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The Path to Timely Completion: Supply- and Demand-Side Analyses of Time to Bachelor's Degree Completion

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The Path to Timely Completion: Supply- and Demand-Side Analyses of Time to Bachelor's Degree Completion

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Dedication

To my beloved husband and family

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The Path to Timely Completion: Supply- and Demand-Side Analyses of Time to Bachelor's Degree Completion

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Time to degree is a key factor in institutional productivity and managing the costs of college for students and families. While there is a robust body of empirical and theoretical work addressing baccalaureate degree completion and persistence, much less is known about the factors that affect time to degree. Most importantly, the institutional factors associated with time to degree have been largely unexamined, with a primary focus on the characteristics of students who delay graduation. As a result, it is unclear if students or institutions should be the target of policy interventions. This dissertation is comprised of three quantitative studies that examine supply- and demand-side factors that contribute to timely—or not so timely—completion using statewide longitudinal student-level data from Texas. The first study uses a discrete-time hazard model to analyze a rich set of institutional and student factors that influence the choice between on-time graduation, late graduation, dropout, and ongoing enrollment. The second explores the impact of student transfer on time to degree and one possible mechanism for delay using propensity score matching analysis. The third examines excess credit accumulation, specifically how the number of credits an institution requires for graduation affects student course-taking behavior using fixed effects analysis. Results suggest time to degree is a complex phenomenon and both

student and institutional factors are significantly associated with time to degree. Student transfer and credit requirements are associated with excess credit accumulation and longer times to degree. Supply side policy strategies targeting institutional resources, transfer, and graduation credits are promising, although there is evidence that strategies aimed at improving efficiency can be in tension with strategies that improve equity in higher education and degree completion.

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Chapter 1: Introduction

Time to degree is a key factor in improving college graduation rates and increasing institutional productivity. While there is a growing body of empirical and theoretical work addressing baccalaureate degree completion and persistence, much less is known about the factors that affect time to degree. Most importantly, the institutional factors associated with time to degree have been largely unexamined. Previous studies focus primarily on the characteristics of students who delay graduation. As a result, it is unclear if students or institutions should be the target of policy interventions. This dissertation is comprised of three quantitative studies that examine supply-side and demand-side factors that contribute to timely—or not so timely—completion. The first study examines a rich set of institutional and student factors that influence the choice between on time graduation, late graduation, dropout and ongoing enrollment. The second study analyzes the effect of transfer on time to degree and explores credit loss at the point of transfer as a mechanism for delay. The third study examines excess credit accumulation, specifically how graduation requirements affect student course-taking behavior.

Time to degree is a salient productivity question for study because of tightening state budgets and a shift in accountability for higher education to focus on measurable outcomes. Time to degree is a pragmatic efficiency measure designed to gauge the output of institutions of higher education (Slichter, 1947). Policymakers are asking how we can produce graduates for the lowest cost, with a minimum of waste and expenditure of resources. The topic is particularly prominent in Texas, the state analyzed in all three studies here. William J. Powers, president of the state flagship university in Texas, declared that the issue of timely graduation is:

> *"… as serious as any other in higher education. We wouldn't voluntarily pay 20 percent extra for a car, a house, or any other major purchase. University leaders must first smooth the path for timely graduation by taking a hard look at degree requirements and ensuring students can get the classes they need. Then, for students' own good, we must be bolder in pushing them out of the nest" (February 29, 2012).*

Others argue that delayed graduation is not only inefficient but that "time is the enemy" because the longer students are enrolled, the less likely they are to ever complete a degree. As time goes on, students run out of private financial resources, exhaust financial aid, experience health problems, find jobs, get married, and have children—activities that are associated with dropout (Complete College America, 2012). Texas Governor, Rick Perry asserted in his 2013 state of the state address that:

> *"…[Graduating] on time is a problem we simply can't ignore anymore. Currently less than 30 percent of full-time students at our four-year institutions graduate in four years, and only 58 percent have their degree in six. That's why we should tie at least a portion of state funding - I'm suggesting a minimum of 10 percent - based on the number of graduates" (January 29, 2013)*

Institutional and state policymakers have begun experimenting with intuitively appealing policy remedies such as charging higher tuition to students who delay graduation, implementing financial aid programs that incent on time completion, capping the number of credits required for graduation, and funding institutional performance based on productivity measures (Volkwein & Lorang, 1996; Groves, 2007). And yet, policy design and implementation decisions are being made without a sophisticated research basis to match the causes and consequences of time to degree with policy strategies. There is little nuanced debate about either the possible efficiencies in the status quo or which valued outcomes policy should attempt to maximize—and for whom. As Aaron Wildavsky observed in 1979, "technical efficiency does not tell you where to go, only that you should arrive there with the least possible effort." Efficiency is thus not a goal in itself. It helps us attain more of the things we value (Stone, 1988).

I argue that time to degree is a useful productivity measure that is worthy of study, but recognize it has many limitations as a single indicator of success in higher education. What is valued among policymakers—in this case degree production—may not be what is valued by faculty, who are both an input in the efficiency equation and an output in terms of research and service to institutions and the community at large. The value for students in extending time to degree may be in academic exploration, opportunities to develop human capital and to explore intellectual interests. It is also important to consider the equity dimensions of time to degree. For example, it may be the case that marginal students—those on the cusp of participation in higher education or completion—may now be participating and graduating more often than in previous decades. Extensions in time to degree may be the cost of improving overall access and equity among historically underrepresented populations, including low-income students, minority students, or students who attend college part-time in order to finance their education through work rather than student loans. Therefore, punitive policies – such as charging higher tuition to extenders – may adversely affect larger state policy goals to increase degree completion and close achievement gaps (Campbell, 1979).

Fortunately, efficiency and equity are not incompatible priorities (Stone, 1988). The art of policy decision making is to enable individuals to maximize their own benefits and to encourage them to exhibit a commitment to shared community needs (Etzioni, 1988). In this spirit, the studies in this dissertation seek to inform how we define the problem of time to degree as well as suggest policy levers and considerations for policy implementation that maximize individual and community values. Together, the three studies offer a nuanced analysis of time to degree and present new evidence about the heterogeneous effects of efficiency improvements on different student populations.

The first study uses a discrete-time hazard model to analyze two complementary sources of data: statewide longitudinal student-level data from the Texas Higher Education Coordinating Board[1] and institutional data from the Integrated Postsecondary Education Data System (IPEDS). Unlike many previous studies of time to degree, which analyze data from a single institution, this study includes detailed information about

[1] The research presented here utilizes confidential data from the State of Texas supplied by the Texas Education Research Center (ERC) at The University of Texas at Austin. The authors gratefully acknowledge the use of these data. The views expressed are those of the authors and should not be attributed to the ERC or any of the funders or supporting organizations mentioned herein, including The University of Texas, the State of Texas, or the study's sponsor. Any errors are attributable to the authors.

institutional expenditures, faculty resources, and student populations served by all Texas institutions of higher education. Results suggest time to degree is a complex phenomenon and both student and institutional factors are significantly associated with it. On-time graduates come to college with the advantages of socioeconomic background and strong academic preparation. Students make tradeoffs among competing outcomes including timely graduation, late graduation, dropout, and ongoing enrollment. Some strategies used by low-income students slow completion but enable persistence. Full-time faculty are consistently and positively associated with on-time completion for students from various backgrounds and educational pathways, although there are significant heterogeneous effects of other institutional inputs.

The second study examines student mobility across institutions of higher education and the impact of transfer on graduation, credit accumulation, and time to degree. Many students now earn credits at multiple institutions of higher education on their way to completing a bachelor's degree. The effects of transfer on degree attainment and years of education accumulated have been studied, with a primary focus on the contributions or drawbacks of community college education. This paper extends the literature regarding the effect of transfer on higher education outcomes to include issues of time to degree by asking, "Does transfer accelerate or extend time to degree?" The focus of this study is less on the role community colleges play in higher education attainment; instead, it more generally examines the issue of student mobility from a transfer policy perspective. This study tests whether the effects of transfer differ among vertical transfer students (who move from two-year to four-year institutions) and lateral transfer students (who move from four-year to four-year institutions) and whether credit loss at the point of transfer is a mechanism for extending time to bachelor's degree completion. Using propensity score matching on statewide longitudinal data from 2004 to 2012, I find that transfer extends time to degree by almost one extra term, contributes to the accumulation of 7.6 excess credits at graduation, and decreases degree completion by approximately 17 percentage points for all transfer students. Although lateral transfer students have modestly shorter times to degree, graduation and credit accumulation penalties are larger for lateral transfers than vertical transfers—results that support the credit loss hypothesis.

The third study focuses on excess credit accumulation as a mechanism for extending time to degree and assesses whether limitations on the number of credits an institution can require for graduation is an effective policy lever for reducing time to degree. The majority of students who complete a bachelor's degree attempt more credits than are required to graduate and take more than four years to complete a degree. I examine trends in credit requirements, time to degree, and excess credits 2003-2012. I explore two definitions of *excess credit requirements*, one that uses the minimum credits required by the state for graduation and another that is specific to a student's institution and major. I observe variation in credit requirements over time, which I leverage to estimate the effects of credit requirements using fixed effects models. In response to reductions in credit requirements, I find that students take fewer required courses; however, they attempt more elective courses. The tradeoff produces a small positive effect on time to degree. Results suggest credit requirement policies can reduce some types of excess credits, but used in isolation these policies may shift rather than reduce student demand for excess courses. Implications for measuring and tracking excess credits as well as policy implementation are discussed.

Each of the three studies highlights a unique dimension of the complex phenomena of time to degree. Beyond the topical consistency, chapters have a common theoretical approach. In the tradition of policy research, each study integrates theory from multiple disciplines. Studies draw primarily on human capital and education production function models of individual and institutional behavior and integrate ideas from social capital, education psychology, and organizational theories. I employ diverse econometric methods most appropriate for the questions at hand, with particular attention to the treatment of time.

Chapters also share three common themes. First, each study explores the central role of institutions in shaping collective behavior and outcomes (Ostrom, 2007). A second theme is that time to degree is but one possible measure of institutional productivity and there are myriad reasons why students delay graduation. Third, each study investigates the tension between efficiency and equity in accelerating time to degree by providing evidence about possible negative consequences for subpopulations of students (Wildavsky, 1979; Stone, 1988).

This dissertation concludes with a summary of findings and recommendations for policy and future research. Results provide insights into potential policy levers, which are available to legislators and institutional administrators who seek to improve timely degree completion. Appropriations for public institutions of higher education, institutional resource allocations and policies, transfer rules and incentives, and graduation requirements receive particular attention.

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Chapter 2: The Effects of Institutional Inputs on Time to Degree[2]

INTRODUCTION

National and state trends indicate many graduates do not complete their bachelor's degrees in a timely fashion. Forty-four percent of students in the 2008–2009 cohort of the Baccalaureate and Beyond Longitudinal Study graduated in four years, 23 percent in five years, and 9 percent in six years. Median time to degree in 2008 was 52 months, seven months longer than a traditional four-year program (U.S. Department of Education, National Center for Education Statistics, 2011). While there is meaningful variation across sectors of higher education, the phenomenon of untimely degree completion is present across all types of higher education institutions, from community colleges to highly selective four-year institutions. Approximately one in three students at selective flagship institutions graduates in four years; at less selective colleges, only one in four graduates on time (Bowen, 2009). Importantly, extended time to graduation has occurred during a time of significant expansion in access to higher education coupled with increasing public and private costs of undergraduate education. It is unclear if extended time to degree is a positive reflection of new opportunities to gain a degree while balancing work and family demands or a negative reflection of wasted resources and inefficiency of institutions of higher education. The answer to this

[2] This chapter is co-authored with Dr. Jane Arnold Lincove. Dr. Cullinane wrote the following sections: introduction, background, theoretical framework, empirical evidence on time to degree, empirical strategy. Dr. Lincove wrote the results section. The authors co-wrote the conclusion.

question requires empirical evidence about how and why students require more than four years to graduate.

This study expands upon recent studies identifying individual student characteristics and institutional characteristics that influence time to degree by estimating the effects of changing institutional inputs on time to degree using a data set that includes 99 colleges and universities, while continuing to control for individual characteristics. We apply a competing-risk model where on-time graduation is compared to multiple alternatives, including late graduation, dropout, and remaining in school for more than six years. Our data set allows us to relax many common assumptions from earlier work by allowing institutional inputs to vary over time as students transfer institutions and as inputs shift in response to policy changes. We also include a broader population of students, including those beginning higher education at a two-year college, those transferring across four-year institutions, and those attending part-time. Our results provide new insight into the role of institutional inputs in timely graduation.

Background

In addition to evidence of low four-year graduation rates, there is evidence that extension in time to degree is increasing over time in the United States. Researchers estimate a 14-point reduction in four-year graduation rates from the 1970s to 1990s (Bound, Lovenheim, & Turner, 2012; U.S. Department of Education, National Center for

Education Statistics, 1996, 2003). While there is a growing body of rigorous evidence regarding the factors influencing college graduation, the issue of time to degree has received much less theoretical and empirical attention.

Longer time to degree is perceived as problematic from both private and public perspectives. Increased costs affect students, through tuition and opportunity costs. In Texas, each additional full-time semester costs a student an average of $7,500, plus opportunity costs from delayed workforce entry (Cardona, 2012). When students spend longer occupying rationed seats in higher education institutions, fewer new students are served, and the average public cost per graduate increases. Each Texas public higher education student costs the state an estimated $7,000 in subsidies (U.S. Department of Education, National Center for Education Statistics. (2012b). These costs increase as students extend time to graduation. The Texas Higher Education Policy Institute (2012) estimates that the average undergraduate in Texas acquires 12 credits hours over graduation requirements at an annual cost of $148 million to taxpayers.

With increasing scrutiny on higher education budgets, states are experimenting with ways to cut costs by accelerating graduation time. At the state level, new policies incentivize universities by linking funding to four-year graduation rates. Universities have responded by incentivizing students to finish faster with strategies such as charging higher tuition to extenders, reducing required credits, and providing tuition incentives for on-time completion (Volkwein & Lorang, 1996; Texas Higher Education Coordinating Board, 1996). The policy approaches have potential for the unintended consequence of reducing overall graduation rates by eliminating or taxing flexibility for students who progress at a slower pace. For example, students who combine work and college may drop out without a degree if costs increase in the fifth year.

These policy changes are moving forward despite a lack of empirical evidence regarding the underlying causes and consequences of extended time to degree. It is unclear whether the target of intervention should be students, who may be rationally consuming additional courses, indecisive, underprepared, or unmotivated to complete their degrees quickly, or universities, which may have excessive credit requirements, low investment in faculty, poor advising, or unclear messages to students about ways to accelerate completion. If extensions in time to degree reflect valuable learning experiences that build human capital and increase labor market returns, it is not clear that reducing time to degree increases efficiency from a public perspective.

Many hypotheses exist in the economics and education literature about why college completers do not make timely progress toward a degree. Some suggest that long times to degree stem from characteristics of student demand—students spend time taking more classes because of preferences for double majors or because they lose credits in transfer or changing majors (Pitter, LeMon, & Lanham, 1996; University of Florida, 1995). Others point to lower levels of credits taken per semester caused by the changing demographics of college student populations. For example, first-generation college students might be less well prepared for college, have a greater need to work during schooling, prefer part-time attendance, or lack motivation (DeSimone, 2008;

Bound, Lovenhiem, & Turner, 2010; Volkwein & Lorang, 1996; Gleason, 1993; Hood, Craig, & Ferguson, 1992; Stinebrickner & Stinebrickner, 2003). Student demand and decisions about the pace of college completion may also be shaped by future returns, including wage premiums and employability (Clotfelter, 1991; Clotfelter & Rothschild, 1993; Kienzl, Alfonso, & Melguizo, 2007).

Others identify supply-side factors such as institutional resources, institutional sector characteristics, college costs, and state policy as causes of longer times to degree (Bound et al., 2010; Volkwein, 1986; Kane & Orzag, 2003; Roska & Keith, 2008). Institutional investments in instruction, student support services, and research are hypothesized to accelerate completion, while poor peer quality is thought to lower student outcomes (Webber & Ehrenberg, 2010; Sacerdote, 2001).

The direction of public policy to promote four-year graduation has important equity consequences. If increased time to degree is associated with changing demographics of college students as access to higher education expands (Bound et al., 2012), policies that punish degree extenders might have differential impacts on students from different demographic groups. First-generation college students, many representing minority groups with historically low college access, may be the least likely to graduate on time, and extensions in time to degree may be a necessary trade-off for improving access and equity in higher education. Extension may also be linked to college affordability and student efforts to reduce student loan borrowing by working and paying as they progress. It is important to examine both the distributional equity and efficiency of punitive policies, such as charging higher tuition to extenders, in the context of goals to promote increased access for historically underrepresented groups.

In this paper, we analyze student and institutional characteristics and their influence on time to degree in Texas, including the disaggregated effects on populations with historically low college access. The study uses a discrete-time hazard model to explore the timing of graduation using statewide longitudinal data for students who entered college in 2005 and 2006. Our empirical objective is to identify whether institutional factors that positively influence on-time graduation have similar effects on late graduation and dropout. This provides insight into the important policy question of whether efforts to increase time to degree and overall degree completion are compatible. In the next section, we lay out a theoretical framework that integrates both demand-side (student-level) and supply-side (institutional-level) explanations for time to degree, followed by a review of literature that develops and tests the hypotheses described above. The fourth section describes the methodology and data sources for the study. Results and discussion follow in the fifth and sixth sections.

Theoretical Framework

The study is built upon an integrated theoretical framework that incorporates human capital, social capital, and neo-institutional theory to explain individual and institutional action. Human capital theory (Becker, 1975) establishes that educational outcomes depend on perceived future labor market returns and nonmonetary benefits to schooling investments. Student decisions to complete a degree—and presumably the pace of that completion—are determined by a comparison of educational costs and the returns to education (Sweetland, 1996). Students invest up to the point where the marginal benefits of college equals the marginal costs of another unit of consumption (Clotfelter, 1991). Student decisions not to attend college or to drop out are explained by information about labor market returns to education, their academic ability, or preferences for leisure (Altonji, 1993). Traditional human capital models posit that three main factors influence postsecondary enrollment participation: (1) rate of return to postsecondary education, (2) cost of the education, and (3) resources to pay for college (Betts & McFarland, 1995).

The basic three-part economic model of college student behavior is useful in its parsimony, but it fails to account for the very complex phenomenon of success in higher education. First, the model places no responsibility on institutions for their role in determining student outcomes. If returns, costs, and income alone determine whether students participate and graduate, the actions of institutions are essentially irrelevant except for establishing tuition. The empirical relationship between college quality and workforce outcomes suggest that institutional inputs play an important role in economics of human capital (Long, 2008; Dale & Kreuger, 2002).

Empirical studies suggest that increasing labor market returns to a degree partially explain rising enrollment and completion (Freeman, 1975; Kane & Rouse, 1995; Long, 2010), but high rates of returns are unable to explain some student outcomes, such as low enrollment of black males (Perna, 2000). Human capital theory provides little explanation for the differences in price response across ethnic groups and socioeconomic status (Heller, 1997). Detailed information about labor market returns is not well understood by students, especially underclassmen and minority students (Betts, 1996). Therefore, it seems unreasonable to suggest this is the only driver of student decision-making.

Sociological, organizational, and psychological perspectives on completion, including social capital theory and neo-institutional theory, offer additional explanations of college student outcomes. Social capital theory (Coleman, 1988; Bourdieu, 1986) argues that access to education and returns to schooling are influenced by social networks, neighborhood effects, and family resources. Connections between peers, students and faculty, students and advisors, and students and parents as well as the social environments of education institutions facilitate positive postsecondary outcomes through the communication of expectations (Coleman 1988; Bourdieu, 1986). Empirical research supports the hypothesis that higher levels of parent education, income, involvement, and academic counseling and advising are predictive of positive education outcomes (Hossler, Braxton, & Coopersmith, 1989; Perna, 2000; Perna et al., 2008). Social capital theory also provides an explanation for why outcomes and price sensitivity might vary across subpopulations of students as expectations and values about higher education vary also across communities (Perna & Titus, 2005; Institute for Higher Education Policy and Excelencia in Education, 2008).

In addition to norms projected by their communities, students may also respond to norms and incentives specific to their universities. Organizations influence patterns of human behavior, reduce uncertainty for individual actors, and create stability (Boin & Kuipers, 2008; Thoenig, 2003; Campbell, 2005). Behavior reflects individual self-interests as well as conditions of institutional constraints (Campbell, 2005). Institutions shape both the options available to individuals and preferences among those limited options (Ostrom, 2007). In the case of higher education, universities seek to maximize their public legitimacy through multiple outcomes, including graduation rates and the quality of graduates (Suchman, 1995). Universities can send a message that slower progress to degree is preferable if funding is linked to outcomes such as admission to graduate school or student satisfaction. Universities are incentivized to instill in students a strong motivation to graduate quickly when public funding is linked to time to degree. In practice, an institutional response to a political push to increase time to degree may be purely symbolic, and internally universities continue to create obstacles to graduation (Meyer & Rowan, 1977). It is common for students to face internal obstacles to completion such a difficulty registering for required courses or a lack of clarity regarding degree requirements.

Taken as whole, the theoretical literature suggests that graduation will be a function of economic costs and benefits as well as community and institutional values and expectations. A complete model of influences on time to degree requires attention to individual-, community-, and institutional-level factors. This study expands upon a foundational study from DesJardins, Ahlburg, and McCall (2002), which identified and tested myriad factors hypothesized to influence time to degree using a discrete-time hazard methodology. Their study models the likelihood of graduation and the likelihood of on-time graduation compared to stopout in a competing-risk approach. When modeling the risk of graduation only, Latino students, students who report needing help studying, and students who have higher cumulative grade point averages (GPAs) are less likely to graduate in four years, while completing a degree in liberal arts and entering college with prior transfer credits increases the likelihood of degree completion. When graduation and stopout are modeled as competing risks, the effect of being Latino on graduation attenuates and the effects of seeking help with studying and cumulative GPA become positive. This means that some types of students were less likely to have graduated on time, but not more likely to drop out. This provides initial insight into delayed graduation as a strategy for many students who encounter obstacles to a traditional four-year pathway. However, the study is limited to empirical estimation of the effects of individual characteristics, as all students in the sample attended a single institution.

In a very different empirical approach, Bound et al. (2012) suggest that institutional characteristics should also not be overlooked. Looking at national demographic changes in the college-going population and changes in resources for higher education, these authors find that decreases in institutional resources explain a significant proportion of increases in average time to degree between the 1970s and 1990s.

The present study addresses limitations of the DesJardins et al. study (2002) in two ways. First, we use a statewide data set from Texas, which provides a large, diverse sample of students who attended 34 four-year universities. Second, we add institutional data from IPEDS to examine the role of institutional inputs identified by Bound et al. This enables us to exploit variation in institutional variables across universities and across time as well as individual characteristics. In addition, we can also test the effects of different college pathways, as students in our data set transfer across institutions, pursue credits at multiple institutions, and transition in and out of full-time enrollment.

EMPIRICAL EVIDENCE ON TIME TO DEGREE

Time to degree generally refers to the length of time students spend working toward completion of postsecondary requirements and earning a credential. Our focus is on time to complete a bachelor's degree. For the purposes of this study, time to degree will begin at college entry and include stopout time when students are not actively making progress toward a bachelor's degree.[3] While research on time to degree

[3] Time to degree has been operationalized in a variety of ways, including the time between high school graduation and college graduation, inclusive of any delay before matriculation (i.e., Bound, Lovenheim, & Turner). Others have defined it as the time spent between first college entry and completion, either inclusive or exclusive of any stopout periods where students are continuously enrolled but not taking classes (i.e., Garibaldi, Giavazzi, Ichino, & Rettore, 2012; Glocker, 2009; Lam, 1999). Stopout time tends to be included in analyses from the student and state perspectives, but excluded from studies of institutional resource use, which tend to focus on actual time students spend enrolled more narrowly (i.e., Lam, 1999). Time to degree may also be described by its mediating outcomes such as attempting fewer than 15

is nascent, previous empirical research on determinants of graduation provide insight into individual and institutional variables that might also influence the likelihood of graduating on time.

Demographic Factors

Student factors that may affect time to degree include the demographics of college student populations and their level of precollege preparation, student preferences for majors, transfer, changing majors, time spent on work or leisure, and future returns to education (DeSimone, 2008; Bound et al., 2010; Volkwein & Lorang, 1996; Gleason, 1993; Hood, Craig, & Ferguson, 1992; Stinebrickner & Stinebrickner, 2003; Clotfelter, 1991; Kienzl et al., 2007).

From an economic perspective, demographics such as age, gender, and race influence higher education through differences in labor market earnings. From a social capital perspective, expectations for educational attainment differ across racial groups and within racial groups by gender. Institutions may also communicate different expectations regarding majors and graduation to students based on demographics. Nationally, minority students tend to graduate less frequently than White students (e.g., Adelman, 2006). In Texas, Black and Hispanic students have significantly lower rates of degree completion (52.7 percent and 65.9 percent, respectively) than their White and Asian peers (76.6 percent and 83.8 percent, respectively) (Texas Higher Education

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credits in a semester, accumulating excess credits, or time spent on academic probation (i.e., Volkwein & Lorang, 1996).

Coordinating Board, 2012a, 2012b). Research suggests that racial gaps in college graduation are often attributable to complex structural inequalities such as poverty and high school quality (U.S. Department of Education, National Center for Education Statistics, 2012a; Light & Strayer, 2002; Adelman, 2006; Fletcher & Tienda, 2010; Massey, 2006). Moving to time to degree, DesJardins et al. (2002) find significant racial differences in on-time graduation, controlling for socioeconomic status and other structural variables.

Older students who delay entry into postsecondary education also face different cost and benefits and societal expectations. Older college entrants exhibit higher levels of academic motivation and a stronger commitment to academic goals (Archer, Cantwell, & Bourke, 1999; Cantwell, Archer, & Bourke, 2001; Calcagno, Crosta, Bailey, & Jenkins, 2007). However, they also face higher opportunity costs due to rusty academic skills and competing demands from work and family (Cleveland-Innes, 1994; Calcagno et al., 2007). Socially, they may be less integrated into university life and therefore less easily influenced by internal university pressures (Cleveland-Innes, 1994). They are more likely to prefer a slower path to graduation that includes scheduling classes around work and family and enrolling part-time.

The economic status of students and their families is another significant factor influencing participation and success in higher education (Rouse, 1994; Manski & Wise, 1983, Manski, 1992) and time to degree (Bound et al., 2012). Low-income students and those with unmet financial need are more likely to stop or drop out due to financial constraints or the simultaneous demands of work and school (DesJardins et al., 2002; Herzog, 2005).

High School Preparation

In addition to demographics, a student's prior preparation and high school experiences can influence graduation and time to degree. Success in high school coursework, especially in mathematics, is predictive of later educational outcomes, including increases in college grades, completing a bachelor's degree, and decreases in dropout (Schneider, Swanson, & Riegle-Crumb, 1998; Long et al., 2009; Ma & Wilkins, 2007; Adelman, 2006, 1999; Long, Iatarola, & Conger, 2009; Cabrera, Burkum, & La Nasa, 2005; Herzog, 2005). From an economic perspective, prior preparation can make degree completion less costly in terms of effort or time. Consistent with the human capital hypothesis, timely four-year degree completion is associated with high school grades, higher mathematics placement examinations, and better grades in college courses (Bound et al., 2012; Parker, 2005; Allen & Robbins, 2010; Deming, Hastings, Kane, & Staiger, 2011). Very low levels of academic preparation are associated with low graduation rates and longer times to degree, due in part to requirements for additional remedial coursework (Horn & Nevill, 2006; Bailey, 2009; Attewell, Lavin, Domina, & Levey, 2006; Bettinger & Long, 2005). However, DesJardins et al. (2002) find neither ACT score nor high school class rank to be significantly associated with time to degree or stopout. An alternative hypothesis is that prior preparation is associated with socialization toward the goal of overall academic success, which may be better measured by grades than time to degree. Two studies find that higher freshman year grades are associated with longer times to degree, which is attributed to student desire to protect GPAs by taking fewer classes per semester (Adelman, 2006; Volkein & Lorang, 1996).

In arguably the most rigorous study on the topic of student time to degree, Bound et al. (2012) provide evidence that *extension* in time to degree over a 20-year period cannot be explained by *changes* in student preparation. In fact, observable characteristics of student preparation, including tests of prior academic achievement and high school GPA, have improved time to degree according to the study's Blinder-Oaxaca decomposition results. However, in a related study, Bound et al. (2010) find that decreases in the prior preparation of students (primarily at community colleges) can explain roughly one-third of the decrease in graduation rates between student cohorts beginning in 1972 and 1992, although simultaneous increases in other student characteristics, such as parental education, actually increased completion. Together, these findings suggest that student preparation may play a larger role in whether students decide to stay enrolled and complete a degree than in the pace of student completion.

College Pathways

In addition to prior characteristics, students make many choices during college that can influence the rate of completion. One important choice is the pace of credit accumulation and intensity of enrollment. Many students enroll in college part-time for a variety of reasons, including protecting GPAs, confusion over registration, inability to get a slot in a required course, competing family or financial commitments, or a desire to enjoy leisure time (Volkein & Lorang, 1996; Adelman, 2006; Bowen, Chingos & McPherson, 2009; U.S. Department of Education, National Center for Education Statistics, 1998). These strategies have ambiguous theoretical effects on graduation.

On average, students who enroll full-time are more likely to complete on time (Adelman, 2006). When work crowds out studying, degree completion can be slowed or stopped (Ehrenberg & Sherman, 1987; Singell, 2004, Stinebrickner & Stinebrickner, 2003). Students who have unmet financial need or high labor market participation (in excess of 20 hours a week) have lower GPAs (Stinebrickner & Stinebrickner, 2003; DeSimone, 2008) and longer time to degree (Volkwein & Lorang, 1996; Gleason, 1993; Lam, 1999).

Students' choice of a program of study can also affect time to degree (Glocker, 2009; Adelman, 2006). Different majors lead to different professions with different rates of return (DesJardins et al., 2002; Thomas & Zhang, 2005; Berger, 1988). Fields with higher rates of return are associated with higher graduation rates (DesJardins et al., 2002), but many high return fields, such as engineering or health sciences, also have more specific and numerous course requirements (The University of Texas at Austin, 2012; Adelman, 2006). In this case, extended time to degree is a positive labor market strategy rather than a disappointing outcome. Students also accumulate useful credits more slowly when they change major, as some accumulated credits may not be applicable toward the new major (Lam, 1999; Washington State Higher Education Coordinating Board, 1994; University of Florida, 1995). Double-majoring is another potential extender of time to degree, although double majors are rare and unlikely to be driving significant and widespread increases in time to degree (Bound et al., 2012; The University of Texas at Austin, 2012; Sugarman & Kelly, 1997).

The concept of a four-year degree path is based on a traditional model of a student spending four years at a single institution. Many students alter their degree path midstream by transferring to a new institution, an act that may be motivated by perceived superior economic or social opportunities or negative feedback from the current institution.[4] Transfer from two-year institutions or across four-year institutions generally has a negative effect on time to degree (Hilmer, 1999; Lam, 1999), often through loss of credits that are not accepted by the receiving institution (Lehman, 2002).

Another option is “swirling” in and among multiple two- and four-year institutions simultaneously (Adelman, 2006; McCormick, 2003). Many students, including 78 percent of all bachelor’s degree completers in Texas, take at least one

[4] Time-to-degree measurement begins at first matriculation to a two-year or four-year institution. The term of transfer is not modeled explicitly, but is reflected in the changes in institutional inputs.

course at a community college, often while enrolled full-time at another institution of higher education (National Student Clearinghouse Research Center, 2013). “Dipping” into a second institution can provide flexibility in course scheduling, better course availability, or lower costs per credit. Unlike permanent transfer, simultaneous enrollment may reduce time to degree by accelerating credit accumulation (Herzog, 2005).

Institutional Factors

The behaviors, decisions, and characteristics of students play an important role, but supply-side factors also influence time to degree. Institutional effects can operate indirectly through shaping student preferences and directly by creating obstacles to graduation. Prior literature suggests that colleges directly influence time to degree in several ways (Pitter et al., 1996; University of Florida, 1995; Bound et al., 2010; Volkwein, 1986; Kane & Orzag, 2003).

A primary influence on credit accumulation occurs through university expenditures on instruction and support services (Webber & Ehrenberg, 2010). Insufficient institutional resources negatively impact timely degree completion when required courses are unavailable, poor quality of advising leads to inefficient progress through college, class sizes grow, or instructional quality declines (Volkwein & Lorang, 1996; Bound et al., 2012). In 2012, an analysis of time to degree at the University of Texas at Austin found that differences in the requirements, sequencing, and availability of courses across programs of study contributed to long times to degree for engineers and other STEM majors. A survey of University of California Davis students found that 50 percent of extenders cite a lack of required course availability as a factor in their delayed completion (Lehman, 2002). Increases in the student-faculty ratio explain a significant proportion of the increase in time to degree between the 1970s and 1990s and 75 percent of the reduction in degree completion (Bound et al., 2012).

A final factor is institutional quality. Higher quality universities exhibit higher graduation rates and shorter times to degree. Dale and Krueger (2002) assert that this relationship is an artifact of selection of higher quality students and not indicative of a causal relationship. They find little financial payoff for students that attend more selective institutions as future earnings are correlated with student characteristics that also influence the selectivity of the college students attend. A more recent analysis from Long (2008) finds that average SATs, tuition, and faculty-student ratio are all positively associated with the probability of graduation. Finally, the Bound et al. (2010, 2012) decomposition studies find the national decrease in overall degree completion and increase in time to degree can be largely explained by the growing enrollment of lower quality institutions, including community colleges and nonselective four-year universities.

Importantly, student pathways and institutional characteristics described above are endogenous to student demographics and prior preparation in ambiguous directions. Students with greater resources and better preparation have access to higher quality institutions through selective admissions and pricing. Low-income students are more likely to enroll part-time due to high costs and the need to work. Well-prepared students are more likely to enroll in challenging majors with longer average degree times. Less-prepared students are more likely to begin in a two-year college and attempt to transfer upward in quality. In this study, we include a rich set of independent variables that describe the individual student, his pathway through college, and the institutions he attends. We also conduct disaggregated analysis of time to degree to identify differential effects of institutional variables on different types of students based on demographics, preparation, and pathways.

EMPIRICAL STRATEGY

This study uses statewide longitudinal data for public higher education students in Texas between 2004 and 2011. To allow sufficient time to measure late graduation, we follow two cohorts of students who began college in 2004 and 2005 through 2011. Student-level data is merged with IPEDS institutional data for all public two- and four-year institutions in the state over the same period.[5] The analysis relies on a production function model in which inputs such as faculty, classrooms, advising, and student skills are transformed into educational outputs, in this case degree completion and time to degree.

[5] The data we use were originally collected as part of the Integrated Postsecondary Education Data System (IPEDS) and later compiled, edited for consistency, and made publicly available by the Delta Cost Project (www.deltacostproject.com).

We estimate the effects of institutional and student characteristics on time to degree using a discrete-time hazard model. Singer and Willet (1993) and Singer (2003) argue that hazard modeling is the most appropriate method for analyzing the presence and timing of educational events such as graduation. Hazard models predict the likelihood of an event occurring across multiple longitudinal observations of individuals. The method is appropriate when estimating not only the probability of an outcome, but the timing of the outcome as well (Allison, 1995).

Data must be structured in person-period format with one observation per person for each time period. A censoring variable is included to indicate if an event *j* occurred in period *t*. Individuals continue to have a period *t* observation until *y* occurs (i.e., the censoring variable is equal to one) and they are removed from the risk pool or the period of the study concludes (i.e., right censoring for students who remain enrolled until 2011) (Singer, 2003). Each time period is included in the estimation as a dummy variable, which enables maximum flexibility on the parameterization of the model (Singer & Willet, 1993). By using a discrete-time approach, we can estimate coefficients for both time-invariant and time-varying predictors of *j*.

Our first empirical objective is to estimate the effects of student and institutional characteristics on the probability of graduation. In this case, the event of interest (*j)* is graduation in a discrete time period *t*. Academic trimesters (fall, spring, summer) provide an appropriate discrete time measure, as graduation always occurs at the conclusion of an academic term. For students who remain in school, the probability of graduation increases with the number of terms enrolled and is also influenced by student and institutional characteristics. Thus, there are two states in which a student can exist and all are influenced by both our independent variables and time enrolled: 1) enrolled with a probability of future graduation or 2) graduated. Figure 2.1 describes the possible events involved in the single-risk case.

