnitude of dropout have motivated questions about whether financial aid is effectively helping students progress to graduation.

While causal research finds that generous and simple aid programs can increase access and produce long-term impacts on completion and earnings (Angrist, Autor, Hudson, & Pallais, 2016; Bettinger, Gurantz, Kawano, & Sacerdote, 2016; Castleman & Long, 2016; Dynarski, 2003; Goldrick-Rab, Kelchen, Harris, & Benson, 2016), little is known about how financial aid affects students after they have enrolled in college. In particular, although most graduates take longer than is customary to finish, it is unclear

[22] Authors' calculations using the U.S. Department of Education's National Center for Education Statistics 2004/2009 Beginning Postsecondary Students Survey.

whether aid that gets disbursed beyond the second year of college affects whether students will graduate and how quickly they do so.

Millions of college students also lose financial aid each year (Schudde & Scott-Clayton, 2016; Suggs, 2016), yet evidence on whether aid loss affects attainment is limited and inconclusive. Focusing on students in Tennessee, Carruthers & Özek (2016) find that losing merit-based aid accelerated when students left college but had no effect on overall degree completion, while Schudde & Scott-Clayton (2016) find evidence that failure to meet academic requirements for renewal of the federal Pell Grant increased dropout in the short-run but also potentially increased long-run rates of transfer and completion for students who persisted. Furthermore, because the studies above have only examined effects of aid loss early in college due to poor academic performance, the findings may not generalize to contexts in which aid is taken away later in college and for non-academic reasons.[23]

Because public support for higher education is limited and in decline (Baum & Ma, 2015), it is important to determine which investments are cost-effective. Given the size of expenditures for student financial aid, it is particularly important to know whether the effects of aid vary over time and how students respond when aid is taken away. This information is critical to maximizing the allocation of aid dollars to support college student success. It is also important because many degree-seeking students earn substantial credits but do not graduate. Mabel and Britton (2018) estimate that 14 percent of all degree-seeking entrants to public colleges and universities in Florida and Ohio

[23] For example, in their study of the effects of post-9/11 price shocks on undocumented students in New York City, Conger & Turner (2015) find that tuition increases affected the likelihood of completion for recent entrants but not for students who had already attended college for two or more years when costs increased.

complete at least three-quarters of the credits that are typically required to graduate before leaving without a degree. Understanding the role of financial aid late into college therefore promises to offer new insights into the causes of college late departure. Furthermore, examining the effects of aid exhaustion on student outcomes is policy-relevant because the federal government and many states impose lifetime limits on the availability of aid receipt. For example, in addition to lifetime eligibility limits on federal Pell Grants, states including California, Florida, and New York cap the duration of need-based aid that students are eligible to receive.[24]

One challenge to studying the effects of aid exhaustion is that student enrollment decisions are endogenous and affect who is affected by lifetime eligibility limits. Straightforward comparisons of students who do and do not exhaust aid will therefore lead to biased estimates of policy effects and may be one reason why previous research has not estimated the causal effects of aid exhaustion on long-term student outcomes. I shed light on this question by exploiting a plausibly exogenous reduction to the lifetime limit for Pell Grant eligibility and by accounting for selection into the group of students affected by the new lifetime Pell Grant limit. Specifically, using matched difference-in-differences (DD) and difference-in-difference-in-differences (DDD) designs, I examine recent changes to federal Pell Grant eligibility rules that reduced the lifetime cap on aid from 9 to 6 full-time-equivalent (FTE) years beginning in the 2012-13 school year. The new lifetime limit immediately and unexpectedly eliminated a subset of continuing students from receiving need-based aid and reduced award amounts for others. I leverage

[24] In California and New York, students are eligible to receive state need-based aid (the Cal Grant and the New York Tuition Assistance Program, respectively) for up to four full-time-equivalent years. In Florida, students attending public institutions are eligible to receive the Florida Student Access Grant for up to 110 percent of the number of credits required to complete their degree program.

the rule change to estimate the effects of exhausting Pell Grant eligibility on several outcomes, including how much students borrow to pay for college, their investments in academic effort, and the probability of bachelor's degree attainment and time to completion.

To preview my results, I find that students lost one-third of their grant aid per term after the new lifetime limit took effect. Students compensated for this loss by borrowing 15 percent more per term to pay for college and increasing their academic effort, as measured by re-enrollment and term credits attempted and earned. The eligibility change increased the probability of term-over-term re-enrollment and bachelor's degree completion within 8 years by 2-3 percentage points, and students who had at least one year to adjust to the new rule before exhausting their eligibility were much more likely to graduate before losing aid. Importantly, I find no evidence that the rule change decreased the probability of degree completion overall. These findings indicate that for students who have demonstrated a sustained commitment to finishing college, setting limits on the availability of need-based aid can accelerate time to completion.

I structure the remainder of the paper as follows. In Section 2, I discuss past research on the effects of financial aid on completion and the theoretical motivation for this study, and I provide details on the change to Pell Grant eligibility. I describe the data, analytic samples, and research design in Section 3. In Section 4, I present the results of the empirical analysis. I conclude in section 5 with a discussion of the findings and directions for future research.

2. BACKGROUND AND LITERATURE REVIEW

2.1 The Theory and Past Research on the Effects of Financial Aid on Completion

Competing hypotheses posit that financial aid may help or have little impact on progress to degree completion. According to standard human capital theory, students are expected to choose to enroll in an additional year of college if the expected lifetime benefit of attending an additional year exceeds the expected lifetime benefit of dropping out. Because this model assumes that students update their expectations with experience, decisions to persist in college may be influenced by changes to the availability of financial aid. For students on the margin of graduating, losing aid may alter the cost-benefit evaluation enough to induce departure.

In addition to changing the investment value of attendance, students may become acclimatized to receiving aid, making it difficult to forecast and contingency plan for abrupt changes in funding. Older students may also face stiffer credit constraints than their younger, financially dependent peers (who can presumably seek funding from parents), making it more difficult to offset grant losses with additional student loans later in college (Gichevu, Ionescu, & Simpson, 2012). Even in the absence of borrowing constraints, loan aversion, which is pervasive among college-goers, may dissuade students from replacing grants with loans (Boatman, Evans, & Soliz, 2017; Goldrick-Rab & Kelchen, 2015). All of these scenarios predict that losing eligibility for need-based aid will decrease the probability of persistence towards the beginning and end of college. Furthermore, because individuals weigh losses more than gains (Kahneman & Tversky, 1979), losing aid may in fact have greater consequences on degree completion than receiving aid of equal value.

On the other hand, the effect of financial aid on attainment may diminish as students progress in school. For instance, if students weigh the marginal costs and benefits to attendance when considering whether to re-enroll, then decisions to persist may stabilize over time (and thereby attenuate the impact of aid on persistence) as investment in college accumulates, the payoff to completion becomes more proximal, and the remaining cost to completion declines. Furthermore, because grant aid offsets the full cost of attendance to students, offering aid late into college may delay graduation for some students. Several studies find that students respond to the availability of financial aid by strategically adjusting their enrollment intensity to meet renewal requirements (Cornwell, Lee, & Mustard, 2005; Richburg-Hayes et al., 2009; Scott-Clayton, 2011), although most studies find that these effects are tied to performance incentives and it is therefore unclear whether need-based aid without strings attached can generate similar responses.

Time to completion may also be driven by several factors unrelated to financial aid. One well-documented reason is a lack of academic preparation among entering students. Approximately 35–40 percent of students are required to take developmental education courses upon entering college before they can progress towards degree requirements (Bettinger, Boatman, & Long, 2013). In addition, discontinuous enrollment, whereby students stop-out from college temporarily but later resume their studies, is commonplace.[25] Students attending broad-access institutions also frequently struggle to get into enrollment-limited courses required for degree completion, which can further delay time to completion (Bahr, Gross, Slay, & Christensen, 2015; Gurantz, 2015).

[25] Using administrative data from Florida and Ohio, I calculate that nearly one-third of students take time off for at least one semester before returning to pursue their degree.

Financial aid may be an ineffective policy lever to accelerate time to completion if degree timing is primarily determined by non-monetary factors. However, if more generous financial aid reduces student labor supply and increases the ability to enroll continuously, then offering additional need-based financial aid may enable students to graduate more quickly. Alternatively, if time to completion partly reflects the financial pressure students feel to enter the labor market, then eliminating aid eligibility late into college could increase the efficiency of degree production.[26]

Generally speaking, there is a growing body of research that suggests financial aid can increase college persistence and completion. Using a regression discontinuity research design, Castleman and Long (2016) find that offering high school graduates in Florida an additional $1,300 in need-based aid increased bachelor's degree completion rates within six years by 4.6 percentage points. Likewise, Goldrick-Rab et al. (2016) find in an experimental study that students offered an additional $3,500 in grant aid per year to attend public universities in Wisconsin increased their bachelor's degree completion within four years by 4.7 percentage points. Angrist et al. (2016) also used random assignment of aid offers in Nebraska and find that scholarship winners were 13 percentage points more likely to be enrolled in college four years later. However, unlike the findings reported by Goldrick-Rab et al. (2016), Angrist et al. (2016) find that aid offers decreased bachelor's degree completion within four years by 5.9 percentage points, indicating that more generous need-based aid can delay time to completion for some students.

[26] The decision to delay completion may also intensify in weak economic cycles when labor market opportunities for recent graduates are less certain. The aftermath of the Great Recession, which coincided with enactment of the new lifetime Pell limit, is one such period when financial aid might have provided a stronger inducement to forego graduation until more promising job opportunities became available.

By examining the impacts of initial or cumulative aid amounts, most studies to date have estimated combined effects on the extensive and intensive margins of enrollment. As a result, and also in light of the mixed evidence to date, whether the duration that need-based aid is offered affects the probability of completing college and time to completion remains an open question. Two recent studies of which I am aware do isolate the attainment impacts of grant aid disbursed late into college, although like Goldrick-Rab et al. (2016) and Angrist et al. (2016), the findings across studies are also inconsistent. Denning (forthcoming) leverages a discontinuous increase in federal Pell Grant aid when students first become financially independent at age 24 and finds that university seniors in Texas were 1.8 percentage points more likely to graduate in the year they first became eligible for additional grant aid. Barr (forthcoming) also finds that expansion of the GI bill after September 11th increased degree completion among veterans and that at least one-half of the attainment effect is explained by persistence gains among inframarginal enrollees. However, Barr (forthcoming) finds little evidence of attainment effects among students eligible for the Post-9/11 GI Bill for only one or two years, which indicates that the effect of grant aid on persistence may diminish over time and have negligible benefit to students once they are within 1-2 years of graduating.

2.2 Extending the Literature: Examining Effects of Reducing Lifetime Pell Eligibility

In this study, I examine how exhausting eligibility for federal Pell Grant aid affects borrowing and enrollment decisions for students who are close to graduating. As my review of the literature reveals, no studies of which I am aware have isolated the effect of losing aid that is disbursed late into college, and it therefore remains unclear whether losing grant aid and receiving more generous grant aid have symmetrical effects on attainment and time to completion. To the extent that aid increases postsecondary attainment, effects may be driven by early subsidies that set students on a path they would follow in the absence of continued support. Alternatively, financial constraints may pose a formidable barrier to attainment along the entire pathway to completion. The findings in this paper help to tease out the mixed evidence on whether the effects of need-based aid vary with time spent in college and how students who have already made considerable educational investments respond to losing grant dollars.

To identify effects on student outcomes, I exploit changes to Pell Grant eligibility rules which took effect in the 2012-13 school year. In 2011, the Pell Grant program faced an $18 billion shortfall as a result of growing enrollments in college and recent program changes that made more students eligible for aid.[27] After infusing the program with $17 billion, Congress addressed the remaining funding gap by implementing four eligibility changes which applied to both incoming and continuing students:

1) Eliminating eligibility for students without a high school diploma or GED;
2) Eliminating eligibility for students who qualified for the smallest grant amount, equivalent to 10 percent of the maximum award, or $555;
3) Reducing the family income ceiling from $32,000 to $23,000 that automatically qualified students for the maximum award; and

[27] The number of students receiving a Pell Grant increased by 13 and 27 percent in 2008-09 and 2009-10, respectively, whereas the year-over-year increase never exceeded 5 percent between 2004-05 and 2007-08 (Mahan, 2011). While part of this increase is attributable to enrollment growth during the Great Recession, Congress also relaxed income eligibility restrictions for Pell Grant aid and increased the maximum grant amount during this time, both of which contributed to skyrocketing program costs (Alsalam, 2013).

4) Reducing the lifetime duration of eligibility from 9 to 6 full-time-equivalent (FTE) years.[28]

I examine effects on student outcomes caused in particular by reducing the lifetime limit for Pell Grant aid. All of the students in my analytic sample are high school graduates who qualify for Pell awards above the minimum amounts. I examine empirically whether the income eligibility change for auto-zero qualification impacts student outcomes. As I discuss in detail in Section 4, effects are concentrated among students who did not qualify for maximum awards, implying that the income restriction did not affect students' schooling decisions. Estimates suggest that nearly 400,000 undergraduates were affected by the lifetime rule change alone and that students attending four-year institutions were disproportionately impacted.[29]

The U.S. Department of Education (ED) first announced these eligibility changes in January 2012, six months before they went into effect. However, ED did not contact students about the changes until April 2012, and the only students directly contacted (via e-mail) were those who had received more than 4.5 FTE years of Pell through spring 2012 (U.S. Department of Education, 2012). Also in April, ED provided institutions with a list of the students who were e-mailed. Beginning in July 2012, students could check their lifetime Pell use by logging into the National Student Loan Data System, and the federal aid processing system began to automatically flag students in excess of 4.5 FTE

[28] As I describe in more detail in the next section, the FTE provision means that lifetime Pell use is determined by two factors: 1) how many years students have received Pell support, and 2) their enrollment intensity (i.e., full-time, part-time, etc.) during those years.