Hazard rates measure the likelihood of graduation (*j*) within a trimester (*t*), conditional on enrollment during *t*, where survival is defined as extending enrollment for an additional semester. Bachelor's level graduation is a single, nonrepeating event. The hazard rate *h* is the risk of graduation. $h_{ij}(t)$ is modeled as

$$h_{ij}(t \mid \alpha_j(t), x_i(t), \varepsilon_i) = Pr_j(T_{i=t} \mid T_i \geq t, \alpha_j(t), x_i(t), \varepsilon_i) \qquad (1)$$

where $\alpha_j(t)$ is the baseline hazard that is common to all students in the sample, $x_i(t)$ is the vector of individual and institutional characteristics for student *i* in trimester *t*, and ε_i is the unobserved error term for individual *i* at time *t.* The conditional nature of the hazard concedes observed heterogeneity among those that complete and those that do not, given the individual and institutional characteristics of that student.

Maximum likelihood estimation using standard logistic regression produces unbiased estimates of the relationships between the hazard function and the covariates.

$$Pr\ (\ graduation_{ij}\ (t) = 1\ ) = \alpha_j\ (t), + x_i\ (t) + \varepsilon_i \qquad (2)$$

With an increasing focus on productivity, policymakers may be less concerned with whether students graduate in a given trimester than whether they graduate in four or more years. DesJardins et al. (2002) find important differences in the relationship between student demographics and graduating compared to graduating on time. It is also likely that policies to promote on-time graduation have negative effects on overall graduation by increasing dropout for those with a low probability of graduating on time. Therefore, we examine the differential effects of institutional inputs on the probability of graduating on time, graduating late, and the probability of dropout.

To accomplish this, we estimate a second hazard model where multiple outcomes are modeled as competing risks (Singer & Willet, 2003). All students begin enrolled in the first period. Their enrollment may cease in any subsequent period for a variety of reasons. In this case the four possible outcomes are (1) still enrolled, (2) graduated in four years, (3) graduated in more than four years, and (4) dropped out. These estimates compare Outcomes 2, 3, and 4 to remaining in the risk pool by still being enrolled. Figure 2.2 describes the possible events involved in the competing-risk model. Each outcome is mutually exclusive and effects of institutional inputs are unique to each outcome. Standard errors are clustered by individual in single-risk and competing-risk models.[6]

Policymakers are also interested in whether changes to higher education policy have differential effects on different types of students—with particular concern for effects on students from groups with historically low graduation rates. Our final empirical strategy disaggregates students by demographics and college pathways to identify differential effects of institutional inputs on time to degree for different types of students.

Data

Our analytic data set includes 200,815 first-time-in-college students. Each student receives one observation per trimester until a terminal event, either graduation or dropout, occurs. To accommodate extended time to graduation, we follow each student for up to 21 trimester observations. A student who was still enrolled at the end of the period at risk has no terminal event. This group of still-enrolled students is used as the reference group for all other outcomes.

Compared to other studies, we place relatively few restrictions on inclusion in the data set. We identify students who expressed intent to obtain a four-year degree by including all eventual college entrants who applied for admission to a four-year university. We include students who enrolled directly from high school, students who transferred from two-year colleges, and nontraditional students who took time off

[6] We tested the sensitivity of estimates to clustering the standard errors by institutions and to the addition of high school fixed effects. No meaningful differences were observed in either case.

between high school and college.[7] The discrete-time model also accommodates flexible and changing pathways through undergraduate programs. Students may be enrolled full- or part-time, may be simultaneously enrolled at two institutions, and may transfer across institutions in the data set during the period of observation. Because these types of choices are also associated with the probability of graduation, we control for both time invariant and time-varying differences in higher education pathways, as suggested by theory. Time invariant variables include age at entry into higher education, a dummy variable indicating the student started at a two-year college, simultaneous enrollment at two institutions, and the number of development education credits acquired.[8] Time-varying variables include dummies for part-time enrollment and major. Unlike prior studies that fix enrollment intensity and major at single point in time, we include a time-varying indicator of the number of credits a student is enrolled in each semester and indicators of the student's current major.

Data on student demographics, family background, high school performance, and enrollment history were obtained from administrative records of students' responses on Apply Texas, a central application used by all Texas public universities. We include controls for demographic information with indicators of gender, race, parents'

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[7] We can follow students across institutions and sectors in the public higher education system in Texas. Students who transfer to private institutions or out of the state are not included in the data set. Measurement error is present, although modest. In Texas, 91 percent of postsecondary enrollment is at public institutions (THECB, n.d.). Few students transfer to private institutions or out of state after first enrolling at an in-state public institution. Two percent of graduates began at a Texas public four-year institution and completed a degree outside of the state (National Student Clearinghouse, 2013).

[8] Developmental education courses remediate precollege skills in reading, writing, and mathematics. Developmental credits do not count toward a degree.

educational attainment, and family income bracket. Prior preparation is measured by high school outcomes. We include SAT composite score and indicators for graduating in the top 10 percent, top 11–25 percent, or bottom 75 percent of the high school class.[9]

The main focus of this study is the effect of institutional inputs on time to graduation and whether these effects vary for historically underserved groups. From IPEDS, we link each student to her institution's inputs at time *t* focusing on the theoretical effects of instruction, research, peers, and student supports. We measure the quantity and quality of instructional supports through the number of full-time faculty per student, the percentage of faculty who are part-time, and instructional expenditures per student. Expectations set by the social setting are measured by the percentage of minority enrollment, which is expected to be negatively associated with expectations regarding graduation and on-time graduation based on historically low minority graduation rates in Texas. Noninstructional student support services to promote graduation (e.g., counseling, mentoring) are measured in expenditures per student for student services. All institutional variables are time-varying and change with changes in university inputs as well as when a student transfers to a different university. For students simultaneously enrolled in two institutions, we selected institutional variables for the institution where the student attempted the most credits.

[9] The Top 10% Rule, passed in 1997, grants automatic admission to Texas public universities to all students who graduate from a Texas public high school ranked in the top 10 percent of their class.

Of the more than 200,000 students in the data set, only 13 percent graduated within four years of enrollment. An additional 34 percent graduated in five to six years, for a total graduation rate of 47 percent. For the remaining students, 23 percent were still enrolled in the final trimester of the study, and 30 percent had dropped out of college without completing. These numbers are lower than prior studies because we retain students on nontraditional pathways, such as those who started at two-year colleges and those who did not enroll immediately after college. Figure 2.3 illustrates the probability of graduation and dropout over a six-year year period compared to remaining enrolled. The likelihood of graduation in the first four years of enrollment is close to zero. Beginning in the eleventh term, the likelihood of graduation begins to increase. Students are most likely to enroll in the fall term and graduate in the spring term, and we see corresponding decreases in survival in the periods just prior to four, five, and six years of enrollment. The likelihood of dropout begins in the first year of enrollment and steadily increases through the entire period of exposure. After six years, more than 50 percent of the sample has dropped out or is still enrolled.

Table 2.1 displays summary statistics on these four groups (graduated on time, graduated late, still enrolled, and dropped out). The average age of students at college entry is 19.2 years. Students in the data set are 55 percent female, 56 percent White, 28 percent Hispanic, and 14 percent Black. Thirty percent have a father with a college degree and 28 percent a mother with a college degree. Family income is nearly equally distributed across income brackets for students who provided information, with 19 percent reporting income less than $40,000, 20 percent $40,000–80,000, and 25 percent more than $80,000. As expected, students who graduated on time are younger and more likely to be White, female, and high income and have parents with college degrees. Minorities are particularly underrepresented as on-time graduates.

Minorities, males, and those in lower income brackets are more equitably represented when we consider late graduation as well. However, both Hispanics and Blacks are overrepresented in the still-enrolled group, and Blacks are overrepresented among dropouts. Students with missing income appear to be relatively high risk. These students make up 36 percent of the data set, but only 18 percent of on-time graduates and more than 50 percent of dropouts.

Table 2.2 displays summary statistics for high school outcomes, college majors, and college experiences. On-time graduates have the highest average SAT scores and distribution of class rank, followed by late graduates. More than 40 percent of on-time graduates and 22 percent of late graduates were in the top 10 percent of their high school class, compared to only 8 percent of still enrolled and dropouts. College major is a time-varying variable, and the summary statistics reveal that many students change majors along the way and many are undeclared at some point during the six-year study period. College experiences, except for starting at a two-year college and developmental education credits, are also time-varying. Nontraditional paths through college are very common. Forty-five percent of students started at a two-year college, and students average 4.7 part-time semesters. Thirty-percent of students were, at some time, enrolled in multiple institutions. Despite the ability to transfer credits, those who begin at two-year colleges are underrepresented as on-time graduates and overrepresented as still enrolled. Those who simultaneously enroll are overrepresented in on-time graduation and late graduation.

Table 2.3 displays variables measuring average institutional inputs over time. The data set includes 65 two-year colleges, 23 four-year nonresearch universities, and 11 research universities. We measure the quantity and quality of faculty through the full-time faculty-student ratio (number per 100 students) and the percentage of part-time faculty. The demographics of the institution are measured by the percentage of minorities, which varies at Texas institutions from 10 to 95 percent. To capture the mix of instructional, support, and research resources, we include measures of per-student expenditures on instruction and student services and a dummy variable equal to one if the institution has zero research expenditures.[10] Importantly, there is a large variance in institutional inputs within these three types. For example, instructional expenditures per student ranged from $5,200 to more than $12,000 at research universities and from $1,400 to more than $14,000 at two-year colleges. The large variances across institutions suggest that we can expect students to experience significant changes in inputs as they transfer schools within Texas.

[10] Expenditures on externally funded research are highly correlated with instructional expenditures, yet prior literature suggests its inclusion in our analysis is important. Research expenditures decrease the likelihood of graduation, controlling for instructional expenditures (Webber & Ehrenberg, 2010). Webber and Ehrenberg (2010) hypothesize higher research expenditures have a negative effect because the more institutions spend on internal departmental research (which is categorized as an instructional expenditure), the less instructional expenditures are used for true instructional activities per student.

Institutional variables also changed due to policy changes during the study period. Figure 2.4 illustrates the annual percentage change in the average values of faculty and expenditure variables. We see annual increases in inputs from 2005 to 2008, with a large spike in inputs in 2006. In 2009, all inputs were suddenly and drastically reduced after many years of annual increases. The faculty-student ratio is the most sensitive input, with spikes of 15 percent growth in 2006, followed by a 10 percent decline in 2009. In addition to changes due to switching institutions, all students in this study experienced changes in institutional inputs due to these dramatic policy shifts during their time in college.

Tables 2.1 and 2.2 indicate that 13 percent of the sample graduates on time and 34 percent of sample graduates late. Twenty-three percent of students are still enrolled in 2011, and 30 percent of students in the sample have dropped out. Mean time to degree is 14.75 months (59 months). Time to degree varies by bachelor's degree-granting institution, as presented in Figure 2.5. At institutions with the lowest average times to degree, students complete in approximately 12.5 terms, while at institutions with the highest average times to degree, students graduate in close to 18 terms.

Our empirical models estimate the probability of graduating during a given semester, controlling for prior time enrolled. We first estimate these effects with a logit model for the dichotomous outcomes of graduated versus not graduated. We then expand to a multinominal logit model with four possible outcomes: still enrolled, graduated on time, graduated late, and dropped out. The tabled results are displayed as log-odds for each variable associated with the probability of a positive outcome. In the single-risk model, a positive outcome is graduation compared with not graduating. The reference group could either have dropped out or still be enrolled and no distinction is made regarding time to degree. In the competing-risk model, three outcomes (graduated on time, graduated late, dropped out) are compared to reference group that is still enrolled. Importantly, dropout is a negative outcome for students while graduation (either on time or late) is positive, so competing-risk results must be interpreted with caution. Log-odds greater than 1.0 indicate the increased likelihood of an outcome, and log-odds less than 1.0 indicate decreased likelihood. For positive graduation outcomes, log-odds greater than 1.0 indicate that a variable is associated with improved outcomes for students. For the negative outcome of dropout, log-odds greater than 1.0 indicate that a variable is associated with diminished opportunities to acquire a degree.

Finally, we disaggregate estimations for different student demographics, college pathways, and institutional types. Our objective is to identify which institutional factors are associated with graduating at all and graduating on time as well as how these associations differ for different types of students. We also examine disaggregated effects on graduating late and dropping out to see if changing inputs that promote on-time graduation might have the perverse effects of reducing overall graduation and increasing dropout.

Results

We begin with a comparison of the single-risk and competing-risk models for the full sample. Table 2.4 displays estimated log-odds for individual student variables. There are more than 1.8 million student-time observations for approximately 200,000 students. Given the large data set, most estimates are statistically significant, so we report only those with large and interesting effect sizes. The reference group for each specification is a White male who graduated in the bottom 75 percent of his class, with parents who did not graduate from high school, family income less than $40,000, and a liberal or fine arts major.

Individual Factors

Our individual control variables are statistically significant and in the expected directions. The probability of graduating versus not graduating is higher for highly ranked high school graduates who are White, female, and children of college graduates. STEM and social science majors are most likely to graduate. Students who begin at two-year colleges or required development education credits are less likely to graduate. Comparing these results to the competing-risk results provides more information about the nuances of these relationships. Females are more likely to graduate on time, compared to remaining enrolled, than males, but females and males have similar probability of dropping out compared to remaining enrolled. Similarly, Hispanics are less likely to graduate on time compared to remaining enrolled than Whites, but equally likely to graduate late or drop out. Blacks are less likely than Whites to graduate on time or late, but are equally likely to drop out. Similar to DesJardins et al. (2002), we find that racial and gender differences in graduation are largely due to staying enrolled longer, rather than an increased propensity to drop out.

High school performance is a strong predictor of on-time graduation. In particular, top 10 percent graduates are more than twice as likely to graduate on time and only half as likely to drop out compared to those in the bottom 75 percent. The odds of on-time completion are positively associated with increases in SAT score as well, but the effects are more modest.

The competing-risk results also provide greater insight into the role of college pathways. Those who begin at a two-year college frequently remain enrolled at the end of the study. Starting at a two-year college has a large, negative effect on graduating on time, but only a small negative effect on graduating late and very little effect on dropping out, compared to remaining enrolled. Enrolling part-time also increases the odds of remaining enrolled, compared to all other outcomes. Beginning at a two-year college and part-time enrollment are not paths to timely graduation, but they are strategies to stay enrolled instead of dropping out. Simultaneous enrollment to gain extra credits slightly increases the odds of graduating on time or late and also significantly reduces the odds of dropping out. It is likely that students who enroll at two schools at once are highly motivated to graduate and may be more price-sensitive.

Institutional Factors

These results for individual characteristics suggest that the probability of graduating and time to degree both vary across demographic groups and, controlling for demographics, with the pathway taken to college. We turn now to the question of whether institutional inputs also influence time to degree. Importantly, our estimation strategy cannot assess causality. While the institutional variables can be controlled by policymakers, we cannot say that deliberate changes in inputs cause graduation or more timely graduation. We can only identify associations in an attempt to understand how students at different types of institutions behave toward graduation. Our models control for student sorting into institutions through observable variables, but not through unobservables such as motivation, career objectives, or opportunity costs. Through disaggregated models, we can observe the interaction of demographics and college pathways and institutional inputs. We acknowledge that students select in to institutional pathways for numerous reasons that are not accounted for in these models.

Table 2.5 displays single-risk and competing-risk results for institutional variables for the same specifications as Table 2.4. In the single-risk model, instructional expenditures have a large, positive effect on the probability of graduating versus not graduating, and faculty-student ratios have a small positive effect. Part-time faculty and minority enrollment have a negative association with graduation. The competing-risk model provides greater insight into time to degree. Compared to remaining enrolled, full-time faculty-student ratio is positively associated with on-time graduation. However, this ratio is also negatively associated with graduating late, compared to remaining enrolled. Part-time faculty are positively associated with on-time graduation and negatively associated with late graduation. Part-time faculty are also positively associated with dropping out versus remaining enrolled.

Instructional expenditures have a significant positive effect on graduation versus not graduating. In the competing-risk model, on-time graduation is not related to instructional expenditures. This effect is concentrated on an increased probability of late graduation. Student services expenditures have a negative association with on-time graduation and a positive association with graduating late. Institutions are likely to increase student services in response to student risk factors. This result suggests that student services have some success promoting graduation, but the pace to graduation is slower on campuses with high student support expenditures. Minority enrollment has a negative effect on the probability of graduating in the single-risk model. Most of the negative effect of minority enrollment occurs through a lower probability of on-time graduation and higher probability of dropout. Minority enrollment has only a small, negative effect on the probability of graduating late.

Overall, these results suggest that faculty inputs are positively associated with graduating on time. Full-time faculty are associated with an increase in the probability of graduating on time and a decrease in the probability of dropping out, compared to staying enrolled. Part-time faculty also increase the probability of graduating on time compared to remaining enrolled, but part-time faculty also decrease the odds of graduating late and increase the odds of dropping out. Instructional expenditures are positively associated with graduation but only through late graduation. Instructional expenditures, holding faculty ratios constant, are not associated with an increased probability of graduating on time. Student services expenditures are likely to be higher on campuses with a high probability of dropout. Although we find no effect on the probability of overall graduation, there is a positive association with graduating late.

Effects by Student Characteristics

We next examine the importance of institutional inputs for students from different backgrounds by estimating effects separately by race, family income, and high school class rank. Each estimation controls for student characteristics, high school outcomes, college major, and college pathways, excluding only the variables that identify selection into the subgroup.

Table 2.6 displays log-odds estimates for the probability of graduating on time compared to the reference outcome of continued enrollment. We estimate effects for three income groups (less than $40,000 or missing, $40,000–$80,000, more than $80,000), three racial groups (White, Hispanic, Black), and three bins of class rank (top 10 percent, top 11–25 percent, bottom 75 percent). We find important differences across groups in the relationship between institutional inputs and the probability of on-time graduation.

In the aggregated results, we estimated a positive effect of full-time faculty on the probability of graduating on time. This result holds for all subgroups in Table 2.6, with the largest effects for Blacks and students in the top 11–25 percent. The effects of part-time faculty vary by group. Part-time faculty have a positive effect on the probability of on-time graduation only for students in higher income brackets, Whites, and those in the bottom bins for class rank. Part-time faculty have a large, negative effect on the probability of on-time graduation for Hispanic students and no effect on Blacks or low-income students.

Instructional expenditures were found to have no independent effect on the probability of on-time graduation in the aggregated model. In disaggregated estimations, instructional expenditures have a positive association with on-time graduation for Hispanics and those in the bottom bin for class rank and a negative association for Blacks. Student services expenditures have a small negative association for all student groups, and the percentage of minorities has a large negative association for all students. Overall, these disaggregated results suggest that full-time faculty are positively associated with graduating on time for all students, while part-time faculty and instructional expenditures have mixed effects.

Table 2.7 displays results from the same disaggregated estimation for the log-odds of graduating late compared to remaining enrolled. Full-time faculty have only small negative effects on the probability of graduating late; part-time faculty have a large, negative effects for all groups. Contrary to the findings for graduating on time, both instructional expenditures and student services expenditures are positively associated with graduating late compared to remaining enrolled. The effects of instructional expenditures are particularly large across all groups, including Blacks, Hispanics, and lower bins of high school class rank.

Table 2.8 displays disaggregated results for the final outcome of dropping out compared to remaining enrolled. Full-time faculty have a small, negative association with dropout, and part-time faculty have a positive association with dropout for all groups. The association between part-time faculty and the probability of dropout is particularly large for low-income students, Hispanics, Blacks, and those in the lowest bin for high school class rank. Instructional expenditures have mixed effects on dropout. High-income students, Whites, Hispanics, and high-ranking students are less likely to drop out as instructional expenditures increase, but Black students are approximately 50 percent more likely to drop out. Student services expenditures are associated with an increased odds of dropout for some groups, but the effect is large only for Hispanics. The percentage of minorities is associated with a large increase in the odds of dropout for all groups.

Effects by College Pathways

Demographic groups also differ in how they navigate college due to differences in opportunities and resources. Minorities and low-income students are more likely to follow a nontraditional path through college, including transfers and part-time enrollment to reduce costs and facilitate work. We examine the differential effects of institutional inputs by subgroups from six college pathways.

The first three pathways describe how students entered higher education. Based on their first enrollment at Texas public institution, we identify students who first enrolled at a two-year college, four-year nonresearch university, or four-year research university.[11] In our data set, 45.1 percent began at a two-year college, 27.6 percent at a four-year nonresearch university, and 28.3 percent at a four-year research university. We also test three nonmutually exclusive pathways that describe how students navigated higher education. The first group, which includes 33.5 percent of students, followed a traditional undergraduate pathway that includes enrolling immediately after high school graduation in a four-year university, taking all courses on a single campus, and enrolling part-time for fewer than two semesters.[12] The second group, which includes 30.1 percent of students, engaged in simultaneous enrollment on two campuses during one or more trimesters, often through part-time enrollment at a two-year college. The final group includes 27.4 percent of students who engaged in frequent part-time enrollment, defined as five or more part-time semesters.

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[11] Institutions are categorized according to 2005 Carnegie sector classification as documented in IPEDS. Carnegie classifications for *public research institutions* correspond to this paper's four-year research university category. Nonresearch universities correspond to the Carnegie classifications for *public masters and public bachelors institutions*. Two-year colleges correspond to the Carnegie *public associates institutions*.

[12] Here, we exclude summer sessions in the count of terms enrolled part-time.

Table 2.9 displays the results for on-time graduation by pathway. The full-time faculty-student ratio is positively associated with graduating on time versus remaining enrolled for all six pathways, with larger effects for students at four-year universities. Full-time faculty are positive but with a small effect for students with simultaneous enrollment, which suggests that simultaneous enrollers may be less connected to full-time faculty at any one institution. Part-time faculty are positively associated with on-time graduation for four pathways with varying size of effects. Part-time faculty have modest positive effects on students on the traditional college pathway and students who simultaneously enroll and large positive effects for students who begin at a two-year colleges or engage in frequent part-time enrollment. Part-time faculty have a large negative association with graduating on time for students at nonresearch universities and no effect for students at research universities. This suggests that institutions with high transfer rates employ more part-time faculty and only full-time faculty contribute to on-time graduation at four-year universities.

Instructional expenditures have mixed effects on students from different pathways. Larger instructional expenditures are positively associated with graduating on time for students with simultaneous enrollment and students who started at a two-year college. Instructional expenditures are negatively associated with graduating on time for traditional pathway students and students at both types of four-year universities. Thus, greater instructional expenditures not associated with increases in full-time faculty are not associated with time to degree at four-year colleges, but instructional expenditures at two-year colleges may facilitate on-time graduation by helping students successfully transfer to institutions with higher instructional expenditures. Expenditures for student services have a similar small to moderate negative association with on-time graduation for students from all pathways. Minority enrollment has a large negative association with graduating on time for all pathways.

Table 2.10 displays results by pathway for graduating late. Unlike on-time graduation, there is no positive effect of full-time faculty on the probability of graduating late. Part-time faculty have a large negative effect on graduating late for all pathways. Unlike the mixed results for graduating on time, instructional expenditures have a large, positive effect on the probability of graduating late for all student pathways—an effect that is largest for traditional students and students who began at research universities. Student services expenditures have smaller positive effects for all student pathways, with those who began at four-year universities having the largest effects. Compared to larger negative effects for graduating on time, the percentage of minorities has only small negative effects on the probability of graduating late.

Table 2.11 displays results by pathway for dropout. Full-time faculty have a small, negative association with the probability of dropout compared to remaining enrolled for all pathways. Part-time faculty increase the odds of dropout for all pathways, with particularly large effects for those who begin at a two-year college. Instructional expenditures have mixed results for dropout, with large positive effects at four-year research universities and a small positive effect for frequent part-time enrollers. For all other pathways, instructional expenditures are associated with reduced odds of dropout. Student support expenditures are associated with increased odds of dropout for students on nontraditional pathways, including simultaneous enrollment, frequent part-time, and starting at a two-year institutions. Minority enrollment increases the odds of dropout for all pathways, with particularly large effects on those who started at two-year institutions and those who simultaneously enroll.

CONCLUSIONS

Using a large, statewide data set, we provide a more nuanced examination of time to degree than previously conducted. We combine longitudinal student-level information with time-varying institutional data to improve our understanding of the complex phenomenon of time to degree. Detailed institutional characteristics related to expenditures, peers, and faculty quantity offer new insights into the operations of institutions and how institutional actions shape the options available to individuals and influence patterns of student behavior. Our results confirm theoretical predications that both student characteristics and institutional inputs are independently associated with time to degree. Discrete-time hazard modeling helps reveal that on-time graduation is not an end unto itself, but one possible outcome that is in tension with other higher education outcomes, including late graduation, dropout, or continuous enrollment. We find considerable evidence that these outcomes are linked and changing individual and institutional inputs present trade-offs between larger completion outcomes and timely outcomes.

Our results also make several new contributions to a theoretical understanding of this issue. First, students who graduate on time vary in important ways from students who graduate late, drop out, or remain enrolled after seven to eight years of higher education. On-time graduates come to college with advantages of race, income, and parents' education as well as having displayed better preparation through SAT score and class rank. Students who do not graduate on time come to higher education with greater challenges, and a slower path to graduation may be the response to those challenges. We find that several demographic disadvantages are associated with a lower probability of graduating on time compared to remaining enrolled, but not a lower probability of graduating late.

Second, we find students take very diverse pathways through undergraduate education that are also associated with time to degree. Only one-third of students in the sample have traditional enrollment pathways that begin in a four-year institution, maintain full-time enrollment, and do not simultaneously enroll in more than one institution. Two-thirds formally transfer, earn credits at institutions other than their primary one, or frequently enroll part-time. It is likely that graduation is often extended because low-income or first-generation college students are unable to sustain full-time enrollment. Other students may spend more time experimenting before choosing a degree program. Our results provide some new insight into these mechanisms. Students in Texas appear to use simultaneous enrollment to accelerate graduation. Enrolling part-time and beginning at a two-year college are not pathways to graduating in four years, but they allow students to graduate eventually or remain enrolled compared to dropping out. These findings have important implications for equity and addressing college attainment gaps.

Ideally, we would be able to identify policy levers to increase time to degree without inadvertently reducing the likelihood of graduating late or increasing the likelihood of dropping out for students who do not finish in four years. One example is altering financial aid, transfer policies, and administrative tracking to facilitate nontraditional enrollment patterns that accelerate time to degree such as simultaneous enrollment or continuous part-time enrollment during summer sessions. Full-time enrollment requirements for financial aid may be achieved across institutions, so institutions in close proximity may want to coordinate student tracking where there is frequent overlap. Punitive policies that increase the cost of tuition after four years or raise the threshold for full-time credit load requirements are likely to have adverse effects on disadvantaged populations. Policies that incentivize timely completion and ease financial burdens (e.g., tuition rebates for four-year completion) may accelerate some without increasing the likelihood of dropout for others.

While our models cannot illustrate causality of institutional inputs, our estimates of the effects of institutional inputs on time to degree reveal institution-level factors that contribute to graduating on time, while identifying potential negative effects on outcomes for those who cannot graduate on time. Our results suggest that full-time faculty are positively associated with the probability of on-time graduation with no significant negative effect on graduating late or dropping out. Investing in full-time faculty is likely a wise investment. Part-time faculty are more problematic. They reduce the odds of on-time graduation for minority students, but may facilitate graduation for students on some nontraditional college pathways. At the same time, part-time faculty decrease the odds of graduating late and increase the odds of dropping out for many groups. Reliance on part-time instructors is a growing trend in higher education, and greater focus on the roles and contributions of part-time faculty in four- and two-year settings that differentially influence time to degree is warranted.

Instructional expenditures have mixed results for graduating on time. In general, it appears that increased instructional expenditures, controlling for faculty quantity, are associated with reduced odds of graduating on time, particularly at four-year universities. However, instructional expenditures are positively associated with graduating late and have little or no effect on dropout. This result could reflect the higher costs of students who delay graduation while accruing more credits or an ineffectiveness of instructional funds used for resources other than faculty. The association between student services expenses and time to degree is also complex, as institutions increase these programs in response to problems with degree completion and dropout. What is apparent in our results is that student services expenditures are negatively associated with time to degree. More interesting is the finding of similar effects of student services on time to degree for students on different pathways. There is some indication that student services increase the probability of eventually graduating for students but only if they begin at four-year universities. This result, combined with the negative effects of beginning at two-year colleges suggests that these institutions could benefit from better alignment of both instruction and support services with goal of graduation from a four-year institution.

Finally, our results highlight racial inequalities in access to timely graduation. Hispanics are less likely to graduate on time than Whites, and Blacks are less likely to graduate on time or late than Whites. Added to this disparity are the institutional effects of attending a university with high minority enrollment. The percentage of minorities is negatively associated with on-time and late graduation and positively associated with dropout for all types of students on all types of pathways. Finally, Whites, Blacks, and Hispanics respond differently to institutional inputs. The largest positive institutional variable associated with on-time graduation for Whites is part-time faculty, for Blacks the largest effect comes from full-time faculty, and for Hispanics the largest effect comes from instructional expenditures. Together findings suggest that policymakers should target graduation interventions for high-minority campuses, using caution to ensure that policies that increase time to degree for one group do not have perverse effects on another group.

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Figure 2.1: Single-risk model of graduation compared to still enrolled over time 2004/2005 through 2011

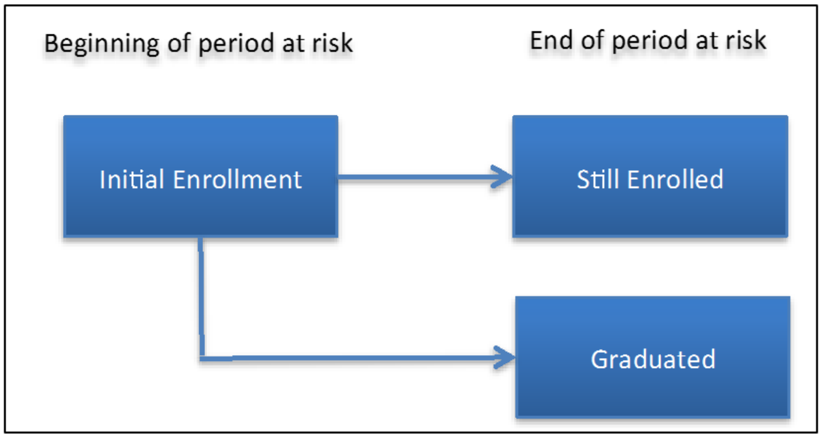


Figure 2.2: Competing-risk model of on-time graduation, late graduation, and dropout compared to still enrolled over time 2004/2005 through 2011

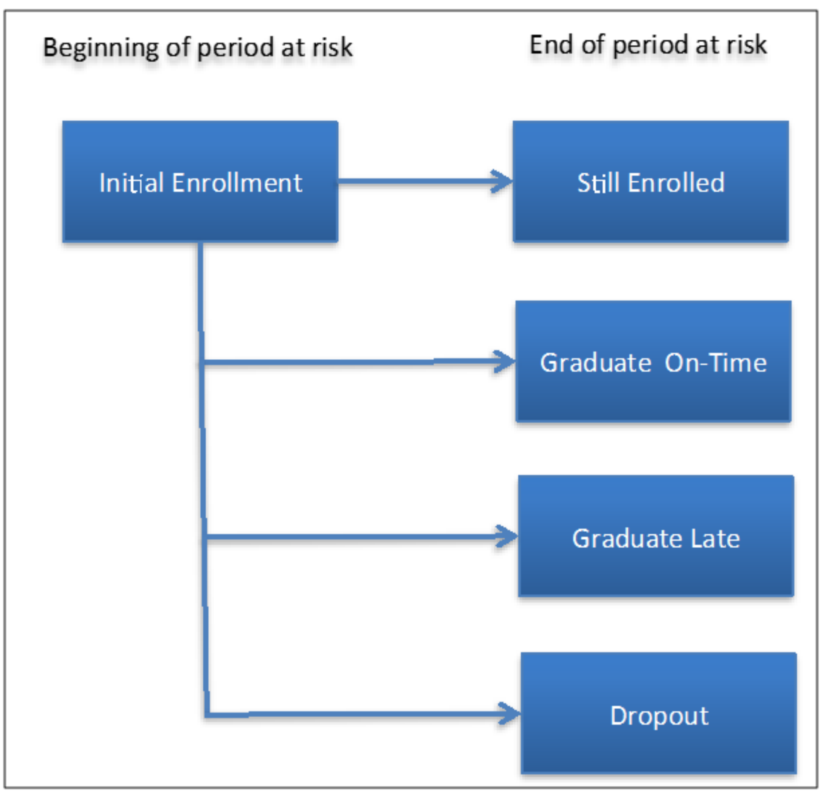
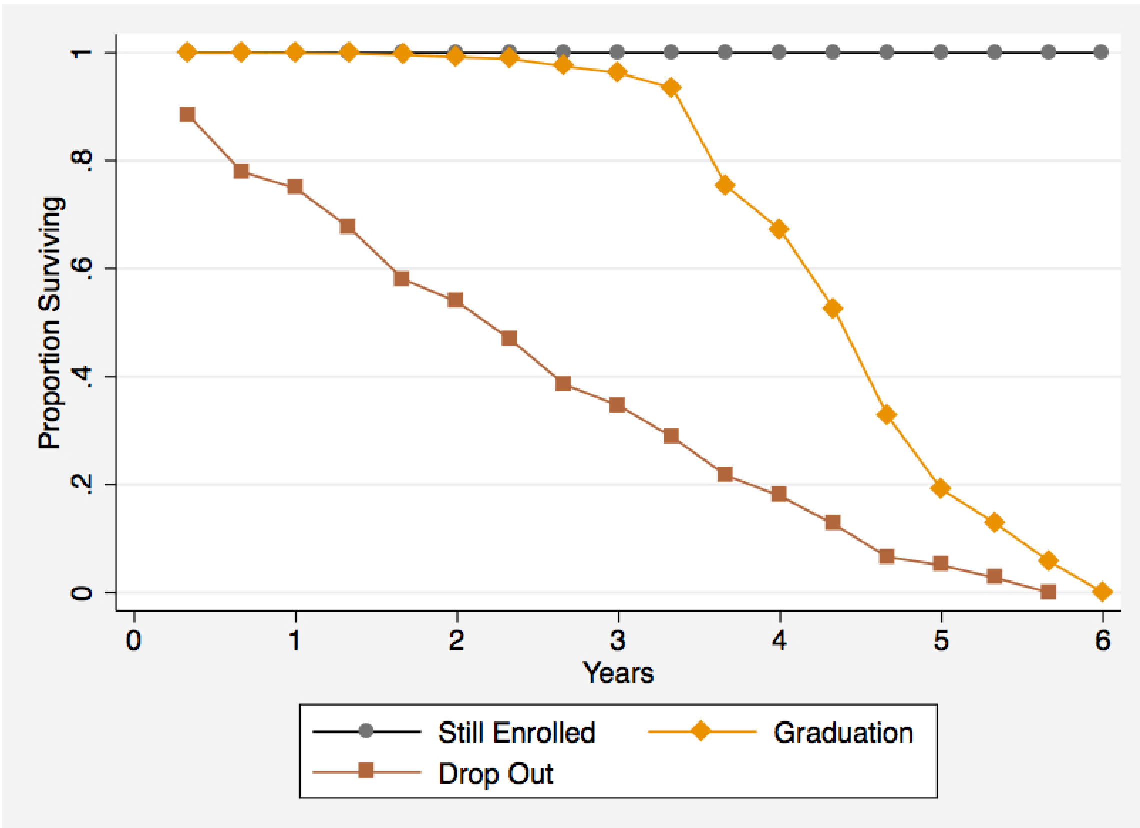
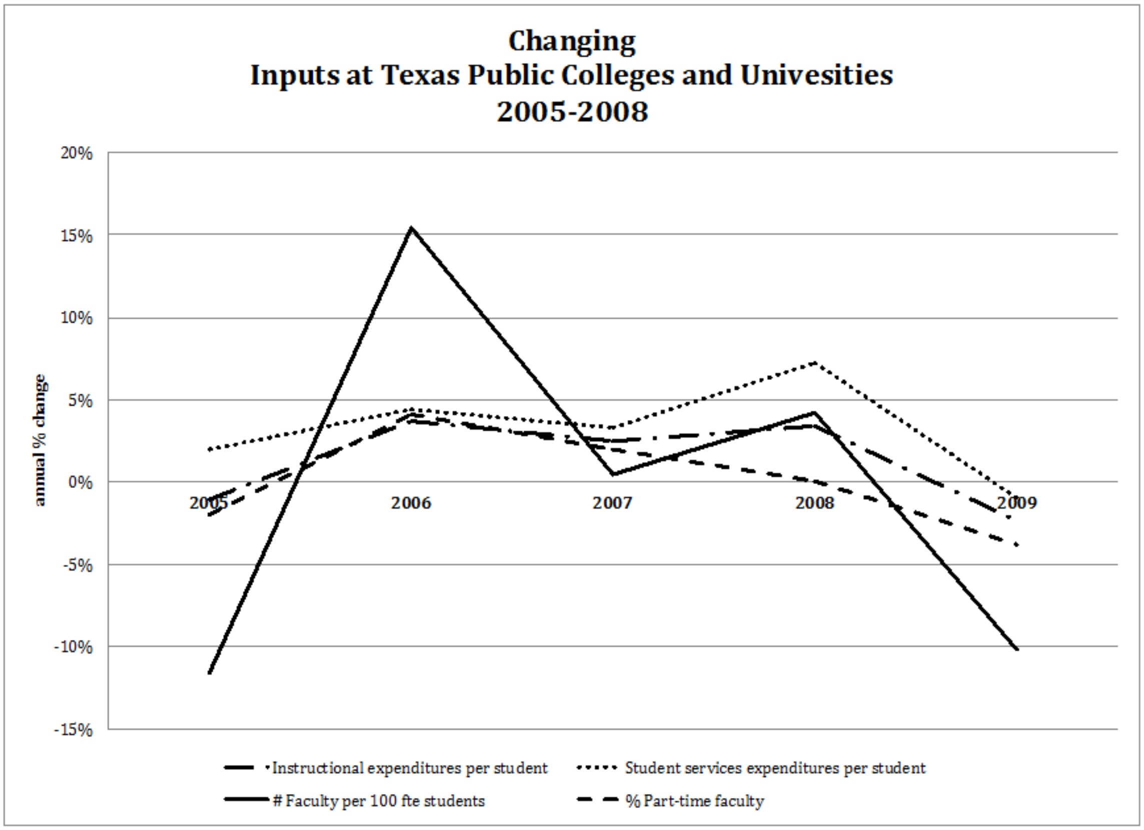


Figure 2.3: Survival graph for graduation and dropout, compared to still enrolled 2004/2005 through 2011



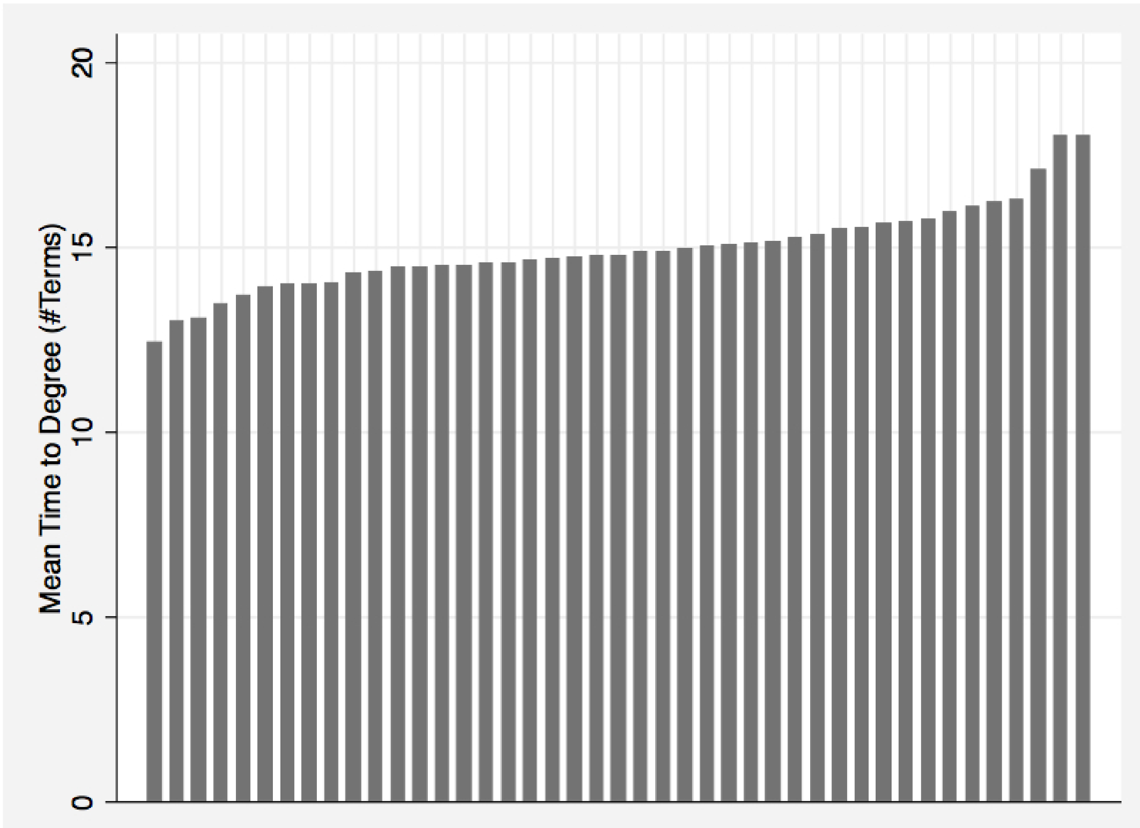
Note: Based on author's calculations using THECB administrative data.

Figure 2.4: Changing inputs at Texas public colleges and universities 2005 through 2009



Note: Based on author's calculations using THECB administrative data.

Figure 2.5: Mean time to bachelor's degree at public bachelor's degree-granting institutions



Note: Based on author's calculations using THECB administrative data.

Table 2.1: Mean students characteristics (sd) by graduation outcome

	Graduated On Time	Graduated Late	Still Enrolled	Dropped Out	All Students
Student demographics					
Age of entry	18.33	18.12	19.30	20.79	19.22
	(2.45)	(2.63)	(5.03)	(6.96)	(4.98)
Female	0.64	0.56	0.55	0.52	0.55
	(0.48)	(0.50)	(0.50)	(0.50)	(0.50)
Hispanic	0.18	0.25	0.34	0.30	0.28
	(0.38)	(0.43)	(0.47)	(0.46)	(0.45)
Black	0.06	0.10	0.18	0.18	0.14
	(0.25)	(0.30)	(0.39)	(0.38)	(0.35)
White	0.69	0.63	0.49	0.50	0.56
	(0.46)	(0.48)	(0.50)	(0.50)	(0.50)
Other race	0.11	0.13	0.14	0.07	0.11
	(0.31)	(0.34)	(0.35)	(0.25)	(0.31)
Father's educational attainment					
College degree	0.51	0.37	0.22	0.18	0.30
	(0.50)	(0.48)	(0.42)	(0.38)	(0.46)
High school diploma	0.30	0.34	0.32	0.26	0.30
	(0.46)	(0.47)	(0.46)	(0.44)	(0.46)
No high school diploma	0.04	0.06	0.09	0.06	0.07
	(0.21)	(0.24)	(0.28)	(0.24)	(0.25)
Mother's educational attainment					
College degree	0.47	0.35	0.22	0.17	0.28
	(0.50)	(0.48)	(0.41)	(0.37)	(0.45)
High school diploma	0.35	0.37	0.34	0.29	0.34
	(0.48)	(0.48)	(0.47)	(0.45)	(0.47)
No high school diploma	0.04	0.06	0.08	0.05	0.06
	(0.20)	(0.23)	(0.27)	(0.22)	(0.23)
Family income					
>$80,000	0.43	0.33	0.17	0.15	0.25
	(0.50)	(0.47)	(0.38)	(0.36)	(0.44)
$40,000 to 80,000	0.24	0.23	0.19	0.15	0.20
	(0.43)	(0.42)	(0.39)	(0.36)	(0.40)
<$40,000	0.15	0.18	0.25	0.18	0.19
	(0.35)	(0.39)	(0.43)	(0.38)	(0.39)
Missing	0.18	0.26	0.39	0.52	0.36
	(0.39)	(0.44)	(0.49)	(0.50)	(0.48)
Number of students	25,843	68,413	46,101	60,458	200,815
% of sample	13%	34%	23%	30%	100%

Note: Based on author's calculations using THECB administrative data.

Table 2.2: Mean (sd) high school outcomes and college pathways by outcome

	Graduated On Time	Graduated Late	Still Enrolled	Dropped Out	All Students
High school outcomes					
SAT composite score	1124.92	1036.90	963.80	954.52	1006.64
	(173.97)	(163.31)	(147.00)	(152.36)	(168.17)
Graduated in top 10%	0.40	0.22	0.08	0.08	0.17
	(0.49)	(0.41)	(0.28)	(0.27)	(0.37)
Graduated in top 11-25%	0.17	0.17	0.11	0.11	0.14
	(0.38)	(0.37)	(0.31)	(0.31)	(0.34)
College major (time varying)					
Undeclared	0.25	0.35	0.35	0.13	0.31
	(0.43)	(0.48)	(0.48)	(0.34)	(0.46)
STEM	0.28	0.31	0.26	0.18	0.25
	(0.45)	(0.46)	(0.44)	(0.38)	(0.43)
Agriculture/Health	0.14	0.19	0.24	0.16	0.19
	(0.34)	(0.39)	(0.43)	(0.36)	(0.39)
Social Science/Business	0.55	0.59	0.47	0.42	0.50
	(0.50)	(0.49)	(0.50)	(0.49)	(0.50)
Liberal Arts/Fine Arts	0.59	0.69	0.67	0.50	0.61
	(0.49)	(0.46)	(0.47)	(0.50)	(0.49)
College pathways					
Started at two-year college	0.17	0.47	0.61	0.43	0.45
	(0.38)	(0.50)	(0.49)	(0.50)	(0.50)
Ever enrolled part-time	0.90	0.97	0.95	0.78	0.90
	(0.29)	(0.18)	(0.23)	(0.41)	(0.30)
Semesters enrolled part-time	4.31	5.23	6.85	2.74	4.74
	(3.02)	(2.93)	(3.82)	(2.58)	(3.43)
Ever simultaneously enrolled	0.37	0.40	0.35	0.12	0.30
	(0.48)	(0.49)	(0.48)	(0.32)	(0.46)
Development education credits	0.38	1.24	2.32	1.94	1.59
	(1.12)	(2.01)	(2.62)	(2.61)	(2.36)
Number of students	25,843	68,413	46,101	60,458	200,815
% of sample	13%	34%	23%	30%	100%

Note: Based on author's calculations using THECB administrative data.

Table 2.3: Mean (sd) institutional inputs by type

	2- year colleges	4-year non-research universities	4-year research universities
Full-time faculty per 100 fte students	3.78	4.33	4.07
	(1.46)	(1.23)	(1.36)
% Part-time faculty	0.54	0.41	0.54
	(0.19)	(0.11)	(0.14)
% Minority students	0.4	0.44	0.31
	(0.20)	(0.28)	(0.20)
Instructional expenditures per student	4638	5736	7238
	(1,491.45)	(1,323.75)	(1,884.15)
Student services expenditures per student	979	998	1134
	(462.98)	(413.68)	(319.87)
Number of institutions	65	23	11

Note: Based on author's calculations using IPEDS Delta Cost Project's publicly released data.

Table 2.4: Log-odds regression results (se) for student variables

	Single Risk	Competing Risk		
	Graduated (vs. not graduated)	Graduated On-time	Graduate Late	Dropout
		(vs. still enrolled)		
Student demographics				
Age of Entry	1.02***	1.05***	0.99***	1.09***
	(0.00)	(0.00)	(0.00)	(0.00)
Female	1.56***	1.94***	1.17***	0.96***
	(0.02)	(0.03)	(0.01)	(0.01)
Hispanic	0.86***	0.79***	0.98***	1.04***
	(0.01)	(0.02)	(0.01)	(0.01)
Black	0.67***	0.58***	0.85***	0.97*
	(0.01)	(0.02)	(0.01)	(0.01)
Other race	0.93***	0.91***	1.34***	0.94***
	(0.02)	(0.02)	(0.02)	(0.02)
Father's educational attainment				
College degree	1.19***	1.24***	1.09***	0.77***
	(0.03)	(0.05)	(0.02)	(0.02)
High school diploma	1.05**	1.08**	1.07***	0.90***
	(0.02)	(0.04)	(0.01)	(0.02)
Mother's educational attainment				
College degree	1.12***	1.23***	1.04***	0.79***
	(0.03)	(0.05)	(0.01)	(0.02)
High school diploma	1.04*	1.10**	1.02	0.89***
	(0.03)	(0.04)	(0.01)	(0.02)
Family income				
>$80,000	1.22***	1.18***	1.18***	0.92***
	(0.02)	(0.03)	(0.01)	(0.02)
$40,000-80,000	1.16***	1.16***	1.11***	1.03*
	(0.02)	(0.03)	(0.01)	(0.02)
Missing	1.14***	1.18***	1.12***	1.31***
	(0.02)	(0.04)	(0.01)	(0.02)

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(Table 2.4: continued)

High school outcomes				
SAT composite	1.17***	1.24***	1.04***	0.89***
	(0.00)	(0.01)	(0.00)	(0.00)
Graduated in top 10%	1.94***	2.24***	1.37***	0.58***
	(0.02)	(0.04)	(0.01)	(0.01)
Graduate in 11-25%	1.32***	1.33***	1.20***	0.75***
	(0.02)	(0.03)	(0.01)	(0.01)
College major				
Undeclared	0.22***	0.20***	0.53***	1.53***
	(0.01)	(0.02)	(0.01)	(0.02)
STEM	1.15***	1.11***	1.03***	0.82***
	(0.02)	(0.02)	(0.01)	(0.01)
Agriculture/Health	0.93***	0.94**	0.88***	1.04**
	(0.02)	(0.03)	(0.01)	(0.02)
Social Sciences/Business	1.49***	1.52***	1.26***	0.80***
	(0.02)	(0.03)	(0.01)	(0.01)
College experiences				
Started at two-year college	0.44***	0.25***	0.87***	1.08***
	(0.01)	(0.00)	(0.01)	(0.01)
# Semesters enrolled part-time	0.87***	0.84***	0.90***	0.64***
	(0.00)	(0.00)	(0.00)	(0.00)
Simultaneously enrolled at two schools	1.09***	1.11***	1.08***	0.33***
	(0.01)	(0.02)	(0.01)	(0.00)
# Development education credits	0.34***	0.34***	0.48***	1.08***
	(0.02)	(0.03)	(0.01)	(0.00)
Number of person-periods	1,818,863		1,818,863	
Number of students	200,815		200,815	
Pseudo R-squared	0.37		0.28	

Note: Based on author's calculations using THECB administrative data and IPEDS Delta Cost Project's publicly released data. Significance indicated by --*: P<0.10, --**: P<0.05, --***: P<0.01.

Table 2.5: Log-odds regression results for institutional variables

	Single Risk	Competing Risk		
	Graduated (vs. not graduated)	Graduated On-time	Graduate Late	Dropout
		(vs. still enrolled)		
Full-time faculty per 100 fte students	1.07***	1.15***	0.93***	0.89***
	(0.01)	(0.01)	(0.00)	(0.00)
% part-time faculty	0.62***	1.38***	0.27***	1.68***
	(0.03)	(0.09)	(0.01)	(0.05)
% minority students	0.50***	0.28***	0.92***	1.95***
	(0.02)	(0.02)	(0.02)	(0.05)
Instructional expeditures per student (log)	1.44***	1.03	1.59***	0.86***
	(0.03)	(0.03)	(0.02)	(0.02)
Student services expenditures per student (log)	0.99	0.85***	1.14***	1.11***
	(0.01)	(0.02)	(0.01)	(0.02)
No research expenditure	0.16***	0.16***	0.34***	2.30***
	(0.00)	(0.01)	(0.01)	(0.03)
Number of person-periods	1,818,863	1,818,863		
Number of students	200,815	200,815		
Pseudo R-squared	0.40	0.30		

Note: Based on author's calculations using THECB administrative data and IPEDS Delta Cost Project's publicly released data. Significance indicated by --*: P<0.10, --**: P<0.05, --***: P<0.01.

Table 2.6: Log-odds estimates for graduating on time by student characteristics

Outcome: graduate on-time vs. still enrolled	(1)	(2) By Income	(3)	(4)	(5) By Race	(6)	(7)	(8) By High School Class Rank	(9)
	<$40k	$40-80k	>$80k	White	Hispanic	Black	Top 10	Top 11-25	Bottom 75
Full-time faculty per 100 fte students	1.21***	1.14***	1.10***	1.11***	1.15***	1.36***	1.11***	1.30***	1.15***
	(0.02)	(0.02)	(0.02)	(0.01)	(0.02)	(0.04)	(0.02)	(0.03)	(0.01)
% Part-time faculty	0.87	1.97***	2.45***	2.81***	0.40***	1.00	1.04	1.30***	2.39***
	(0.09)	(0.28)	(0.30)	(0.23)	(0.05)	(0.24)	(0.13)	(0.20)	(0.23)
% Minority students	0.43***	0.21***	0.05***	0.05***	0.53***	0.44***	0.48***	0.31***	0.23***
	(0.03)	(0.04)	(0.01)	(0.01)	(0.05)	(0.06)	(0.06)	(0.04)	(0.02)
Instructional expeditures per student (log)	0.97	1.09	1.10*	0.96	1.29***	0.74**	1.12*	0.92	1.26***
	(0.05)	(0.07)	(0.06)	(0.04)	(0.10)	(0.09)	(0.07)	(0.07)	(0.06)
Student services expenditures per student (log	0.85***	0.84***	0.83***	0.80***	0.89**	0.83**	0.83***	0.96***	0.81***
	(0.03)	(0.03)	(0.03)	(0.02)	(0.05)	(0.06)	(0.04)	(0.04)	(0.02)
Number of observations	924,999	382,067	511,797	1,131,469	477,070	210,324	337,472	263,174	1,218,217
Number of students	110,044	39,613	51,158	126,831	55,682	27,798	33,974	27,312	139,529
Pseudo R-squared	0.28	0.31	0.33	0.30	0.30	0.28	0.28	0.31	0.33

Note: Based on author's calculations using THECB administrative data and IPEDS Delta Cost Project's publicly released data. Significance indicated by --*: P<0.10, --**: P<0.05, --***: P<0.01.

Table 2.7: Log-odds estimates for graduating late by student characteristics

Outcome: graduate late vs. still enrolled	(1)	(2) By Income	(3)	(4)	(5) By Race	(6)	(7)	(8) High School Rank	(9)
	<$40k	$40-80k	>$80k	White	Hispanic	Black	Top 10	Top 11-25	Bottom 75
Full-time faculty per 100 fte students	0.92***	0.93***	0.97***	0.94***	0.94***	0.89***	0.98**	0.91***	0.93***
	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)
% Part-time faculty	0.30***	0.28***	0.21***	0.24***	0.38***	0.30***	0.25***	0.24***	0.30***
	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.03)	(0.02)	(0.02)	(0.01)
% Minority students	0.85***	1.03	1.29***	1.39***	0.89***	0.89**	1.11**	0.95	.89***
	(0.02)	(0.05)	(0.07)	(0.05)	(0.03)	(0.04)	(0.05)	(0.04)	(0.02)
Instructional expeditures per student (log)	1.57***	1.69***	1.78***	1.76***	1.67***	1.77***	1.47***	1.87***	1.67***
	(0.03)	(0.05)	(0.04)	(0.03)	(0.05)	(0.08)	(0.05)	(0.06)	(0.03)
Student services expenditures per student (log)	1.23***	1.09***	1.09***	1.12***	1.09***	1.25***	1.24***	1.27***	1.10***
	(0.02)	(0.02)	(0.02)	(0.01)	(0.02)	(0.04)	(0.03)	(0.03)	(0.01)
Number of observations	924,999	382,067	511,797	1,131,469	477,070	210,324	337,472	263,174	1,218,217
Number of students	110,044	39,613	51,158	126,831	55,682	27,798	33,974	27,312	139,529
Pseudo R-squared	0.28	0.31	0.33	0.30	0.30	0.28	0.28	0.31	0.33

Note: Based on author's calculations using THECB administrative data and IPEDS Delta Cost Project's publicly released data. Significance indicated by --*: P<0.10, --**: P<0.05, --***: P<0.01.

Table 2.8: Log-odds estimates for dropping out by student characteristics

Outcome: dropout vs. still enrolled	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		By Income			By Race			High School Rank	
	<$40k	$40-80k	>$80k	White	Hispanic	Black	Top 10	Top 11-25	Bottom 75
Full-time faculty per 100 fte students	0.91***	0.87***	0.88***	0.90***	0.92***	0.85***	0.89***	0.89***	0.89***
	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)
% Part-time faculty	2.15***	1.17**	1.39***	1.48***	1.92***	1.91***	1.39***	1.55**	1.91***
	(0.08)	(0.09)	(0.11)	(0.07)	(0.11)	(0.17)	(0.15)	(0.14)	(0.07)
% Minority students	1.70***	2.69***	4.65***	2.41***	2.04***	1.54***	2.08***	2.32***	1.86***
	(0.05)	(0.22)	(0.43)	(0.12)	(0.09)	(0.09)	(0.20)	(0.18)	(0.06)
Instructional expeditures per student (log)	1.05*	0.92	0.58***	0.88***	0.78***	1.46***	.53***	0.77***	1.04
	(0.03)	(0.05)	(0.03)	(0.03)	(0.04)	(0.10)	(0.04)	(0.05)	(0.03)
Student services expenditures per student (log	1.15***	1.07*	1.11***	1.08***	1.27***	1.03	0.98	0.92***	1.13***
	(0.02)	(0.04)	(0.04)	(0.02)	(0.04)	(0.04)	(0.05)	(0.04)	(0.02)
Number of observations	924,999	382,067	511,797	1,131,469	477,070	210,324	337,472	263,174	1,218,217
Number of students	110,044	39,613	51,158	126,831	55,682	27,798	33,974	27,312	139,529
Pseudo R-squared	0.28	0.31	0.33	0.30	0.30	0.28	0.28	0.31	0.33

Note: Based on author's calculations using THECB administrative data and IPEDS Delta Cost Project's publicly released data. Significance indicated by --*: P<0.10, --**: P<0.05, --***: P<0.01.

Table 2.9: Log-odds estimates for graduating on time by student characteristics

	(1)	(2)	(3)	(4)	(5)	(5)
		first enrollment			navigating higher education	
Outcome: graduate on-time vs. still enrolled	2-year college	4-year non-research university	4-year research university	Traditional 4-year enrollment	Simultaneous enrollment	Frequent part-time enrollment
Full-time faculty per 100 fte students	1.11***	1.46***	1.36***	1.23***	1.09***	1.12**
	(0.02)	(0.03)	(0.04)	(0.02)	(0.01)	(0.06)
% Part-time faculty	2.58***	0.39***	1.00	1.26**	1.34***	4.13***
	(0.35)	(0.06)	(0.24)	(0.13)	(0.14)	(1.83)
% Minority students	0.49***	0.45***	0.44***	0.29***	0.24***	0.27***
	(0.06)	(0.04)	(0.06)	(0.03)	(0.03)	(0.08)
Instructional expeditures per student (log)	1.44***	0.54***	0.74**	0.87***	1.37***	0.87
	(0.09)	(0.04)	(0.09)	(0.04)	(0.07)	(0.18)
Student services expenditures per student (log)	0.78***	0.72***	0.83**	0.89***	0.80***	0.86
	(0.04)	(0.03)	(0.06)	(0.03)	(0.03)	(0.13)
Number of observations	833,007	463,597	534,380	548,139	658,945	571,265
Number of students	90,608	55,329	56,842	67,371	60,443	54,974
Pseudo R-squared	0.29	0.30	0.34	0.33	0.29	0.31
% of all students	45%	28%	28%	34%	30%	27%

Note: Based on author's calculations using THECB administrative data and IPEDS Delta Cost Project's publicly released data. Significance indicated by --*: P<0.10, --**: P<0.05, --***: P<0.01.

Table 2.10: Log-odds estimates for graduating late by student characteristics

	(1)	(2)	(3)	(4)	(5)	(5)
		first enrollment			navigating higher education	
Outcome: graduate late vs. still enrolled	2-year college	4-year non-research university	4-year research university	Traditional 4-year enrollment	Simultaneous enrollment	Frequent part-time enrollment
Full-time faculty per 100 fte students	0.94***	0.88***	0.89***	0.91***	0.96***	0.93***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
% Part-time faculty	0.26***	0.40***	0.30***	0.30***	0.23***	0.22***
	(0.01)	(0.03)	(0.03)	(0.02)	(0.01)	(0.01)
% Minority students	0.92***	0.86***	0.89**	0.85***	0.96	0.88***
	(0.03)	(0.03)	(0.04)	(0.03)	(0.03)	(0.03)
Instructional expeditures per student (log)	1.61***	1.44***	1.77***	1.70***	1.60***	1.61***
	(0.03)	(0.04)	(0.08)	(0.04)	(0.03)	(0.04)
Student services expenditures per student (log)	1.11***	1.25***	1.25***	1.23***	1.12***	1.09***
	(0.01)	(0.02)	(0.04)	(0.02)	(0.02)	(0.02)
Number of observations	833,007	463,597	534,380	548,139	658,945	571,265
Number of students	90,608	55,329	56,842	67,371	60,443	54,974
Pseudo R-squared	0.29	0.30	0.34	0.33	0.29	0.31
% of all students	45%	28%	28%	34%	30%	27%

Note: Based on author's calculations using THECB administrative data and IPEDS Delta Cost Project's publicly released data. Significance indicated by --*: P<0.10, --**: P<0.05, --***: P<0.01.

Table 2.11: Log-odds estimates for dropping out by student characteristics

	(1)	(2)	(3)	(4)	(5)	(5)
	first enrollment			navigating higher education		
Outcome: dropout vs. still enrolled	2-year college transfer	4-year non-research university	4-year research university	Traditional 4-year enrollment	Simultaneous enrollment	Frequent part-time enrollment
Full-time faculty per 100 fte students	0.86***	0.95***	0.85***	0.94***	0.90***	0.89***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
% Part-time faculty	2.28***	1.73***	1.91***	1.20***	1.52***	1.55***
	(0.11)	(0.10)	(0.17)	(0.07)	(0.14)	(0.09)
% Minority students	4.04***	1.71***	1.54***	1.48***	2.05***	1.18***
	(0.16)	(0.07)	(0.09)	(0.07)	(0.16)	(0.06)
Instructional expeditures per student (log)	0.90***	0.91**	1.46***	0.78***	0.82***	1.19***
	(0.03)	(0.04)	(0.10)	(0.03)	(0.05)	(0.06)
Student services expenditures per student (log)	1.19***	1.02	1.03	1.01	1.17***	1.21***
	(0.03)	(0.02)	(0.04)	(0.02)	(0.06)	(0.04)
Number of observations	833,007	463,597	534,380	548,139	658,945	571,265
Number of students	90,608	55,329	56,842	67,371	60,443	54,974
Pseudo R-squared	0.29	0.30	0.34	0.33	0.29	0.31
% of all students	45%	28%	28%	34%	30%	27%

Note: Based on author's calculations using THECB administrative data and IPEDS Delta Cost Project's publicly released data. Significance indicated by --*: P<0.10, --**: P<0.05, --***: P<0.01

Chapter 3: Transfer and Time to Degree: A Quasi-Experimental Study of Credits, Preparation, and Pace

Introduction

Student enrollment patterns in higher education are increasingly diverse. Many students who wish to pursue a bachelor's degree enroll first at community colleges to lower the cost of higher education, remain close to home, build academic skills, or have more flexible enrollment options (Hearn, 1992). To complete a bachelor's degree, community college students must typically transfer to a four-year institution in a process known as vertical transfer. Students beginning at two-year institutions tend to have lower rates of graduation and years of educational attainment than students beginning and remaining at a single four-year institution. They are hypothesized to take more time to complete degrees.

The requirement that a two-year attendee physically change schooling locations may cause a barrier to timely completion of a bachelor's degree. Community colleges may not adequately prepare students to succeed in four-year academic or social environments, or they may divert student interests away from the bachelor's degree. Transfer students may have characteristics that are correlated with lower education outcomes such as low levels of high school preparation and high likelihood to enroll part-time and work. Students may lose credits in the transfer process because universities do not accept courses to satisfy general graduation requirements or specific major requirements.

Increasing student mobility and its effects on higher education attainment are not limited to students who start at community colleges. Students beginning at four-year institutions may also attend more than one university through processes of formal transfer, simultaneous enrollment, or periodic "dips" into coursework at two- or four-year institutions other than their primary one. Scholars have identified nearly a dozen enrollment patterns that cross institutions (McCormick, 2003; Adelman, 2005), known collectively as student "swirl" (Townsend, 2001). Much less in known about four-year to four-year *lateral transfer*, as much of the transfer literature focuses on comparisons between vertical transfers and native students (Goldrick-Rab, 2006; Bahr, 2012; Adelman 1999). In terms of the effect of transfer on degree completion and time-to-degree completion, some consequences of lateral transfer mirror those of vertical transfer (e.g., credit loss), while other hypotheses about institutional quality or student enrollment characteristics would be distinct for the two types of transfer.

Previous work on transfer has focused on two outcomes—total years of education attained or bachelor's degree attainment. This paper extends the literature on transfer student success by asking whether transfer students in Texas are as successful and efficient as *native students* who enroll at a four-year institution and do not transfer. Do transfer students complete degrees, accumulate credits, and complete at a pace that is similar to native students? Can differences in outcomes be explained by differences in student populations who enroll at a two-year institution or transfer? The paper explores differences between native students and two types of transfer students—two-year to four-year vertical transfers and four-year to four-year lateral transfers—to determine (1) how transfer affects time to degree and (2) the similarities and differences between the causal mechanisms that lead transfer students to extend time-to-degree completion. Examining vertical transfer only makes if difficult to differentiate selection effects from transfer effects. Comparing vertical and lateral transfer provides insights into whether the effects of transfer can be attributed to student background and preparation, features of particular sectors, or policy more generally.

I use propensity score matching to address selection bias caused by the differences in student populations who begin at two- and four-year institutions in a nonexperimental setting (Heckman, Ichimura, & Todd, 1998; Heckman, Lalonde, & Smith, 1999). I match native students with transfer students based on propensity to transfer predicted with a robust set of observable student characteristics, including student demographics, family background, prior academic preparation, and college preferences. Propensity score matching has been used previously to study graduation likelihood and credit accumulation. This study extends the quasi-experimental approach to questions of time to degree, operationalized as the number of elapsed terms between first enrollment in higher education and graduation. The study uses statewide student longitudinal data from Texas for traditional-aged students who enrolled between 2004 and 2006 and were followed for six years.

I find a significant transfer penalty in terms of graduation, credit hours, and time to degree. Results suggest credits lost at the point of transfer contribute to poorer transfer student outcomes compared to native students. Mobile students are approximately 17 percentage points less likely to graduate within six years of matriculation. Among those who complete a bachelor's degree, transfer students attempt 7.6 more credits than native students and extend their time to degree by almost one term. The negative effects of transfer are not unique to vertical transfers who begin in community colleges. The likelihood of graduation is lower and the number of attempted credits at graduation is higher for lateral transfers than vertical transfers, although the extension in time to degree associated with transfers is greater for vertical transfer than lateral transfer. The results of this study undermine popular hypotheses for explaining transfer penalties by student and institutional quality. Credit loss affects both vertical and lateral transfers; therefore, penalties should not be attributed to community colleges alone. Instead results suggest institutional transfer practice and state policy efforts in both sectors should target the preservation of transfer credits to accelerate time to degree.

Theoretical Framework

Student transfer, like educational outcomes more generally, depends on perceived future labor market returns and nonmonetary benefits to schooling investments according to human capital theory (Becker, 1975). Student decisions to complete a degree—and presumably the pace of that completion and decisions about transfer—are determined by a comparison of educational costs and the returns to education. Students invest up to the point where the marginal benefits of a unit of college equal the marginal costs of another unit of consumption (Clotfelter, 1991). Student decisions not to complete college or to drop out are explained in the human capital theory model by students acquiring new information about labor market returns to education, their academic ability, or preferences for leisure (Altonji, 1993). Traditional human capital models posit that three main factors influence postsecondary enrollment: (1) rate of return to postsecondary education, (2) cost of the education, and (3) resources to pay for college (Betts & McFarland, 1995). Assuming limited resources to pay for college, students with aspirations of completing a bachelor's degree may choose a transfer pathway to reduce the cost of education or increase the rate of future returns. Students may first enroll at a community college due to the lower direct costs of tuition and fees and lower room and board expenses. Community colleges lower opportunity costs because they offer flexible scheduling, accommodate part-time enrollment, and often enable students to live at home (Horn & Nevill, 2006).

Some transfer students, especially lateral transfers, may be less influenced by short-term costs and instead seek to maximize the fit between their academic ability and institutional quality in order to improve their future economic returns or increase satisfaction with their educational experience (Light & Strayer, 2000; Herzog, 2005; Goldrick-Rab & Pfeffer, 2009; Kirk-Kuwaye & Kirk-Kuwaye, 2007). Fit is described as the interaction and congruence of personal, intellectual, and social values with the college environment that engenders a subjective sense of belonging (Astin, 1993; Tinto, 1987; Cohen, Brawer, & Bensimon, 1985). A lack of academic or social integration is associated with student decisions to drop out or transfer (Tinto, 1987). One important feature of academic fit associated with college choice decisions is college major. Whether an institution offers a particular major or a student can access a particular major influences initial college selection and subsequent transfer decisions (Arcidiacono, 2004)

There are several hypotheses about why transfer student outcomes may differ from those of native students; some suggest transfer student outcomes are better. There is evidence that students who successfully transfer tend to be highly motivated and therefore may have stronger or equivalent outcomes once preparation, background characteristics, and academic progress are controlled (Monaghan & Attewell, 2014; Volkein & Lorang, 1996; Kienzl, Alfonso, & Melguizo, 2007). Alternatively, transfer student outcomes may be worse in the short-term and long-term. Students may experience transfer shock, a period of disequilibration and adjustment to a new academic environment and culture evidenced by a short-term decrease in student grades at the time of transfer (Cejia, 1997; Hilmer, 1999; Lam, 1999). Community colleges or less selective four-year institutions may not adequately prepare students for success at more selective four-year institutions. Long-term transfer student outcomes such as persistence and graduation may be weaker because student populations that first enroll at community colleges and nonselective four-year institutions tend to have lower levels of financial, human, and social capital (Roska & Keith, 2008; Sandy, Gonzalez, & Hilmer, 2006; Alfonso, 2006; Long & Kurlaender, 2009; Bastedo & Jaquette, 2011). Alternatively, observed differences between transfer student and native student outcomes could be an artifact of student selection into different higher education pathways (Kienzl et al., 2007).

The focus of this study is on the credit loss hypothesis, which suggests that students who transfer take more time to complete a bachelor's degree than native students because they lose accumulated credits in the transfer process (Monaghan & Attewell, 2014, Bowles, 1988; Cohen & Brawer, 1989; Dougherty, 1992, 1994; Pincus & DeCamp, 1989; Richardson & Bender, 1987). When a receiving institution does not accept courses as equivalent to those taken at another institution or when completed courses cannot be applied to a major, students must repeat or replace coursework to satisfy the requirements of their new institution (Lehman, 2002; Hilmer, 1999, Lam, 1999; DesJardins, Ahlburg, & McCall, 2002). General transfer credit problems occur when similar courses are not offered at the new institution or if learning outcomes or rigor are not equivalent between two institutions. At the level of student major, credits may be lost when particular course requirements (e.g., a general education mathematics course) are not applicable to the same major at different institutions (The Charles A. Dana Center, 2013).

A study by Monaghan and Attewell (2014) explicitly links credit loss to transfer student penalties using detailed transcript-level data from the national Beginning

Postsecondary Students longitudinal study. They find 58 percent of transfer students were able to transfer 90 percent of their community college credits, 28 percent transferred between 10 and 90 percent of their credits, and 14 percent transferred fewer than 10 percent of their credits. Students who lose credits are significantly less likely to graduate. In a simulation model, the authors find that if all credits were transferable, graduation rates among transfer students would increase from 45 to 54 percent overall (Monaghan & Attewell, 2014).