[29] For example, the California State University System predicts that 4 percent of its total undergraduate population lost eligibility as a result of the new lifetime limit (Nelson, 2012). If this percentage is nationally representative, then 374,000 of the 9.35 million students enrolled in four-year degree programs are predicted to have been affected. I find that four percent of students in the USG dataset were also potentially affected by the new lifetime limit. However, the USG dataset excludes students who entered as transfer students, and as a result, the 400,000 estimate may be conservative.

years of Pell for school financial aid administrators. As a result of this communication strategy, students and institutions had only a few months to prepare for the eligibility changes when they first took effect in 2012-13. For example, a student contacted in April could have had their aid package impacted as early as July 1st (i.e., the beginning of the new aid year). In later years, more time afforded students greater opportunity to adjust their enrollment decisions to the more stringent lifetime limit.

3. EMPIRICAL ANALYSIS

3.1 Data

The data in this study are from the University System of Georgia Enterprise Data Warehouse (USG), which maintains longitudinal student-level records for the twenty-eight public, four-year colleges and universities in the State of Georgia.[30] The dataset includes records on all 301,423 degree-seeking students who first attended a USG institution in the fall term between 2002 and 2008, inclusive. From this data I observe information on students at the time of application, including their demographics and college entrance examination scores. The data also contain the financial information that students and their families supplied when completing the Free Application for Federal Student Aid (FAFSA), including the Expected Family Contribution (EFC) used to calculate how much federal Pell Grant aid students are eligible to receive, and all financial aid disbursements students actually received while enrolled in college. Lastly, the dataset includes complete records of students' enrollment, course-taking, and degrees received across the USG system through summer 2016, as well as records of transfer into

[30] Since 2013, the Board of Regents of the University System of Georgia has consolidated eighteen institutions into nine for cost-saving purposes. However, because the GDW data include institutional identifiers prior to consolidation, the dataset in practice covers student enrollments across thirty-seven unique campuses.

USG from other postsecondary systems. Taken together, this rich dataset allows me to construct a cumulative measure of lifetime Pell receipt for each student and examine how the threat or actual loss of Pell Grant eligibility affects student borrowing, re-enrollment decisions, and bachelor's degree completion.

3.2 Defining Students affected by the Lifetime Rule Change

Because the dataset does not include a direct measure of cumulative Pell receipt, I used reported EFC and disbursed Pell Grant amounts over eight years to construct this measure for each student and identify those affected by the new lifetime rule. Specifically, I used the following algorithm to calculate the amount of lifetime Pell students used over eight years:

(1) $$Total\ Pell\ FTE\ Years_i \ = \sum_{t=1}^{8} \frac{Pell\ Received_{it}}{Max\ Pell\ Eligible_{it} |\ EFC_{it}, Cost_{st}}$$, where

FTE years of Pell received for student i in year t was calculated as the amount of Pell aid received relative to the maximum amount the student was eligible to receive to subsidize the cost of full-time enrollment at college s. To determine maximum eligible award amounts, I relied on annual Pell award disbursement schedules published by the U.S. Department of Education (ED), which identify the grant amounts students qualify for as a function of their EFC and cost of attendance.[31]

In most years in this study, Pell recipients who enrolled full-time (defined as attempting 12 or more credits per term) over an entire school year received one FTE year

[31] While the USG dataset includes the EFC for students who filed the FAFSA, it does not include the cost of attendance charged to each student; however, this does not preclude using the disbursement schedules to identify eligible award amounts because the cost to attend USG institutions is sufficiently high that eligible award amounts in practice are based solely on EFC for the vast majority of students in the system. This holds, with very few exceptions, for students across all school years, institutions, and living arrangements in this study.

of Pell. Recipients who enrolled less than full-time received less than one FTE year of Pell, with the specific amount determined by the student's EFC and enrollment intensity (i.e., whether the student enrolled three-quarters-time, half-time, or less-than-half-time in each term that Pell aid was disbursed).[32] An exception to these rules occurred in the 2009-10 and 2010-11 school years, when Pell recipients could qualify for a second award in the same year to subsidize the cost of summer attendance. In those two years, some students accumulated more than one FTE year of Pell during a single award year. Nationally, 1.2 million students (13 percent of all Pell Grant recipients) received supplemental awards in 2010-11, which increased the average grant per recipient by approximately $200, or 6 percent (Baum et al., 2014; Delisle & Miller, 2015). In my main analytic sample, which I describe in the next section, 26 percent of students received more than one FTE year of Pell in either 2009-10 or 2010-11.

While students remain eligible for Pell Grants until they receive 6 FTE years of Pell under the new lifetime limit, I define treated students as those who enrolled on or after spring 2012 and received 5 or more FTE years of Pell. The rationale for defining treated students more expansively than is set by the statutory limit is twofold. First, under the new eligibility rules, students whose cumulative Pell receipt exceeds 5 FTE years receive proportionally smaller award disbursements in new award years until they reach the lifetime limit. For example, a student with an EFC of $1,000 who had received exactly 5 FTE years of Pell through 2011-12 would have been eligible for a Pell Grant of $4,600 in 2012-13, whereas the largest grant available to a student who had accumulated 5.5 FTE years of Pell with the same financial need would have been $2,300. Including

[32] Less-than-half-time enrollment is defined as attempting fewer than 6 credits per term. Half-time enrollment is defined as attempting at least 6 but less than 9 credits per term. Three-quarters-time enrollment is defined as attempted at least 9 but less than 12 credits per term.

students who received 5 or more FTE years of Pell in the treated group therefore accounts for effects resulting from declines in aid generosity before complete aid exhaustion.

It is also possible that the new lifetime limit created anticipatory effects which altered the probability of aid exhaustion in the post-policy period. Under the new rules, students may have chosen to withdraw before they experienced award reductions if they knew they needed to complete more than one year of coursework to graduate. Students aware of the new limit may also have increased their enrollment intensity in order to graduate before experiencing aid losses. As a result, including students who received 5 or more FTE years of Pell in the treated group allows for estimation of both direct and anticipatory policy effects.

3.3 Sample

If all Pell recipients made the same enrollment decisions over time, then students affected by the new lifetime limit could be identified by when they first entered college. In practice, which students are affected is more complicated because students' enrollment decisions are not exogenous. Some students enroll continuously, while others stop out. Some students also alter their enrollment intensity over time. Because these endogenous decisions affect who is at risk of exhausting aid eligibility and they are correlated with academic outcomes, straightforward comparisons of treated and non-treated students will lead to biased estimates of policy effects. A key challenge in this study is therefore identifying an analytic sample that accounts for selection into the treatment group.

I address the selection issue by conditioning the study sample on students who attended a USG college or university for five or more FTE years within eight years of initial entry (hereafter referred to as "5+ FTE" students) and then matching students who received 5 or more FTE years of Pell (hereafter referred to as "High-Pell" students) to observably-similar students who received less than 5 FTE years of Pell (hereafter referred to as "Low-Pell" students).[33,34] Figure 5 illustrates the process I used to create the matched sample. Of the 46,766 5+ FTE students, 16,588 students are included in the matched analysis sample (of which 8,656 are High-Pell students affected by the lifetime rule change and 7,932 are Low-Pell students in the comparison group).[35]

Matching High-Pell to Low-Pell students attempts to address the fact that even after conditioning the sample on 5+ FTE students, the majority of High-Pell students are observably different from other 5+ FTE students on key dimensions. This is evident in Table 7, which reports summary statistics for the 5+ FTE sample overall and the subset of matched students. Compared to all 5+ FTE students, High-Pell students are more likely to be female (62 percent vs. 56 percent) and Black (61 percent vs. 41 percent), have greater financial need according to their EFCs at entry and in year 5 ($1,092 vs. $14,434 at entry, for example), and entered college with lower average SAT scores (928 vs. 1,012).

I used the coarsened exact matching (CEM) procedure developed by Iacus, King, & Porro (2012) to construct the matched sample. This procedure allows the researcher to

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[33] I also restricted the sample to students who never transferred into USG in order to observe Pell receipt over eight years as near-complete as possible. Eighteen percent of first-time, degree-seeking students left the USG system but subsequently returned as a transfer student.

[34] I use a modified version of equation (1) to calculate FTE status for all students, where students' EFC-eligibility status is ignored and FTE status is determined solely by enrollment intensity. For example, a student who attempted 12 credits during fall 2010 and 6 credits during spring 2011 would be assigned an FTE of 0.75 for that year (i.e., 0.5 for full-time enrollment in the fall and 0.25 for part-time enrollment in the spring). An attractive feature of this approach is that Pell FTE years and FTE years are derived from a consistent set of rules.

[35] 88 percent of 5 Pell FTE students and 21.5 percent of other 5 FTE students are included in the matched sample.

identify which characteristics to match on and specify how to coarsen the data for matching (if at all), and then exactly matches treated and non-treated observations using the coarsened data. CEM has a number of attractive properties over more traditional matching methods like propensity score matching. First, it obviates the search for a suitable matching algorithm to achieve ex-post balance. Second, it avoids creating uninformative matches that approximate random matching and can produce more biased inferences than not matching at all (King, Nielsen, Coberley, & Pope, 2011). CEM also ensures that matching on a subset of observed variables has no effect on the imbalance of variables not used in the matching procedure. Checking for balance on non-matched covariates therefore sheds light on the plausibility of the key assumption of matching: that treatment is independent of potential outcomes conditional on the covariates used to match treated and non-treated observations.

I matched High-Pell students to Low-Pell students using the following baseline characteristics: entry cohort (not coarsened), sex, race (White, Black, or Other), an indicator of whether the student enrolled continuously or stopped out in the first four years of college, number of years to attain 5 FTE status (not coarsened), quartile of cumulative credits attempted at the start of students' fifth FTE year (not coarsened), EFC in the fifth FTE year ($0-$1,300, $1,300-$2,600, $2,600-$5,200, > $5,200), and an indicator of whether each student enrolled on or after fall 2012.[36] In Section 4.6, I examine the sensitivity of the results to alternative matching decisions. I estimate effects on matched samples that include both fewer and more baseline characteristics in the CEM procedure. I also estimate effects using propensity score matching instead of CEM.

[36] The upper bounds of the bottom three attempted credit quartiles are: 126, 136, and 146 credits.

The results indicate that after matching on the enrollment trajectory measures described above, including additional characteristics in the match leads to larger effect estimates. Propensity score matching also returns slightly larger effect estimates. These results imply that my main matching procedure generates conservative effect estimates on degree attainment and time to completion for students affected by the new lifetime Pell limit.

I report summary statistics for High-Pell and Low-Pell students in the main matched sample in columns 3-4 and 5-6 of Table 7, respectively. Treated and comparison students exhibit similar mean characteristics on the variables that were used in the matching procedure. For example, 62 percent of both groups are female and 25 percent are White. Both groups are also similar on non-matched measures of academic performance at entry and in college. The mean difference in SAT achievement between groups in the matched sample is 22 points (928 vs. 950 among High-Pell and Low-Pell students, respectively). Students in both groups also completed the same number of credits on average (121) and earned the same grades on average (2.65) at the start of their fifth FTE year.

The key difference that distinguishes High-Pell from Low-Pell students is the number of years of Pell that students received. On average, High-Pell students received 5.6 years of Pell within eight years of entering college compared to 3.2 years for Low-Pell students. Because I matched students on EFC in their fifth FTE year to ensure treated and comparison students had similar income profiles when the new lifetime limit took effect, there are two major reasons why Low-Pell students in the matched sample received less than five FTE years of Pell. First, 21 percent of Low-Pell students failed to file the FAFSA at the start of college, whereas only 1 percent of High-Pell students did not submit the FAFSA in their first year. Second, many Low-Pell students who applied for aid were initially ineligible for a Pell Grant. The average EFC at entry among Low-Pell students was $6,642 (in 2016 dollars), which exceeds the maximum value for Pell receipt. In summary, whereas High-Pell students routinely filed the FAFSA and received Pell aid, Low-Pell students did not. As a result, Low-Pell students' eligibility for need-based aid remained unaffected when Congress reduced the lifetime limit to 6 FTE years of Pell receipt in July 2012.

My empirical strategy rests on comparing the outcomes of High-Pell students to Low-Pell students before versus after the lifetime rule change took effect. To obtain unbiased estimates of policy effects, differences between students who enrolled before versus after the rule change should be stable across groups in the matched sample. If this holds, then I can obtain unbiased causal estimates by differencing out any selection effects observed within each group over time.

I examine evidence for differential selection in the matched sample in Table 8. Columns 1-4 report group-specific means before versus after the rule change was introduced. In columns 3 and 6, I present estimates of within-group selection effects. Column 7 shows whether those changes differed for High-Pell and Low-Pell students. The results in column 3 indicate that High-Pell students who enrolled post-2011 entered college with more financial resources than previously enrolled students and were more academically disadvantaged. However, because these differences (and all others reported in Table 8) are also observed in the Low-Pell group, there is no evidence of differential selection between groups in the matched sample. Again, this holds by definition for the characteristics on which students were matched as well as for all observable dimensions on which students were not matched.