The issue of credit loss is the subject of much state and institutional policy. To reduce credit loss, many states have designed policy interventions such as creating a common lower division core curriculum that is guaranteed to transfer to any public institution statewide, common course numbering systems, and articulation agreements that guarantee particular courses are accepted for credit between two or more institutions (Southern Regional Education Board, 2007). Some states have pursued statewide articulation agreements detailing the courses in specific majors. In other states, articulation agreements are made independently among individual institutions of higher education (Texas Higher Education Coordinating Board, 2012; Roska & Keith, 2008; Sun, Anderson, Gregory & Alfonso, 2006).

This study tests the credit loss hypothesis and applies it to a new population—lateral transfer students. The hypothesis predicts that both vertical transfers and lateral transfers would confront similar obstacles in transitioning to a new four-year institution. If true, I would expect to find that both vertical and lateral transfer students take longer to complete degrees and both types of transfer students accumulate more credits at graduation than native students. If the outcomes of vertical transfers and lateral transfer differ, especially if vertical transfer student outcomes are significantly worse than those of lateral transfer students, I would conclude hypotheses related to institutional quality or student inputs may be more influential.

Transfer Literature Review

Students who first enroll in two-year institutions or transfer among four-year institutions are different in both observable and unobservable ways. Community college students are more likely to attend part-time, to be minority and low income, and to have lower high school grades and lower standardized test scores than students who first enroll at a four-year institution (Adelman, 1999, 2006; Horn & Nevill, 2006; Goldrick-Rab, 2010; Roderick, Nagaoka, Coca, & Moeller, 2008, 2009). Approximately two-thirds of community college students enroll part-time (less than 12 credits in a semester), and a quarter of students enroll in fewer than six credits in a semester. Part-time enrollment is associated with constrained financial resources and outside-of-school commitments including work and family. Students who attend community colleges are more likely to have financial need, rely on financial aid, and to be married and have children (U.S. Department of Education, 2013; U.S. Department of Education NCES, 1998, 2006; Adelman, 2005; Horn & Nevill, 2006; The College Board, n.d.). The factors that contribute to initial selection to transfer are likely negatively correlated with graduation, credit accumulation, and time-to-degree completion.

A modest proportion of community college students successfully transfer to four-year institutions. Roughly one-quarter to one-third of community college students transfer vertically (Texas Higher Education Coordinating Board, Higher Education Accountability System, 2013; Adelman, 2005; Moore & Shulock, 2009). Compared to the community college population at large, students who transfer from community colleges to four-year institutions tend to have attributes associated with better higher education outcomes, including higher levels of academic preparation, higher family incomes, and being White (Doughtery, 1987, 1994; Dougherty & Kienzl, 2006; Grubb, 1991, Lee & Frank, 1990; Whitaker & Pascarella, 1994; Surette, 2001).

A challenge in studying the impact of transfer is disentangling the features of students and institutions that influence transfer student outcomes from the features of the policy environment more generally. The literature has focused primarily on the effects of vertical transfer and attributed the contributions or drawbacks of transfer primarily to community colleges. It is important to compare transfer student outcomes under different conditions—as I do here for those starting at two-year institutions and those at four-year institutions—to differentiate common transfer policy conditions from institutional sector effects.

Students who initially enroll at four-year institutions are highly mobile as well. Many four-year students earn credits at institutions other than their primary or initial institution.[13] Approximately 50 percent of undergraduates who first enroll at four-year institutions attend another institution as part of their undergraduate education within six years. Another 15 to 19 percent attend more than two institutions (McCormick, 2003; Goldrick-Rab, 2006). Students who start at four-year institutions may formally transfer to a two-year institution (reverse transfer), but more often “drop in” to community colleges to earn a small number of credits (Adelman, 2005). Forty-seven percent of transfers from four-year public institutions move laterally to other four-year public or private institutions, while 53 percent transfer to two-year public or private institutions (National Student Clearinghouse Research Center, 2012; Adelman, 2006).[14] Adelman (2006) estimates 14 percent of students who first enroll at four-year institutions go on to earn their degree from another four-year institution. Lateral transfer students tend to come from more economically advantaged backgrounds than students who remain at a single institution (Goldrick-Rab, 2006), and their parents tend to be more highly educated (Goldrick-Rab & Pfeffer, 2009). They are also more likely to be female and out-of-state students (Kim, Saatcioglu, & Neufeld, 2012; Goldrick-Rab, 2006; Goldrick-Rab & Pfeffer, 2009; Porter, 2003). Lateral transfer is less likely

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13Estimates from Choy (2002) suggest only one-quarter of undergraduate students follow a traditional enrollment path by enrolling directly after high school, remaining at a single institution, enrolled first time, and graduating in four years.

14Note: The term *lateral transfer* is also used in the literature to describe students who move between two-year institutions. See for example, Bahr (2012).In this paper, this term refers only to students who transfer between four-year institutions.

associated with financial constraints and more likely associated with personal, social, or academic issues (Kim et al., 2012).

Conclusions to date have been mixed about the effects of community college education and transfer on higher education outcomes. In terms of time-to-degree completion, a small number of descriptive studies suggest that students who decide to transfer tend to take more time to complete a degree than native students who remain at a single institution (Knight & Arnold, 2000; Hilmer, 1999, Lam, 1999; Lehman, 2002). Students who first enroll at a two-year institution are less likely to complete a bachelor's degree within four years, but only modestly less likely to complete a degree within six years (Cullinane & Lincove, 2014). Time-to-degree extension is concentrated among students who start in two-year colleges and nonselective four-year institutions (Bound, Lovenheim, & Turner, 2012). Decreases in institutional resources and growing rates of students working while enrolled in higher education underlie this disproportionate effect. Changes in student demographics and student academic preparation in all sectors of higher education, including two-year institutions, decreased time to degree during the 1970s and 1980s, although this positive effect is smaller than the influences of resource constrictions and student work (Bound et al., 2012).

In terms of other completion outcomes, some researchers argue that community colleges divert students from four-year institutions where they are more likely to be successful. Students who transfer from a community college to a four-year institution attain fewer years of schooling (Leigh & Gill, 2003; Kane & Rouse, 1995), are less likely to graduate (Sandy et al., 2006; Alfonso, 2006; Long & Kurlaender, 2009; Doyle, 2009, Goldrick-Rab & Pfeffer, 2009), and earn lower grades and wages than students who begin at four-year institutions (Cejda, 1997; Volkwein & Lorang, 1996; Hilmer, 1999; Black & Smith, 2004). Estimated graduation penalties range from 15 to 30 percent (Long & Kurlaender, 2009; Alfonso, 2006). Between 52 and 71 percent of the differences are explained by institutional quality and 28 to 47 percent of the differences by student preparation and background characteristics (Sandy et al., 2006).

Other researchers argue that transfer student outcomes are better or equivalent to nontransfer students and that community colleges democratize access to higher education, enabling a wider proportion of the population access to higher education. They demonstrate that more marginal students now participate in higher education due to community colleges (Sandy et al., 2006) and that community college attendance increases educational attainment by 0.7 – 1.0 years among students with aspirations of a bachelor’s degree (Kane & Rouse, 1995; Leigh & Gill, 2003). Having transfer credits is positively associated with graduation (DesJardins et al., 2002). When observable characteristics of transfer students and native student are controlled, transfer students are just as likely to graduate and accumulate similar numbers of credits (Monaghan & Attewell, 2014; Melguizo, Kienzl, & Alfonso, 2011; Dougherty & Kienzl, 2006). Results are similar when comparing lateral transfer students with native students (Goldrick-Rab & Pfeffer, 2009) and students who transfer to a selective flagship institution regardless of the sector they started in (Bowen, Chingos, & McPherson, 2009).

The differences between the previous findings may be explained in part by heterogeneous effects on subpopulations of students. Hispanic students have been found to have no transfer penalty (Melguizo, 2008). Another study found that the positive impact of community college on Hispanic students was even larger—an increase of 2.6 years of education compared to 2.2 additional years for White students and a decrease of 0.5 years for Black students (Gonzalez & Hilmer, 2006). Differences between earlier findings may be attributed to the use of national, state, or single-institutions data sets. The majority of transfer studies rely on national data sets that may mask important institutional and policy differences between states (Monaghan & Attewell, 2014; Melguizo et al., 2011). Just one study—Long and Kurlaender (2009)—uses state-level data. State contexts vary in terms of mix of institutions available and the participation of students, and transfer policies and practices may be apparent in state analyses but washed out in aggregate national studies. The studies also differ in their definitions of treatment and control groups. For instance Monaghan and Attewell (2014), Adelman (2005), and Melguizo et al. (2011) restrict analysis to rising juniors who have completed at least 60 credits prior to transfer, which limits the comparison of transfer and native students to those students who successfully transferred at junior status, while Long and Kurlaender (2009) rely on expressed intentions of students to complete a bachelor’s degree and the existence of a valid ACT or SAT score to establish student intent to transfer. Finally, studies vary in their methodological strategies to address selection bias. As described above, many of the known differences between community college and four-year participants are also correlated with success in higher education, including successful transfer, degree completion, and timely degree completion. Standard linear regression models suffer from selection bias, as they are unable to differentiate between unobserved differences in treatment and control groups and the outcomes. Various strategies such as propensity score matching and instrumental variables have been employed to overcome selection bias (Long & Kurlaender, 2009; Melguizo et. al., 2011; Gonzalez & Hilmer, 2006; Kane & Rouse, 1995).

This study uses propensity score matching and statewide data from Texas public colleges and universities. Higher education in Texas is primarily publicly controlled. Public community college students comprise more than 50 percent of the total undergraduate enrollment in the state, public university students comprise 38 percent, and approximately 10 percent of students attend private four-year institutions (Wellman, 2002). The Texas higher education transfer policy context is characterized by a strong statewide core curriculum policy with relatively decentralized aspects of transfer in practice, including voluntary statewide field-of-study agreements, voluntary common course numbering, and institution-by-institution articulation agreements (Texas Higher Education Coordinating Board, 2012; Wellman, 2002). The core curriculum guarantees many lower division courses for transfer if courses meet standardized learning outcomes (Texas Education Code, 2013). If students complete the full 42-hour lower division of core curriculum courses, all 42 credits must transfer to receiving institutions as a block (Texas Education Code, 2013). Less than 8 percent of community college transfer students complete the core curriculum prior to transfer. If students transfer before completing the 42-hour core curriculum, receiving institutions have discretion to accept transfer credit on a course-by-course approval basis (Texas Education Code, 2013). The voluntary nature of field-of-study agreements, course-numbering, and articulation agreements means that students may take courses at one institution anticipating credits will be preserved during transfer, but they later discover particular courses are not transferable depending on the receiving institution's course offerings and program of study requirements (Roska & Keith, 2008; Goldrick-Rab & Roska, 2008)

While the literature has convincingly asserted that there is a relationship between transfer and degree completion, findings have been mixed. The relationship between transfer and time to degree is even less well understood. This study makes two contributions. First, it extends a quasi-experimental approach to questions of time to degree. Propensity score matching attempts to compare treatment and control individuals who are similar based on their observable characteristics. Propensity score matching is used to create statistically comparable treatment and comparison groups, based on individuals' observed, pretreatment characteristics that adjust for selection bias and allow for causal inference. Second, because I am interested in the process of transfer and its influence on pace of completion, I do not limit my sample only to community college transfers. Four-year to four-year lateral transfers are included in the analysis to test whether credit loss contributes to extensions in time to degree. With the inclusion of lateral transfer students, this study improves upon previous research by testing whether credit loss is specific to community college transfer or a feature of transfer and transfer policy more generally.

EMPIRICAL STRATEGY

To test the effect of transfer on higher education outcomes, I begin by regressing graduation, time to degree, and student credit hours on transfer while controlling for observable characteristics of students. I estimate the following equation using ordinary least squares (OLS):

$$Y_i = \gamma_0 + \gamma_1 Z_i + \gamma_2 D_i + \gamma_3 F_i + \gamma_4 A_i + \gamma_5 C_i + \eta_t + \varepsilon_i \qquad (1)$$

where Y is the student outcome, D_i is a vector of student demographic characteristics, F_i is a vector of family background characteristics, A_i is a vector of precollege academic preparation variables, C_i is a vector of precollege preferences, and η represents a cohort year dummy variable. ε_i is the individual idiosyncratic error term, and *Z* represents transfer.

In the first models, I estimate the aggregated effect of transfer, including both vertical and lateral transfers together, compared to native students. In subsequent models, I estimate the effects of vertical transfer compared to native students and lateral transfer compared to native students separately. I use logistic regression for the dichotomous outcome of graduation and report marginal effects. I include robust standard errors for all models. Results provide a baseline understanding of the relationship between transfer and higher education outcomes; however, OLS techniques suffer from selection bias. Given the fact that students are not randomly assigned to initial institutions and different students tend to select transfer paths rather than remain at a four-year institution, simply comparing transfer and native students produces biased results.

In the absence of random assignment of students to treatment and control groups, propensity score matching is a quasi-experimental method that attempts to create treatment and comparison groups that are similar based on students' observable characteristics. By improving the comparability of students based on matching observable characteristics, I seek to reduce variation among unobservable characteristics as well. Assuming that the conditioning variables balance observable characteristics between the treatment and comparison groups so that participation in treatment is independent of outcomes, then matching approximates randomization (Becker & Ichino, 2002; Austin, 2011). I match native students with transfer students based on a robust set of observable student characteristics, including student demographic characteristics, family background, academic preparation, and college preferences.

The first step in propensity score matching is to calculate a propensity score for each person in the data set that estimates the likelihood of transfer (treatment) given a particular distribution of observed characteristics. The propensity score provides a single efficient measure, conditioned upon which treatment and control students are similar in their observed characteristics (Rosenbaum & Rubin, 1983). For individuals with equivalent propensity scores, the distribution of observable characteristics are the same:

$$Y \perp Z \mid X \implies Y \perp Z \mid P(X) \qquad (2)$$

where Z is the indicator of treatment, X is a vector of individual student pretreatment characteristics, and Y is the outcome of time to degree (Rosenbaum & Rubin, 1983). Exposure to treatment is essentially random and mean comparisons are presumed to be unbiased, assuming two conditions are met (Lunceford & Davidian, 2004). First, there must be no unmeasured confounders, and treatment must be independent of outcomes conditional on the propensity score (Imbens, 2004; Rosenbaum & Rubin, 1983). Second, observable characteristics of transfer and native students must share an area of common support, and balancing properties must be met so that matched treated and control observations share a similar distribution of characteristics independent of treatment (Currie, 2003; Caliendo & Kopeinig, 2008).

$$E(Y \mid Z = 1, X) = E(Y \mid Z = 0, X) \qquad (3)$$

In the first stage, I regress treatment status on the observable characteristics that predict transfer and outcomes (Heinrich, Maffioli, & Vázquez, 2010; Austin, Grootendorst, & Anderson, 2007; Brookhart et al., 2006).[15] Propensity scores are estimated with the following logit specification using the aggregated sample of both types of transfer students and native students:

$$Prob\ (Z_i = 1) = (\beta_0 + \beta_1 D_i + \beta_2 F_i + \beta_3 A_i + \beta_2 C_i + \eta_t + \varepsilon_i) \qquad (4)$$

Student demographic characteristics include race, gender, and age (with a quadratic term to allow for diminishing effects of age). Family background characteristics include family income and parental education. Family income is a categorical variable with values of less than $40,000 per year, $40,000 to $80,000 per year, more than $80,000 per year, or missing.[16] Parental education for mothers and fathers is signaled by dummy variables for three categories of education: less than a high school degree, high school degree or some college, and college degree or above. High school graduating class rank, math SAT score (or equivalent ACT score), number of dual-enrollment credits earned while in high school, and whether a student was referred to developmental (remedial) education variables provide information about

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[15]Brookhart et al. (2006) argue that variables that do not affect treatment but affect the outcome should always be included in the propensity score model.
[16]Rosenbaum and Rubin (1984) demonstrate both observed and missing data balance using propensity score matching techniques.

students' precollege academic skills. High school class rank is represented by three dummy variables for students graduating in the top 10 percent, top 11 to 25 percent, and bottom 75 percent of their class. Students' precollege preferences are described by initial institutional sector attended, precollege enrollment intensity preferences, and precollege major interest, which are proxied by whether a student began his/her first semester part-time and whether students had a declared major at the time of first enrollment. Interactions between enrollment intensity and levels of family income are included to ascertain financial need and the likelihood of work commitments. Matching transfer and native students based on this rich set of control variables help satisfy the conditional independence assumption. The propensity score is predicted by

$$P_i = \Phi\left(\hat{\beta}_0 + \hat{\beta}_1 D_i + \hat{\beta}_2 F_i + \hat{\beta}_3 A_i + \hat{\beta}_4 C_i\right) \qquad (5)$$

Using the Stata module, PSMATCH2 (Leuven & Sianesi, 2012), I match native and transfer students using kernel matching[17] of the propensity score and limit poor matches by imposing the common support restriction and defining appropriate caliber distance and trim levels.[18] I bootstrap standard errors[19] (Dehejia & Wahba, 2002;

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[17]Single and multiple nearest neighbor matching routines were also examined. Estimates were robust to choice of matching estimator. Kernel matching is favorable when control observations are not evenly distributed as in this study. It leverages good matches and discounts poor matches by giving the highest weight to propensity scores closest to treated observations (Heinrich et al., 2010).
[18]A variety of caliper and trim levels were tested. Final models rely on caliper distance of .02 and trim of 4 percent to limit poor matches.

Heinrich et al., 2010). To achieve complete balancing on all variables and reduce bias, I stratify the sample into deciles on the distribution of the estimated sample propensity score (Long & Kurlaender, 2009). I examine the distribution of propensity scores for treatment and control groups graphically (psgraph) and compare observable characteristics using t-tests (pstest) (Sianesi, 2001). Finally, I estimate the impact of transfer on treated students [average treatment effect on the treated (ATT)] for each strata. These estimates are pooled across strata to estimate the overall ATT (Rosenbaum & Rubin, 1984; Lunceford & Davidian, 2004). I replicate this process for vertical transfer and lateral transfer separately and conduct t-tests of the differences between vertical and lateral transfer estimates. Native students are the comparison group in the aggregated and disaggregated models. The final empirical strategy further disaggregates students by the selectivity of receiving institutions and student prior academic preparation to identify differential effects of transfer on graduation, credit accumulation, and time to degree for different students and transfer pathways.

Readers must use caution when interpreting and generalizing findings of this study. The potential limitation of propensity score matching analysis is that even though observable variables are controlled for, there is no guarantee that matched treatment and control observations do not differ significantly along unobservable variables. Unobservables such as motivation may increase the likelihood of transfer and collegiate

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[19]Bootstrapping proved very computationally demanding with the large study sample. Lechner (2001) suggests that with large samples it is not always feasible to calculate bootstrap standard errors for all estimates.

success, but are not measured in my data set; therefore, they are not feasible for inclusion in my analysis. By controlling for a robust set of observable characteristics, I assume that I am also accounting for the unobservable characteristics of students. For this reason, estimates are not considered truly causal.

Data

The study sample includes 29,613 first-time-in-college students who began higher education in Texas during the 2004–2005 and 2005–2006 academic years and were followed until 2010 or 2011, respectively. Student data are collected by the Texas Higher Education Coordinating Board and include longitudinal (every trimester) records of all students enrolled in Texas' public institutions of higher education, including information on student demographics, family background, prior academic achievement, college readiness, institutions attended, course-taking, and degrees completed. The longitudinal data allow tracking of students across periods of enrollment and withdrawal as well as across enrollment at multiple Texas public institutions.

The primary dependent variable of interest is time to degree, which is constructed as the number of trimesters (fall, spring, summer) that pass between initial enrollment and graduation (up to 18 trimesters). I also examine bachelor's degree completion (a binary indicator of whether a student graduated), the total number of nonremedial credits earned, and the number of nonremedial credits earned at the time of graduation.

The key inferential variable is a dummy variable for any type of transfer. Additional variables are used to differentiate vertical transfer from lateral transfer. Control variables include student demographic and family background characteristics, prior academic preparation, and college preference variables as described above in the first-stage prediction model.

The sample is limited to Texas students between the ages of 17 and 20 who began at two- or four-year institutions and who demonstrated an intention to achieve a bachelor's degree by completing the Texas common application for higher education admissions and had a valid SAT or ACT score.[20] All students in the sample enrolled in at least six credits in their first semester, achieved junior status of 60 credits, and enrolled in at least one semester at a four-year Texas public university, either by remaining at a single four-year institution or transferring (Melguizo et al., 2011; Adelman, 2005; Texas Higher Education Coordinating Board, 2012). Vertical transfer students first enrolled at a two-year institution, and lateral transfer students first enrolled at a four-year institution. Transfer students may have attended more than one institution prior to achieving 60 credits, but were limited to a single institution after reaching junior status and had to transfer before reaching senior status (90 credits). Students who transferred from four-year institutions to two-year institutions (reverse transfer) after achieving 60 credits were excluded. The impact of transfer is first modeled by aggregating all transfer

[20]ACT scores were converted to SAT scores using College Board's ACT-SAT Concordance tables.

students together compared to native students, followed by disaggregated models for vertical and lateral transfer compared to native students separately.

The comparison group is defined as native students who first enrolled in and remained in a single nonselective four-year institution during all fall and spring semesters that they were enrolled.[21] A student earning credits only during the summer at a different institution without formal transfer are also considered native students. Students with high school dual-enrollment credits from a community college who subsequently enroll as first-time students at a four-year institution and remain there are also considered native students. Students who enroll directly in highly selective four-year institutions[22] were excluded from the sample to better reflect the true initial choice set of students entering community colleges (Long & Kurlaender, 2009).

Table 3.1 summarizes the native and transfer student characteristics in this sample. Column 1 includes all students, and Column 2 includes only native students. Columns 3 and 4 describe vertical and lateral transfer students. Transfer and native students are similar in terms of gender and Hispanic ethnicity; however, all other characteristics of student demographics, family background, high school academic preparation, and college preferences differ between these two groups. In general, transfer students are more likely to have characteristics associated with disadvantages

[21]Attendance during the fall and spring semesters remains primary in education enrollment patterns, and students take summer courses for a variety of reasons (Goldrick-Rab, 2006). Therefore, credits earned at institutions other than the primary institutions of enrollment are not considered transfers.
[22]Selective universities in Texas include The University of Texas at Austin, Texas A&M University College Station, Texas Tech University, the University of Houston, and UT Dallas.

in higher education. There is, however, some interesting variation in characteristics between lateral transfers who initially enroll at four-year institutions and vertical transfers who initially enroll at two-year institutions. Black students are more likely to be native or lateral transfers and less likely to be vertical transfers. Lateral transfer students are more likely to have highly educated parents than either native students or vertical transfers. Students initially enrolling in four-year institutions—either native or lateral transfer—have similarly high levels of academic preparation compared to vertical transfer students in terms of SAT scores, tests of college readiness, high school class rank, and dual credits. Not surprisingly, vertical transfer students are most likely to have a preference for part-time enrollment with 27 percent of that subpopulation. Just 3 percent of native and lateral transfers prefer part-time enrollment.

Descriptive statistics suggest native student outcomes are more likely to graduate and more likely to graduate on time than lateral and vertical student outcomes. Transfer students accumulate more total credits (140 for vertical and 143 for lateral) than native students (136) and have more credits at graduation (150 for transfer compared to 142 for native).

Limitations

While this study is more inclusive than some transfer studies because it includes both lateral and vertical transfer students and native students, the students in this sample represent a fraction of all students in Texas. As Imbens (2004) suggests, in propensity score matching analysis:

> "The quest is typically not whether such a comparison should be made, but rather which units should be compared, that is, which units best represent the treated units had they not been treated."

In this study, the comparable population is limited only to a population of relatively successful transfer and native students at nonselective universities;[23] therefore, the following results should not be generalized to the very highest performing students at selective Texas universities and lower performing community college students. Most community college students do not successfully transfer, and many students at both two- and four-year institutions do not achieve junior status of 60 credit hours (Texas Higher Education Coordinating Board, 2012). Some students transfer before junior standing, while others transfer later. Some swirl across many institutions in ways that do not fit this paper's definitions of transfer. Results do not reflect the challenges of transfer for the many community college students who never reach a four-year institution. The estimates found in this paper reflect a conservative estimate of the

[23]For example, overall time to degree is 5.37 years for native students at four-year institutions and 7.42 years for transfer students according to a 2012 study from the Texas Higher Education Coordinating Board (THECB). This paper's sample of native students graduate in 4.2 years and transfer students in 4.7 years. The difference in these averages stems from the exclusion of native students from selective universities in Texas and the six-year tracking period in the paper's sample. This paper defines a starting cohort that first enrolled between fall 2004 and fall 2005 and was tracked until summer 2010 and summer 2011. The THECB report (2012) defines its cohort by students who achieved junior status in 2007 and tracks them through 2011. The start date of transfer students in the THECB study was not defined. Many students started earlier than 2005 and had longer than six years of study, as evidenced by the 7.42-year average.

differences in outcomes between all transfer and native students. Differences in the overall population are likely larger, although comparing students outside of the area of common support would likely downwardly bias estimates.

The study relies upon data from a single state, so results are generalizable only to other large, predominately public higher education states with significant community college enrollment and similar transfer policy contexts. Only data from public institutions are available. I cannot account for transfer to or from private institutions, so some successful students may be counted as dropouts. Workforce data are not available; however, I include income data and interactions between the income categories and preferences for part-time enrollment to account for financial need and work obligations to meet the assumption of strong ignorability.[24] Finally, I use a six-year period of time to track student outcomes. A significant number of students require more than six years to graduate, yet these students are not counted as successes in this analysis.

RESULTS

Ordinary Least Squares Results

Table 3.2 presents the results of the OLS regression analysis by transfer type and outcomes in Panel A. Columns 1–3 present estimates of the relationship between transfer and graduation. Column 1 provides aggregated estimates, while Columns 2 and

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[24]Low-income students are disproportionately less likely to enroll full-time due to work obligations (Cabrera, Burkum, & La Nasa, 2005).

3 provide estimates for vertical transfers and lateral transfers compared to native students, respectively. Results of the logistic regression model are reported as marginal effects—the probability of graduating given a change in transfer status and other covariates. Columns 4–6 and 7–9 estimate the relationship between transfer and total nonremedial credit accumulation and nonremedial credit accumulation at the time of graduation, respectively. Columns 10–12 estimate the effect of transfer on time to degree. All estimates described below are significant at the 1-percent level of significance. Table A.1 in the appendix presents detailed estimates for all covariates in the models.

The reference category is a White male student who graduated in the bottom 75 percent of his high school class and was not referred to developmental education. The reference student enrolls at a four-year nonselective university, his family earned less than $40,000 per year at the time of enrollment, and his parents each earned less than a high school diploma. This student does not demonstrate a preference for part-time enrollment, nor does he have a preference for college major at the time of enrollment.

Transfer is significantly associated with lower rates of graduation compared to native students according to the aggregated logistical regression estimates. In the aggregated model, transfer is associated with an 18-percentage point decrease in graduation compared to native students. Transfer students initially enrolling at a two-year institution (vertical) are 15 percentage points less likely to graduate, and those initially enrolling at a four-year institution (lateral) are 22 percentage points less likely to complete a bachelor's degree than native students. Covariates are similar in statistical and substantive significance across vertical and lateral transfer students, so just the aggregated estimates are described in detail. Black, Hispanic, and students of other races are significantly and negatively associated with graduation in both aggregated and disaggregated models. Higher levels of father's education and income are positively associated with graduation, as are all of the high school preparation variables. An increase of 100 points on the SAT is associated with between a 4- and 7-percentage point increase in the likelihood of graduation. Graduating in the top 10 percent of a student's high school class is associated with a 17-percentage point increase in the likelihood of graduation, while graduating in the top 11 to 25 percent increases the likelihood of graduation by 9 percentage points. The chance of graduating is associated with roughly a 6-percentage point increase for students with an interest in social science or business, but associated with a 3-percentage point decrease in the likelihood of graduation for students interested in STEM majors.

Models 4–6 estimate the relationship between transfer and total credit hours earned for all transfer students, vertical transfer students, and lateral transfer students compared to native students. Engaging in either form of transfer is associated with a 6.32 increase in total credits in the aggregated model that includes all transfer and native students. Transfer students starting at two-year institutions are associated with 4.98 additional credit hours. Transfer students starting at four-year institutions are associated with 5.53 additional credit hours compared to native students. In the aggregated and disaggregated models, the credit accumulation increases with the Other Race category (8.96–9.93), high levels of mother's education (2.5–3.17), and middle-income levels (1.77–2.57). A 100-point increase in SAT, graduating in the top 11 to 25 percent of high school class, and participating in dual enrollment are positively associated with credit accumulation. Students who have a preference for social science/business majors are associated with lower credit accumulation, while those interested in STEM or agriculture/health are associated with higher credit accumulation.

Among graduates, the estimated differences between transfer and native student credit accumulation are larger, as presented in Columns 7–9. Being a transfer student is associated with 7.32 additional credits at graduation in the aggregated model, with vertical transfer students earning 6.20 additional credit hours at the time of graduation and lateral transfers students 8.67 additional credit hours. All estimates are statistically significant at the 1-percent level. Across all three models, Black and other race students are associated with 11.28- to 18.18-credit-hour increases and 6.59- to 6.82-credit-hour increases, respectively. Hispanics are associated with a 13.12-credit-hour increase at graduation for lateral transfers only. Levels of father education are significantly and negatively associated with credit accumulation for transfer students in all three models (–1.19 to –1.54). Credits at graduation decrease with graduating in the top 10 percent (between 4 and 5 credits less) and in the top 11 to 25 percent (2 credits) of a student's high school class. Higher SAT scores, dual credit, and not being ready for college are positively associated with the number of credits earned. Students interested in pursuing social science and business majors are associated with a 3.17- to 3.35-credit-hour reduction in credits earned, while those interested in STEM, agriculture, and health are associated with increases in credits earned.

Finally, Columns 10–12 provide estimates of the relationship between transfer and time to degree completion. Column 10 shows that any type of transfer student is likely to take more time to complete a bachelor's degree that a native student. (Note: Here negative estimates on time to degree are better outcomes.) Being a transfer student on average is associated with an additional 0.87 terms for all transfer students to earn a degree. Vertical transfer students take slightly longer—0.89 terms—and lateral transfer students finish slightly more quickly—0.82 terms. Across all three models of time to degree, the other factors most substantively and significantly related to time to degree are connected to prior preparation and college enrollment preferences. The largest decreases in time to degree are associated with graduating in top 10 percent (–0.67 to –0.71 terms). Smaller reductions in time to degree are associated with top 11 to 25 percent graduation and dual-credit accumulation. The large increases in time to degree are associated with not being college ready (0.49 to 0.51 terms). Higher SAT scores are also associated with longer times to degree (0.29 to 0.30 terms). Students intending to major in social science and business graduate more quickly (–0.48 to –0.51 terms). Students preferring part-time enrollment take almost a full additional term (0.97 to 1.08 terms), but those who prefer part-time and are low income complete more quickly (–0.77 to –0.95 terms).

Propensity Score Matching Results

Table 3.2 displays the results of the propensity score matching analysis in Panel B. The average treatment effects on the treated (ATT) are reported for students who transfer. Tables A.2 – A.5 in the appendix present the distributions of the propensity scores for each strata and each outcome. Each strata contains a substantial number of treated (transfer) and control (native) students. Tables A.6 and A.7 provide the results of pstests for balancing the two primary outcomes—graduation and time to degree. Balance among covariates is not achieved in the unstratified models, but balance is achieved in the stratified models at the 5-percent level. Unstratified and a sample of stratified estimates are provided. Figure 3.1 presents a graphical representation of the region of common support for all transfer and native students and the graduation outcome. Figure 3.2 provides similar information for all transfer students and the outcome of time to degree. These graphs indicate that conditioning on the propensity score, there is significant overlap in the transfer and native student populations. Therefore, the outcomes of transfer and native students in the sample can be compared. Approximately 5 percent of the sample falls outside of the common support region.

The propensity score matching estimates confirm that transfer negatively affects the likelihood of graduation, increases total credit hours, increases credit hours at graduation, and increases time-to-degree completion. All results are statistically significant at the 1-percent level. Kernel matching estimates indicate the transfer penalty is a 17-percentage point decrease in the likelihood of graduation in the aggregated model. The estimated effect is 15 percentage points for vertical transfers. The penalty for lateral transfer is a 20-percentage point decrease in the likelihood of graduation.

All transfer students earn 5.24 more credits than native students—5.32 for vertical transfers and 6.10 for lateral transfers. The credit penalty is larger among graduates. After controlling for a myriad of demographic characteristics, family background, and academic and college preference differences between transfer and native students, propensity score matching estimates indicate that transfer causes students to accumulate 7.55 additional credits in the model that includes all native and transfer students—6.83 for vertical transfers and 8.93 for lateral transfers—at the time of graduation.

Finally, transfer students also take longer to complete degrees. Extensions are modest but statistically significant. In the first model that includes all native and transfer students, kernel matching estimates indicate transfer students take 0.91 additional terms compared to native students. Vertical transfer students take more time—1.04 additional terms—while lateral transfer students take 0.89 additional terms.

Compared to the OLS results, propensity score results are similar but smaller for graduation and larger for credit accumulation and time-to-degree outcomes in the aggregated and disaggregated models. Propensity score matching reduces bias found in the OLS results in the expected direction by comparing matched students, however the size of the bias is quite small. The modest magnitude of the bias is likely due to the constrained definitions of transfer and native students employed in the analysis. Comparing the two types of transfer, both OLS and PSM results suggest vertical transfer student outcomes are worse in terms of time to degree compared to lateral transfers. Students engaging in lateral transfer, however, suffer a larger transfer penalty than vertical transfers in terms of graduation likelihood and excess credit hour accumulation.

Effects by Institutional and Student Characteristics

Through disaggregated models, I observe the interaction of transfer with institutional selectivity and student academic preparation. There is evidence of transfer penalties across all models, with heterogeneous effects on transfer types and the various outcome measures. I begin with two tests of institutional selectivity.

More selective institutions tend to have higher graduation rates and lower average times to degree (Ehrenberg, & Smith, 2004); however, a priori it is not clear whether students who transfer to selective institutions are more or less likely to lose credits. To address this question, I disaggregate all transfer and native students by the selectivity of their last institution (or only institution in the case of native students). This model does not account for initial institution, but this issue is addressed below. Institutional selectivity is defined by the 2005 Carnegie classification from the Integrated

Postsecondary Education Data System.[25] In Panel A of Table 3.3, I present the effects of transfer on graduation, credits required at graduation, and time to degree disaggregated by institutional selectivity. Comparing vertical and lateral transfer students to native students, the graduation penalty is larger for transfer students who finish their studies at a less selective institution. The penalty is 18 percentage points for vertical transfers at less selective institutions and 10 percentage points for students who finish their studies at more selective institutions. As observed in the main effects models, the graduation penalty is larger for lateral transfer students, especially for lateral transfer students who last attend less selective institutions (27 percentage points) compared to more selective institutions (13 percentage points). Findings suggest more selective institutions may have better completion outcomes generally and that transfer students, like native students, benefit from institutional assets such as high-quality advising, faculty, and student peers.

Patterns of credits at graduation diverge for vertical and lateral transfer students based on the selectivity of their last institution. Vertical transfer students at less selective institutions attempt 6.13 extra credits compared to native students, while vertical transfer students at selective institutions attempt 6.56 additional credits. Although the difference is small, it is statistically significant. For lateral transfer,

[25] Low selectivity is indicated by the Carnegie classification of the institution. Public masters, public bachelor's, and public associate's institutions that confer bachelor's degrees are considered less selective, while the 11 public research institutions in the state are considered highly selective.

attending a less selective four-year institution has a larger credit penalty (9.53) compared to more selective four-year institutions (7.45).

Transfer students who finish their studies at more selective institutions are not only more likely to graduate but tend to graduate more quickly. Vertical transfer students who last attend a selective institution extend by 0.77 terms. The extension in time to degree is 0.98 terms for vertical transfer students who move to a less selective four-year institution, which suggests academic preparation among community college students is not driving transfer penalties. If community college transfers were underprepared, I would expect a larger penalty for students moving to a selective institution.

Although my initial findings suggest lateral transfers on average have a smaller extension in time to degree than vertical transfers, the disaggregated models indicate the overall results are driven by the small extensions of lateral transfers who last enroll at a selective institution (0.53 additional terms). Lateral transfer students who last enroll at a less selective institution take longer to complete a bachelor's degree (1.16 terms) than vertical transfers at either more or less selective institutions (0.77 and 0.98 terms, respectively). The influence of institution selectivity is greater to lateral transfer students than vertical transfer students as evidenced by the differences in time to degree between students who attend more or less selective institutions. The difference is 0.63 terms for lateral students and is 0.21 terms for vertical transfers.