3.4 Empirical Strategy

I estimate intent-to-treat effects on students' term-by-term enrollment decisions using a matched difference-in-difference-in-differences (DDD) strategy, where the first difference is after versus before the policy change, the second difference is whether or not a student ever received 5 FTE years of Pell, and the third difference is whether or not a student had enrolled for more than 4.5 FTE years at the start of each academic term.[37] This design is implemented by fitting the following statistical model to a student-by-term dataset:

$$(2)\quad Y_{ijt} = \alpha_1 Treat_i * Post2011_t * Post4.5FTE_{it} + \alpha_2 Post2011_t * Post4.5FTE_{it} + \alpha_3 Treat_i * Post2011_t + \alpha_4 Treat_i * Post4.5FTE_{it} + \alpha_5 Treat_i + \alpha_6 Post2011_t + \alpha_7 Post4.5FTE_{it} + \phi X_i + \omega_j + \eta_t + \gamma Treat_i * t + \varepsilon_{ijt}$$

In equation (2), Y_{ijt} is a measure of re-enrollment, term credits attempted or earned, or term GPA for student i in term t at college j. $Treat_i$ is an indicator for students who received five or more FTE years of Pell. $Post2011_t$ is an indicator for terms on or after fall 2012 when the new lifetime limit took effect. $Post4.5FTE_{it}$ is an indicator set to one in terms after students attained 4.5 FTE status and is zero otherwise. Because it is unlikely that High-Pell students far from the eligibility limit in 2012-13 would have immediately changed their enrollment behavior, this indicator is used to

[37] I also use a modified version of equation (2) to estimate effects on financial aid receipt. In the modified triple difference model, I define the third difference as whether or not a student had enrolled for more than 5 FTE years since students remain eligible for full Pell Grant amounts until they exceed 5 FTE years of Pell under the new policy.

identify when treated students would have been likely to respond to the policy, if at all, based on their proximity to the lifetime limit. I define terms post-4.5 FTE as treated terms given that the ED initially notified this group of students about the rule change and later developed warning alerts in the aid processing system specifically for them.[38] α_1 captures the effect estimate of interest. It represents the average difference in outcomes of High-Pell versus Low-Pell students in terms after versus before exceeding 4.5 FTE years and after versus before the policy change. In theory, one might expect policy effects to vary by the size of the Pell Grants students received. Unfortunately, award amounts vary too little in the matched sample to model effects continuously. The 25th percentile of the eligible award amount in the matched sample is $5,000 (in 2016 dollars) and the maximum eligible amount is $6,050. I therefore estimate average treatment effects, but I examine if effects vary for students eligible for awards less than versus more than $5,000.[39]

To increase the precision of the estimates and reduce bias, I also include a vector of individual-level covariates (X_i) not used in the matching procedure. This vector is comprised of the following controls: race dummy variables (Black, Hispanic, Asian, Other, and Missing race/ethnicity), indicators for U.S. citizenship status and Georgia residency status, an indicator of whether each student initially pursued a bachelor's degree at entry, and an indicator of whether each student was assigned to remedial coursework at entry, as well as continuous measures of age at entry, SAT math and verbal scores (imputed where missing), and Expected Family Contribution at entry

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[38] In equation (2), The $Post4.5FTE_{it}$ indicator also accounts for secular enrollment trends that arise as students spend more time in college (e.g. if students naturally tend to re-enroll at higher rates or take larger courseloads as they get closer to graduation).

[39] Results are similar when I estimate effects separately for zero-EFC and non-zero-EFC students and are available upon request.

(imputed where missing).[40] The model also includes school (ω_j) and term (η_t) fixed effects, as well as a linear term trend (γ) that allows enrollment patterns to vary by treatment status. Finally, assuming that the differences in outcomes between High-Pell and Low-Pell students would not have changed over time in the absence of the eligibility change, ε_{ijt} represents a mean-zero random error term. In all estimates, I report standard errors that account for the potential clustering of schooling behavior within USG campuses.[41]

Because degree attainment is a singular event for most students, effects on the probability of bachelor's degree completion and time to degree cannot be estimated using the same student-by-term framework as in equation (2). Instead, I estimate degree effects at the student level using a difference-in-differences (DD) design, where the first difference is after versus before the policy change and the second difference is whether or not a student ever received 5 FTE years of Pell. This model takes the following form:

$$(3) \qquad Y_{ij} = \beta_1 Treat_i * Post2011_i + \beta_2 Post2011_i + \beta_3 Treat_i + \phi\, X_i + \omega_j + \varepsilon_{ijt}.$$

In equation (3), Y_{ij} is a measure of bachelor's degree attainment overall or within a specific time interval (e.g., before 6 FTE years) for student i at college j. All other terms are defined as above, and the coefficient on the interaction term (β_1) is the parameter of interest.

4. RESULTS

4.1 Graphical Evidence

[40] Missing SAT scores and EFC at entry are predicted using the full set of non-missing baseline characteristics. In all results, I present estimates from multiple imputation regressions that account for uncertainty in the imputed values for students with missing data.

[41] I cluster standard errors by the 37 unique campuses prior to USG consolidation activities.

Comparing the re-enrollment and degree attainment trends of High-Pell and Low-Pell students suggests the lifetime rule change caused High-Pell students to increase their effort and graduate more quickly. To illustrate this, I plot re-enrollment rates by treatment status and enrollment status relative to the policy change in Figure 6. In the figure, the solid lines show re-enrollment rates for students who enrolled in the post-policy period and the dashed lines show the same for students who last enrolled before the new lifetime limit took effect. High-Pell students and Low-Pell students are denoted by white and black circles, respectively. Differences between the solid and dashed lines before versus after students attained 5 FTE status approximate the DDD estimates from equation (2). In terms before 5 FTE attainment, High-Pell students re-enrolled at slightly higher rates than Low-Pell students; however, the relative difference between the two groups remained constant over time. By comparison, High-Pell students in the post-policy period were more likely to re-enroll after receiving 5 FTE years of Pell compared to High-Pell students who last enrolled in the pre-policy period, whereas the re-enrollment rate among Low-Pell students did not change before versus after the new lifetime limit took effect.

Importantly, in each time period, High-Pell and Low-Pell students made nearly identical enrollment decisions in the first four years of college. Those results, presented in Figure 7, provide additional evidence that the spike in re-enrollment observed among High-Pell students is unlikely to be a random artifact of the data. Descriptive patterns of time to bachelor's degree completion also provide visual evidence of an acceleration effect. In Figure 8, I plot rates of bachelor's degree completion before 6 FTE years for High-Pell (dashed line) and Low-Pell (solid line) students by year of 5 FTE attainment. The trends show that both groups of students followed similar attainment trajectories prior to 2012, yet after the policy change, High-Pell students were much more likely to graduate before reaching the point of aid exhaustion.

4.2 First-Stage Effects of the Rule Change on Financial Aid Receipt

Table 9 shows estimated effects of the rule change on financial aid receipt. In column 1, I report estimates from a student-by-year panel restricted to four terms preceding and three terms following 5 FTE attainment, with terms after 5 FTE years defined as treated terms. After the rule change took effect, High-Pell students received $443 less Pell aid per term on average, which represents a 33 percent reduction in grant aid. As discussed above, treated students did not lose their Pell aid in full because they remained eligible for reduced awards after exceeding 5 FTE years of Pell but before receiving 6 FTE years of Pell. In addition, under the new policy students who have received exactly 5 FTE years of Pell at the start of an award year remain eligible for full awards. The results in panel B indicate that students did not replace lost Pell Grant dollars with other sources of grant aid.[42] However, they did compensate by borrowing more – $408 on average per term – which amounts to a 15 percent increase in loan receipt. The share of aid that High-Pell students received in the form of loans thereby increased from 66 percent to 76 percent after the new eligibility regime took effect. In column 2 of Table 9, I show that the results are similar if I condition the data on only terms in which students attended college. In Table B1 of Appendix B, I further show that the estimates are robust to restricting to a balanced panel of student-by-term observations and to graduates, as well as the inclusion of student fixed effects in the model, which account for any estimation bias due to time-invariant, unobserved student characteristics that are

[42] This in part reflects the fact that Georgia does not offer state need-based aid to students.

correlated with aid receipt and exposure to the rule change. In summary, the net effect of the policy change on total aid dollars appears to be zero, but High-Pell students received more of their aid in the form of loans after Congress reduced the lifetime eligibility limit.

4.3 Effects on Re-enrollment, Credits, and GPA

In Table 10, I report results from estimation of equation (2) on short-term academic outcomes to examine whether increased borrowing altered students' enrollment behavior. As in Table 9, I report results using the full student-by-term sample in column 1 and an enrollment-conditioned sample in column 2. Consistent with the graphical evidence presented earlier, the coefficient in panel A indicates that after attaining 4.5 FTE status, term-over-term re-enrollment increased by 2.8 percentage points (3 percent) for High-Pell students in the post-policy period. The estimates in panels B and C indicate the new lifetime limit also increased the number of credits treated students attempted and earned per term by approximately 0.5 credits.

The enrollment-conditioned estimates in column 2 shed light on whether the impacts in column 1 are driven by effects on the extensive margin (i.e., by increasing re-enrollment) or on the intensive margin (i.e., by inducing enrolled students to increase their academic effort). The point estimates in panels B and C of column 2 are roughly one-half the magnitude of the estimates in column 1, and the coefficient on credits completed remains statistically significant. This provides some evidence that the lifetime limit affected not only whether students re-enrolled in college but the intensity with which they did so. In panel D of column 2, I find no evidence that losing aid affected the grades students earned. The coefficient on term GPA is small (0.026) and effects larger than .095 points can be ruled out. As in the case of the estimates on financial aid receipt, the effects on short-term academic outcomes appear robust to alternative sample restrictions and to the inclusion of student fixed effects. Results of these robustness checks are presented in Table B2 of Appendix B.

4.4 Effects on Bachelor's Degree Attainment and Time to Completion

To examine effects on the probability of degree completion and time to degree, I turn to results from estimation of equation (3). I present the main results in Table 11 with and without the inclusion of student-level controls in even- and odd-numbered columns, respectively. In the first two columns, the estimates on the interaction term indicate that losing aid did not affect the overall likelihood that students graduated before exhausting their aid eligibility. The coefficients with and without controls are both near zero and non-significant. However, this null effect is not surprising given that more than 80 percent of High-Pell students in the study sample received 5 FTE years of Pell on or before 2012-13 and therefore had little time to graduate before reaching the lifetime limit.

In the next four columns, the estimates indicate that the new lifetime rule increased the probability that treated students graduated in years 6-8 following entry.[43] The coefficient in column 4 is suggestive of a 2.4 percentage point (3 percent) increase in bachelor's degree attainment within 8 years, although it is only marginally significant at the 10 percent level. In column 6, the coefficient on degree completion in years 6-8 is larger in magnitude and more precisely estimated. Reducing the lifetime Pell limit increased the probability of bachelor's degree completion within this timeframe by 3.1

[43] I report on degree outcomes within 8 years given that this is the longest I observe students across all cohorts. However, I also report on BA attainment ever, which captures degree completion through spring 2016. This outcome therefore captures degree attainment over a longer timeframe, but the time horizon varies across cohorts. For the earliest cohort (fall 2002), the BA ever outcome captures degree attainment through 14 years following entry. For the last cohort (fall 2008), this outcome captures degree attainment through 8 years.

percentage points, or 7 percent. The last two columns of Table 11 report effects on bachelor's degree attainment overall. The coefficients are positive, but one-third the size of the effects on completion in years 6-8 and not distinguishable from zero. Taken together, this evidence suggests that High-Pell students were no more likely to graduate overall or before reaching the eligibility limit, but nevertheless accelerated their time to completion after losing access to Pell aid.

The graphical evidence in Figure 8 suggests that pooled analyses may conceal dynamic effects on completion according to how much time students had to react to the new lifetime limit. In Table 12, I therefore examine degree effects by year of 5 FTE attainment. As expected, the results in column 1 indicate that High-Pell students who attained 5 FTE status before or in the first year of the new regime were no more likely to graduate before exhausting their eligibility for aid. However, students who attained 5 FTE status after 2012-13 had more time to adjust to the new policy and were increasingly likely to graduate before exhausting eligibility for Pell aid. The effect estimates for students who attained 5 FTE status in 2013-14 and 2014-15 are 6.7 percentage points and 17.5 percentage points, respectively, which represent relative impacts of 15 percent and 53 percent over Low-Pell students who attained 5 FTE status in the same years.

I also reject that the impacts on graduating before aid exhaustion are time invariant (the p-value on an F-test of equal effects is less than 0.001). By contrast, I find no evidence of dynamic effects on bachelor's degree attainment within 8 years or overall in columns 2 and 3 of Table 12.[44] Thus, treated students appear to have reacted to the

[44] Although the coefficient on overall degree attainment for students who attained 5 FTE status in 2014-15 is substantively large (0.044), this is likely an overestimate since most students in this group are members of the 2008 entry cohort and I only observe degree completion through 8 years for this group. Because the

new lifetime limit consistently (i.e., by accelerating time to completion), but only treated students who maintained more than one year of eligibility when the new limit took effect increased their likelihood of graduation before exhausting Pell aid.

I also find evidence that effects on time to completion vary by the amount of Pell Grant aid students were eligible to receive, although it is unclear a priori whether effects should rise or fall with financial need. On the one hand, students who are eligible for larger awards stand to lose more when aid is lost and might increase their effort more in response. However, if students with greater financial need also juggle more commitments outside of school, they may have less flexibility to increase their enrollment intensity. To examine this question, I disaggregate the effects in panel A of Table 13 for students who were eligible for Pell Grants of less than versus more than $5,000, which denotes the bottom quartile of eligible award amounts in the matched sample.[45] All of the acceleration effects are driven by students eligible for less than $5,000 of aid. Degree completion prior to 6 FTE years increased by 7.6 percentage points for this group, whereas the point estimate for students eligible for larger awards is slightly negative (-0.019) and not significant, and I reject that the effects are equal for both groups (the p-value from the joint F-test is 0.009). The results suggest that need-based aid dissuades some wealthier Pell recipients from graduating sooner, whereas the availability of grant aid is not a deterrent to graduating sooner for very low-income recipients.

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point estimates on overall attainment are near zero for students I observe over a longer time horizon, I expect the estimate for the 2014-15 group would attenuate over time.

[45] The majority (82 percent) of students eligible for Pell Grants of $5,000 or more had zero EFCs in their 5 FTE year, which suggests this group is comprised of very low-income students with family incomes below $30,000. In contrast, the average EFC among students eligible for less than $5,000 of Pell aid was $2,888, which equates to an adjusted gross income of approximately $48,000 (in 2016 dollars) for families with two dependents.

In panel B of Table 13, I examine variation in effects by total credit completion at the start of students' fifth FTE year. Students further from degree completion should be most responsive to the rule change since those close to degree completion may not need to alter their enrollment at all to graduate. For this analysis, I also divide students into two mutually exclusive groups: those who completed fewer than versus more than 120 credits, with 120 credits serving as a proxy for proximity to graduation. Although bachelor's degree programs in the USG system require completion of 120 credits at minimum, 95 percent of graduates in the matched sample completed more than 120 total credits and most graduates completing substantially more credits. The average number of cumulative credits earned by graduates was 143 credits in the study sample. I therefore define 120 credits as the proxy for proximity to completion for this analysis. As predicted, all of the acceleration effect is driven by students who completed fewer than 120 credits at the start of their fifth FTE year. In column 1, the estimated effect on completion before the point of aid exhaustion is 5 percentage points for this group. The effect on degree completion within 8 years in column 2 is 6.6 percentage points. The analogous point estimates for students who completed 120 credits ore more at the start of their fifth FTE year are both negative (-0.032 and -0.012, respectively) and not significant. Once again, I reject that effects by total credit attainment are homogenous (the p-values from the joint F-tests are 0.041 and 0.027, respectively).

4.5 Robustness Check 1: Did Concurrent Policy Changes Drive Acceleration Effects?

The new lifetime limit was enacted in the aftermath of the Great Recession when federal and state governments cut many programs to save costs. In this section, I explore whether the acceleration effects can be attributed to changes to other financial aid programs made around the same time. I examine two concurrent changes to financial aid policy which took effect in 2011-12: 1) elimination of the summer Pell Grant provision, which in 2009-10 and 2010-11 allowed eligible students to receive more than one Pell Grant in an award year, and 2) changes to eligibility requirements for Georgia's merit-aid HOPE Scholarship, which reduced award amounts for some students already enrolled in college.[46] If the effects are partly a function of eligibility changes to the state merit aid program, then the point estimates should be larger for merit award recipients. Likewise, if the acceleration effects are due to the year-round Pell rather than the new lifetime limit, the effects should be larger for students who received two Pell awards in the same year.

I present the results of these analyses in Table 14. Panel A reports effects on degree completion separately for students who did and did not receive HOPE funding in their fifth FTE year. Panel B reports analogous results for students who did and did not receive two Pell awards during the 2009-10 or 2010-11 award years. Across all degree outcomes, I fail to reject that effects for HOPE and non-HOPE recipients and for dual-Pell versus non-dual-Pell recipients are equal (none of the p-values from joint F-tests are below 0.25). Furthermore, the magnitudes of the point estimates are suggestive of larger effects for non-HOPE recipients and for non-dual-Pell recipients. For instance, in panel A of column 1, the estimated effect on completion before exhausting Pell eligibility is 1.3 percentage points for non-HOPE recipients and -1.5 percentage points for HOPE recipients. In panel B of column 1, the point estimates for non-dual and dual-Pell recipients are 2.1 and -1.8 percentage points, respectively. The acceleration effects thus

[46] In 2010-11, approximately one-third of USG students received HOPE Scholarships. On average, award amounts the following year declined by $300 per semester for students who no longer qualified for full HOPE scholarships (Suggs, 2016). Details about the summer Pell provision are provided in the text on p.60.

do not appear to be driven by coinciding changes to either the federal Pell Grant or to Georgia's merit-based aid program.

4.6 Robustness Check 2: Stability of Effect Estimates to Alternative Matching Procedures

In addition to concurrent policy changes, another possible concern is that the results may be sensitive to the choice of covariates used in matching or to the matching procedure itself. I therefore examine the stability of the estimates on degree attainment to alternative estimation and matching solutions in Table 15. Column 1 reports the main results from Table 11 for purposes of comparison. To examine whether matching is necessary in the first place, column 2 presents estimates using the main matched sample but ignoring the matching solution and instead controlling for the full set of covariates used in the matching procedure. The results in columns 1 and 2 differ only with respect to the weights used in estimation. In column 1, the weights depend on the fraction of High-Pell students in each matched cell. Strata with more treated students are weighted more heavily to obtain the estimand of interest: the average treatment effect on the treated. In column 2, strata with equal shares of High-Pell and Low-Pell students receive greatest weight to minimize the variance of the effect estimate. As a result, the estimates in column 2 will only approximate the average treatment effect on the treated if effects are homogenous over students. Consistent with the evidence of heterogeneous effects in Table 13, the estimated effect on degree completion in years 6-8 in column 2 of Table 15 is 3 times larger than the estimate in column 1 (9.2 versus 3.1 percentage points, respectively) because treatment effects vary over strata. Ignoring the matched solution thus yields upward-biased estimates of the new lifetime limit on time to completion.

Columns 3-6 of Table 15 report estimates of degree effects from four alternative samples that match High-Pell to Low-Pell students using fewer observable characteristics. In column 3, students are only matched according to their post-2011 enrollment status and cohort of entry. In column 4, I add the enrollment trajectory measures (i.e., whether students enrolled continuously in years 1-4, total credits attempted at the start of students' 5 FTE year, and years to 5 FTE attainment) to the matching procedure. In column 5, gender and race are also included. In column 6, I include EFC status in students' fifth FTE year but exclude gender and race. The results indicate that the effect estimates are upward-biased when the enrollment trajectory measures are excluded from the matching procedure. For example, the point estimate on degree completion in years 6-8 is 6.3 percentage points in column 3 compared to 2.5 percentage points in column 4. However, once the enrollment trajectory measures are included, the estimates on degree completion within 8 years and in years 6-8 *increase* when imbalance is reduced further by also matching on sex, race, and EFC. The effects in the fully matched sample in column 1 are also more precisely estimated than in columns 4-6, and therefore do not suffer from a bias-variance tradeoff.

In column 7 of Table 15, I add cumulative credits earned and cumulative GPA at the start of students' fifth FTE year to the matching solution to examine if the main results are robust to the inclusion of additional controls. While matching on these additional measures reduces the size of the estimation sample by half and leads to less precise estimates, the magnitude of the coefficients are substantively similar to the main results shown in column 1. Lastly, in column 8, I examine the stability of the estimates to using propensity score matching instead of CEM to match High-Pell to Low-Pell students.[47] The results are also similar in magnitude to the main results, and even slightly larger. Taken together, the results in Table 15 suggest that matching is necessary to obtain unbiased causal estimates and estimates from the main CEM-matched sample are robust to alternative matching solutions.

5. CONCLUSIONS AND SUGGESTIONS FOR FUTURE RESEARCH

Despite large public investments in financial aid and concern that too many college students are not finishing college or taking too long to do so, little is known about whether aid disbursement policies influence student decisions over whether and when to graduate. Leveraging a recent eligibility change to the lifetime availability of federal Pell Grants, my findings reveal that students are responsive to lifetime eligibility limits for need-based aid and that these limits can be designed to accelerate time to completion. Students who exhausted full or partial eligibility for Pell Grant aid made up for the loss by borrowing 15 percent more on average per term to pay for college. This in turn affected their subsequent enrollment decisions. Reducing the lifetime Pell limit from 9 to 6 FTE years increased the probability of term-over-term re-enrollment and degree completion in years 6-8 since entry by 3 percentage points. Assuming that 400,000 students were initially affected by the new lifetime limit, this translates into 12,000 students who accelerated their time to completion in response to the eligibility change.[48] Degree completion before 6 FTE years also increased 7-18 percentage points (15-53

[47] For this procedure, I used the same covariates as in the main CEM matching solution to estimate the probability of being a High-Pell student after running logit regressions separately by post-2011 enrollment status. I then matched High-Pell to Low-Pell students with the same post-2011 enrollment status and similar predicted probability of High-Pell status (i.e., within +/- 0.05 percentage points).

[48] Fifty-one percent of 5 Pell FTE students not enrolled post-2011 graduated in years 6-8 versus 54 percent of treated students enrolled post-2011. As a result, 12,000 students [(400,000*0.54)-(400,000*.51)] are estimated to have graduated more quickly. See footnote 29 for how the estimated number of affected students is derived.

percent) for students who had at least one year to adjust to the new lifetime limit before exhausting their eligibility for aid. Importantly, reducing lifetime availability for Pell aid did not affect the overall probability of bachelor's degree completion for this sample of students.

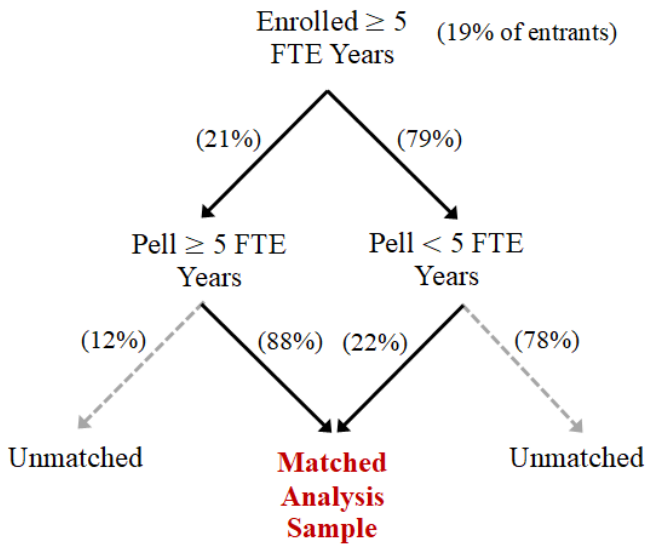
An obvious question is whether the results would persist if aid eligibility limits were more binding and consequently affected more students. This is an important question because many state need-based aid programs impose more stringent lifetime caps than the federal Pell Grant. For example, in California and New York, students are eligible to receive state need-based aid for up to four full-time-equivalent years. I believe the findings from this study should be extrapolated cautiously, as the generalizability of the results is unclear. On the one hand, Congress restricted Pell Grant eligibility to 6 FTE years on the basis of fiscal necessity, not because this limit was known to benefit students. It is therefore possible that more stringent lifetime limits could produce acceleration effects of similar magnitude for more students. However, students impacted by the current Pell lifetime limit are also distinct with respect to their commitment to degree completion and their consistency of applying for and receiving financial aid over time. At some point, excessively stringent aid limits would certainly introduce costs (e.g., increased dropout) that outweigh the benefits realized from the current policy. The tipping point at which lifetime aid limits begin to do more harm than good remains an important question left for further research.

A related question is whether reallocating how aid is disbursed along the path to completion would produce greater benefits than simply eliminating aid that is disbursed late into college. My estimates imply that Pell awards to the approximately 2.1 million first-year recipients per year could have been increased by $705 per year on average if the cost savings from the new limit ($1.48 billion if 400,000 students lost eligibility) were redistributed instead of eliminated. Several recent studies have found that disbursing more generous need-based aid to students in the first two years of college can increase postsecondary attainment and generate positive returns on investment (Angrist et al., 2016; Castleman & Long, 2016; Goldrick-Rab et al., 2016), and so it is possible that reallocating instead of eliminating aid would have achieved the same impacts on time to completion while also increasing overall graduation rates. More attention should therefore be paid to the impacts of front-loading policies, given their widespread use by institutions (Pratt, 2015; Sharpe, 2016).

Finally, this study arrives at a time when free college plans are widely popular. Legislation making college tuition-free for certain groups of students has passed in six states as of 2016, and 17 additional states are actively considering free college legislation (Pingel, Parker, & Sisneros, 2016). Despite their intention of making college more affordable, free college plans may have adverse effects for some students, such as by incentivizing attendance at resource-constrained institutions where students are less likely to graduate (Svrluga, 2015). The results in this study offer another note of caution: for very low-income students enrolled in college over many years, free college plans may hamper efforts to accelerate time to completion by relinquishing students from having to pay some costs to attend school.

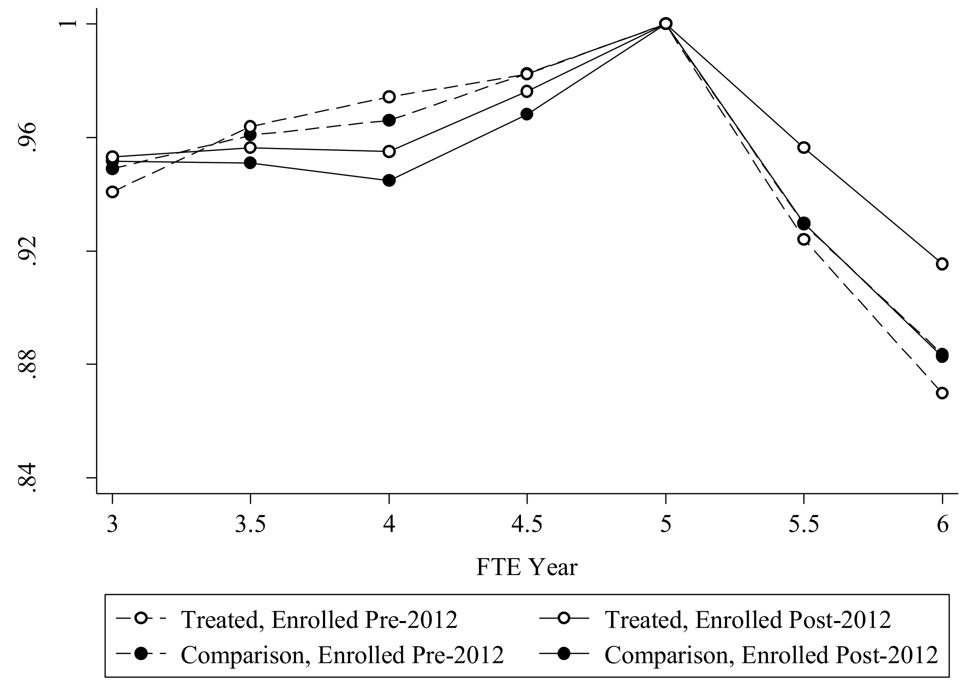
In closing, the findings from this study indicate that students who have demonstrated a sustained commitment to earning a degree can be encouraged to graduate more quickly by setting limits on the availability of need-based aid. This implies that the effect of need-based aid on attainment is time-varying, and as a result, decisions over how to allocate financial aid are consequential. Disbursement policies can be designed with attention towards accelerating time to degree and can impact the cost-effectiveness of financial aid expenditures.