Next, I take a closer look at the pathways of lateral transfer students by examining the selectivity of both their initial and last institution according to average SAT score of each institution (Table 3.4). Unlike vertical transfers who are all moving to more selective institutions, lateral transfers may be moving up or down in institutional selectivity. Students on a downward academic trajectory may have experienced academic failure, a lack of social fit at their initial institution, or other personal or family issues that contribute to mobility and lower likelihood of graduation, more excess credit accumulation, and longer time to degree. I find only 28 percent of lateral transfer students move to less selective institutions, while 72 percent move up in institutional selectivity. Lateral transfers moving to a more selective institution have a graduation penalty of 21 percentage points. Lateral transfers moving to a less selective institution have a smaller graduation penalty of 16 percentage points. Alternatively, students transferring up have fewer credits at graduation (8.15 additional credits) and complete more quickly (0.75 terms), while students who transfer down have more credits (11.57) and take more time to complete a degree (1.05 terms). Lateral students transferring down are more likely to graduate than lateral students who transfer up, although they experience larger credit penalties and extensions in time to degree. While excess credits among lateral transfers seems linked to time to degree, the implications for the credit loss hypothesis on graduation are ambiguous here.

Next, I estimate the effects for students with higher and lower levels of academic preparation for college indicated by SAT score. Table 3.3 presents results in Panel B.

Looking first at graduation penalties, I find that vertical transfer students who scored in the bottom 50 percent of SAT scores have a small but statistically significantly lower likelihood of graduating compared to native students (14 percentage points), while vertical transfer students with SAT scores in the top 50 percent have a smaller penalty (13 percentage points) compared to matched native students. This expected pattern is consistent for lateral transfer students based on SAT score. Students with lower levels of academic preparation have a larger graduation penalty (22 percentage points) than lateral transfer students who are more prepared for college (20 percentage points).

Next, I examine the interaction of student prior academic preparation and credit requirements. Vertical transfer students with lower SAT scores attempt 4.78 extra credits, while vertical transfer students with higher SAT scores attempt 9.27 extra credits. For lateral transfer students, the trend is reversed. Students with lower SAT scores are associated with larger extra credits (8.48) compared to lateral transfer students with higher SAT scores (7.85).

Finally, in the disaggregated results for time to degree by student preparation, vertical and lateral transfer students who have lower levels of academic preparation based on SAT scores take less time to complete bachelor's degrees. Vertical transfer students scoring in the bottom 50 percent of SAT scores delay 0.84 terms and lateral transfer students scoring in the bottom 50 percent of SAT scores delay 0.7 terms. Vertical transfer students scoring in the top 50 percent of SAT scores delay 1.01 terms, while high-achieving lateral transfers delay 0.8 terms. In the SAT models, the slower time-to-degree outcomes may be associated with the final major selection of high-ability students. These students tend to sort into more lucrative majors that have higher credit requirements and often take more time to complete (Johnson, 2009). A limitation of this analysis is students are matched only on precollege information about major interests, not final major, so this hypothesis cannot be tested here directly.

Conclusions

First, this study finds that time to degree is longer for transfer students using OLS and propensity score matching estimation. Both subpopulations of vertical and lateral transfer students experience delays. The average time to degree in this sample of particularly successful transfer students is 4.3 years, which is considerably lower than the population average of 5.37 years for native students and 7.42 years for transfer students (Texas Higher Education Coordinating Board, 2012). A full-term extension in time to degree due to transfer is quite sizeable in the context of this successful sample. Estimates are likely larger for the population.

Second, findings support the hypothesis that longer times to degree for transfer students are associated with credit loss at the time of transfer. After controlling for the academic and background differences between transfer and native students, the propensity score matching estimates indicate that transfer causes students to accumulate 7.55 additional credits on average at the time of graduation—6.84 for vertical transfers and 8.93 for lateral transfers. It is interesting to note that the number of excess credits transfer students accumulate is larger for lateral transfers than vertical transfers. Under the credit loss hypothesis, credit penalties might be larger for lateral transfers because universities have more specialized coursework and specialized program requirements. Community colleges tend to offer more courses aligned to standard courses accepted for transfer and general degree plans, which may explain the lower levels of credit loss for students who begin at community colleges relative to transfer students from four-year institutions. The larger penalty among lateral transfers in terms of credits undermines both the student quality and institutional quality hypotheses for time to degree. Disaggregated models, which suggest transfer students have smaller penalties at more selective receiving institutions, substantiate this claim. Findings suggest improving the preservation of credits would improve outcomes for transfer students. Findings also suggest transfer penalties are not limited to community college students. Credit loss affects both vertical and lateral transfers; therefore, penalties should not be attributed only to particular institutions and sectors, but to the transfer practice and policy environment more broadly.

Third, outcomes for lateral transfer are more consistent with those of vertical transfer students (and often lower), despite the fact that lateral students have more in common with native students than vertical transfers in terms of prior academic preparation and demographic characteristics. Lateral transfers have almost equivalent SAT scores compared to native students. Native students are somewhat more likely to have graduated in the top 10 percent of their high school class; however, rates of college readiness and graduating in the top 11 to 25 percent of high school class are very similar between the two groups of students who begin at four-year institutions. Where these groups differ most significantly is in levels of parental education. Lateral transfer students have more highly educated parents than native and vertical students. It appears transfer students with higher levels of academic and social capital begin at four-year institutions, while those with lower levels of parent education and academic preparation begin at two-year institutions. The poor outcomes of lateral transfer students are incongruous with conventional academic or social capital explanations that suggest unobservable characteristics of these students, perhaps related to motivation or social fit, may be important drivers of their behaviors and outcomes. The selection of a major and its interaction with both decisions to transfer and the outcomes of credit accumulation and time to degree is also noteworthy. These issues are ripe for further study, as much less in known about the experiences of four-year to four-year transfer students.

Finally, returning to the descriptive statistics momentarily, the average number of credits at the time of graduation in this study is 142 for native students and 150 for vertical and lateral transfer students. Undergraduate degrees typically consist of 120 credits. Even native students are averaging more than 20 excess credits. This paper has explored the role of excess credits attributed to the transfer process and found sizeable numbers of excess credits; however, this appears to be only one piece of the puzzle. The role of credits and credit requirements for different degree programs has received little empirical attention. The extent to which institutional degree requirements contribute to excess credit accumulation relative to student behaviors should be studied further.

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Figure 3.1: Region of common support for all transfer and native students with graduation

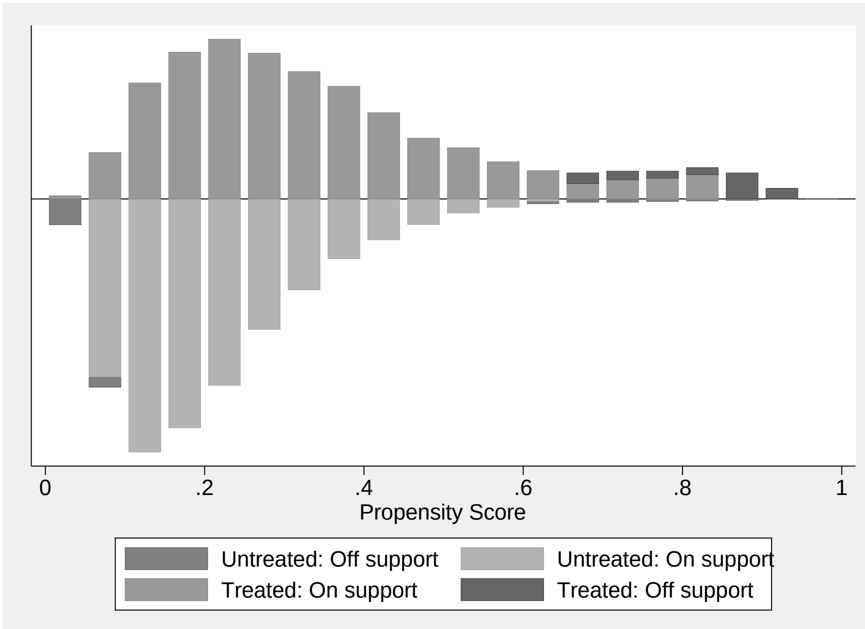

Figure 3.2: Region of common support for all transfer and native students with time to degree

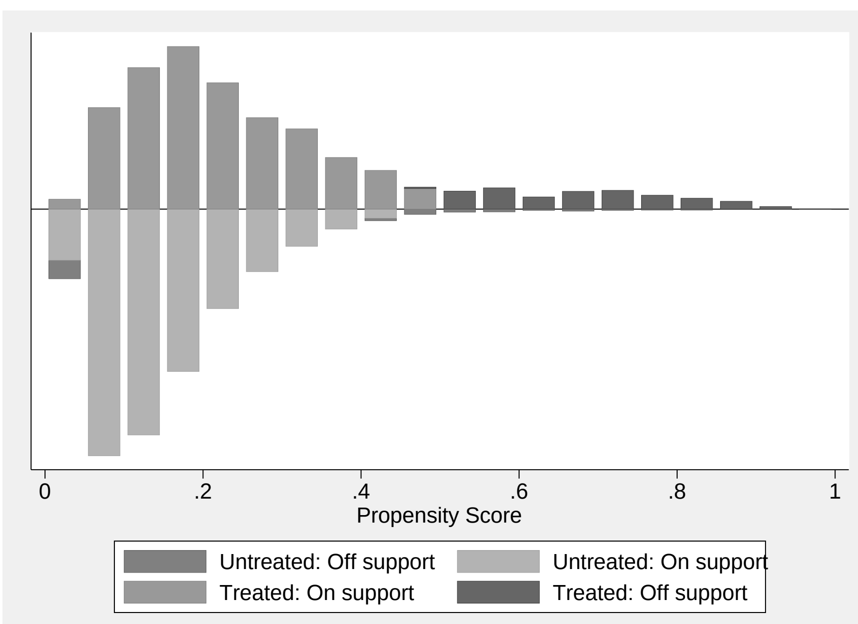

Table 3.1: Mean student characteristics (sd) by transfer type

	All Students	Native	Vertical Transfer	Lateral Transfer
Student demographics				
Age of Entry	18.00	18.01	17.94	17.98
	(0.44)	(0.41)	(0.56)	(0.41)
Female	0.57	0.57	0.56	0.58
	(0.50)	(0.49)	(0.50)	(0.49)
Hispanic	0.31	0.31	0.33	0.26
	(0.46)	(0.46)	(0.47)	(0.44)
Black	0.15	0.16	0.09	0.14
	(0.35)	(0.36)	(0.29)	(0.35)
White	0.54	0.52	0.60	0.63
	(0.50)	(0.50)	(0.49)	(0.48)
Other Race/Ethnicity	0.14	0.12	0.23	0.18
	(0.35)	(0.32)	(0.42)	(0.39)
Father's educational attainment				
College Degree	0.30	0.29	0.29	0.40
	(0.46)	(0.46)	(0.45)	(0.49)
High School Degree/Some College	0.35	0.34	0.38	0.41
	(0.48)	(0.47)	(0.49)	(0.49)
Did Not Complete High School	0.07	0.06	0.07	0.07
	(0.25)	(0.24)	(0.26)	(0.26)
Mother's educational attainment				
College Degree	0.29	0.28	0.26	0.39
	(0.45)	(0.45)	(0.44)	(0.49)
High School Degree/Some College	0.38	0.37	0.42	0.44
	(0.49)	(0.48)	(0.49)	(0.50)
Did Not Complete High School	0.06	0.06	0.07	0.05
	(0.23)	(0.23)	(0.25)	(0.23)
Family income				
Income Greater Than $80000	0.25	0.23	0.28	0.37
	(0.43)	(0.42)	(0.45)	(0.48)
Income between $40000 & $80000	0.23	0.23	0.25	0.26
	(0.42)	(0.42)	(0.43)	(0.44)
Income Less Than $40000	0.20	0.19	0.20	0.22
	(0.40)	(0.40)	(0.40)	(0.41)
Income Unknown	0.32	0.35	0.27	0.15
	(0.47)	(0.48)	(0.45)	(0.36)
Prior academic preparation				
SAT100	990	1,001	931	996
	(164.08)	(162.47)	(164.39)	(156.88)
Graduated in top 10%	0.17	0.19	0.09	0.13
	(0.37)	(0.39)	(0.28)	(0.33)
Graduate in 11-25%	0.24	0.26	0.13	0.25
	(0.43)	(0.44)	(0.33)	(0.44)
Not college ready (remediation)	0.39	0.36	0.55	0.40
	(0.49)	(0.48)	(0.50)	(0.49)
#Dual credit hours	0.19	0.21	0.11	0.18
	(0.39)	(0.41)	(0.31)	(0.38)

(Table 3.1: continued)

Pre-college preferences				
Interested in STEM	0.15	0.17	0.07	0.14
	(0.36)	(0.37)	(0.25)	(0.35)
Interested in Agriculture/Health	0.11	0.11	0.08	0.12
	(0.31)	(0.32)	(0.27)	(0.32)
Interested in Social Science/Business	0.25	0.27	0.15	0.22
	(0.43)	(0.45)	(0.36)	(0.42)
Interested in Other Major	0.49	0.45	0.70	0.51
	(0.50)	(0.50)	(0.46)	(0.50)
Part-time Proclivity	0.07	0.03	0.27	0.03
	(0.25)	(0.18)	(0.44)	(0.17)
Need for work - Unknown	0.02	0.02	0.07	0.01
	(0.15)	(0.13)	(0.26)	(0.07)
Need for work - Low	0.02	0.01	0.07	0.01
	(0.12)	(0.07)	(0.26)	(0.09)
Need for work - Medium	0.01	0.01	0.07	0.01
	(0.12)	(0.07)	(0.25)	(0.08)
Need for work - High	0.01	0.01	0.06	0.01
	(0.12)	(0.08)	(0.23)	(0.09)
Year				
Started in 2005	0.50	0.51	0.48	0.51
	(0.50)	(0.50)	(0.50)	(0.50)
Started in 2006	0.50	0.49	0.52	0.49
	(0.50)	(0.50)	(0.50)	(0.50)
Outcomes				
Graduated (within 6 years)	0.60	0.66	0.42	0.45
	(0.49)	(0.47)	(0.49)	(0.50)
Graduated in 4 Years	0.21	0.25	0.07	0.11
	(0.41)	(0.44)	(0.25)	(0.31)
Graduated in 5 Years	0.20	0.21	0.16	0.17
	(0.40)	(0.41)	(0.36)	(0.37)
Graduated in 6 Years	0.19	0.20	0.20	0.18
	(0.40)	(0.40)	(0.40)	(0.39)
Time to Degree	12.80	12.58	13.99	13.50
	(2.35)	(2.34)	(2.06)	(2.19)
#Credits Earned	137.52	136.21	140.42	143.04
	(28.70)	(28.97)	(26.64)	(28.63)
#Credits at Graduation	143.43	141.91	150.07	150.76
	(18.27)	(17.91)	(17.35)	(19.51)
Number of students	29,613	22,240	4,424	2,949
Proportion of sample	1.00	0.75	0.15	0.10

Note: Based on author's calculations using THECB administrative data.

Table 3.2: Ordinary least squares and propensity score matching estimation results: Graduation, total student credit hours, credit hours at graduation, and time to degree

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
		Graduation			Total credit hours			Credit hours at graduation			Time to degree	
	Pooled Transfer	Vertical Transfer	Lateral Transfer	Pooled Transfer	Vertical Transfer	Lateral Transfer	Pooled Transfer	Vertical Transfer	Lateral Transfer	Pooled Transfer	Vertical Transfer	Lateral Transfer
Panel A: Ordinary Least Squares												
Marginal Effect	-0.18***	-0.15***	-0.22***	5.17***	4.98***	5.53***	7.32***	6.20***	8.67***	0.87***	0.89***	0.82***
	(0.01)	(0.01)	(0.01)	(0.41)	(0.51)	(0.57)	(0.37)	(0.47)	(0.53)	(0.04)	(0.06)	(0.06)
Panel B: Propensity Score Matching												
Pooled ATT	-.17***	-.15***	-.20***	5.24***	5.32***	6.10***	7.55***	6.83***	8.93***	0.91***	1.04***	.89***
	(0.02)	(0.03)	(0.03)	(1.33)	(1.57)	(1.77)	(1.17)	(1.36)	(1.71)	(0.14)	(0.17)	(0.29)
Strata ATT												
1	-.19***	-.14*	-.20***	7.83***	8.50*	11.04**	8.71***	7.31*	9.54***	1.27***	1.30**	1.15***
	(0.04)	(0.08)	(0.06)	(2.26)	(4.63)	(3.73)	(2.24)	(4.36)	(3.37)	(0.28)	(0.59)	(0.43)
2	-.17***	-.13**	-.16***	5.02***	8.04***	9.56***	6.61***	6.91**	10.75***	1.11***	1.78***	1.25***
	(0.03)	(0.06)	(0.05)	(1.62)	(2.98)	(2.75)	(1.58)	(3.10)	(2.53)	(0.20)	(0.36)	(0.25)
3	-0.21***	-.17***	-.22***	3.04**	0.05	4.25	7.87***	5.04**	6.61**	1.03***	1.26***	0.52
	(0.03)	(0.04)	(0.04)	(1.52)	(2.13)	(2.60)	(1.51)	(2.24)	(2.72)	(0.17)	(0.29)	(0.34)
4	-0.17***	-.20***	-.19***	3.92***	2.05	3.38	6.24***	7.08***	11.60***	.72***	0.69**	1.17***
	(0.03)	(0.04)	(0.04)	(1.43)	(2.12)	(2.25)	(1.45)	(2.15)	(2.07)	(0.18)	(0.28)	(0.23)
5	-0.18***	-.14***	-.22***	6.60***	9.28***	0.99	8.13***	8.21***	4.60**	0.93***	1.27***	.38*
	(0.02)	(0.03)	(0.03)	(1.32)	(1.76)	(1.84)	(1.30)	(1.95)	(1.90)	(0.15)	(0.23)	(0.22)
6	-.15***	-.15***	-.23***	4.73***	5.79***	6.68***	8.81***	7.72***	7.89***	1.07***	.81***	.74***
	(0.02)	(0.03)	(0.03)	(1.25)	(1.65)	(1.82)	(1.21)	(1.68)	(1.60)	(0.14)	(0.20)	(0.20)
7	-.16***	-.08***	-.21***	4.16***	3.06**	7.92***	6.67***	6.09***	9.44***	.63***	1.05***	0.81***
	(0.02)	(0.03)	(0.03)	(1.21)	(1.36)	(1.72)	(1.17)	(1.34)	(2.04)	(0.14)	(0.15)	(0.21)
8	-0.19***	-.18***	-.18***	5.69***	4.07***	6.77***	6.84***	6.44***	10.54***	.77***	0.69***	1.26***
	(0.02)	(0.02)	(0.03)	(1.14)	(1.33)	(1.53)	(1.07)	(1.29)	(1.50)	(0.13)	(0.16)	(0.17)
9	-0.14***	-.14***	-.22***	6.84***	6.94***	5.44***	9.26***	7.61***	8.57***	0.88***	0.93***	0.85***
	(0.02)	(0.02)	(0.03)	(1.10)	(1.21)	(1.41)	(0.98)	(1.09)	(1.43)	(0.12)	(0.14)	(0.16)
10	-.16***	-.16***	-.20***	4.60***	5.46***	4.94***	6.32***	5.95***	9.79***	0.66***	0.62***	0.78***
	(0.02)	(0.02)	(0.02)	(1.43)	(1.60)	(1.34)	(0.97)	(1.08)	(1.19)	(0.12)	(0.13)	(0.14)
Number of Students	29,613	26,664	25,189	29,613	26,664	25,189	17,820	16,482	15,947	17,820	16,482	15,947

Note: Based on author's calculations using THECB administrative data. Significance indicated by --*: P<0.10, --**: P<0.05, --***: P<0.01.

Table 3.3: Effects of transfer on graduation, credits at graduation, and time to degree by institutional selectivity and student academic preparation

Panel A: Selectivity of Last Institution

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Graduation				Credits at Graduation				Time to Degree			
	Vertical Transfer		Lateral Transfer		Vertical Transfer		Lateral Transfer		Vertical Transfer		Lateral Transfer	
	Less Selective	More Selective	Less Selective	More Selective	Less Selective	More Selective	Less Selective	More Selective	Less Selective	More Selective	Less Selective	More Selective
Pooled ATT	-.18***	-.10***	-.27***	-.13***	6.13***	6.56***	9.53***	7.45***	.98***	.77***	1.16***	.53***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.91)	(0.94)	(0.95)	(0.91)	(0.11)	(0.11)	(0.11)	(0.11)
Number of Students	18,863	7,801	17,974	7,215	11,564	4,918	11,194	4,753	11,564	4,918	11,194	4,753

Panel B: Student Academic Prepartion (SAT Score)

	Graduation				Credits at Graduation				Time to Degree			
	Vertical Transfer		Lateral Transfer		Vertical Transfer		Lateral Transfer		Vertical Transfer		Lateral Transfer	
	Bottom 50%	Top 50%	Bottom 50%	Top 50%	Bottom 50%	Top 50%	Bottom 50%	Top 50%	Bottom 50%	Top 50%	Bottom 50%	Top 50%
Pooled ATT	-.14***	-.13***	-.22***	-.20***	4.78***	9.27***	8.48***	7.85***	.84***	1.01***	.70***	.80***
	(0.01)	(0.02)	(0.02)	(0.02)	(0.77)	(1.00)	(0.96)	(0.82)	(0.09)	(0.13)	(0.11)	(0.10)
Number of Students	13,839	12,825	12,390	12,799	7,669	8,813	7,114	8,833	7,669	8,813	7,114	8,833

Note: Based on author's calculations using THECB administrative data. Significance indicated by --*: P<0.10, --**: P<0.05, --***: P<0.01

Table 3.4: Effects of lateral transfer on graduation, credits at graduation, and time to degree by selectivity of receiving institution

	(1)	(2)	(3)	(4)	(5)	(6)
	Graduation		Credits at Graduation		Time to Degree	
	Lateral Transfer Down	Lateral Transfer Up	Lateral Transfer Down	Lateral Transfer Up	Lateral Transfer Down	Lateral Transfer Up
Pooled ATT	-.16***	-.21***	11.57***	8.15***	1.05***	.75***
	(0.02)	(0.01)	(1.31)	(0.72)	(0.16)	(0.09)
Number of Students	23,051	24,378	14,812	15,581	14,812	15,581

Note: Based on author's calculations using THECB administrative data. Significance indicated by --*: P<0.10, --**: P<0.05, --***: P<0.01.

Chapter 4: Excess Credit Accumulation: Exploring the Missing Link Between Graduation Requirements and Time to Degree

INTRODUCTION

The majority of postsecondary students take longer than four years to complete a bachelor's degree. Extensions in time to degree are both a national trend and a trend found in many states (U.S. Department of Education, National Center for Education Statistics [NCES], 2003; Adelman, 2006; Cullinane & Lincove, 2014; Bound, Lovenheim, & Turner, 2012; Complete College America, 2011; Office of Program Policy Analysis and Government Accountability, 2005). While some assert that longer times to degree maximize student economic and personal utility, policymakers argue that extensions in time to degree are problematic because students and institutions inefficiently use public and private resources for higher education (Knight, 2004; Groves, 2007; Wellman, 2010). Inefficiency contributes to rising college costs and student loan debt (Federal Student Aid, U.S. Department of Education, 2012). Policymakers have identified the number of credits required for graduation as a lever for reducing time to degree, although little empirical work has been done to evaluate the presence and magnitude of the effects of reducing credits requirements. This paper examines whether restricting credit requirements is an effective strategy to reduce excess credits and time to degree.

Two key questions exist in the literature on time to degree. The first is whether students who extend their studies attempt credits more slowly or attempt more credits than required for graduation. The traditional undergraduate degree requires that students complete 120 credit hours to graduate. A recent report from Complete College America (2011) examines the credit totals of graduates in 33 states. Illinois averaged the lowest levels of excess credits with 124 credits attempted on average among bachelor's degree students, while Texas had the highest average in the study. Texas students attempt 149 credits on average by the time of graduation, which is equivalent to taking between 7 and 10 additional courses. While there is evidence that some students make slow progress because they do not enroll in a sufficient number of hours each term to complete degree requirements in four years (Knight, 2004; U.S. Department of Education, NCES, 2006; Grove, 2007; Adelman, 2006), average credit accumulation totals among graduates suggest a sizable proportion of students take many more courses than they need to reach the graduation minimum 120 hours.

The second question is to what extent the mechanisms for extensions in time to degree—slow progress and excess credit accumulation—can be explained by factors related to students or factors related to institutions. Previous studies on time to degree have primarily focused on student attributes, identifying prior academic preparation, financial need, race, student mobility, and major changes as drivers of time to bachelor's degree completion. Recent papers by Cullinane and Lincove (2014) and Bound et al. (2012) suggest institutional resources also meaningfully influence the pace of student completion. In particular, Pitter, LeMon, and Lanham (1996) point to the prevalence of graduation credit requirements exceeding 120 credits at many institutions and in many majors. Anecdotal evidence links increases in the number of credits required for graduation with longer times to degree, though no academic studies have been conducted on this topic.

In this paper, I explore credit requirements, excess credits, and their effects on time-to-degree completion in light of individual and institutional factors. Using 2003–2012 statewide data from Texas, I conduct a descriptive analysis of trends in credit requirements, excess credits, and time to degree. I explore two alternative definitions of excess credit. *Total excess credit* calculations rely on state minimum graduation requirements and *net excess credit* calculations are specific to a students' major and institution. I then conduct multivariate regression analyses to quantify the associations between key variables. Specifically, I examine whether changes in the number of credits required for graduation over time—within institutions and majors—extend time to degree through the mechanism of reducing excess credits. I control for the unobserved, time-invariant features of institutions and majors using a fixed-effects approach and leverage variation in credit requirements within institution and major over time to identify the effects of credit requirements.

I find credit requirements influence time to degree through the predicted mechanism of excess credit accumulation. Credit requirement reduction has an unexpected positive association with time to degree because although reductions in credit requirements are associated with decreases in the total number of excess credits, they are also associated with commensurate increases in elective course-taking (net excess credits). Decreasing credit requirements by one course (3 to 4 credits) reduces total excess credits by 0.6 to 0.8 credits and increases elective credits by 1.0 to 1.3 credits. Together, these changes produce a 0.34-month increase in time to degree. Controlling for course-taking tradeoffs, I find reducing credit requirements by one course reduces time to degree by 0.34 to 0.45 months. Results suggest controlling directly for both required and elective credits improves estimation of time to bachelor's degree completion and indicate that students make tradeoffs between required and elective credits.

The structure of the paper is as follows. In Section 2, I outline a conceptual framework for time to degree and an underlying theory of action. In Section 3, I summarize the literature on excess credits and time to degree. In Section 4, I describe the empirical approach, data, and descriptive statistics of students and institutions in the sample. In Sections 5 and 6, I provide findings and conclusions.

THEORETICAL FRAMEWORK

This study employs an education production function framework, which explains student educational outcomes by the inputs of students, families, and schools. I integrate human capital and social capital theories of student outcomes to help explain the influence of student and family inputs. Figure 4.1 describes visually the hypothesized relationship between time to degree, excess credits, and student, family, and institutional inputs. The length of time it takes a student to complete a degree is the result of a variety of supply-side (institutional) and demand-side (individual) factors.

Excess credit accumulation is one mechanism for increasing or decreasing time to degree (Knight, 2004). Student and institutional factors have both direct and indirect relationships with time to degree through the excess credit mechanism. These theoretical relationships are described in more detail below.

First, on the supply side, longer times to degree may be a direct or indirect function of decreasing institutional resources or increasing credit requirements (Webber & Ehrenberg, 2010; Volkwein & Lorang, 1996; Bound et al., 2012; The University of Texas at Austin, 2012; Lehman, 2002). For example, when resource constraints lead to insufficient capacity for students to enroll in high-demand, required introductory courses in a particular semester, students must wait until the following semester to enroll in the course, thereby slowing time to degree (Lehman, 2002). If a replacement course that satisfies graduation requirements is taken or no replacement course is taken, no excess credits are accumulated. If the replacement course is not applicable to graduation requirements, it adds to excess credit totals. Alternatively, without sufficient advising support, students who begin college without a declared major may spend time exploring courses that do not align to their eventual major, accumulating excess credits and extending time to degree (Volkwein & Lorang, 1996). Finally, students majoring in fields such as engineering and architecture, which often require students to complete more than 120 credits for their degree program, accrue more total excess credits than peers in lower requirement majors and may extend time to degree (Adelman, 2006). Supply-side economic theory and organizational theory argue that organizations shape the behavior of individuals and the options available for individuals to select (Boin & Kuipers, 2008; Thoenig, 2003; Ostrom, 2007; Campbell, 2005). According to these theoretical sources, institutional policies designed to decrease credits required for graduation would likely decrease student course-taking and time to degree (Clotfelter & Rothschild, 1993; Campbell, 2005; Bound & Turner, 2007).

On the demand side, human capital and social capital theories explain how student inputs affect time to degree or work through the interim outcome of excess credit accumulation. Human capital theory argues that students invest in higher education to enjoy associated benefits, namely improved future labor market returns and a number of nonmonetary benefits such as status and enjoyment of learning (Becker, 1975; Sweetland, 1996). Students invest up to the point where costs exceed expected benefits (Clotfelter, 1991). Rather than waste time and resources, students may strategically delay graduation to improve labor market opportunities and intentionally consume excess courses in order to maximize their utility in postsecondary education, especially when tuition for full-time enrollment is structured as a flat fee rather than tied to the number of credit hours students consume (Campbell & Siegel, 1967; Kahn, 2010). Excess course-taking may be a rational strategy for assessing majors and students' fit with the demands and returns for different majors, for developing additional major-specific or general skills, or for satisfying intellectual curiosities (Altonji, 1993; Johnstone, Ewell, & Paulson, 2002). Demand-side economic theory suggests changes in credit requirements for graduation would have small effects on student course-taking because course-taking decisions reflect students' understandings of their own utility maximization.

Observed variation in the quantity and quality of higher education student consumption is correlated with student characteristics. Differences across gender, racial and ethnic groups, income, and major in higher education consumption and pace decisions can be explained in human capital theory by differences in labor market returns to education, academic preparation, and financial resources by subpopulation (Betts & McFarland, 1995; Perna, 2000; Heller, 1997). Success in high school coursework is predictive of college persistence and graduation (Schneider, Swanson, & Riegle-Crumb, 1998; Long et al., 2009; Ma & Wilkins, 2007; Adelman, 2006, 1999; Long, 2008; Cabrera, Burkum, & La Nasa, 2005; Herzog, 2005). Income could affect both time to degree and excess credits if high-income students are more likely to consume excess credits and delay graduation than low-income students. Income may be associated with time to degree but not with excess credit accumulation if financial constraints affect student decisions about pace of completion through part-time enrollment (Betts & McFarland, 1995; DesJardins, Ahlburg, & McCall, 2002; Stinebrickner & Stinebrickner, 2003; DeSimone, 2008; Ehrenberg, & Sherman, 1987).

Social capital theory argues that student educational outcomes are not only influenced by labor market returns, academic preparation, and financial resources, but by access to information about educational settings as well (Coleman, 1988; Bourdieu, 1986). Information about how to navigate postsecondary education comes from families, peers, and institutional resources, including human resources (Hossler, Braxton, & Coopersmith, 1989; Perna, 2000; Perna et al., 2008). Social capital theory provides an alternative explanation of the variation in educational outcomes by student subpopulations as information networks and college experience vary by gender, race, income, and major (Perna & Titus, 2005; Institute for Higher Education Policy and Excelencia in Education, 2008). Students with strong parental, peer, and social networks have better access to needed information. Students without access to information about college in their personal networks, especially low-income and minority populations, rely more heavily on faculty, advisors, and college support staff to make educational plans and decisions (Roderick, Nagaoka, Coca, & Moeller, 2008). Social capital theory may attribute excess credit accumulation to unintentional course-taking if students are not well informed by parents/peers with college experience or robust institutional advising resources. Alternatively, if excess course-taking improves student outcomes as described above, students with better information networks may intentionally take more courses that improve their labor market returns.

LITERATURE REVIEW OF EXCESS CREDITS

This paper builds on three strands of literature. First, this study draws upon research related to productivity in higher education motivated by public concerns about increasing costs of higher education, rising student loan debt, and decreasing public revenues to support universities as well as the need for higher levels of collegiate attainment (Kane, Orszag & Gunter, 2003; Auguste, Cota, Jayaram, & Laboissière, 2010; Wellman, 2010; Johnson, 2009; Clotfelter, 1996). Productivity studies tend to reflect a belief that excess course-taking is an inefficient use of resources (Washington State Higher Education Coordinating Board, 1996; Office of Program Policy Analysis and Government Accountability, 2005). Consistent with supply-side analyses of the education production function, these studies document the presence and trends in excess credits and identify policy levers to accelerate timely completion (Johnstone & Maloney, 1998). Much of this work is descriptive in nature and is published outside of academic journals by policy, advocacy, and business operations organizations.

Most graduates accumulate excess credits beyond the 120-credit minimum graduation requirement (Romano, Losinger, & Millard, 2011). Using the National Longitudinal Study of the 1972 high school class and the High School and Beyond survey of the 1982 high school class, the average number of credits earned among bachelor's degree completers increased from 126 to more than 139 over the decade (Adelman, 1995). In a multistate sample of students who graduated in 2007–2008, the average was 16.5 excess credits for bachelor's degree completers and 19 excess credits for associate's degree completers (Complete College America, 2011). Estimates of the proportion of credits that are in excess of bachelor's degree requirements range from 9 to 14 percent (Johnson, 2009; Auguste et al., 2010). In one state, roughly 20 percent of bachelor's degree completers accumulated more than 30 excess credits, which is equivalent to one year's worth of full-time coursework (Auguste et al., 2010). Twelve percent of all college-level credits earned by students completing two-year degrees are in excess (Zeidenberg, 2012). Excess credits come at a significant public cost. Excess credits were estimated to increase the cost of producing bachelor's degrees by 27 percent in Florida (Johnson, 2009). A Texas study estimates the state spends $148 million per entering cohort on excess credits (Texas Higher Education Policy Institute, 2012).

Extensions in time to degree are concentrated in particular institutions and majors, including engineering, architecture, education, and health sciences (Adelman, 2006, 1999; Zeidenberg, 2012). Not surprisingly, students in programs that require more credits tend to take more time to complete bachelor's degrees. Differences in excess credit accumulations between institutions could be driven by high credit requirements for particular majors compared to other institutions, differences in the proportion of students served in majors that are higher credit on average, or general institutional factors such as poor advising or poor course availability (University of Wisconsin System, 2002; Zeidenberg, 2012).

While the dominant policy narrative asserts that reducing excess credits will improve degree completion and efficiency in higher education systems, there is debate about the merits of excess credits and the drivers of credit requirement increases (Auguste et al., 2010; Complete College America, 2011; Johnstone & Maloney, 1998). Credit requirements rise when departmental faculty, accrediting agencies, or licensure bodies add course requirements or when institutions or state agencies impose prerequisites (Johnstone & Maloney, 1998). Johnstone and Maloney point out that some additions may reflect legitimate changes in required preparation, while others may reflect the "academic tendency to add and rarely replace requirements" in a phenomenon known as *credit creep*. High-requirement fields such as engineering, architecture, and health programs have many courses required for skill development that are specific to careers in those fields as well as specific licensure examinations and accrediting requirements (University of Wisconsin System, 2002). Additional credits may reflect new demands from the labor market. Excess credits may also result from implicit institutional requirements such as taking a computer course to become proficient in technology-based resources on campus and course requirements (i.e., learning management systems) (Zeidenberg, 2012). While it is difficult to establish the most efficient level of credit requirements or implicit prerequisites from an educational or institutional perspective, it seems clear that institutions, not students, are responsible for excess credit accumulations associated with these two factors.

The second strand of literature identifies institutional factors other than credit requirements that contribute to time to degree and student outcomes more broadly. This strand of academic literature builds on the education production function framework as well. In terms of time to degree, instructional expenditures and the ratio of faculty to students is positively associated with on-time graduation, while student support services expenditures are associated with late graduation, compared to still being enrolled after six years (Cullinane & Lincove, 2014; Bound et al., 2012; Long, 2008). Academic and student support services expenditures are positively associated with graduation and first-year persistence, especially for less selective institutions and those that serve students with high financial need (Ewell, 2004; Webber & Ehrenberg, 2010). Although the problem of selection bias is debated in the institutional quality literature (Dale & Krueger, 2002; Long, 2008), recent studies using a variety of rigorous methodological techniques find student who attend institutions with higher levels of tuition and more selective admissions requirements earn higher wages and are more likely to graduate (Dale & Krueger, 2002; Long, 2008).