Figure 5. Illustration of the matching procedure used to define the study sample



Notes: The analytic sample is restricted to students who attended a USG institution for five or more FTE years within eight years of entry. Within this group, treated students who received 5 or more FTE years of Pell are matched to observably-similar comparison students who received less than 5 FTE years of Pell.

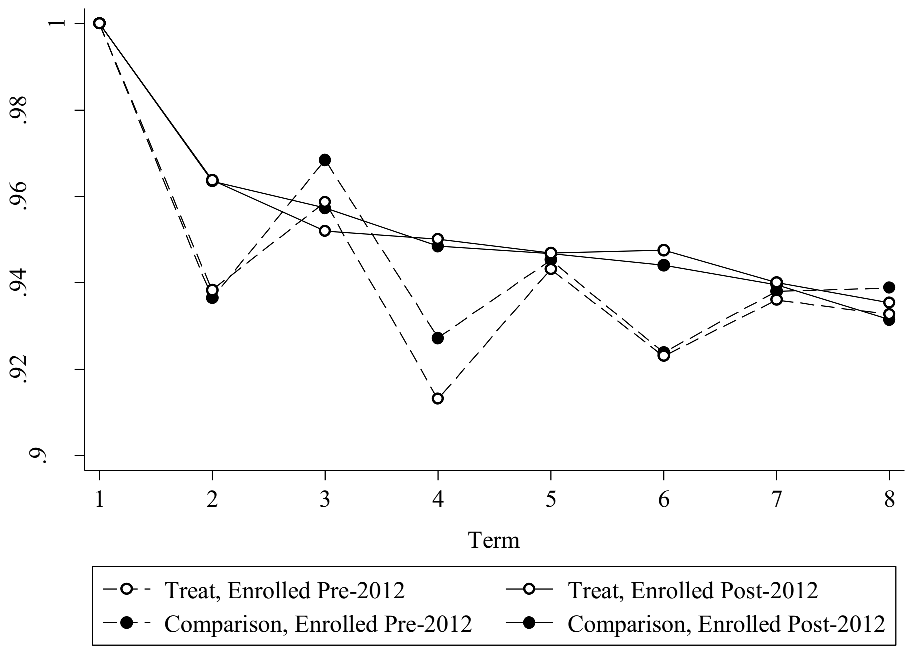
Figure 6. Re-enrollment by term within three years of the new lifetime Pell limit, by treatment and enrollment status relative to the policy change



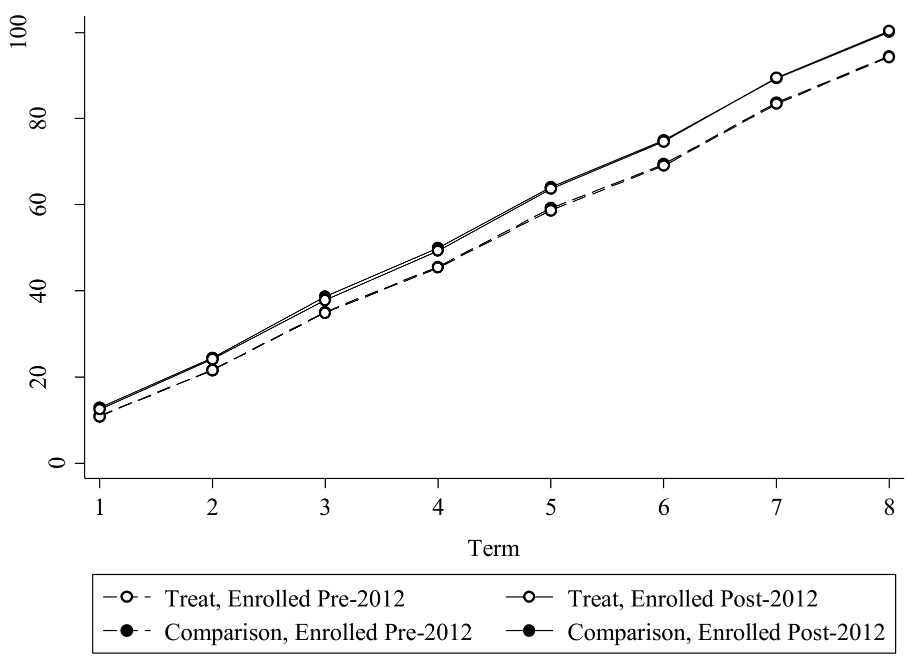
Notes: The sample is restricted to matched students who attended a USG institution for five or more FTE years within eight years of entry. Within this group, treated students who received 5 or more FTE years of Pell are matched to observably-similar students who received less than 5 FTE years of Pell. The new lifetime Pell limit took effect in July 2012. Source: University System of Georgia administrative records.

Figure 7. Enrollment and credit attainment in years 1-4 of college, by treatment and enrollment status relative to the policy change

A. Enrollment by term

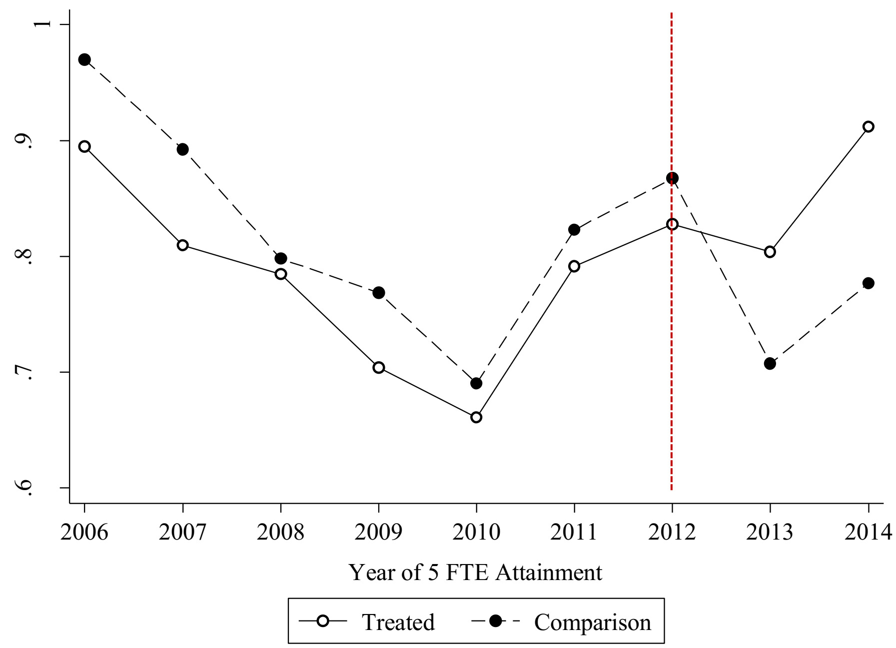


B. Total credits attempted by term



Notes: The sample is restricted to matched students who attended a USG institution for five or more FTE years within eight years of entry. Within this group, treated students who received 5 or more FTE years of Pell are matched to observably-similar students who received less than 5 FTE years of Pell. The new lifetime Pell limit took effect in July 2012. Source: University System of Georgia administrative records.

Figure 8. Bachelor's degree completion rates before the attainment of 6 FTE status, by treatment status and year of 5 FTE attainment



Notes: The sample is restricted to matched students who attended a USG institution for five or more FTE years within eight years of entry. Within this group, treated students who received 5 or more FTE years of Pell are matched to observably-similar students who received less than 5 FTE years of Pell. The reference line denotes the first year in which the 6 FTE year lifetime Pell limit took effect.

Source: University System of Georgia administrative records.

Table 7. Summary statistics of full 5 FTE year sample and matched sample by treatment status

	(1)	(2)	(3)	(4)	(5)	(6)
			Matched Sample			
	All students enrolled for 5+ FTE years		Treated: Enrolled for 5+ FTE years and received 5+ years of Pell		Comparison: Enrolled for 5+ FTE years and received < 5 years of Pell	
	Mean	SD	Mean	SD	Mean	SD
Pre-entry characteristics						
Female	0.561	0.496	0.624	0.484	0.624	0.484
Black	0.405	0.491	0.613	0.487	0.613	0.487
Asian	0.063	0.243	0.063	0.244	0.060	0.237
Latino	0.045	0.208	0.039	0.193	0.042	0.201
White	0.447	0.497	0.251	0.434	0.251	0.434
Race Other	0.029	0.167	0.024	0.153	0.023	0.150
Missing Race	0.011	0.103	0.010	0.101	0.011	0.104
U.S. Citizen	0.942	0.235	0.936	0.245	0.932	0.252
GA Resident	0.970	0.171	0.976	0.154	0.961	0.195
BA Degree Program at Entry	0.978	0.148	0.970	0.170	0.978	0.147
SAT Math + Verbal Score	1012	159	928	146	950	147
Missing SAT	0.05	0.217	0.064	0.245	0.046	0.21
Assigned to Remedial Coursework	0.189	0.392	0.244	0.430	0.194	0.395
Age at Entry	18.63	0.91	18.72	1.27	18.69	1.03
EFC at Entry	$14,434	$20,344	$1,092	$2,975	$6,642	$6,702
Missing EFC at Entry	0.155	0.361	0.014	0.119	0.206	0.405
Post-entry characteristics						
Age 5 FTE Year	23.55	1.27	23.51	1.56	23.52	1.31
EFC in 5 FTE Year	$8,201	$14,735	$476	$1,029	$534	$1,244
Cum Credits Att. at Start of 5 FTE Year	135.30	13.58	136.20	15.74	136.28	13.32

Table 7. Summary statistics of full 5 FTE year sample and matched sample by treatment status

	(1)	(2)	(3)	(4)	(5)	(6)
			Matched Sample			
	All students enrolled for 5+ FTE years		Treated: Enrolled for 5+ FTE years and received 5+ years of Pell		Comparison: Enrolled for 5+ FTE years and received < 5 years of Pell	
	Mean	SD	Mean	SD	Mean	SD
Cum Credits Earned at Start of 5 FTE Year	118.83	15.61	120.46	15.92	120.78	15.09
Cum GPA at Start of 5 FTE Year	2.70	0.52	2.64	0.50	2.65	0.52
Terms to 5 FTE Status	15.71	2.47	15.34	2.33	15.42	2.33
Total Pell FTE Years	2.07	2.26	5.57	0.50	3.20	1.35
Observations	46,766		8,656		7,932	

Notes: The sample in columns 1 and 2 is restricted to all degree-seeking entrants to public, four-year institutions in Georgia from 2002-2008, inclusive, who attended a public, four-year institution for five or more FTE years within eight years of entry. Students with a record of transfer into USG after initial entry are excluded from the sample. The sample in columns 3-6 is restricted to the subset of 5 FTE students included in the matched analytic sample. See Figure 5 for details.

Source: University System of Georgia administrative records.

Table 8. Matched sample characteristics of treated and comparison students by enrollment status relative to the Pell eligibility rule change

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Treated Students			Comparison Students			
	Did Not Enroll After Fall 2011	Enrolled On or After Spring 2012	Post - Pre	Did Not Enroll After Fall 2011	Enrolled On or After Spring 2012	Post - Pre	DID
Pre-entry characteristics							
Female	0.627	0.622	-0.005	0.627	0.622	-0.005	0.000
			(0.008)			(0.023)	(0.024)
Black	0.631	0.600	-0.030	0.631	0.600	-0.030	-0.000
			(0.018)			(0.022)	(0.023)
Asian	0.063	0.063	0.000	0.055	0.063	0.008*	-0.008
			(0.006)			(0.005)	(0.006)
Latino	0.020	0.052	0.032***	0.027	0.053	0.025***	0.007
			(0.005)			(0.006)	(0.008)
White	0.262	0.243	-0.018	0.262	0.243	-0.018	0.000
			(0.018)			(0.019)	(0.020)
Race Other	0.021	0.026	0.005	0.020	0.025	0.005	-0.000
			(0.003)			(0.005)	(0.005)
Missing Race	0.003	0.015	0.012***	0.005	0.015	0.010***	0.001
			(0.002)			(0.004)	(0.003)
SAT Math + Verbal Score	943	917	-26.232***	958	945	-12.665*	-13.568
			(5.264)			(6.772)	(8.249)
Assigned to Remedial Coursework	0.219	0.262	0.042***	0.180	0.203	0.023	0.019
			(0.015)			(0.019)	(0.021)
Age at Entry	18.72	18.71	-0.009	18.67	18.71	0.047	-0.056
			(0.030)			(0.035)	(0.045)

Table 8. Matched sample characteristics of treated and comparison students by enrollment status relative to the Pell eligibility rule change

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Treated Students			Comparison Students			
	Did Not Enroll After Fall 2011	Enrolled On or After Spring 2012	Post - Pre	Did Not Enroll After Fall 2011	Enrolled On or After Spring 2012	Post - Pre	DID
EFC at Entry	$967	$1,178	206.392***	$6,349	$6,843	539.191*	-332.798
			(70.486)			(268.983)	(280.382)
Post-entry characteristics							
Age 5 FTE Year	23.50	23.52	0.016	23.46	23.55	0.090**	-0.074
			(0.046)			(0.044)	(0.051)
EFC in 5 FTE Year	$500	$460	-39.207	$565	$513	-52.932*	13.725
			(25.528)			(30.448)	(36.492)
Cum Credits Att. at Start of 5 FTE Year	137.50	135.30	-2.195***	137.87	135.18	-2.681***	0.486
			(0.730)			(0.659)	(0.743)
Cum Credits Earned at Start of 5 FTE Year	119.47	121.15	1.688***	120.11	121.23	1.122**	0.566
			(0.559)			(0.543)	(0.500)
Cum GPA at Start of 5 FTE Year	2.67	2.62	-0.046***	2.66	2.64	-0.017	-0.029
			(0.015)			(0.025)	(0.023)
Observations	3,532	5,124	8,656	3,446	4,486	7,932	16,588

*** p<0.01 ** p<0.05 * p<0.10

Notes: The sample is restricted to matched students who attended a USG institution for five or more FTE years within eight years of entry. Within this group, treated students who received 5 or more FTE years of Pell are matched to observably-similar students who received less than 5 FTE years of Pell. Means are reported in columns (1), (2), (4), and (5). Estimates of pre-post compositional differences are reported in columns (3) and (6). Estimates of the difference in pre-post differences between treated and comparison students are reported in column (7). Standard errors are clustered by institution and reported in parentheses.