The third strand of literature argues that student characteristics matter for time to degree in ways consistent with human and social capital. Specifically, student ability, demographics, and family background moderate student pace of completion and credit accumulation. From a human capital perspective, well-prepared students may find college to be a less costly investment and are less likely to fail courses and repeat them (Bound et al., 2012; Parker, 2005; Allen & Robbins, 2010; Long et al., 2009).[26] Well-prepared students expedite their education by taking dual-enrollment college courses while in high school or placing into more advanced coursework when they begin postsecondary education (Deming, Hastings, Kane, & Staiger, 2011). On the other hand, high-ability students sometimes decide to delay graduation to protect high GPAs or

[26] There is evidence that small numbers of excess credits are accumulated because courses were dropped or failed because students who fail courses are unlikely to graduate (Office of Program Policy Analysis and Governmental Accountability, 2005; Romano et al., 2011; Auguste et al., 2010).

build skills for graduate school or the labor market (Volkwein & Lorang, 1996; Adelman, 2006).

Low-income students face financial constraints that reduce the likelihood of graduation and slow time to degree. They have lower demand for higher education and are more likely to drop out due to increases in costs than higher income peers (Jackson & Weathersby, 1975; Heller, 1997). In addition to financial constraints, low-income students are less likely to persist in higher education because low-income status is often closely correlated with lower levels of prior academic preparation, poor high school quality, and lower levels of parental education (Perna, 2006). Low levels of family income can also slow completion of higher education when the demands of work compete with class or study time (DesJardins et al., 2002; Herzog, 2005; Bound et al., 2012; Cullinane & Lincove, 2014). Students who have unmet financial need and heavy labor market participation (in excess of 20 hours a week) tend to take longer to complete degrees (Volkwein & Lorang, 1996; Gleason, 1993; Lam, 1999). DesJardins et al. (2002) find significant differences in time to degree by race and income groups, which can be explained by the differences in returns to education by groups or social capital in terms of the networks of parents, peers, and education professionals (Perna & Titus, 2005).

Excess courses may be part of a student's academic exploration or may provide valuable learning experiences. A study of excess credit at two-year institutions reveals that both general courses and major specific courses contribute to excess credits

(Zeidenberg, 2012). Alternatively, experimenting with different majors and institutions may reflect inefficiency or, from a social capital perspective, a lack of information about important college decisions. Student preferences for particular majors or double majors, transfer pathways, or a lack of a strong preference for a major influence time to degree and excess credit accumulation because graduation requirements are specific to majors and institutions (Pitter, LeMon, & Lanham, 1996; Johnstone & Maloney, 1998; Lam, 1999; Washington State Higher Education Coordinating Board, 1994; University of Florida, 1995; Hilmer, 1999). Institutions and majors affect which courses students take as well as the quantity of consumption. Initial student major is associated with course withdrawal, course failure, and the likelihood that a student changes major (Johnson, 2009; Arcidiacono, 2004). Students in high-cost, high-return majors tend to take more credits (Johnson, 2009), and high-ability students tend to sort into high-return majors (Grogger & Eide, 1995; Loury & Garman, 1995; Arcidiacono, 2004). Major selection also has significant implications for future labor market returns. In fact, differences in returns to majors are larger than differences in returns to college quality (Arcidaicono, 2004; (James, Alsalam, Conaty, & To, 1989). Like changes in major, changes in institutions through transfer slow time to degree as students accumulate excess credits (Cullinane, 2014; Texas Higher Education Coordinating Board, 2012).

Policy Context

Explanations from all three strands of literature are implicit in the abundant policy and institutional experimentation aimed at reducing excess credits and shortening time to degree. Some strategies target student decisions about course-taking. Since 2000, North Carolina, Florida, Texas, and Virginia enacted policies that penalize students who retake courses multiple times or accumulate credit hours beyond degree requirements (Grove, 2007). Institutional strategies for decreasing excess credit and time to degree include improving course availability and scheduling, developing structured course pathways with few electives, and improved advising and monitoring of student progress (Auguste et al., 2010, University of Wisconsin, 2002). Policies targeting institutional decision-making include performance funding that links timely degree completion to institutional funding (Indiana and Virginia) and transfer policies to preserve credits (Florida and California) (Grove, 2007). In 1995, Florida mandated that institutions reduce baccalaureate requirements to 120 credit hours (Pitter, LeMon, & Lanham, 1996; Johnstone & Maloney, 1998). Texas passed a similar policy in 2005, which is an important factor in understanding the variation in credit requirements over time in this study (Texas Higher Education Coordinating Board [THECB], 2005).

Texas House Bill 1172 required that public senior colleges and universities limit required credits for undergraduate bachelor's degree programs to 120—the minimum number required for graduation by the state's regional accrediting body, the Southern Association of Colleges and Schools (Texas Legislature Online, 2005). Compliance was required for new student cohorts by fall 2008 unless institutions demonstrated a compelling academic reason to exempt particular majors. The Texas Higher Education Coordinating Board (2005) identified engineering and architecture as five-year degree programs, which would qualify for exemption. As will be demonstrated in the descriptive analysis below, credit requirements were reduced in the years after the law was passed. Some institutions and majors were more responsive than others (THECB Texas Higher Education Data, n.d.). A variety of implementation issues appear to have contributed to institutions' partial compliance. First, there was no penalty for institutions that did not comply with the policy (THECB, 2005). Second, decision-making about credit requirements is highly decentralized within institutions. While central administration within institutions contribute to institution-wide policies and culture around degree requirements, departments and faculty program chairs have considerable decision-making authority about the courses required for particular majors; therefore, compliance varies both between institutions and within institutions at the level of major (THECB Texas Higher Education Data, n.d.). It is important to note that additional provisions designed to reduce time to degree were passed simultaneously. Institutions were required to submit reports about their specific efforts to decrease time to degree (THECB, 2005). Other provisions of the bill targeted student decision-making about time to degree by charging students out-of-state tuition for credits that exceeded 30 credits beyond the major requirements and offering financial incentives to reward timely completion (Grove, 2007).

Empirical Strategy

The goals of this analysis are to examine the interrelationships of time to degree, excess credits, and credit requirements and to assess whether institutional credit requirements are effective policy levers for reducing time to degree. This analysis begins with a description of the presence, prevalence, and patterns of excess credit over time and across majors among public university students in Texas, followed by regression analysis to test the associations and possible causal relationships between credits and time to degree. *Total excess credits* are initially defined as the number of credits attempted by graduates above the graduation minimum 120 credits, an approach consistent with state policy and previous empirical studies. Evidence is provided below that indicates a significant proportion of excess credits come from institutional credit requirements that exceed the graduation minimum. The policy definition of *total excess credits* muddies the analysis of other student and institutional mechanisms of time to degree by pooling required and elective excess credits. An alternative definition of excess credits that is more representative of student experiences is the number of credits attempted net of the number of credits required for a student's institution and major. The second definition, which I refer to as *net excess credits*, allows me to disaggregate elective courses in excess of 120 from required courses in excess of 120. Although slightly more demanding in terms of data collection and computation than the uniform 120-credit minimum definition, net excess credits clarifies the drivers of time to degree and improves estimation by isolating the excess credits with unknown drivers.

While there are many factors that potentially contribute to excess credit (e.g., changing majors, failing courses, institutional advising), the remainder of this paper focuses primarily on the role of credits institutions require for graduation, controlling for a rich set of individual characteristics and enrollment choices.

I address three related questions:

Question 1: What is the effect of excess credit accumulation on time to degree?

Question 2: Are credit requirements associated with excess credit accumulation?

Question 3: Do credit requirements influence time to degree indirectly through excess credit accumulation?

The methodological concern in estimating these relationships is that students earning fewer excess credits are more likely to have certain unobservable characteristics (e.g., taking particular courses, exhibiting particular study behaviors or motivation, a strong appreciation for learning or academic exploration) that are also correlated positively or negatively with time-to-degree completion. (Adelman, 2006; Bailey & Alfonso, 2005; Cabrera et al., 2005; The University of Texas at Austin, 2012). Comparing the excess-credit accumulation of students with different unobservable characteristics would yield biased estimates of the impact of excess credits on time to degree. The identification strategy used in this study leverages the variation in institution- and major-specific credit requirements at universities over time in Texas, while controlling for other unobservable features of institutions and majors using a fixed-effects approach. I assume that all students in the same institution, same major, and same enrollment cohort have the same credit requirements. The changes in credit requirements and fixed-effects approach allow me to compare two students in the same institution and same major who face different numbers of required credits because they first enroll in different years. Credit requirements change during the period of observation due in part to a state policy passed in 2005 that limited the number of credits an institution could require for graduation to 120. I argue that changes in credit requirements serve as an exogenous source of variation in excess course-taking, even if the decisions to comply with the policy are endogenous to other institutional or major factors.

First, I estimate the association between excess credits and time to degree as

$$Time\ to\ Degree_{itn} = \alpha_0 + \alpha_1 Excess\ Credits_{itn} + \alpha_2 X_{itn} + M + \eta + M^*\eta + \varepsilon_{itn} \quad (1)$$

where the number of months to complete a bachelor's degree for student *i* at time *t* at university η is determined by the number of excess credits attempted, a vector of student characteristics *X,* and an idiosyncratic error term ε. To control for time-invariant characteristics of majors and institutions, I include *M* major fixed effects, η institutional fixed effects, and an interaction of major and institution to capture the institution-specific characteristics of majors (or the major-specific characteristics of institutions). This model estimates the general association between time to degree and excess credits derived from any student or institutional factor, not credit requirements alone. I anticipate that excess credits are endogenous and thus estimates of their association with time to degree are likely biased and should not be interpreted as causal. This basic model is included to motivate subsequent analyses and provide a baseline estimation for the magnitude of delays associated with excess course-taking.

Next, I examine the relationship between excess credits and credit requirements using variants of Equation (2),

$$Excess\ Credits_{itn} = \alpha_0 + \alpha_1 Credits\ Required_{tn} + \alpha_2 X_{itn} + M + \eta + M^*\eta + \varepsilon_{itn} \qquad (2)$$

For all specifications related to Equation 2, the α_1 coefficient for credit requirements represents the key variable of interest. Because I assume changes in credit requirements provide an exogenous source of variation in excess credits attempted, estimates of α_1 should be unbiased.

To evaluate Question 3 regarding the net effect of credit requirements on time to degree, I regress time to degree on credit requirements along with student control variables, major and institutional fixed effects, and a major-institution interaction term in Equation (3),

$$Time\ to\ Degree_{itn} = \alpha_0 + \alpha_1 Credit\ Requirements_{tn} + \alpha_2 X_{itn} + M + \eta + M^*\eta + \varepsilon_{itn} \quad (3)$$

I explore variations of Equation 3 that also control directly for excess credits. If the mechanism for changes in time to degree works entirely through the interim outcome of excess credits, I expect credit requirements will have no effect in specifications that include controls for excess credits. If changes in credit requirement have other indirect effects on students, I expect credit requirements and excess credits will both have significant relationships with time to degree.

Data

This study uses statewide longitudinal data for public higher education students in Texas between 2003 and 2012. The analytical sample includes 52,184 Texas residents who initially enroll in a four-year university in the fall between 2003 and 2006.[27] Each cohort is followed for six years—35,689 students graduate within this time period. Descriptive information about nongraduates is included here to contextualize the variation in characteristics among graduates; however, subsequent descriptive and regression analyses are limited to the subsample of graduates. Data on student demographics, family background, high school performance, and college enrollment history were obtained from administrative records of the students' responses on Apply Texas, a central application used by all Texas public universities, and term-by-term enrollment data provided by universities to the Texas Higher Education Coordinating Board. I include controls for demographic information with indicators of gender, race, parents' educational attainment, and family income bracket in the analysis. Prior preparation is measured by high school outcomes. I include SAT composite score, total dual-enrollment credits earned, and indicators for graduating in the top 10 percent, top

[27] HB 1172 was passed in 2005 and required implementation by 2008. Analysis of credit requirement changes over time revealed the largest decreases in credit requirements took place during and immediately after the law passed between 2004 and 2006. Requirements were relatively constant between 2006 and 2007 before increasing in 2008.

11–25 percent, or bottom 75 percent of the high school class.[28] College pathway information includes the number of developmental (remedial) credits attempted, the number of semesters a student enrolls part-time, transfer, student major, the number of credits required for graduation, institution attended, and degrees completed. The sample was restricted to students with valid information about major, number of credits required for graduation, and degrees that require 120 credits or more.[29]

Results of the empirical analysis can be generalized to public university graduates in Texas and other states with high levels of excess credits. The analysis does not include students who attend private institutions or community colleges and who do not graduate, so findings may not be representative of the course-taking patterns of these kinds of students. The analysis also does not address the levels of selection inherent in higher education application, acceptance, enrollment, and completion processes; instead, it focuses on the admittedly narrow experiences of graduates who successfully navigate the complex choice architecture of higher education.

Table 4.1 presents descriptive statistics of the sample disaggregated by enrollment cohort and graduation outcomes that range from on-time graduates who complete a bachelor's degree in four years, those who complete in five years, those who complete in six years, to students who do not graduate. Twenty-nine percent of

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[28] The Top 10% Rule, passed in 1997, grants automatic admission to Texas public universities to all students who graduate from a Texas public high school ranked in the top 10 percent of their class.
[29] This restriction primarily discards students who do not graduate, which is not cause for concern as the time-to-degree analysis only applies to the subsample of students who graduate within six years. All graduates have a major. More than 99 percent of graduates have available program credit information.

students graduate within four years (48 months), 21 percent graduate in five years (60 months), and 19 percent graduate in six years (72 months).[30] The average graduate in the sample is 18.15 years old in September of their first year of enrollment. Fifty-three percent of the sample is female. White students make up 64 percent of the graduate sample, Hispanics 21 percent, Blacks 10 percent, and Other 12 percent. On-time graduates are more likely to be female (57 percent) compared to 5-year and 6-year graduates (50 percent). On-time graduates are also more likely to be White (68 percent) and less likely to be Hispanic (17 percent) or Black (7 percent) than graduates who take more time to complete a degree.

According to information provided by students on their college applications, 45 percent of graduates in the sample have fathers with a high level of education, which is classified as completion of a college degree; 40 percent of their mothers have a high level of education. Thirty percent of graduates' fathers have attained a medium level of education, which refers to completion of a high school degree or some college; 36 percent of their mothers have a medium level of education. Few parents, just 5 percent of both fathers and mothers, have low levels of education and did not complete a high school degree. Students graduating on time have higher levels of parental education. Fifty-two percent of students graduating in four years have fathers in the highest

[30] Earlier cohorts in the data set have additional time to complete degrees. Although all students in the sample are limited to six years of observation, it is interesting to note the proportion of students graduate given additional time. An additional 14 percent of students graduate within nine years. An additional 13 percent graduate within eight years. An additional 10 percent of students graduate within seven years.

education category; 46 percent of their mothers are in this category. The proportion of later graduates with parents in the highest education category is 41 percent of fathers and 37 percent of mothers for five-year graduates and 38 and 34 percent, respectively, for six-year graduates. The trend is similar for income. Income information is a categorical variable with four levels: high income (more than $80,000), middle income ($40,000 to $80,000), low income (less than $40,000), and missing. The sample of graduates includes 36 percent of students in the high-income bracket, 22 percent in the middle-income bracket, and 16 percent in the low-income bracket. Income information is missing for 26 percent of the sample. On-time graduates are more likely to come from high-income families (41 percent) compared to students who graduate in five years (34 percent) or six years (31 percent). Late graduates are most likely to come from lower income backgrounds. They are also most likely to have missing income information.

Table 4.2 presents means and proportions of high school and college academic characteristics. Indicators of high school academic preparation are provided by SAT score, rank in a student’s high school graduating class, and the number of dual credits a student earned for college credit while in high school. SAT score reflects combined reading and mathematics scores out of a total of 1,600 possible points. High school class rank is divided in to three categories: top 10 percent, top 11 to 25 percent, and bottom 75 percent. The average SAT score of graduates in the sample is 1,103. Students who graduate in the top 10 percent of their high school class represent 32 percent of the graduate sample, while those who graduated in the top 11 to 25 percent make up 21 percent of the sample. Students in the sample do not attempt many dual credits in high school, just 0.11 credits on average. Students graduating on time have higher levels of high school academic preparation. The average SAT score of students who graduate in four years is 1,148. Forty-one percent of on-time graduates finished high school in the top 10 percent of their class and 19 percent in the top 11 to 25 percent. Students graduating later have lower levels of academic preparation. The average SAT score is 1,081 for five-year graduates and 1,057 for six-year graduates. Twenty-eight and 22 percent of five- and six-year graduates, respectively, were in the top 10 percent of their high school class. Just 22 percent of late graduates finished high school in the top 11 to 25 percent of their class.

Students graduating more quickly also differ in terms of their college pathways as observed by institutional enrollment data. On average, students in the graduate subsample take 0.98 developmental (remedial) education credits. Students who graduate on time take just 0.47 developmental credits, while late graduates complete 1.21 to 1.51 developmental education credits. A student is considered enrolled full-time if he or she is enrolled in at least 12 credits in a term. I measure part-time status as the total number of semesters a student enrolls in fewer than 12 credits, including summers. The average number of part-time semesters in the graduate sample is 3.21 for all students. On-time graduates have 3.06 terms in which they enrolled part-time. Students graduating in five years have 3.23 part-time terms, and students graduating in six years have 3.4 part-time semesters. Transfer is a dummy variable that identifies students moving from one Texas public university to another during their postsecondary education. On-time graduates are unlikely to transfer. Just seven percent of four-year graduates transfer, while 10 and 11 percent of five- and six-year graduates transfer, respectively. Students who do not graduate have the highest proportion of transfer. Finally, I include information about departmental majors, which group individual majors into seven categories based on content, departmental governance, and patterns of credit requirements during the period of observation. The highest proportions of graduates enroll in social science (25 percent). Business and liberal arts majors each make up 21 percent of graduates. Science, math and health majors make up 16 percent of graduates. The smallest numbers enroll in agriculture (2 percent), arts and architecture (6 percent), and engineering (7 percent). There are not large differences in major selection across enrollment cohorts, although there is variation in graduation outcomes by major. Engineers and arts and architecture majors are less likely to graduate in four years compared to students who complete in five and six years. Science, math, and health students are more likely to complete on time (18 percent) compared to five- and six-year graduates (15 percent for both).

With a few exceptions, there is not much variation in student demographics, family background characteristics, academic preparation, and college pathways over time. The 2003 cohort appears larger than other cohorts, and I observe modest advantages in this cohort in terms of race, parent education, and fewer developmental education credits. Students in 2004 had slightly lower SAT scores than other years, although this change is not statistically significant. The number of dual-enrollment credits students attempt rises steadily between 2003 and 2006, but remain quite small, 0.20 credits on average at its peak. Most importantly for this analysis, I see no evidence of changes in the proportion of students in different departmental majors between the 2003 and 2006 starting cohorts.

Limitations

While student characteristics and enrollment pathways will be controlled for in the subsequent analysis, it is possible there are other changes taking place over time within institutions and majors that are unrelated to credit requirements but correlated with excess credits and time to degree that could bias results. Based on the descriptive statistics, I do not find significant differences in other predictors over time, except for modest increases in dual enrollment between the 2003 and 2006 cohorts, which appear too small to explain the magnitude of excess credits present. Unobservable factors that vary over time such as broader economic trends are another possible concern as unemployment is linked to strategic delay in graduation (Pechacek, 2013). While I do not control for economic factors directly, the consistency of observable characteristics over time is encouraging.

Advantages of the 2003 cohort could underestimate the effect of time-to-degree reductions if more advantaged students are more likely to complete on-time and overestimate the effect of time-to-degree reductions if more advantaged students are more likely to protect their grades and consume excess credits. This issue will be addressed by running sensitivity analyses on the 2004–2006 cohorts.

Construction of the major variable at a single point in time is another potential limitation of the analytical approach. The major fixed effects are based on students' graduation major due to poor tracking of major over time. Students regularly change majors during postsecondary education; however this dynamic process is not incorporated in the analysis. Previous studies regarding student major suggest students are most likely to change from liberal arts, science, mathematics, and architecture majors, while social science and engineering majors are less likely to change. Business and agriculture majors are least likely to change (Johnson, 2009). The two majors that students are least likely to change are relatively lower requirement majors. In these majors, I would expect excess credit estimates to be highly attributable to elective course-taking, not major change. High-requirement majors (architecture and engineering) have many students switching to other majors, as do some low-requirement majors (liberal arts). When students switch from a low-requirement major to a high-requirement major, students will likely have accumulated credits that cannot be applied to their new major. Low-requirement majors often have more space for elective courses in degree plans; therefore, it is possible that when students switch from a high-requirement major to a low-requirement major, excess credits associated with major change could be similar or larger. Major changes could confound the estimated effects of credit requirement changes in majors if the frequency of major changes varies over time or if there are changes in which majors students depart from and subsequently select over time. Excess credits associated with changing majors will appear as elective courses among students in second-choice graduation majors. Effects on excess credits may be smaller or larger depending on the trend on major changes and which majors students move to and from.

RESULTS

Descriptive Analysis of Credits

Table 4.3 summarizes outcome variables. The average credits hours attempted[31] by graduates is 135 (Figure 4.2). Students who graduate on time attempt the smallest number of credits—124; five- and six-year graduates attempt 142 and 146 credits, respectively. Credits are approximately normally distributed with 50 percent of completers falling between 123 and 148 credits.

Students extending time to degree not only take more time to complete, but attempt significant numbers of excess credits. Total excess credits are calculated as the number of credits a student attempts less the graduation minimum 120 credits, excluding developmental education credits. This definition is used by higher education accrediting agencies and instantiated in state and institutional policy. The average number of excess credits among graduates is 18. Four-year graduates have the smallest number of excess credits on average. The mean number for on-time graduates is 8

[31] All credit totals in the paper reflect attempted credits. Credit hour information in the THECB administrative data is counted at the beginning rather than the end of the semester, so successful completion of the courses is not guaranteed.

credits. Excess credits are skewed by a small number of students with very high numbers of excess credits. The median number of excess credits for on-time graduates is 5 (Figure 4.3). Five- and six-year graduates average 24 and 27 total excess credits, respectively. Median total excess credits for five- and six-year graduates are 23. It appears the difference between four- and five-year graduates is primarily driven by excess credits, while the difference between five- and six-year graduates appears driven by fewer credits taken per term of periods of stopout.

Excess credits vary with major. Figure 4.4 displays excess credit levels by departmental major across the cohorts that first enrolled between 2003 and 2006. The average number of total excess credits increases from 17 to 19 credits between 2003 and 2004, before declining to 18 in 2005 and 2006 in all majors. Excess credit totals range from less than 16 to approximately 25 across majors. Liberal arts majors attempted the fewest excess credits. Arts/architecture and engineering majors attempted the most excess credits (between 20 and 25 excess credits). Engineering majors experienced the most significant increase in excess credits during this period. Agriculture and arts/architecture programs began with an initial increase in excess credits followed by a decline after 2004. Science/math, liberal arts, social science, and business majors experienced relatively steady levels of excess credits. With the exception of engineering and arts/architecture, the relative ranking of total excess credits by major remains constant over time, suggesting differences in credit patterns differ largely between majors rather than within majors over time.

Next, I examine credit requirements and net excess credits over time. The mean number of credits required for graduation is 127. According to Table 4.3, there is not much variation of credit requirements among on-time graduates, late graduates, and nongraduates. There is, however, variation across time and major in credit requirements (Figure 4.5). Students who first enrolled in 2003 were required by their institution and major to take an average of 128 credits. Students who first enrolled four years later average 126. Science/math, liberal arts, social science, and business majors experienced relatively similar trends. Each began with credit requirement averages between 125 and 128 and experienced a plateau between 2003 and 2004, followed by a steady decrease in conjunction with 2005 policy change. The range of credit requirements for these four major groupings ranged from 124 to 126 for the 2007-starting cohort. Agriculture, arts/architecture, and engineering majors had high levels of credit requirements in 2003. Credit requirements for agriculture majors declined over time by approximately 5 credits. By 2006, agriculture credit requirements were as low as business majors, the lowest credit requirement major in the sample. Arts/architecture major requirements fell by almost 3 credits. Engineering major credit requirements did not change significantly over time. Engineering requirements began and ended the period near 132 required credits. Variation over time allows me to identify the effects of credit requirements on excess credits and time to degree, while controlling for major- and institution-specific characteristics. Given the credit requirement patterns, I would expect to see little or no effects for engineering majors and larger effects for agriculture majors.

The average number of net excess credits for all graduates in the sample is 13. The median number of net excess credits is 7. Among on-time graduates, net excess credits total just 4 credits, and the median number is 0 (Figure 4.6). Once I account for the credits students are required to complete according to their institution and major for graduation, the median four-year graduate is not attempting any truly excess credits. There are considerable policy implications from this finding for data collection, reporting, and accountability. It also implies significant proportions of perceived excess credits identified in policy reports are not actually related to student preferences for course-taking and that credit requirements may be ripe for policy intervention at the institutional level.

Five- and six-year completers attempt 17 and 21 net excess credits, respectively. Median net excess credits are 16 for both five- and six-year graduates. Figure 4.7 presents net excess credits by major over time. Compared to the first definition of total excess credits, net excess credits are on average lower but increase over the four starting cohorts. The average number of net excess credits for graduates is 12 credits for the 2003 cohort and 14 for the 2006 cohort. Liberal arts, social science, and science/math majors start at different levels of net excess credits, but experience a similar positive trend of about 2 additional net excess credits over time. Business majors have a smaller increase in net excess credits. Engineering majors have below average net excess credits throughout, although they have almost a 3-credit increase in net excess credits over time. Arts/architecture majors who first enrolled in 2003 had the most net excess credits at 14. Net excess credits spike to 17 for arts/architecture majors in the 2004 cohort before decreasing to 15 credits by the 2006 cohort. Agriculture majors experienced the largest increase in net excess credits over this period, beginning below average and ending close to 18 net excess credits. Comparing the patterns of Figures 4.4 and 4.5, it appears that when credit requirements change there may be a shift in course-taking from required to elective credit or a lag in student course-taking behavior. Students may continue taking previously required courses for an additional year or two. During that time, total credits attempted remain flat, but credits that were required become totaled as net excess credit counts.

Finally, time to degree is constructed as the number of months between a student's initial enrollment in higher education and the date of graduation. Students who do not graduate do not have a time-to-degree measure. The average time to degree of graduates in the full sample is 53 months, and the median is 56 months. On-time graduates complete in approximately 44 months, five-year graduates in 56 months, and six-year graduates in 66 months on average. Figure 4.8 displays the histogram of months to bachelor's degree completion. A small proportion of students complete degrees in three years or fewer. For students beginning in the fall of any cohort, the largest period of graduation is the spring term 44 months later.

Figure 4.9 suggests that time to degree decreases modestly over time, although the change is not statistically significant. Business, liberal arts, social science, and science/math majors began the period with an average of approximately 53 months to graduation. These four major groupings saw a rise in time to degree in 2004 and then a fairly steady decline in 2005 and 2006. Time to degree for agriculture majors dipped in 2004 before increasing by approximately 1.5 months in 2005 and returning to 2003 levels in 2006. Engineering majors began the period with an average of 55 months to graduation. After a modest decline in 2004, engineers experienced an increase in time to degree between 2004 and 2006. Arts/architecture majors have the longest times to degree in the period, close to 56 months. Time to degree for arts/architecture majors increased in 2004 before an almost 1.5-month decrease between 2004 and 2006.

Fixed-Effects Regression Results

Fixed-effects models improve on descriptive trends by controlling for a rich set of students characteristics and the unobservable, time-invariant characteristics of institutions and majors. The reference group for regression analyses is comprised of White male engineering majors graduating in the bottom 75 percent of their high school class and whose parents both had low levels of education and income. Table 4.4 presents estimates of months to bachelor’s degree completion associated with increases in excess credits based on Equation 1 for graduates in the sample. Recall this model estimates the association between time to degree and excess credits that derive from any factor—either related to students or institutions, including credit requirements. Excess credits are endogenous, so these results should not be interpreted as causal.

All estimates discussed below are significant at the 1-percent level unless otherwise noted. Column 1 presents the main effects of the relationship between total excess credits and time to degree. A one-unit decrease in the number of excess credits is associated with a 0.3-month decrease in time to degree, which is equivalent to a little more than an extra week for all students on average. It is useful to simulate the magnitude of the 0.3-month delay in the context of realistic credit changes. Excess credits are rarely added in single units. If a student or institution adds an extra course, which confers between 3 and 4 credits, the change in time to degree multiples to between 0.9 to 1.2 months.[32] Excess credits alone explain 29 percent of the variation in time to degree.

Model 2 adds a number of student demographic, family background, high school preparation, and college pathway covariates. Excess credits maintain their predicted positive association with time to degree, although decrease slightly (0.83 to 1.10 months) as a result of the significant positive associations (longer time to degree) with Hispanic, other race, developmental education, and transfer variables. Age, female,

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[32] Tabled estimates present the marginal effects of a *one-unit* increase in excess credits, although I will interpret outcomes here as well as those in subsequence models in light of a *one-course decrease* in excess credits. I define a course as 3 or 4 credits. Further, the purpose of this study is to examine the effectiveness of credit requirement reductions, so interpretations will suggest the effects of decreases, rather than increases, in credit requirements and excess credits.

Black, high education for fathers, SAT score, graduating in the top 10 percent, dual credits, and part-time enrollment variables are negatively associated with time to degree (shorter time to degree). All of these associations are in the expected direction except for the Black students and part-time semesters. Previous empirical work suggests that Black students are more likely to have longer times to degree than White students and that additional part-time semesters would increase time to degree, not decrease it. The association with part-time semesters may be picking up the effect of part-time enrollment during summer terms, which may expedite student completion.

Model 3 adds institution and major fixed effects to the specification and the interaction of institution and major.[33] In the fixed-effects model, within an institution and major grouping, a one-course decrease in excess credits is associated with a 0.84- to 1.12-month decrease in time to degree. Model 3 explains 31 percent of the variation in time to degree. With the addition of fixed effects, the significant relationship between time to degree and the Hispanic and other race variables are no longer significant. The negative associations with Black and high levels of father education variables drop in significance to the 5-percent level and developmental education is no longer significant, which suggests students sort in to particular majors and institutions based on these characteristics.

[33] I estimated separately the addition of institution fixed effects and major fixed effects. Neither incremental change is very different from the final models, which include both plus an interaction term, so I have only reported the full models here.

Models 4–6 use the net excess credit definition and test its association with time to degree. A one-course decrease in the number of net excess credits is associated with a 0.93 to 1.24-month decrease in time to degree in Model 4. Adding student controls, the association falls to 0.83 to 1.11 months. Covariates in Model 5 are similar in magnitude and direction to those described previously in Model 2, including total excess credits except that medium levels of mother's education has a significant association with shorter times to degree. Model 6 includes fixed effects. Here the association between net excess credits and time to degree falls to 0.85 to 1.13 months. This result is almost indistinguishable from the estimates found using the 120-credit threshold definition of total excess credits. Black and part-time enrollment variables are associated with longer time to degree, and Hispanic and mother's education (high school degree or some college) variables are associated with shorter time to degree, but each falls in significance to the 10-percent level in the fixed-effects specification.

Table 4.5 presents results of Equations 2 and 3, which estimate the effects of credit requirements on excess credits and time to degree, respectively. Controlling for institutional and major fixed effects, I assume changes in credit requirements are an exogenous source of variation in excess credits; therefore, estimates should be unbiased. The dependent variable in Models 1–3 is total excess credits, which aggregates required and elective credits in excess of 120 credits. In Model 1, I find the expected positive association of credit requirements and excess credits. A one-course decrease in requirements reduces total excess credits by 0.60 to 0.80 credits in the main-effects model. Model 2 adds student covariates. The effect of credit requirements decreases on total excess credits in Model 2 is 0.79 to 1.05 excess credits. Age, female, all income categories, higher SAT, and high school class rank variables have significant negative associations with total excess credits. Students who are older and female and have high family incomes and higher levels to academic preparation are associated with lower levels of excess credit accumulations. Black, other race, developmental education, part-time enrollment, and transfer variables have significant positive associations with excess credits. In Model 3, the fixed-effects model, a one-course reduction in credit requirements reduces excess credits by 0.63 to 0.84 credits. Estimates for the student covariates maintain direction and significance, although there are minor changes in their magnitude in Model 3.

The dependent variable in Models 4–6 is net excess credits, which totals only elective excess courses. Compared to the 120-credit definition, the association between credit requirements and net excess credit accumulation is *negative*. Decreasing credit requirements increases net excess credits. Reducing credit requirements by one course increases net excess credits by 1.08 to 1.44 credits in Model 4. Adding covariates in Model 5 reduces the effect of credit requirements on net excess credits to 0.93 to 1.24. Student covariates in the net excess credit model are similar in significance and direction to the total excess credit model. In the fixed-effects model, the effect of a one-course reduction in credit requirements on net excess credits is a 0.99- to 1.32-credit increase.

The net excess credit findings suggest students make a tradeoff between required credits and electives. When credit requirements ease, students may perceive more flexibility to take other courses of interest within their preconceived timeframe for graduation and anticipated level of costs for a degree. Without full transcript data, it is impossible to determine whether the apparent tradeoff is caused by students taking the same courses (formerly but no longer required) or different courses (swapping formerly required course with electives). It is also impossible to tell how intentional these changes are from a student perspective. Both students and advisors may not respond to changes in degree requirements right away. There may be some delay in changes to course-taking behavior and advising as people learn about and adjust to changes to credit requirements.

Models 7–9 present estimates of the direct relationship between credit requirements and time to degree. In the main-effects model, there is no statistically significant association between these two variables. Adding student controls sharpens the relationship. Accounting for fixed effects in Model 9 substantiates that there is not a statistically significant, independent association between the number of credits required for graduation and time to degree. In light of the apparent tradeoff in required course-taking and elective course-taking evidenced in Models 1–6, it is not surprising that I find no direct effect of credit requirement changes on time to degree. Estimated covariates are in the expected direction.

Rather than a direct relationship with time to degree, I next test whether credit requirements influence time to degree indirectly through excess credits. Models 1–3 in Table 4.6 examine the effects of credit requirements on time to degree, controlling for total excess credits. In the preferred fixed-effects specification in Model 3, a one-course decrease in total excess credits is associated with the expected 0.84- to 1.12-month decrease in graduation. This finding replicates the results found previously when excess credits and time to degree were modeled alone. Now controlling for total excess credits, I find a one-course decrease in credit requirements increases time to degree by 0.13 to 0.17 months. Credit requirement estimates are only significant at the 10-percent level; however, the magnitude and sign of the estimates correspond with the tradeoff hypothesis. As credit requirements decrease, other forms of elective course-taking increases, producing a net increase in time to degree.

Models 4–6 in Table 4.6 present the effects of credit requirements on time to degree, controlling for excess credits. Unlike Models 1–3 in which total excess credits aggregate both required and elective excess credits, in Models 4–6 I can isolate the changes in elective excess credits. The fixed-effects model in Column 6 estimates a similar, though slightly larger, association between net excess credits and time to degree (0.88 to 1.17 months) compared to total excess credits and time to degree in Model 3. Controlling for the tradeoff effect in net excess credits, however, I find that a one-course reduction in credit requirements decreases time to degree by 0.34 to 0.45 months. The results are statistically significant at the 1-percent level. This is the expected result of reductions in credit requirements, which only become apparent when elective course-taking in held constant.

Findings further substantiate the tradeoff students make between required and elective excess course-taking. Comparing estimates of the direct effect of credit requirements on time to degree (Model 9 from Table 4.5) to estimates of the credit requirements on time to degree controlling for the tradeoff mechanism (Model 6 in Table 4.6), I determine credit requirements appear to have no effect on time to degree because decreases in required credits are offset by increases in elective credits. Using conventional definitions of total excess credits that do not account for institution- and major-specific degree requirements, and therefore aggregate required and elective excess credits, obscures tradeoffs students make between required and elective coursework and masks the consequences of credit requirement reductions. Using the net excess credit definition, I find evidence that time to degree can be decreased by reductions in credit requirements, but only when the tradeoff effect is controlled.

Compared to the first definition of excess credit, modeling net excess credits clarifies the significant, positive relationship between program credit requirements and time to degree. The estimate of the direct relationship between total excess credits and time to degree compared to net excess credits and time to degree are modestly larger, but the most important improvement in this model is the clear negative association between program credit requirements and net excess credits.[34]

Heterogeneous Effects

Finally, I examine differences in the tradeoff between required credits and excess credits by race, income, high school academic preparation, and major. I use the preferred specification that models the effect of credit requirements on net excess credits (including student control variables), institution and major fixed effects, and the interaction of institution and major (Table 4.5, Model 6). I focus on differences in the tradeoff relationship because the effects of excess credit on time to degree are biased by the other institutional and student factors that contribute to excess credits. In addition, prior results of this relationship appear stable across a variety of specifications. The substantive contribution of this paper is the tradeoff relationship between credit requirements and net excess credits.

Table 4.7 presents the differences by major. Panel A presents disaggregated models, and Panel B tests the significance of differences between the models using interactions. Increases in net excess credits due to a one-course reduction in credit requirements are largest for agriculture majors (1.66 to 2.22 net excess credits), social science majors (1.11 to 1.48 net excess credits), and business majors (1.10 to 1.46 net excess credits). The effects are smallest for arts/architecture majors (0.84 to 1.12 net

[34] I verified that results are not sensitive to abnormalities in the 2003 cohort by reanalyzing 2004–2006 cohorts. Magnitude and significance is the same for all models.

excess credits) and engineering majors (0.67 to 0.89 net excess credits). In Panel B, I test whether the differences across major are statistically significantly different from one another. The effect of credit requirements on net excess credits is significantly larger for social science majors and science/math majors. That is, decreases in credit requirements in these relatively low-requirement majors have a larger tradeoff effect than for other majors. Results may be driven in part by the high likelihood of students to change from science/math majors and the modest likelihood of students to change from social science majors to other majors (Johnson, 2009). The effect of credit requirement reductions on net excess credits is significantly smaller for engineering majors than other majors. Results may be driven by the relatively high level of requirements observed for engineering majors or by the lack of variation in credit requirements. Unlike other major groupings in the study, engineering major requirements start and remain high throughout the period of observation while net excess credits increase. It is also reasonable to infer that engineers, who are among the least likely to change majors, accumulate few excess credits by changing program requirements (Johnson, 2009). Liberal arts, agriculture, and arts/architecture majors are not statistically significantly different from other majors in terms of net excess credits.

Table 4.8 presents the interactions with race, income, and high school academic variables 8. Panel A presents disaggregated models, and Panel B tests the significance of differences between the models. Models 1–3 estimate the determinants of net excess credits separately for White and other race students, Black students, and Hispanic students. White and other race students have a 0.89- to 1.19-net-excess-credit increase associated with a one-course decrease in credit requirements. The effect for Black and Hispanic students is larger, 1.69 to 2.24 and 1.24 to 1.65 net excess credits, respectively. In Panel B, I confirm the larger tradeoff effect for Black students compared to White and other race students is statistically significant, but not for Hispanic students.

Models 4 and 5 in Panel A report results from interacting net excess credits with income status. Low-income students have a 1.21- to 1.62-net-excess-credit increase associated with a one-course decrease in credit requirements. High-income students have a smaller tradeoff effect—0.71 to 0.94 net excess credits. Panel B indicates the difference between low- and high-income populations is significant at the 5-percent level. Low-income students are likely to be most responsive to financial aid requirements to enrollment full-time, which may encourage them to take excess credits when required courses are unavailable.

The remaining models in Panel A disaggregate results by prior academic preparation. Columns 6 and 7 report results from disaggregating students with low high school class rank (bottom 90 percent) and high class rank (top 10 percent). With a one-course increase in credits required, students who graduated in the bottom 90 percent of their high school class take 1.20 to 1.60 net excess credits. For students in the top 10 percent, the net excess credit increase is smaller (0.70 to 0.92). The difference is statistically significant at the 1-percent level. For SAT, I also find that better prepared students take fewer net excess credits than less prepared students. Students with SAT scores in the bottom 50 percentile increase net excess credits by 1.587 to 2.116 with a one-course decrease in credit requirements. Students scoring in the top 50 percent of SAT scores increase net excess credits by 0.75 to 1 credits. Although the magnitudes of these differences are small, the differences are significant and consistent. Even controlling for a host of student background characteristics, institutions, and choice of major, less academically prepared students experience larger increases in net excess credits. This may be related to higher levels of social capital among better prepared students that enables them to navigate higher education course-taking more efficiently. Alternatively, less prepared students may decide they need more coursework to improve their labor market outcomes compared to their better prepared peers. They may also be most likely to fail and repeat coursework.

CONCLUSION

In summary, I explore time to degree and the mechanism by which credits required for graduation increase excess credit accumulation and delay degree completion. I use statewide student-level data from Texas between 2003 and 2012 to examine trends in time to degree and associated credits as well as fixed-effects analyses to quantify the strength and direction of the relationships between these variables. This study finds that 42 percent of students who graduate within six years complete their degree on time. On-time graduates attempt a small number of excess credits, while those who take an additional year or two to complete their degree attempt many more excess credits. Approximately one-quarter of excess credits can be explained by institutional and major graduation requirements. Using a fixed-effects estimation strategy that exploits variation in credit requirements over time within institutions and majors, I find that requirements, credits, and time to degree are closely related issues, but these relationships are more complex than anticipated.

One source of complexity is how policymakers define *excess credits*. The conventional policy definition of excess credits counts both required and elective courses above the state graduation minimum 120 credits as “excessive.” Using the total excess credit definition, I find reducing credit requirements by one course decreases total excess credits by 0.72 credits on average; in turn, a one-course reduction in total excess credits is associated with a one-month reduction in time to degree. This simplistic analysis, however, provides misleading results about the effectiveness of credit requirement limitations as policy levers. It fails to account for the possibility that changes in credit requirements might affect both required and elective course-taking. The conventional definition obscures tradeoffs students make between required and elective coursework, and it masks the extension effect of credit requirement limits on time to degree.

A better definition of *excess credits* accounts for institution- and major-specific degree requirements, which often exceed 120 credits. Using net excess credits, I find that reductions in credit requirements decrease required credits but increase the consumption of elective credits. This tradeoff effect helps explain why I find a small positive effect of credit requirement reductions directly on time to degree. Only when controlling for changes in elective course-taking do I find the predicted negative effect on time to degree. I suggest two possible explanations for these findings. The first is that there is a lag between when credit requirements change and when students and institutional advising respond to changes. The second hypothesis is that students do not reduce consumption because existing student course-taking is optimal and maximizes student returns to higher education. Study of the heterogeneous effects of the tradeoff between required and elective courses by student characteristics could support either hypothesis. I find that Black and low-income students have larger increases in net excess credits, while students with high levels of prior academic preparation have smaller tradeoff effects. Students with lower human and social capital appear least likely to benefit from efficiencies related to streamlining graduation requirements. Alternatively, students with lower human and social capital may be most compelled to increase consumption of electives to improve labor market outcomes or meet financial aid requirements of full-time enrollment.

The findings raise some fundamental questions about time to degree and productivity measures in higher education. What is the socially optimal level of excess course-taking? Higher numbers of excess credits may be efficient for individuals but less so for public higher education systems. Is there value in double-majoring and taking extra courses in foreign language or art history? Is major exploration part of the college experience and the development of well-rounded citizens? These issues are questions of social values and fiscal priorities. While educators, policymakers, and students may disagree about these questions, the fact that Texas has the highest levels of total excess credits in a 33-state sample (149) suggests some level of reduction may reduce the cost of higher education while maintaining flexibility for students.

Results further suggest credit requirement limitations can be useful policy levers to reduce time to degree under certain conditions. I offer three considerations. First, there is evidence that institutional credit creep is sizable. Many majors and institutions in Texas require well more than 120 credits for graduation even after the 2005 policy change. Results in this paper have been reported in relation to a one-course decrease in credit requirements. The average number of required credits for all majors is 127. For engineers the average number is 132, and for arts/architecture majors the average is 130. Effects would be larger than those reported here if all programs were decreased to 120.

Second, credit requirement restrictions contribute to reducing some forms of excess credits, but they are not sufficient stand-alone strategies. From the perspective of policymakers, course tradeoffs subvert the intent of credit reductions, although they may increase utility from the student perspective. To achieve policy goals related to reducing time to degree, complementary efforts may be necessary. If students who increase net excess credits are not informed about changes to credit requirements, efforts to improve advising or restructure more coherent programs of study seem promising. If students simply prefer more course-taking, changes to student incentive structures would be a better strategy for altering course-taking behavior (e.g., loan forgiveness programs).

Third, even though Texas introduced a policy designed to reduce credit requirements over time, I observe modest changes in credit levels. As evidenced by the Texas example, policy design, implementation issues, and weak accountability undermine compliance with credit reduction policies. Decisions about credit requirements are largely made at the level of departments and majors, which are accountable to accrediting and licensure bodies as well as state policymakers. Some majors are particularly resistant to reductions. These tend to be majors with more specific licensure and accreditation requirements. Reductions in high-requirement majors such as engineering, health, and architecture would benefit from coordination from these bodies as well if policymakers seek better compliance. Or, if exemptions are permitted, reporting and accountability efforts should take in to account differences in credit requirements by major. The 120-credit threshold measure may be reasonable for liberal arts majors, but not engineering majors.

Finally, this study surfaces two issues for future research. Studying the tradeoff effect using transcript-level data would help assess whether students take the same courses (formerly but no longer required) or different courses (swapping formerly required course with electives) in response to changes in credit requirements. I also observe that a significant proportion of students in the Texas data complete 120 credits or more and yet do not earn a degree. In terms of inefficient uses of resources, these students consume many higher education credits with no payoff for the university. Additional research about these students and strategies to improve the likelihood of their degree completion seems promising.

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Figure 4.1: Conceptual framework for time to bachelor's degree

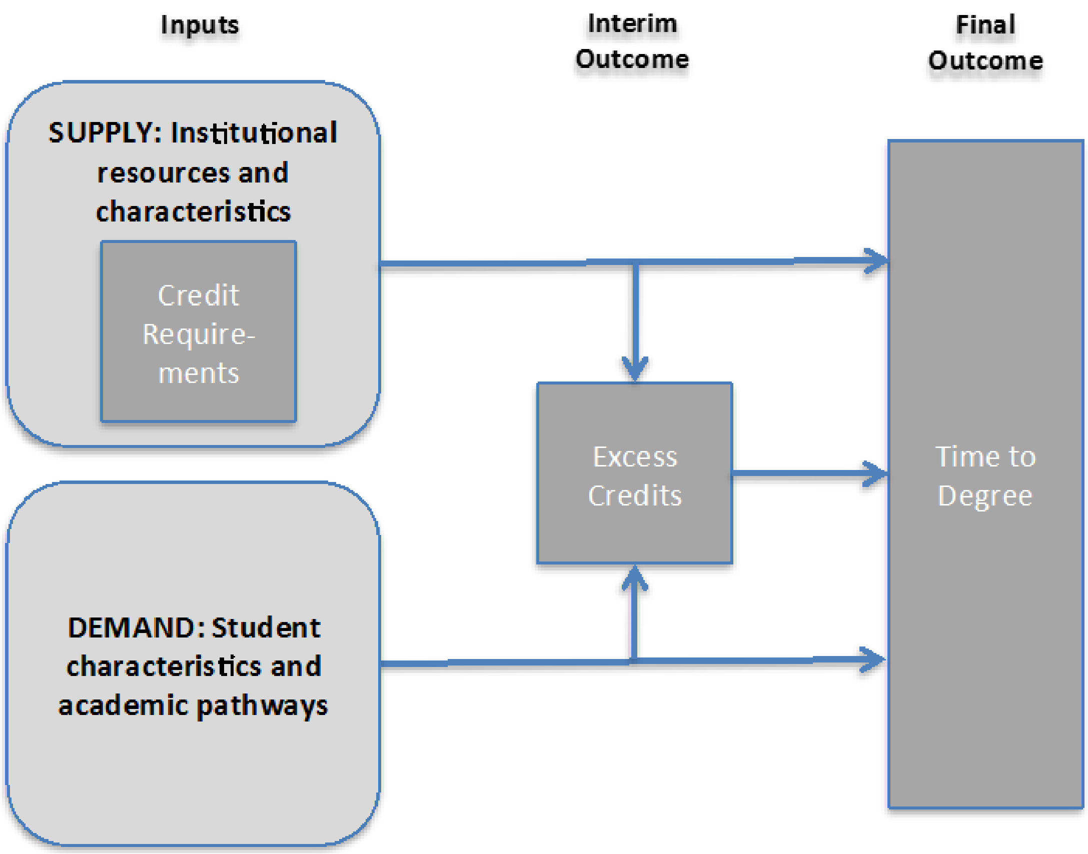
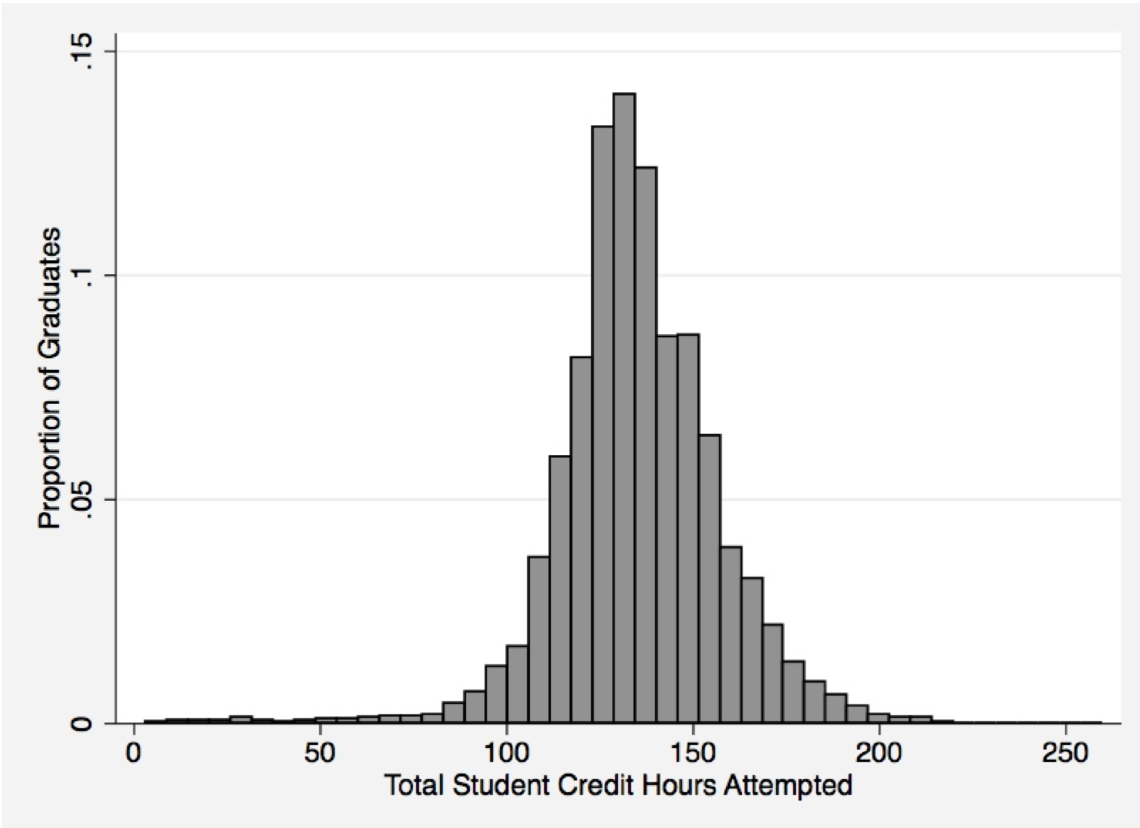
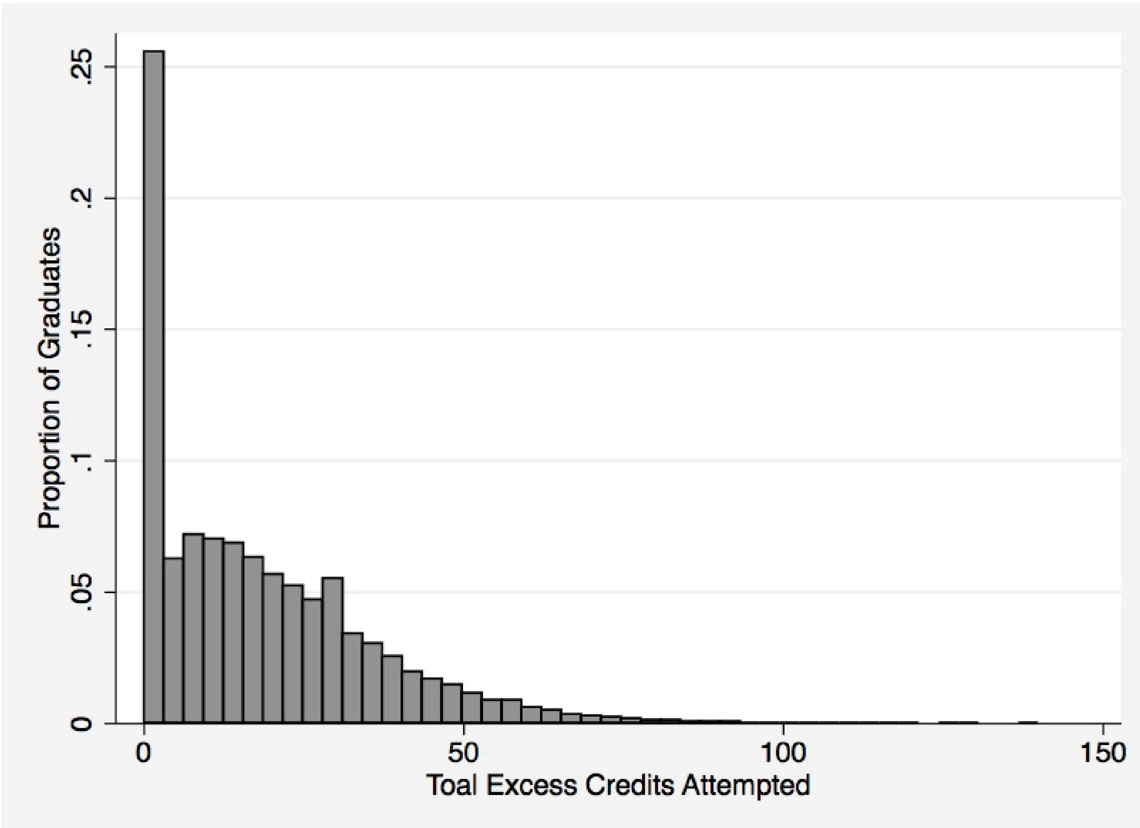


Figure 4.2: Histogram of total credits attempted by graduation status



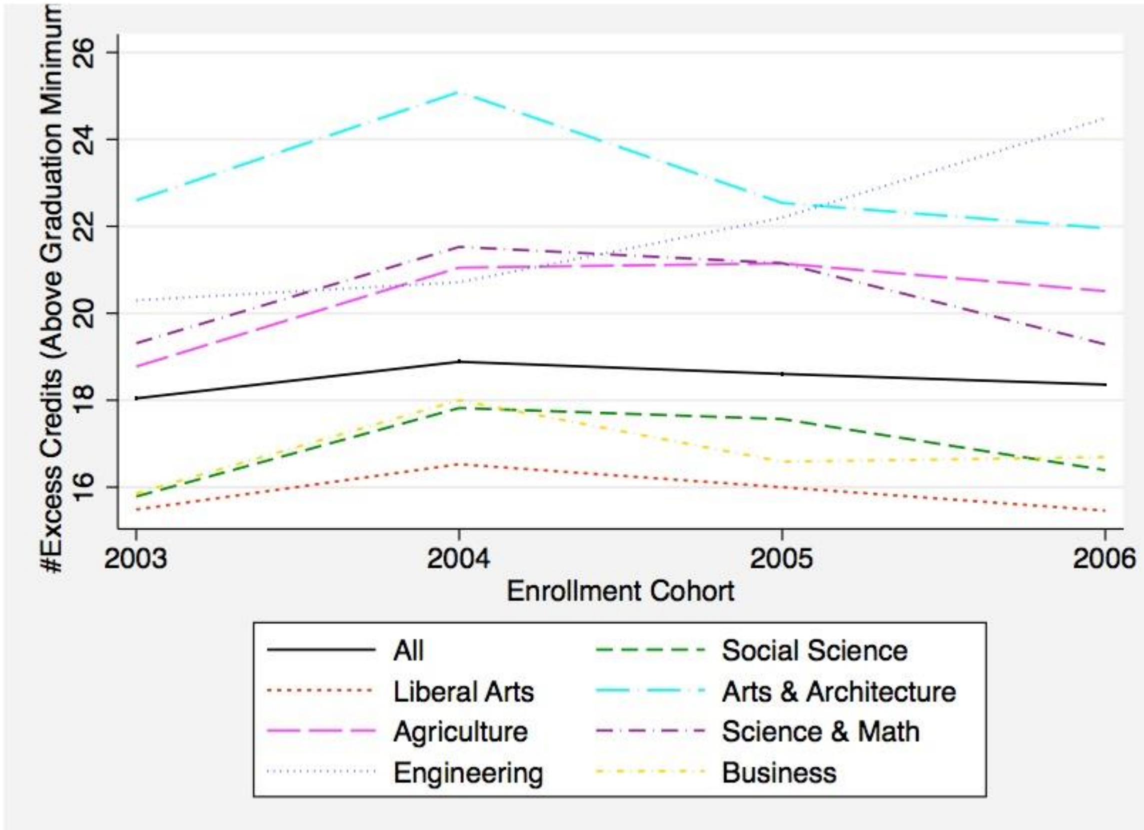
Note: Based on author's calculations using THECB administrative data.

Figure 4.3: Histogram of total excess credits attempted



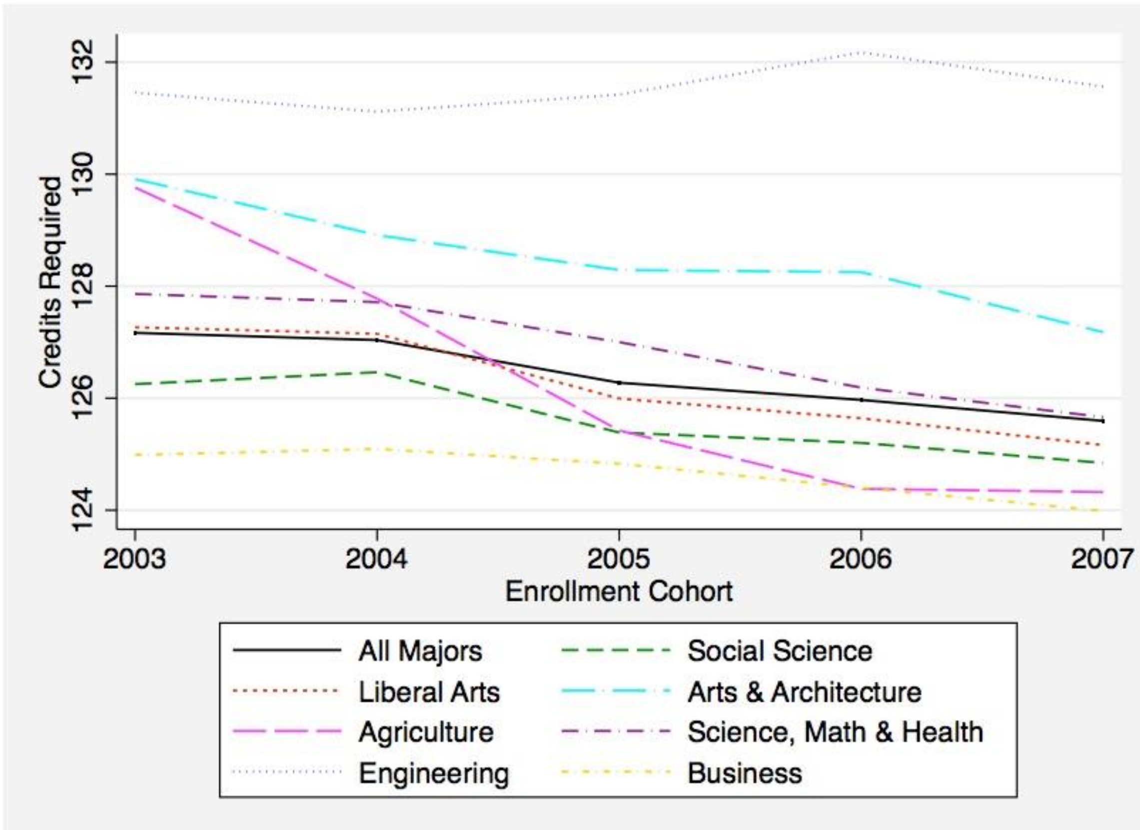
Note: Based on author's calculations using THECB administrative data.

Figure 4.4: Excess credit accumulation, by major and year of initial enrollment



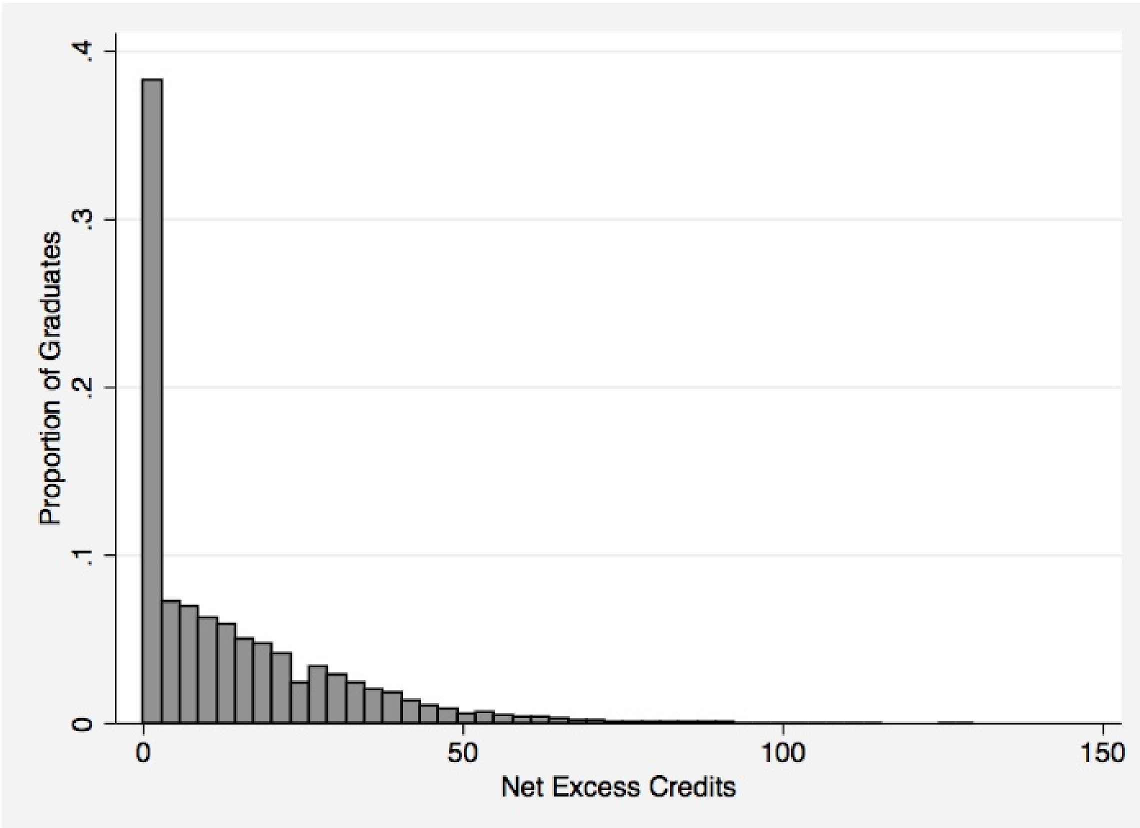
Note: Based on author's calculations using THECB administrative data.

Figure 4.5: Credits required for graduation, by major and year of initial enrollment



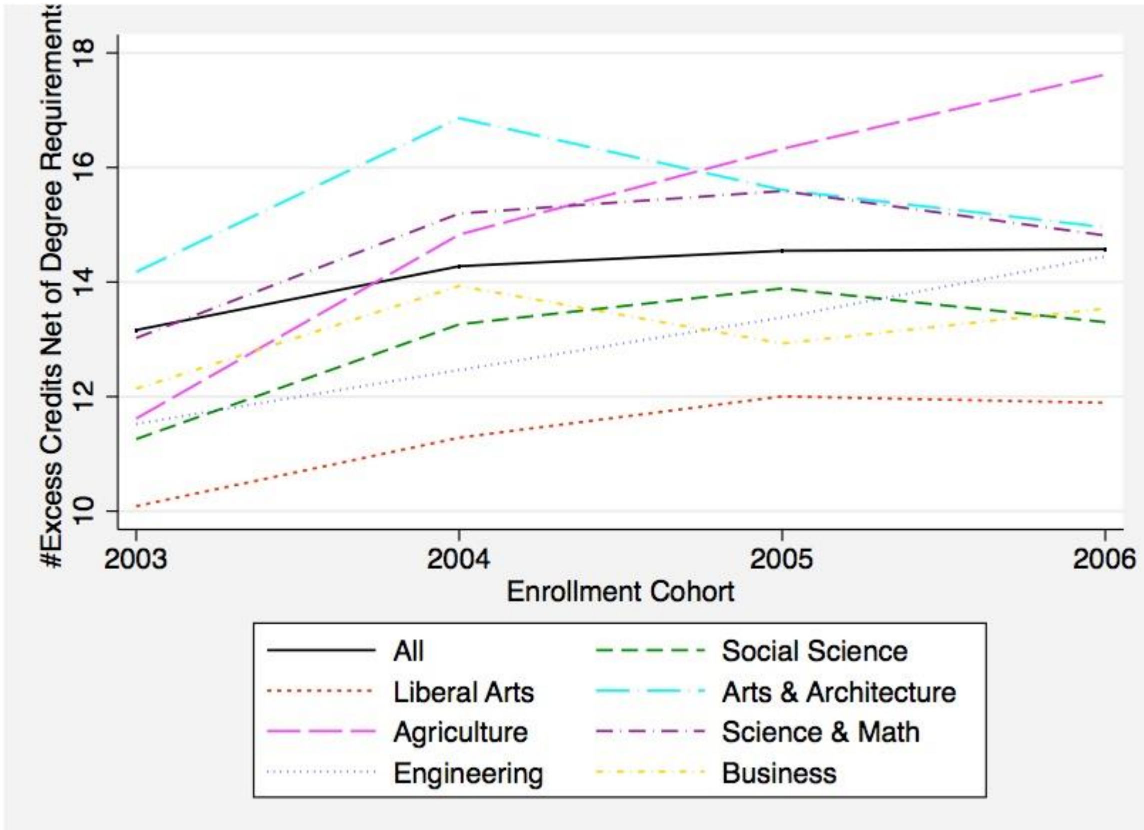
Note: Based on author’s calculations using THECB administrative data.

Figure 4.6: Histogram of net excess credits attempted



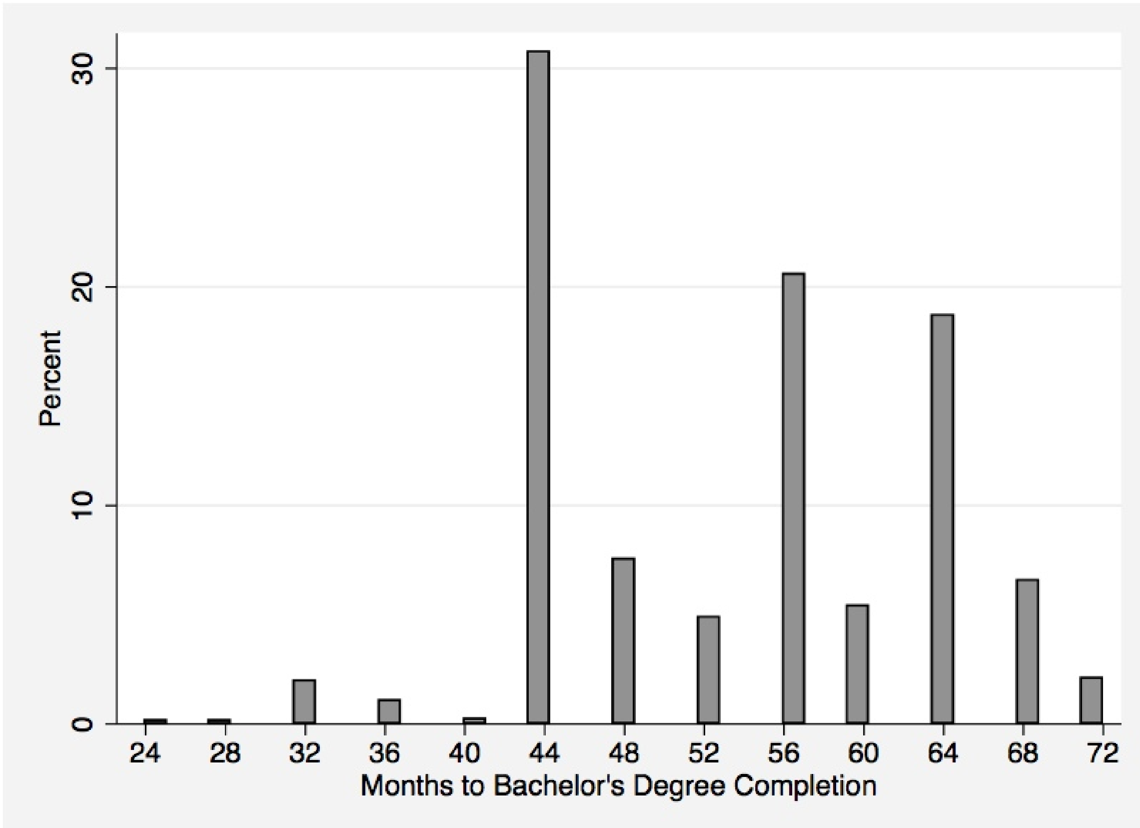
Note: Based on author's calculations using THECB administrative data.

Figure 4.7: Net excess credit accumulation of graduates, by major and year of initial enrollment



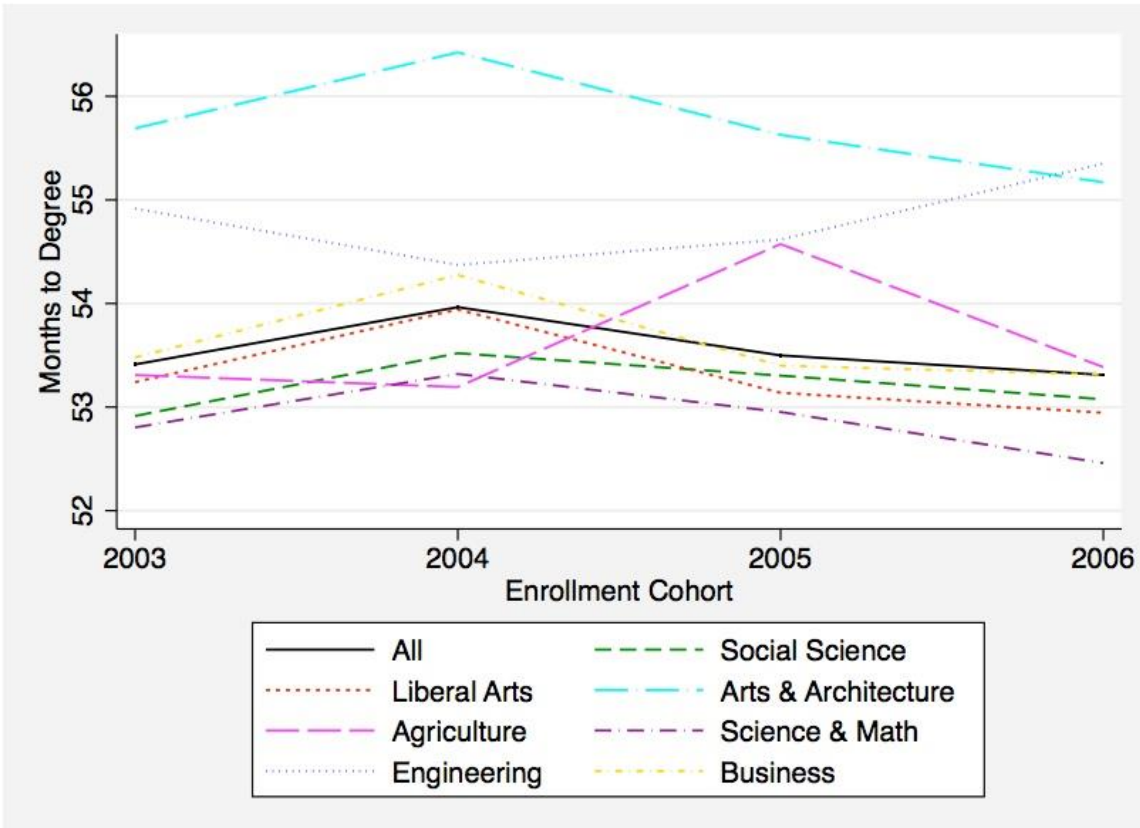
Note: Based on author's calculations using THECB administrative data.