Source: University System of Georgia administrative records.

Table 9. Estimates of the effect of the lifetime Pell limit reduction on financial aid receipt

	(1)	(2)
	All student-by-term observations	Restricted to enrolled terms only
A. Pell Grant Aid	-443.288***	-582.163***
	(58.116)	(57.032)
R^2	0.220	0.202
Baseline mean	$1,327	$1,826
B. Other grant aid	30.150	49.772
	(25.108)	(32.955)
R^2	0.092	0.098
Baseline mean	$53	$74
C. Loans	408.054***	454.952**
	(145.994)	(195.708)
R^2	0.131	0.158
Baseline mean	$2,714	$3,769
D. Total financial aid	7.540	-60.062
	(166.901)	(210.731)
R^2	0.180	0.196
Baseline mean	$4,103	$5,679
Student-by-term observations	104,596	92,545

*** p<0.01 ** p<0.05 * p<0.10

Notes: The sample is restricted to matched students who attended a USG institution for five or more FTE years within eight years of entry. The analytic window is restricted to four terms preceding and three terms following 5 FTE attainment, with terms after 5 FTE years defined as treated terms. Student-by-term observations following bachelor's degree receipt and summer terms are excluded. Results are estimated with multiple imputation OLS models that control for: race (Black, Hispanic, Asian, Other, and Missing race/ethnicity); U.S. citizenship status; Georgia residency status; initial degree pursued; remedial assignment at entry; SAT math and verbal scores (imputed where missing); age at entry; and student's Expected Family Contribution at entry (imputed where missing). All models also include institution fixed effects, linear time trends allowed to vary by treatment status and before versus after the policy change, and a constant. Robust standard errors, clustered by institution, are reported in parentheses.

Source: University System of Georgia administrative records.

Table 10. Estimates of the effect of the Pell Grant eligibility change on the probability of re-enrollment, credits attempted and earned, and GPA in terms following 5 FTE attainment

	(1)	(2)
	All student-by-term observations	Restricted to enrolled terms only
A. Re-enrolled	0.028***	
	(0.010)	
R^2	0.154	
Baseline mean	0.835	
B. Term credits attempted	0.473**	0.225
	(0.184)	(0.140)
R^2	0.161	0.070
Baseline mean	10.39	12.41
C. Term credits earned	0.470***	0.295**
	(0.163)	(0.144)
R^2	0.158	0.073
Baseline mean	9.13	10.90
D. Term GPA		0.026
		(0.035)
R^2		0.080
Baseline mean		2.55
Student-by-term observations	104,596	92,545

*** p<0.01 ** p<0.05 * p<0.10

Notes: The sample is restricted to matched students who attended a USG institution for five or more FTE years within eight years of entry. The analytic window is restricted to four terms preceding and three terms following 5 FTE attainment, with terms on or after 5 FTE years defined as treated terms. Student-by-term observations following bachelor's degree receipt and summer terms are excluded. Results are estimated with least squares models that include the full set of controls. See Table 9 for details. Robust standard errors, clustered by institution, are shown in parentheses.

Source: University System of Georgia administrative records.

Table 11. Estimates of the effect of the Pell Grant eligibility change on bachelor's degree attainment overall and time to degree completion

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	BA before 6 FTE year		BA w/in 8 years of entry		BA in year 6-8 since entry		BA ever	
Post-2011 x Treated	0.004	0.006	0.025*	0.024*	0.036**	0.031**	0.012	0.010
	(0.017)	(0.018)	(0.014)	(0.013)	(0.016)	(0.014)	(0.016)	(0.016)
Treated	-0.031**	-0.030**	-0.002	0.006	0.030**	0.054***	0.006	0.020*
	(0.013)	(0.013)	(0.014)	(0.012)	(0.014)	(0.013)	(0.012)	(0.011)
Post-2011	-0.169***	-0.159***	-0.096***	-0.085***	0.001	-0.003	-0.090***	-0.081***
	(0.017)	(0.016)	(0.015)	(0.016)	(0.017)	(0.016)	(0.017)	(0.018)
R^2	0.029	0.088	0.010	0.091	0.003	0.047	0.011	0.090
Controls	N	Y	N	Y	N	Y	N	Y
Comparison mean post-2011	0.544		0.728		0.454		0.769	
Observations	16,588							

*** p<0.01 ** p<0.05 * p<0.10

Notes: The sample is restricted to matched students who attended a USG institution for five or more FTE years within eight years of entry. Results are estimated with linear probability models. Models with controls are from multiple imputation specifications that include the following covariates: race dummy variables (Black, Hispanic, Asian, Other, and Missing race/ethnicity); U.S. citizen dummy variable; Georgia resident dummy variable; pursued bachelor's degree at entry dummy variable; assigned to remedial coursework at entry dummy variable; SAT math and verbal scores (imputed where missing); age at entry; and the student's Expected Family Contribution at entry (imputed where missing). All models with controls also include institution fixed effects and a constant. Standard errors are clustered by institution and reported in parentheses.

Source: University System of Georgia administrative records.

Table 12. Estimates of the effect of the Pell Grant eligibility change on bachelor's degree attainment by year of 5 FTE attainment

	(1)	(2)	(3)
	BA before 6 FTE year	BA w/in 8 years of entry	BA ever
5 FTE in 2012-13 or earlier	-0.013	0.020	0.007
	(0.019)	(0.015)	(0.018)
5 FTE in 2013-14	0.067*	0.032	0.006
	(0.038)	(0.036)	(0.031)
5 FTE in 2014-15	0.175***	0.038	0.044
	(0.052)	(0.054)	(0.064)
Tests of equal effects (p-values)	<.001	0.357	0.494
R^2	0.092	0.105	0.108
Comparison mean in 2012-13 or earlier	0.569	0.760	0.801
Comparison mean in 2013-14	0.462	0.639	0.683
Comparison mean in 2014-15	0.328	0.415	0.442
Observations		16,588	

*** p<0.01 ** p<0.05 * p<0.10

Notes: The sample is restricted to matched students who attended a USG institution for five or more FTE years within eight years of entry. Results are estimated with multiple imputation linear probability models that include the full set of controls. See Table 11 for details. Standard errors are clustered by institution and reported in parentheses.

Source: University System of Georgia administrative records.

Table 13. Estimates of the effect of the Pell Grant eligibility change on bachelor's degree attainment by eligible Pell award amount and cumulative credit attainment at start of 5 FTE year

	(1) BA before 6 FTE year	(2) BA w/in 8 years of entry	(3) BA ever
A. Eligible annual Pell award amount (in 2016 dollars)			
Less than $5,000	0.076**	0.061**	0.043
	(0.028)	(0.024)	(0.026)
$5,000 to $6,050	-0.019	0.008	-0.004
	(0.020)	(0.017)	(0.020)
Tests of equal effects (p-values)	0.009	0.119	0.165
R^2	0.634	0.795	0.83
Comparison mean post-2011: Pell award < $5,000	0.611	0.782	0.813
Comparison mean post-2011: Pell award of $5,000 to $6,050	0.529	0.715	0.758
Observations		16,588	
B. Credits completed at start of 5 FTE term			
Less than 120 credits	0.050*	0.066***	0.035
	(0.027)	(0.023)	(0.026)
120 credits or more	-0.032	-0.012	-0.012
	(0.021)	(0.018)	(0.019)
Tests of equal effects (p-values)	0.041	0.027	0.177
R^2	0.668	0.804	0.836
Comparison mean post-2011: Completed < 120 credits	0.349	0.596	0.663
Comparison mean post-2011: Completed 120 credits or more	0.701	0.834	0.854
Observations		16,588	

*** p<0.01 ** p<0.05 * p<0.10

Notes: The sample is restricted to matched students who attended a USG institution for five or more FTE years within eight years of entry. Results are estimated with multiple imputation linear probability models that include the full set of controls. See Table 11 for details. Standard errors are clustered by institution and reported in parentheses.

Source: University System of Georgia administrative records.

Table 14. Estimates of the effect of the Pell Grant eligibility change on bachelor's degree attainment by HOPE scholarship receipt in 5 FTE year and receipt of two Pell awards in 2009-10/2010-11

	(1)	(2)	(3)
	BA before 6 FTE year	BA w/in 8 years of entry	BA ever
A. Received Georgia HOPE Scholarship in 5 FTE year			
No	0.013	0.031**	0.014
	(0.021)	(0.015)	(0.017)
Yes	-0.015	-0.002	0.002
	(0.037)	(0.025)	(0.023)
Tests of equal effects (p-values)	0.563	0.265	0.636
R^2	0.638	0.797	0.831
Comparison mean post-2011: Did not receive HOPE	0.509	0.702	0.747
Comparison mean post-2011: Received HOPE	0.770	0.897	0.909
Observations		16,588	
B. Received two Pell awards in 2009-10/2010-11			
No	0.021	0.024	0.010
	(0.025)	(0.018)	(0.021)
Yes	-0.018	0.019	0.006
	(0.030)	(0.023)	(0.026)
Tests of equal effects (p-values)	0.359	0.880	0.901
R^2	0.633	0.795	0.829
Comparison mean post-2011: Did not receive two Pell awards	0.539	0.704	0.753
Comparison mean post-2011: Received two Pell awards	0.550	0.764	0.792
Observations		16,588	

*** $p<0.01$ ** $p<0.05$ * $p<0.10$

Notes: The sample is restricted to matched students who attended a USG institution for five or more FTE years within eight years of entry. Results are estimated with multiple imputation linear probability models that include the full set of controls. See Table 11 for details. Standard errors are clustered by institution and reported in parentheses.

Source: University System of Georgia administrative records.

Table 15. Robustness of estimates of effects on bachelor's degree attainment overall and time to degree completion to alternative matching solutions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Main Sample		Alternative Matched Samples					
	Matched (CEM)	Unmatched (OLS)	CEM	CEM	CEM	CEM	CEM	PSM
A. BA before 6 FTE year	0.006	-0.011	-0.005	0.004	0.005	0.018	-0.003	0.006
	(0.018)	(0.015)	(0.011)	(0.013)	(0.016)	(0.015)	(0.031)	(0.017)
B. BA w/in 8 years of entry	0.024*	0.019*	0.004	0.008	0.012	0.022	0.035	0.031**
	(0.013)	(0.011)	(0.013)	(0.015)	(0.016)	(0.015)	(0.022)	(0.013)
C. BA in years 6-8 since entry	0.031**	0.092***	0.063***	0.025	0.025	0.031	0.037*	0.054***
	(0.014)	(0.013)	(0.015)	(0.018)	(0.019)	(0.018)	(0.021)	(0.010)
D. BA ever	0.010	0.009	-0.006	-0.001	-0.010	0.015	0.019	0.017
	(0.016)	(0.012)	(0.013)	(0.015)	(0.014)	(0.015)	(0.022)	(0.013)
Covariates used in matching solution								
Cohort	✓		✓	✓	✓	✓	✓	✓
Post-2011 Enrollment Status	✓		✓	✓	✓	✓	✓	✓
Enrolled Continuously in Years 1-4	✓			✓	✓	✓	✓	✓
Credits Att. at Start of 5 FTE Year	✓			✓	✓	✓	✓	✓
Years to 5 FTE Status	✓			✓	✓	✓	✓	✓
Gender	✓				✓		✓	✓
Race	✓				✓		✓	✓

Table 15. Robustness of estimates of effects on bachelor's degree attainment overall and time to degree completion to alternative matching solutions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Main Sample		Alternative Matched Samples					
	Matched (CEM)	Unmatched (OLS)	CEM	CEM	CEM	CEM	CEM	PSM
EFC in 5 FTE Year	✓					✓	✓	✓
Credits Earned at Start of 5 FTE Yr							✓	
Cum GPA at Start of 5 FTE Yr							✓	
Observations	16,588		26,031	25,995	24,844	20,148	8,678	16,588

*** p<0.01 ** p<0.05 * p<0.10

Notes: All samples are restricted to degree-seeking entrants to public, four-year institutions in Georgia from 2002-2008, inclusive, who attended a public, four-year institution for five or more FTE years within eight years of entry. Students with a record of transfer into USG after initial entry are excluded. Results are estimated with linear probability models that include the full set of controls. See Table 11 for details. Results in column 2 control for the covariates used in matching instead of weighting by the matched stratum. Results in column 8 use propensity score matching to estimate the probability of 5 Pell FTE attainment separately by post-2011 enrollment status and then match students with the same enrollment status and similar predicted probabilities (i.e., within +/- 0.05 percentage points). Standard errors are clustered by institution and reported in parentheses.

Source: University System of Georgia administrative records.

IV. CONCLUSION

The magnitude of dropout in the U.S. higher education system, and its implications on the life outcomes for millions of Americans, calls for greater efforts to support students along the path to degree completion. In this dissertation, I examine new avenues for increasing degree attainment by examining the scope and cause of dropout among students who make considerable academic progress towards their degree requirements. Results from the first study indicate that late departure from college is widespread, especially at two- and open-admission four-year institutions, where nearly 20 percent and 14 percent of students respectively began their college careers but dropped out after earning three-quarters of the credits typically required for graduation.

To begin to understand why students drop out late into college, I conducted a quasi-experimental study of the effects of exhausting eligibility for need-based aid on bachelor's degree completion in part two of my dissertation. This study was motivated by the premise that college affordability may present a growing challenge to students over time for two reasons. First, as students age in school, they are more likely to assume family responsibilities that contribute to financial constraints (Erisman & Steele, 2015; U.S. Department of Education, 2017). Second, time limits on the availability of need-based aid can result in the sudden exhaustion of tuition subsidies, and older students may not offset grant reductions with additional borrowing due to credit constraints and loan aversion (Boatman et al., 2017; Gichevu et al., 2012; Goldrick-Rab & Kelchen, 2015). On the other hand, if students weigh the marginal costs and benefits to attendance when considering whether to re-enroll, the effect of financial aid on persistence and attainment may diminish as students get close to earning their degree.

The findings from the second study indicate that losing financial aid very late into college is not a major driver of college late departure for students who have already been in college for at least 5 full-time equivalent years. In fact, for students who demonstrate a sustained commitment to finishing college, setting more stringent time limits on the availability of need-based grants accelerated time to completion without decreasing overall graduation rates. These results spur important questions about how financial aid is allocated throughout college to best support students, but leave open the question that initially motivated the study. Future research might address whether financial aid programs that have more binding lifetime limits also produce degree acceleration effects and whether reallocating instead of eliminating late-stage aid impacts degree attainment and time to completion in different ways.

In addition, several other factors that may explain why students leave college within reach of graduation warrant further study. One possibility, consistent with the findings in study one, is that academic challenges may intensify as students transition into more rigorous, upper division coursework. My results in study one indicate that late dropouts have a harder time passing coursework as they progress in school compared to graduates, and late dropouts may only need to pass three or four additional courses in their major to graduate. If specific courses require competencies which students have not developed and the psychic and effort costs of acquiring those skills are sufficiently high, even a few courses that stand between students and their degrees may lead students to withdraw and require intensive academic supports to mitigate late dropout.

Even if students possess the skills to finish, unanticipated economic shocks and life events, such as job loss, illness, housing instability, and food insecurity, may derail students on the path to completion. Nearly one-half of full-time college students work while attending school, and those who do average more than 20 hours per week on the job (Scott-Clayton, 2012). Likewise, new research finds that approximately half of college students are food insecure, and one-third of community college students live in unstable housing arrangements (Broton & Goldrick-Rab, 2017). Given the incidence of employment and economic insecurity among college-goers, unanticipated shock events may be a common occurrence, especially at broad-access institutions where late dropout is most prevalent. If this is a primary determinant of late departure, then addressing students' material hardships may be an essential component to increasing college completion rates.

Another potential explanation is that the road to completion becomes increasingly self-directed as structured student supports taper off after the first year of college (Scott-Clayton, 2015). Students may therefore struggle to make and follow through on complicated decisions, such as determining which courses to take to fulfill their degree requirements, when academic advising is limited and difficult to access. The psychic costs to navigating a challenging environment alone may also be difficult for older students who lead busy lives and have limited networks of academic support outside of school. These potential barriers suggest that providing students with information to simplify decision-making, guidance on where they can turn for help, and encouragement to persist in school could meaningfully increase degree completion and lower attainment gaps.

Finally, some students who drop out late into college may simply decide that the costs in terms of foregone wages exceed the benefit. This may partly reflect impulsivity on the part of students, as impatient individuals appear more likely to drop out late, tend to regret that decision in the future, and experience lower earnings later in life (Cadena & Keys, 2015). But dropout may also be an optimal economic decision for some because educational investments are uncertain (Lee, Yoon, & Lee, 2015; Stange, 2012). This may be true in particular for students in fields where labor market returns to skill acquisition are high and the marginal value to degree completion is low or highly variable (e.g., graphic design or web development).

Although late departure is likely to be an optimal human capital investment decision for some, providing students with more support towards the end of college is also likely to benefit many given the pervasiveness of college late departure and the high returns to degree completion for most students. In ongoing work, I am therefore continuing to explore why students drop out late and how interventions can help them finish.

In 2015, I initiated a study with Ben Castleman and Eric Bettinger to design an experimental intervention intended to address the limited advising and psychological challenges that may prevent students from taking the final steps to earning their degree. Through the Nudges to the Finish Line (N2FL) intervention, we are examining the impact of providing students who have completed at least half of the credits typically required for graduation with text messages containing: 1) information to simplify decision-making in college, 2) guidance on where students can turn for help, and 3) encouragement to persist in school.

Our findings from the first-year of intervention in 2016-17 at nine community colleges and broad-access four-year institutions across five states suggest that many students within reach of graduation stand to benefit from more outreach. Students who received outreach were 14 percent less likely to withdraw between fall 2016 and spring 2017, and treated students at high risk of dropout were 38 percent more likely to graduate after one year. These impacts, while preliminary, were generated from an intervention that cost only $100 per student, including start-up costs, and compare favorably to cost-effective interventions that target students at earlier points along the degree pipeline and that are more resource-intensive (Bettinger & Baker, 2014; Castleman & Page, 2015).

Over the next two years, we are expanding the study to include 25,000 students at approximately 20 institutions to examine effects on persistence and completion over a longer time horizon and at scale for this student population. In future work, I am also interested in exploring the efficacy of technology-assisted academic advising to help clarify for students what courses they must take to graduate. According to survey research, one-third of community college students never use academic advising even though nearly half of students do not understand their graduation requirements or what courses count towards their degree (Center for Community College Student Engagement, 2015; Rosenbaum, Deil-Amen, & Person, 2006). Interventions that build upon existing technology solutions, such as using degree audit tools to send a list of outstanding course requirements to students before registration begins or default-registering students into courses they must take to graduate, may enhance the effectiveness of investments institutions are already making to support students. They may also provide valuable insights into the most acute challenges that make the disconnection between degree intention and attainment an unintended, but defining feature of higher education in the United States.

APPENDIX A: Study 1 Supplemental Figures and Tables

Figure A1. The share of college entrants that are late dropouts at four-year institutions, by race/ethnicity

A. Four-Year Open Admissions Institutions

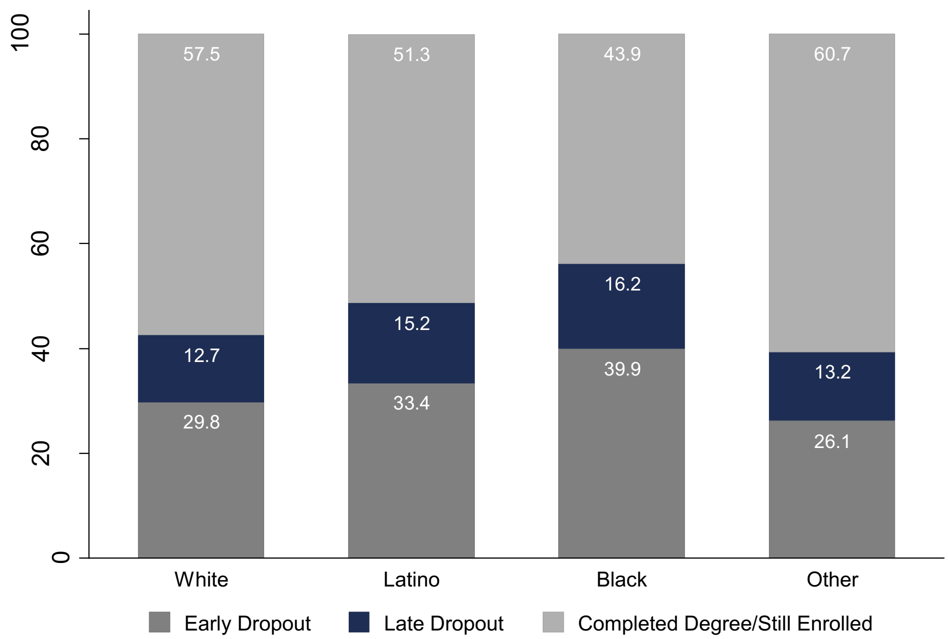
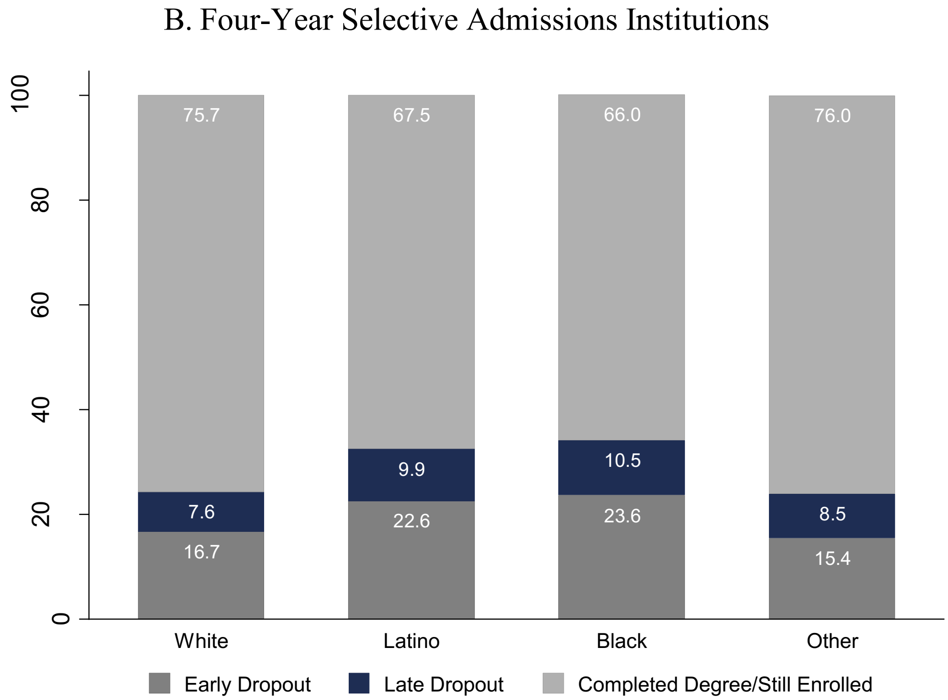


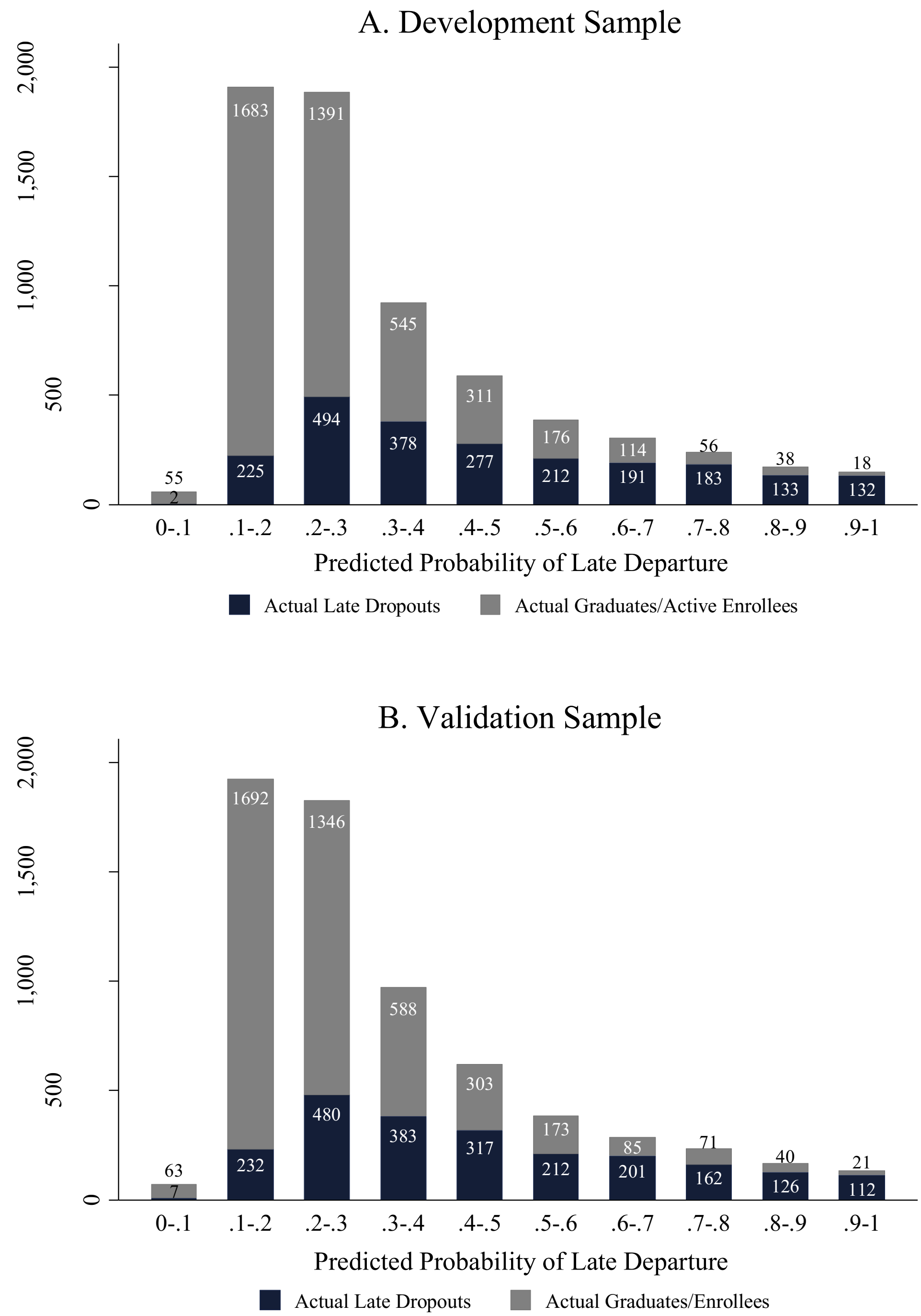
Figure A1, Continued. The share of college entrants that are late dropouts at four-year institutions, by race/ethnicity



Notes: The sample is comprised of all degree-seeking undergraduates ages 17-19 at high school graduation with non-missing pre-and post-entry data who enrolled at least half-time at public postsecondary institutions in Florida and Ohio within 16 months of high school completion. Outcomes are reported through six years following initial college enrollment. Early dropouts capture students who withdrew prior to earning three-quarters of the college-level credits typically required to graduate. Students who surpassed the three-quarter credit threshold before dropping out are captured as late dropouts. Students who graduated within six years of entry or who were actively enrolled in year 7 are captured in the completed degree/still enrolled category.

Sources: Florida Department of Education and Ohio Board of Regents.

Figure A2. Observed enrollment outcomes by the predicted probability of late departure, among students who first attended two-year colleges



Notes: The sample is comprised of degree-seeking undergraduates ages 17-19 at high school graduation with non-missing pre-and post-entry data who enrolled at least half-time at public institutions in Florida and Ohio within 16 months of high school completion and completed 75 percent or more of the college-level credits typically required for graduation. Predicted probabilities are derived from logit regression models that include the predictors in Model 1 of Table 6. See Table 6 for details.

Source: Florida Department of Education and Ohio Board of Regents.

Table A1. Sample departure rates by credit completion status and college sector

	(1)	(2)	(3)	(4)
	2-Yr	4-Yr Open Admissions	4-Yr Selective	All
Share of departures among students that…	Panel A. Before 25% of credits completed			
Ever enrolled in college	0.197	0.133	0.064	0.135
Reached the credit threshold	0.197	0.133	0.064	0.135
	[22,499]	[12,318]	[19,195]	[54,012]
Ever dropped out	0.343	0.291	0.248	0.310
	Panel B. 25-50% of credits completed			
Ever enrolled in college	0.108	0.108	0.061	0.091
Reached the credit threshold	0.136	0.125	0.065	0.106
	[17,915]	[10,614]	[17,881]	[46,410]
Ever dropped out	0.188	0.236	0.235	0.209
	Panel C. 50-75% of credits completed			
Ever enrolled in college	0.072	0.080	0.053	0.067
Reached the credit threshold	0.106	0.108	0.061	0.088
	[15,259]	[9,120]	[16,603]	[40,982]
Ever dropped out	0.124	0.175	0.205	0.153
	Panel D. 75% or more of credits completed			
Ever enrolled in college	0.198	0.136	0.080	0.142
Reached the credit threshold	0.337	0.213	0.102	0.212
	[13,228]	[7,900]	[15,150]	[36,278]
Ever dropped out	0.345	0.299	0.312	0.327

Notes: The sample is comprised of degree-seeking undergraduates ages 17-19 at high school graduation with non-missing pre-and post-entry data who enrolled at least half-time at public institutions in Florida and Ohio within 16 months of high school completion. The number of students that ever enrolled at 2-, 4-year open admission, and 4-year selective institutions are 22,499, 12,318, and 19,195, respectively. The numbers of students that ever dropped out are 12,943, 5,618, and 4,947, respectively. The numbers of students that reached each credit threshold are reported in brackets.

Sources: Florida Department of Education; Ohio Board of Regents.

Table A2. Conditional probabilities of departure by credit completion status and college sector (N = 177,331)

	(1)	(2)	(3)	(4)	(5)	(6)
		Model 1			Model 2	
Proportion of college-level credits completed	2-Yr	4-Yr Open Admissions	4-Yr Selective Admissions	2-Yr	4-Yr Open Admissions	4-Yr Selective Admissions
0-25%	0.193	0.131	0.063	0.174	0.114	0.056
	(0.172 - 0.213)	(0.110 - 0.152)	(0.038 - 0.087)	(0.162 - 0.186)	(0.102 - 0.126)	(0.047 - 0.065)
25-50%	0.134	0.123	0.063	0.113	0.115	0.061
	(0.125 - 0.142)	(0.113 - 0.133)	(0.048 - 0.079)	(0.104 - 0.121)	(0.106 - 0.124)	(0.055 - 0.067)
50-75%	0.104	0.105	0.060	0.098	0.112	0.058
	(0.095 - 0.112)	(0.094 - 0.116)	(0.044 - 0.076)	(0.086 - 0.109)	(0.101 - 0.123)	(0.049 - 0.067)
75% or more	0.336	0.209	0.100	0.377	0.242	0.116
	(0.308 - 0.364)	(0.179 - 0.239)	(0.074 - 0.127)	(0.336 - 0.418)	(0.207 - 0.277)	(0.091 - 0.141)
χ^2 test: Is the probability of departure equal across credit intervals?	**771.8** (0.001)	**36.96** (0.001)	**14.27** (0.007)	**226.4** (0.001)	**44.55** (0.001)	**29.47** (0.001)
χ^2 test: Is the probability of late departure equal across college sectors?		**144.7** (0.001)			**220.5** (0.001)	
Demographic + college experience controls					✓	

Notes: The sample is comprised of degree-seeking undergraduates ages 17-19 at high school graduation with non-missing pre-and post-entry data who enrolled at least half-time at public institutions in Florida and Ohio within 16 months of high school completion. Conditional probabilities are estimated from logistic regression models using the student-by-credit category dataset. See text for details. The covariates in Model 2 include: indicators for gender and race; high school GPA and GPA squared; whether the student entered college immediately following high school graduation; whether the student took one or more remedial education courses; whether the student stopped out at least once prior to exceeding credit threshold c; whether the student ever transferred schools prior to exceeding credit threshold c; age at the time the student reached credit threshold c and the square of this term; number of terms between the time each credit period was reached and initial college entry; average term GPA in each credit period; average number of credits attempted per semester in each credit period; and the average proportion of credits earned per semester in each credit period. Lower and upper bounds of the 95% confidence interval around fitted probabilities are reported in parentheses and account for the clustering of students within schools. Adjusted p-values that account for multiple hypothesis testing are shown in parentheses below chi-square statistics. Point estimates in bold are statistically significant at the .10 level.

Sources: Florida Department of Education; Ohio Board of Regents.

Table A3. The evolution of academic performance in the last three terms of enrollment among students who withdrew from college after completing 75% or more of their college-level credits (N = 22,401)

	(1)	(2)	(3)
	Term credits attempted	Term credits completed	Term GPA
Penultimate term (t-1)	-0.288***	-0.493***	-0.015
	(0.067)	(0.088)	(0.013)
Final term (t)	-1.476***	-2.161***	-0.120***
	(0.085)	(0.127)	(0.020)
Constant	12.036***	9.481***	2.388***
	(0.300)	(0.263)	(0.039)
R^2	0.018	0.029	0.003

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

Notes: The sample is comprised of degree-seeking undergraduates ages 17-19 at high school graduation with non-missing pre-and post-entry data who enrolled at least half-time at public institutions in Florida and Ohio within 16 months of high school completion and completed 75 percent or more of the college-level credits typically required for graduation. The analytic window is restricted to student-by-term observations in late dropouts' last three terms of enrollment. All results are estimated from ordinary least squares models. The omitted category is students' third-to-final term. Standard errors, clustered by institution, are reported in parentheses.

Sources: Florida Department of Education; Ohio Board of Regents.

APPENDIX B: Study 2 Supplemental Tables

Table B1. Robustness of estimates of the effect of the Pell Grant eligibility change on financial aid receipt in terms following 5 FTE attainment

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Not conditioned on enrollment				Restricted to enrolled terms only			
	Baseline model and sample	+ Student fixed effects	Sample restricted to balanced panel	Sample restricted to graduates	Baseline model and sample	+ Student fixed effects	Sample restricted to balanced panel	Sample restricted to graduates
A. Pell Grant Aid	-443.29***	-412.16***	-491.65***	-498.14***	-582.16***	-524.80***	-720.49***	-630.90***
	(58.116)	(55.273)	(85.981)	(54.962)	(57.032)	(55.361)	(96.253)	(57.253)
R^2	0.220	0.521	0.279	0.188	0.202	0.563	0.251	0.200
Baseline mean	$1,327	$1,327	$1,020	$1,822	$1,826	$1,826	$1,751	$2,019
B. Other grant aid	30.150	29.744	69.569*	35.896	49.772	33.844	73.787	42.139
	(25.108)	(36.514)	(38.657)	(31.685)	(32.955)	(46.925)	(50.875)	(40.983)
R^2	0.092	0.663	0.076	0.095	0.098	0.700	0.084	0.099
Baseline mean	$53	$53	$22	$81	$74	$74	$35	$88
C. Loans	408.054***	376.561**	616.808**	495.069**	454.952**	328.274*	766.637**	324.885
	(145.994)	(183.285)	(286.449)	(187.356)	(195.708)	(181.517)	(319.471)	(202.715)
R^2	0.131	0.571	0.134	0.151	0.158	0.665	0.172	0.170
Baseline mean	$2,714	$2,714	$2,194	$3,381	$3,769	$3,769	$3,787	$3,751
D. Total financial aid	7.540	18.613	218.855	42.834	-60.062	-132.788	153.354	-255.511
	(166.901)	(216.315)	(331.253)	(203.457)	(210.731)	(230.819)	(357.189)	(215.072)
R^2	0.180	0.541	0.183	0.185	0.196	0.641	0.185	0.211

Table B1. Robustness of estimates of the effect of the Pell Grant eligibility change on financial aid receipt in terms following 5 FTE attainment

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Not conditioned on enrollment				Restricted to enrolled terms only			
	Baseline model and sample	+ Student fixed effects	Sample restricted to balanced panel	Sample restricted to graduates	Baseline model and sample	+ Student fixed effects	Sample restricted to balanced panel	Sample restricted to graduates
Baseline mean	$4,103	$4,103	$3,239	$5,292	$5,679	$5,679	$5,577	$5,868
Student-by-term observations	104,596	104,596	33,512	80,398	92,545	94,731	27,402	76,427

*** p<0.01 ** p<0.05 * p<0.10

Notes: The sample is restricted to matched students who attended a USG institution for five or more FTE years within eight years of entry. The analytic window is restricted to four terms preceding and three terms following 5 FTE attainment, with terms after 5 FTE years defined as treated terms. Student-by-term observations following bachelor's degree receipt and summer terms are excluded. In columns (3) and (7), the analytic window is further restricted to students who did not graduate before two terms following 5 FTE attainment. Results are estimated with multiple imputation OLS models that control for: race (Black, Hispanic, Asian, Other, and Missing race/ethnicity); U.S. citizenship status; Georgia residency status; initial degree pursued; remedial assignment at entry; SAT math and verbal scores (imputed where missing); age at entry; and student's Expected Family Contribution at entry (imputed where missing). All models also include institution fixed effects, linear time trends allowed to vary by treatment status and before versus after the policy change, and a constant. Robust standard errors, clustered by institution, are shown in parentheses.

Source: University System of Georgia administrative records.

Table B2. Robustness of effect estimates on the probability of re-enrollment, credits attempted and earned, and GPA in terms following 5 FTE attainment

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Not conditioned on enrollment				Restricted to enrolled terms only			
	Baseline model and sample	+ Student fixed effects	Sample restricted to balanced panel	Sample restricted to graduates	Baseline model and sample	+ Student fixed effects	Sample restricted to balanced panel	Sample restricted to graduates
A. Re-enrolled	0.028***	0.026**	0.056**	0.027***				
	(0.010)	(0.011)	(0.023)	(0.008)				
R^2	0.154	0.371	0.212	0.0315				
Baseline mean	0.835	0.835	0.704	0.947				
B. Term credits attempted	0.473**	0.413*	0.636**	0.632***	0.225	0.165	-0.047	0.306*
	(0.184)	(0.207)	(0.308)	(0.210)	(0.140)	(0.162)	(0.228)	(0.167)
R^2	0.161	0.393	0.202	0.0701	0.0701	0.350	0.0714	0.0637
Baseline mean	10.39	10.39	8.616	11.98	12.41	12.41	12.25	12.64
C. Term credits earned	0.470***	0.348*	0.481	0.678***	0.295**	0.110	0.124	0.388**
	(0.163)	(0.186)	(0.311)	(0.187)	(0.144)	(0.154)	(0.300)	(0.152)
R^2	0.158	0.411	0.200	0.0677	0.0734	0.362	0.0857	0.0567
Baseline mean	9.13	9.134	6.947	11.07	10.9	10.90	9.802	11.69
D. Term GPA					0.026	-0.000	0.098*	0.035
					(0.035)	(0.038)	(0.056)	(0.036)
R^2					0.0804	0.595	0.0779	0.0803
Baseline mean					2.545	2.545	2.112	2.752

Table B2. Robustness of effect estimates on the probability of re-enrollment, credits attempted and earned, and GPA in terms following 5 FTE attainment

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Not conditioned on enrollment				Restricted to enrolled terms only			
	Baseline model and sample	+ Student fixed effects	Sample restricted to balanced panel	Sample restricted to graduates	Baseline model and sample	+ Student fixed effects	Sample restricted to balanced panel	Sample restricted to graduates
Student-by-term observations	104,596	104,596	33,512	80,398	94,731	94,731	27,402	76,427

*** p<0.01 ** p<0.05 * p<0.10

Notes: The sample is restricted to matched students who attended a USG institution for five or more FTE years within eight years of entry. The analytic window is restricted to four terms preceding and three terms following 5 FTE attainment, with terms on or after 5 FTE years defined as treated terms. Student-by-term observations following bachelor's degree receipt and summer terms are excluded. In columns (3) and (7), the analytic window is further restricted to students who did not graduate before two terms following 5 FTE attainment. Results are estimated with multiple imputation OLS models that control for: race (Black, Hispanic, Asian, Other, and Missing race/ethnicity); U.S. citizenship status; Georgia residency status; initial degree pursued; remedial assignment at entry; SAT math and verbal scores (imputed where missing); age at entry; and student's Expected Family Contribution at entry (imputed where missing). All models also include institution fixed effects, linear time trends allowed to vary by treatment status and before versus after the policy change, and a constant. Robust standard errors, clustered by institution, are shown in parentheses.

Source: University System of Georgia administrative records.

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