Figure 4.8: Months to bachelor's degree completion



Note: Based on author's calculations using THECB administrative data.

Figure 4.9: Months to bachelor's degree, by major and year of initial enrollment



Note: Based on author's calculations using THECB administrative data.

Table 4.1: Mean (sd) student demographic and family background characteristics by enrollment cohort and outcome

	Full sample		Graduate Sample						
	Did Not Graduate	All Graduates	Graduated in 4 Years	Graduated in 5 Years	Graduated in 6 Years	2003	2004	2005	2006
Student Demographics									
Age of Entry	18.68	18.15	18.13	18.14	18.17	18.14	18.15	18.17	18.13
	(3.02)	(1.38)	(1.29)	(1.36)	(1.52)	(1.37)	(1.34)	(1.51)	(1.28)
Female	0.45	0.53	0.57	0.5	0.5	0.54	0.53	0.52	0.52
	(0.50)	(0.50)	(0.49)	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)
White	0.4	0.64	0.68	0.61	0.59	0.67	0.61	0.62	0.63
	(0.49)	(0.48)	(0.47)	(0.49)	(0.49)	(0.47)	(0.49)	(0.48)	(0.48)
Hispanic	0.28	0.21	0.17	0.23	0.24	0.19	0.21	0.22	0.22
	(0.45)	(0.41)	(0.37)	(0.42)	(0.43)	(0.39)	(0.41)	(0.41)	(0.42)
Black	0.3	0.10	0.07	0.11	0.13	0.08	0.11	0.11	0.11
	(0.46)	(0.30)	(0.26)	(0.31)	(0.34)	(0.27)	(0.32)	(0.31)	(0.31)
Other Race/Eth	0.14	0.12	0.1	0.12	0.14	0.07	0.08	0.12	0.22
	(0.35)	(0.32)	(0.29)	(0.32)	(0.35)	(0.26)	(0.28)	(0.32)	(0.41)
Family Background									
Father College Degree	0.22	0.45	0.52	0.41	0.38	0.45	0.44	0.45	0.45
	(0.42)	(0.50)	(0.50)	(0.49)	(0.49)	(0.50)	(0.50)	(0.50)	(0.50)
Father HS Degree/Some College	0.25	0.30	0.29	0.31	0.31	0.32	0.28	0.29	0.30
	(0.43)	(0.46)	(0.45)	(0.46)	(0.46)	(0.47)	(0.45)	(0.46)	(0.46)
Father Did Not Complete HS	0.06	0.05	0.04	0.05	0.06	0.04	0.04	0.05	0.05
	(0.23)	(0.21)	(0.19)	(0.21)	(0.23)	(0.20)	(0.20)	(0.22)	(0.22)
Mother College Degree	0.2	0.40	0.46	0.37	0.34	0.40	0.40	0.41	0.40
	(0.40)	(0.49)	(0.50)	(0.48)	(0.47)	(0.49)	(0.49)	(0.49)	(0.49)
Mother HS Degree/Some College	0.29	0.36	0.35	0.36	0.37	0.38	0.33	0.35	0.36
	(0.45)	(0.48)	(0.48)	(0.48)	(0.48)	(0.49)	(0.47)	(0.48)	(0.48)
Mother Did Not Complete HS	0.05	0.05	0.04	0.05	0.05	0.04	0.04	0.05	0.05
	(0.21)	(0.21)	(0.19)	(0.22)	(0.22)	(0.20)	(0.20)	(0.22)	(0.22)
Income Greater Than $80000	0.16	0.36	0.41	0.33	0.31	0.34	0.35	0.37	0.38
	(0.37)	(0.48)	(0.49)	(0.47)	(0.46)	(0.47)	(0.48)	(0.48)	(0.49)
Income between $40000 & $80000	0.16	0.22	0.23	0.22	0.21	0.23	0.21	0.22	0.20
	(0.36)	(0.41)	(0.42)	(0.41)	(0.41)	(0.42)	(0.41)	(0.42)	(0.40)
Income Less Than $40000	0.18	0.16	0.15	0.17	0.18	0.16	0.15	0.17	0.16
	(0.38)	(0.37)	(0.35)	(0.37)	(0.38)	(0.36)	(0.36)	(0.38)	(0.37)
Income Unknown	0.5	0.26	0.22	0.28	0.31	0.27	0.29	0.23	0.25
	(0.50)	(0.44)	(0.41)	(0.45)	(0.46)	(0.44)	(0.45)	(0.42)	(0.43)
Number of Students	16495	35689	14933	11015	9741	12054	8171	7814	7650
Proportion of Full Sample/Graduate Sample	32%	68%	29%	21%	19%	23%	23%	22%	21%

Note: Based on author's calculations using THECB administrative data.

Table 4.2: Mean (sd) academic preparation and college pathways by enrollment cohort and outcome

	Full sample		Graduate Sample						
	Did Not Graduate	All Graduates	Graduated in 4 Years	Graduated in 5 Years	Graduated in 6 Years	2003	2004	2005	2006
Academic Preparation									
SAT	972	1103	1148	1081	1057	1103.66	1097.25	1106.76	1102.12
	(177)	(172.47)	(169)	(168)	(166)	(129.03)	(191.71)	(191.67)	(189.00)
Top 10 Percent	0.13	0.32	0.41	0.28	0.22	0.34	0.31	0.29	0.31
	(0.34)	(0.46)	(0.49)	(0.45)	(0.42)	(0.47)	(0.46)	(0.45)	(0.46)
Top 11-25 Percent	0.18	0.21	0.19	0.22	0.22	0.20	0.21	0.21	0.22
	(0.38)	(0.41)	(0.39)	(0.41)	(0.42)	(0.40)	(0.41)	(0.41)	(0.41)
#Dual Credits	0.05	0.11	0.13	0.12	0.06	0.01	0.09	0.18	0.20
	(0.71)	(1.22)	(1.19)	(1.54)	(0.79)	(0.32)	(0.84)	(1.81)	(1.63)
College Pathways									
#Developmental Education Credits	3.00	0.98	0.47	1.21	1.51	0.81	1.07	1.06	1.09
	(4.57)	(2.54)	(1.61)	(2.80)	(3.17)	(2.36)	(2.68)	(2.58)	(2.62)
#Semesters Part-time	3.19	3.21	3.06	3.23	3.4	3.52	3.39	3.05	2.68
	(3.02)	(2.75)	(2.99)	(2.54)	(2.58)	(3.12)	(2.86)	(2.50)	(2.09)
Transfer	0.13	0.09	0.07	0.10	0.11	0.10	0.09	0.09	0.08
	(0.34)	(0.29)	(0.26)	(0.31)	(0.31)	(0.30)	(0.28)	(0.28)	(0.08)
Social Science	0.21	0.25	0.26	0.25	0.24	0.25	0.26	0.25	0.26
	(0.41)	(0.44)	(0.44)	(0.43)	(0.43)	(0.43)	(0.44)	(0.43)	(0.44)
Liberal Arts	0.23	0.21	0.22	0.2	0.22	0.22	0.22	0.22	0.20
	(0.42)	(0.41)	(0.41)	(0.40)	(0.41)	(0.41)	(0.41)	(0.41)	(0.40)
Arts & Architecture	0.08	0.06	0.05	0.08	0.07	0.06	0.06	0.06	0.07
	(0.27)	(0.25)	(0.21)	(0.27)	(0.26)	(0.25)	(0.24)	(0.25)	(0.25)
Agriculture	0.01	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.02
	(0.12)	(0.15)	(0.15)	(0.14)	(0.15)	(0.17)	(0.15)	(0.13)	(0.14)
Science Math & Health	0.22	0.16	0.18	0.15	0.15	0.16	0.16	0.16	0.16
	(0.41)	(0.37)	(0.38)	(0.36)	(0.36)	(0.37)	(0.37)	(0.36)	(0.37)
Engineering	0.05	0.07	0.06	0.08	0.08	0.07	0.07	0.07	0.07
	(0.22)	(0.25)	(0.23)	(0.27)	(0.27)	(0.25)	(0.25)	(0.26)	(0.26)
Business	0.19	0.21	0.21	0.22	0.21	0.21	0.21	0.22	0.21
	(0.40)	(0.41)	(0.41)	(0.41)	(0.41)	(0.41)	(0.41)	(0.42)	(0.41)
Number of Students	16495	35689	14933	11015	9741	12054	8171	7814	7650
Proportion of Full Sample/Graduate Sample	32%	68%	42%	31%	27%	23%	23%	22%	21%

Note: Based on author’s calculations using THECB administrative data.

Table 4.3: Mean (sd) credit accumulation and time to degree by enrollment cohort and outcome

	Full sample		Graduate Sample						
	Did Not Graduate	All Graduates	Graduated in 4 Years	Graduated in 5 Years	Graduated in 6 Years	2003	2004	2005	2006
Outcomes									
#Credits Earned	115	135	124	142	146	134	136	136	135
	(52.91)	(21.92)	(16.75)	(20.47)	(22.50)	(21.50)	(21.98)	(22.30)	(22.05)
#Total Excess Credits (Above Graduation Minimum)	20	18	8	24	27	17	19	18	17.77
	(23.38)	(17.13)	(9.68)	(15.91)	(19.60)	(16.98)	(17.40)	(17.12)	(17.01)
#Credits Required for Graduation	125	127	127	128	127	128	128	127	126
	(7.53)	(8.85)	(8.92)	(9.12)	(8.40)	(8.61)	(9.20)	(8.64)	(8.91)
#Net Excess Credits (Net of Requirements)	16	13	5	17	21	12	13	14	14
	(21.42)	(15.67)	(7.75)	(14.99)	(19.06)	(15.20)	(16.05)	(15.88)	(15.67)
Time to Degree (Months)	-	53.54	43.82	56.07	65.56	53.41	53.96	53.50	53.31
	-	(9.48)	(3.66)	(2.31)	(2.49)	(9.51)	(9.51)	(9.49)	(9.37)
Number of Students	16495	35689	14933	11015	9741	12054	8171	7814	7650
Proportion of Full Sample/Graduate Sample	32%	68%	42%	31%	27%	23%	23%	22%	21%

Note: Based on author’s calculations using THECB administrative data.

Table 4.4: Regression estimates (se) of time to degree with institution and major fixed effects

	Time to Degree (Months)					
	Total Excess Credits			Net Excess Credits		
	(1)	(2)	(3)	(4)	(5)	(6)
	Main Effects	Student Controls	FE + Interaction	Main Effects	Student Controls	FE + Interaction
#Excess Credits	0.300***	0.276***	0.279***	0.309***	0.278***	0.282***
	(0.00)	(0.003)	(0.004)	(0.003)	(0.003)	(0.005)
Student Demographics						
Age of Entry		-1.109***	-1.010***		-1.168***	-1.069***
		(0.192)	(0.296)		(0.194)	(0.310)
Age-Squared		0.017***	0.015***		0.018***	0.016***
		(0.003)	(0.005)		(0.003)	(0.005)
Female		-1.440***	-1.556***		-1.561***	-1.603***
		(0.086)	(0.101)		(0.088)	(0.140)
Hispanic		0.419***	0.272		0.495***	0.328*
		(0.118)	(0.183)		(0.120)	(0.180)
Black		-0.593***	-0.616**		-0.646***	-0.583*
		(0.153)	(0.254)		(0.156)	(0.289)
Other Race/Eth		0.783***	0.454		0.668***	0.449
		(0.135)	(0.471)		(0.138)	(0.404)
Family Background						
Father College Degree		-0.604***	-0.534**		-0.621***	-0.490**
		(0.212)	(0.248)		(0.215)	(0.236)
Father HS Degree/Some College		-0.245	-0.236		-0.275	-0.213
		(0.199)	(0.196)		(0.202)	(0.190)
Mother College Degree		0.127	0.100		0.084	0.127
		(0.217)	(0.312)		(0.219)	(0.292)
Mother HS Degree/Some College		0.370*	0.330		0.432**	0.405*
		(0.204)	(0.257)		(0.206)	(0.239)
Income Greater Than $80000		0.157	0.079		0.066	0.016
		(0.140)	(0.121)		(0.143)	(0.114)
Income between $40000 & $80000		0.197	0.099		0.193	0.102
		(0.138)	(0.128)		(0.141)	(0.140)
Income Unknown		0.080	-0.065		0.287*	-0.101
		(0.159)	(0.273)		(0.161)	(0.280)
Academic Preparation						
SAT100		-0.523***	-0.575***		-0.587***	-0.608***
		(0.039)	(0.074)		(0.039)	(0.079)
Top 10 Percent		-1.027***	-0.716***		-1.108***	-0.921***
		(0.110)	(0.203)		(0.113)	(0.146)
Top 11-25 Percent		-0.108	0.022		-0.117	0.014
		(0.111)	(0.139)		(0.113)	(0.139)
#Dual Credits		-0.282***	-0.260***		-0.259***	-0.240***
		(0.052)	(0.048)		(0.047)	(0.043)

(Table 4.4: continued)

College Pathway						
#Developmental Education Credits		0.054***	0.038		0.060***	0.039
		(0.018)	(0.027)		(0.019)	(0.031)
#Semesters Part-time		-0.121***	-0.101***		-0.078***	-0.070*
		(0.018)	(0.036)		(0.016)	(0.034)
Transfer		1.339***	1.062***		1.227***	1.082***
		(0.142)	(0.177)		(0.145)	(0.167)
Constant	48.155***	70.717***	68.405***	49.541***	73.227***	75.059***
	(0.07)	(2.466)	(4.113)	(0.059)	(2.506)	(4.527)
Institutional Fixed Effects			X			X
Major Fixed Effects			X			X
Major*Institution Interaction			X			X
Number of Students	35689	35689	35689	35689	35689	35689
R-Squared	0.29	0.32	0.31	0.26	0.29	0.28
Number of Institutions			34			34

Note: Based on author's calculations using THECB administrative data. Significance indicated by --*: P<0.10, --**: P<0.05, --***: P<0.01.

Table 4.5: Regression estimates (se) of excess credits, net excess credits, and time to degree on credit requirements

	Total Excess Credits			Net Excess Credits			Time to Degree		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Main Effects	Student Controls	FE + Interaction	Main Effects	Academic Controls	FE + Interaction	Main Effects	Student Controls	FE + Interaction
Credits Required for Graduation	0.200***	0.263***	0.210***	-0.361***	-0.309***	-0.331***	-0.004	0.032***	0.016
	(0.012)	(0.011)	(0.041)	(0.008)	(0.008)	(0.080)	(0.006)	(0.005)	(0.034)
Student Controls		X	X		X	X		X	X
Institutional Fixed Effects			X			X			X
Major Fixed Effects			X			X			X
Major*Institution Interaction			X			X			X
Number of Students	35689	35689	35689	35689	35689	35689	35689	35689	35689
R-Squared	0.01	0.17	0.16	0.04	0.18	0.16	0.00	0.12	0.10
Number of Institutions			34			34			34

Note: Based on author's calculations using THECB administrative data. Significance indicated by --*: P<0.10, --**: P<0.05, --***: P<0.01.

Table 4.6: Regression estimates (se) of time to degree on excess credits, net excess credits, and credit requirements on time to degree

	Time to Degree (Months)					
	Total Excess Credits			Net Excess Credits		
	(1)	(2)	(3)	(4)	(5)	(6)
	Main Effects	Student Controls	FE + Interaction	Main Effects	Student Controls	FE + Interaction
#Excess Credits	0.304***	0.279***	0.281***	0.322***	0.292***	0.293***
	(0.002)	(0.003)	(0.004)	(0.003)	(0.003)	(0.005)
#Credits Required for Graduation	-0.065***	-0.041***	-0.043*	0.112***	0.123***	0.113***
	(0.005)	(0.005)	(0.023)	(0.005)	(0.005)	(0.012)
Student Controls		X	X		X	X
Institutional Fixed Effects			X			X
Major Fixed Effects			X			X
Major*Institution Interaction			X			X
Number of Students	35689	35689	35689	35689	35689	35689
R-Squared	0.30	0.33	0.31	0.27	0.30	0.29
Number of Institutions			34			34

Note: Based on author's calculations using THECB administrative data. Significance indicated by --*: P<0.10, --**: P<0.05, --***: P<0.01.

Table 4.7: Heterogeneous effects of credit requirements of net excess credit by major

	Panel A: Net Excess Credits Disaggregated by Major						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Social Science	Liberal Arts	Arts& Architecture	Agriculture	Science & Math	Engineering	Business
#Credits Required for Graduation	-0.369***	-0.319***	-0.280***	-0.554***	-0.318***	-0.223*	-0.365***
	(0.073)	(0.093)	(0.032)	(0.161)	(0.094)	(0.113)	(0.084)
Student Controls	X	X	X	X	X	X	X
Institution & Major Fixed Effects	X	X	X	X	X	X	X
Major*Institution Interaction	X	X	X	X	X	X	X
Number of Students	9085	7632	2297	802	5754	2457	7662
R-Squared	0.22	0.23	0.18	0.21	0.19	0.22	0.17
Within Institution Variation	0.17	0.17	0.14	0.18	0.13	0.16	0.14
Between Institution Variation	0.64	0.01	0.67	0.13	0.46	0.44	0.32
Number of Institutions	34	34	29	15	31	20	33
	Panel B: Interactions of Credits Required for Graduation with Major						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
All Other Majors							
#Credits Required for Graduation	-0.342***	-0.358***	-0.364***	-0.349***	-0.338***	-0.362***	-0.348***
	(0.062)	(0.054)	(0.068)	(0.062)	(0.061)	(0.060)	(0.061)
Interacted Major	Social Science	Liberal Arts	Arts& Architecture	Agriculture	Science & Math	Engineering	Business
Interaction with #Credits Required for Graduation	-.032**	0.027	0.090	-0.177	-0.063**	0.143**	-0.018
	(0.020)	(0.037)	(0.063)	(0.154)	(0.026)	(0.061)	(0.025)

Note: Based on author's calculations using THECB administrative data. Significance indicated by --*: P<0.10, --**: P<0.05, --***: P<0.01.

Table 4.8: Heterogeneous effects of credit requirements of net excess credit by student characteristics

	Panel A: Net Excess Credits Dissaggregated by Race, Income, and High School Preparation Outcomes								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	White/ Other	Black	Hispanic	Low Income	High Income	Bottom 90%	Top 10%	Low SAT	High SAT
#Credits Required for Graduation	-0.297***	-0.562***	-0.413***	-0.404***	-0.236***	-0.400***	-0.231***	-0.525***	-0.247***
	(0.085)	(0.083)	(0.045)	(0.063)	(0.080)	(0.066)	(0.077)	(0.046)	(0.077)
Number of Students	26431	3607	7380	8712	12745	24407	11282	14543	21146
R-Squared	0.03	0.07	0.01	0.03	0.02	0.01	0.10	0.04	0.04
Within Institution Variation	0.15	0.21	0.24	0.15	0.13	0.17	0.15	0.22	0.11
Between Institution Variation	0.05	0.14	0.01	0.04	0.02	0.04	0.01	0.01	0.04

	Panel B: Interactions of Credits Required with Race, Income, and High School Preparation Outcomes				
	(1)	(2)	(3)	(4)	(5)
Reference Category	White/ Other	White/ Other	Low Income	Bottom 90%	Low SAT
#Credits Required for Graduation	-0.328***	-0.322***	-0.358***	-0.383***	-0.438***
	(0.069)	(0.074)	(0.053)	(0.05)	(0.03)
Interaction Variable	Black	Hispanic	High Income	Top 10%	High SAT
Interaction with #Credits Required for Graduation	-0.201***	-0.045	0.086**	0.090**	.140**
	(0.041)	(0.055)	(0.035)	(0.034)	(0.055)

Note: Based on author's calculations using THECB administrative data. Significance indicated by --*: P<0.10, --**: P<0.05, --***: P<0.01.

Chapter 5: Conclusion

Introduction

This dissertation has examined supply- and demand-side factors associated with time to bachelor's degree completion. Three quantitative studies provide nuanced evidence about the student and institutional factors influencing time to degree and the roles of transfer and excess credit accumulation in determining the pace of student completion. These studies take place in Texas between 2003 and 2012, a time and place with ample evidence of extension behavior, high levels of excess credits, and a high degree of nontraditional enrollment. During this period, Texas students had the highest average credit accumulation at graduation among a 33-state sample. In addition, Texas had the largest proportion in any state of bachelor's degree students completing some coursework at a community college during their postsecondary education. From a pragmatic policy perspective, Texas is an ideal case for studying higher education efficiency. From a research perspective, the unique features of the Texas higher education context limit the generalizability of results; however, I argue that these studies offer useful lessons that are relevant to other states as well.

Summary of Findings and Contributions

Findings in Chapter 2 indicate time to degree is a complex phenomenon that cannot be attributed to students alone. Institutional factors significantly contribute to timely completion. On-time graduates come to college with the advantages of income, race, parents' education, and better academic preparation. Disadvantaged populations are less likely to graduate on time but not less likely to graduate later. The presence of heterogeneous effects of various supply- and demand-side factors suggests policy strategies should be sector-specific and sensitive to unintended consequences for particular student subpopulations. For example, some strategies used by low-income students may slow completion but enable persistence: simultaneous enrollment, starting at a two-year college, and part-time enrollment.

This study makes three substantive contributions to the literature on time to degree. It adds to the very small number of studies focusing on supply-side issues of time to degree. It improves on previous studies by analyzing a large sample of colleges and universities and incorporating more detailed information about institutional expenditures, faculty resources, and information about the student population institutions serve. To the best of my knowledge, this is the first study of time to degree to examine the interaction of student background characteristics and college pathways with institutional expenditures.

In Chapter 3, the study finds that transfer extends time to degree by approximately one term and is associated with excess credit accumulation. By the time of graduation, students who transfer from a community college attempt seven extra credits compared to native students who are similar based on their observable characteristics. Students transferring between four-year universities attempt nine extra credits than matched native students. Findings support the credit loss hypothesis, which argues that students must retake or replace coursework when transfer credits are not accepted by receiving transfer institutions, thus extending time to degree. The larger credit penalty for lateral four-year transfers undermines student and institutional quality hypotheses, which would suggest larger penalties for community college transfers. Disaggregated models suggest transfer students attending more selective institutions tend to have shorter times to degree than transfer students attending less selective institutions. Transfer students with higher levels of academic preparation tend to complete degrees more slowly than transfer students with lower levels of prior academic preparation.

Findings from Chapter 3 contribute to the transfer literature by extending the research about transfer penalties to include the outcome of time to degree. Results support the credit loss hypothesis, which practitioners often assert but the academic literature has only very recently documented (Monaghan & Attewell, 2014). Most importantly, it compares two types of transfer. Previous studies focus almost exclusively on community college transfer, while this study attends to the experiences of four-year lateral transfer students as well. The study suggests that the lateral transfer students share some common challenges with community college transfers, while other challenges are unique and less well understood.

In Chapter 4, I find that time to degree is influenced by the number of excess credits students consume. The fewer courses students take, the more likely they are to finish on time. Limitations on the number of credits an institution requires for graduation reduces the number of required courses students take, but increases the number of elective courses students take. The tradeoff produces a small positive effect of credit requirements on time to degree. Major is an important moderator of this relationship in terms of whether credit requirements change and the direction and magnitude of course tradeoffs. Engineers and students with high levels of prior academic preparation are most likely to take advantage of the efficiency gains when credit requirements change by reducing overall course-taking in response to credit requirement reductions. Social science and science/math majors and Black students are most likely to trade required course-taking for elective course-taking.

This study explores a relatively new area in the academic literature, as credit consumption has more often been the focus of higher education business and financial analysis than academic literature connected to student persistence and completion. The study makes three primary contributions. First, it documents the mechanism and the magnitude of the relationships between time to degree, excess credits, and credit requirements. Second, it debunks the most commonly used measure of excess credits used by policymakers and state higher education agencies and points out that many institutions and majors require more than the minimum number of credits for graduation. Finally, it offers several explanations for why policies that limit credit requirements may not decrease time to degree as expected.

CROSS-STUDY CONCLUSIONS

Looking across the three studies, a number of conclusions emerge. First, there are a myriad of reasons for extensions in time to degree. Studying the dimension of time presents opportunities to develop a more nuanced understanding of the complexity of student persistence and completion. I conclude that time is better characterized as a buffer than as an enemy. Students trade timely completion for persistence. They avoid dropout by extending their studies. The concept of tradeoff is not unique to completion events. In Chapter 3, I find that community college transfer students trade timely completion for cheaper education or close proximity to home. Lateral four-year transfers appear to trade timely completion to improve institutional fit or maximize returns to education. In Chapter 4, students substitute required courses for electives. These tradeoffs suggest time to degree is just one indicator of higher education success that should be examined in conjunction with other measures of completion: cost, consumption, and equity.

A second cross-study conclusion is that institutions significantly influence the calculus of time to degree completion. Institutional decisions regarding expenditures, staffing, and admission matter, as do decisions about transfer credits and graduation requirements. Some of these areas are amendable to policy action at the state level, while others could be addressed through institutional policy and practice decisions.

Finally, factors associated with timely completion have heterogeneous effects on students based on their individual characteristics and enrollment choices and the characteristics of the institutions they attend. In Chapter 2, some institutional inputs benefit Blacks, while others benefit Whites or Hispanics. Unlike high-income students, low-income students use some strategies that slow timely completion but aid persistence. Low-income students also attempt more elective courses than high-income students in response to changes in credit requirements. High-ability students generally take less time to complete a bachelor's degree and are most likely to take advantage of the efficiency gains associated with credit requirement reductions. Nontraditional enrollment, including part-time attendance and transfer, tend to be slower pathways for high-ability students and students who attend less selective institutions. Students taking nontraditional enrollment pathways tend to be most positively associated with student support services expenditures. The lack of consistency in the direction of associations between individual and institutional factors is problematic for policymaking, although most heterogeneous effects are primarily a question of magnitude, rather than opposing effects.

Implications for Policy and Research

The studies in this dissertation provide evidence about how policy might improve time to degree. Previous supply-side studies suggest increases in public appropriations for higher education decrease time to degree system-wide (Bound, Lovenheim, & Turner, 2012; Bound & Turner, 2007). Findings in this dissertation suggest increases in particular expenditure categories related to faculty and advising quality and quantity have the largest effects on time to degree. Institutional investment in full-time faculty has the most significant and consistently positive association with on-time graduation of the institutional inputs analyzed here. Increasing instructional expenditures are particularly positive for students at four-year research institutions, and student support expenditures are particularly positive for students who begin at two-year institutions and then transfer.

All three studies provide evidence that students shop for courses and institutions. This implies that efforts to reduce transfer burdens and broaden policies that do not currently support multicampus consumption (e.g., financial aid administrative rules for full-time enrollment) are promising. I find evidence that continuous enrollment, often through part-time summer enrollment and at a different institution (perhaps closer to home), is a strategy that decreases time to degree. Administrative systems are not well designed for these less formal transfers and the easy preservation of credit across institutions. Addressing credit loss through state policy or institutional efforts to ensure student credits are applied and accepted by majors should help moderate transfer penalties. Credit requirement reductions can be useful policy strategies to increase the efficiency of student progress through higher education, although not without complementary efforts from institutions and external governance entities such as accrediting agencies. Within institutions, additional advising or student incentives may be necessary complements, as evidenced by the fact that students with lower levels of human and social capital are most likely to trade rather than reduce excess credits.

The studies also suggest that a number of policy strategies would likely have negative consequences for equity. The easiest way to decrease time to degree is to serve the most advantaged students and restrict access to higher education. Time to degree would decrease and graduation rates would increase, but income and race achievement gaps would expand as a result. If both equity and efficiency are policy goals, we should exercise caution in the importance placed on time to degree as a singular accountability measure. The more important a single measure is the more likely we are to see corruption—in this case, a restriction on access to higher education (Campbell, 1976). We should also avoid strategies that penalize extenders by charging extra tuition or inadvertently encourage excess course-taking (e.g., raising the number of credits required for full-time enrollment). Policymakers are actively considering raising full-time enrollment classification to 15 hours, which is particularly important for low-income students reliant on federal financial aid. If students do not have a clear major or course availability is limited, a 15-hour requirement for full-time status may encourage students to take additional courses and strain student capacity to handle the additional coursework without accelerating progress toward degree completion. Stand-alone strategies, as described previously, are likely to be ineffective in reducing time to degree without complementary action at many levels of the higher educational system

(Cullinane, 2013). Finally, in terms of policy design, weak accountability or voluntary adoption of policy reduces the potential impact of efficiency maximizing efforts.

As many questions as this dissertation answers, many more issues have emerged for future inquiry. The literature on institutional expenditures is very nascent, but it is becoming clear that outcomes are a function of the quantity of resources as well as how resources are strategically used. The four categories of institutional spending available in the Integrated Postsecondary Education Data System are very broad, and it is difficult to assess which activities or priorities within categories contribute to improving student outcomes. Institutional spending within categories requires more attention. For example, how are instructional expenditures net of faculty salaries used? Is it faculty quantity or quality that matters? How are part-time faculty used in different settings that explain the heterogeneous effects on time to degree? For transfer, more detailed transcript-level data about the courses students are actually taking, the courses that are transferring, and the courses that are not transferring will be important in informing policy design. In particular, much more needs to be known about four-year lateral transfer. Why do students transfer laterally? What roles do changing major and academic failure play in transfer? Are there benefits for students in matching their academic ability with the quality of the institution? Transcript-level information could also inform questions related to course consumption and course-taking tradeoffs. Finally, there are a host of questions related to nontraditional enrollment pathways (e.g., part-time, simultaneous, continuous summer enrollment) as strategies used by low-income and less prepared students that affect completion and pace. In these areas, we do not yet know enough to make informed policy decisions.

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Appendix A

Table A.1: Ordinary least squares estimation results for various outcomes: graduation, total nonremedial credits attempted, total nonremedial credits attempted at graduation, and time to degree

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Graduation (logit marginal effects)			Total credit hours			Credit hours at graduation			Time to degree		
	All Students	Native & Vertical Transfer	Native & Lateral Transfer	All Students	Native & Vertical Transfer	Native & Lateral Transfer	All Students	Native & Vertical Transfer	Native & Lateral Transfer	All Students	Native & Vertical Transfer	Native & Lateral Transfer
Transfer												
Transfer	-0.18***	-0.15***	-0.22***	5.17***	4.98***	5.53***	7.32***	6.20***	8.67***	0.87***	0.89***	0.82***
	(0.01)	(0.01)	(0.01)	(0.41)	(0.51)	(0.57)	(0.37)	(0.47)	(0.53)	(0.04)	(0.06)	(0.06)
Student demographics												
Age of Entry	0.2	0.25	0.19	37.49	39.08	57.14**	-33.90*	-37.49*	-43.76**	1.01	0.91	1.34
	(0.35)	(0.36)	(0.39)	(22.87)	(23.94)	(27.64)	(19.53)	(20.19)	(22.10)	(2.22)	(2.32)	(2.53)
Age^2	-0.01	-0.01	-0.01	-1.07*	-1.12*	-1.60**	0.89*	0.99*	1.16*	-0.03	-0.02	-0.03
	(0.01)	(0.01)	(0.01)	(0.63)	(0.66)	(0.76)	(0.54)	(0.55)	(0.61)	(0.06)	(0.06)	(0.07)
Female	-2.98	-2.81	-7.46*	132.55	111.84	252.09	-270.12	-243.46	-298.07	-8.82	-3.7	-12.52
	(3.87)	(4.01)	(4.54)	(262.42)	(272.55)	(322.97)	(223.86)	(227.53)	(260.14)	(26.34)	(27.04)	(30.06)
Hispanic	-0.17***	-0.18***	-0.19***	-3.37	-5.13	-2.64	7.86*	5.91	13.12***	0.04	0.14	0.32
	(0.06)	(0.07)	(0.07)	(3.65)	(4.03)	(4.16)	(4.32)	(4.70)	(3.76)	(0.40)	(0.45)	(0.41)
Black	-0.22***	-0.22***	-0.23***	2.42	0.98	3.37	13.40***	11.28**	18.18***	0.23	0.32	0.54
	(0.06)	(0.07)	(0.07)	(3.62)	(4.01)	(4.13)	(4.30)	(4.69)	(3.74)	(0.39)	(0.45)	(0.41)
Other Race/Ethnicity	-0.17***	-0.17***	-0.16***	8.96***	9.54***	9.93***	6.63***	6.82***	6.59***	0.89***	0.94***	0.90***
	(0.01)	(0.01)	(0.01)	(0.52)	(0.55)	(0.59)	(0.49)	(0.52)	(0.54)	(0.06)	(0.06)	(0.06)
Father's educational attainment												
College Degree	0.08***	0.08***	0.08***	1.55**	1.21	1.13	-1.19**	-1.35**	-1.54**	-0.1	-0.12	-0.12
	(0.01)	(0.01)	(0.01)	(0.78)	(0.83)	(0.85)	(0.61)	(0.63)	(0.63)	(0.08)	(0.08)	(0.08)
High School Degree/Some College	0.05***	0.05***	0.05***	0.47	-0.03	0.39	-1.21**	-1.25**	-1.32**	-0.04	-0.04	-0.06
	(0.01)	(0.01)	(0.01)	(0.71)	(0.75)	(0.77)	(0.55)	(0.56)	(0.56)	(0.07)	(0.07)	(0.07)
Mother's educational attainment												
College Degree	0.01	0.02	0.02	2.50***	3.17***	2.63***	0.32	0.43	0.25	-0.1	-0.1	-0.12
	(0.01)	(0.02)	(0.02)	(0.80)	(0.85)	(0.87)	(0.63)	(0.65)	(0.65)	(0.08)	(0.08)	(0.09)
High School Degree/Some College	-0.01	-0.01	-0.01	0.85	1.56**	0.53	0.2	0.32	0.19	-0.01	0	-0.02
	(0.01)	(0.01)	(0.01)	(0.74)	(0.77)	(0.80)	(0.57)	(0.59)	(0.59)	(0.07)	(0.08)	(0.08)
Family income												
Income Greater Than $80000	0.02**	0.02	0.02**	0.59	0.45	0.68	-0.28	-0.19	0.04	-0.02	-0.05	-0.04
	(0.01)	(0.01)	(0.01)	(0.64)	(0.66)	(0.69)	(0.48)	(0.49)	(0.50)	(0.06)	(0.06)	(0.06)

(Table A.1: continued)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Graduation (logit marginal effects)			Total credit hours			Credit hours at graduation			Time to degree		
	All Students	Native & Vertical Transfer	Native & Lateral Transfer	All Students	Native & Vertical Transfer	Native & Lateral Transfer	All Students	Native & Vertical Transfer	Native & Lateral Transfer	All Students	Native & Vertical Transfer	Native & Lateral Transfer
Income between $40000 & $80000	0.06***	0.05***	0.06***	2.57***	1.77***	2.52***	-0.02	-0.1	0.14	-0.01	-0.02	0.02
	(0.01)	(0.01)	(0.01)	(0.55)	(0.59)	(0.60)	(0.43)	(0.45)	(0.45)	(0.06)	(0.06)	(0.06)
Income Unknown	0.03***	0.02**	0.03***	-0.15	-0.49	0.11	-0.87**	-0.90**	-0.68	-0.12**	-0.14**	-0.10*
	(0.01)	(0.01)	(0.01)	(0.53)	(0.57)	(0.57)	(0.42)	(0.44)	(0.44)	(0.05)	(0.06)	(0.06)
Prior academic preparation												
SAT100	0.05***	0.04**	0.07***	5.42***	5.29***	7.01***	2.31***	1.87**	2.26**	0.29***	0.29***	0.30***
	(0.02)	(0.02)	(0.02)	(0.94)	(1.00)	(1.15)	(0.80)	(0.83)	(0.90)	(0.10)	(0.10)	(0.11)
SAT^2	-0.00***	-0.00**	-0.00***	-0.30***	-0.30***	-0.38***	-0.16***	-0.14***	-0.16***	-0.02***	-0.02***	-0.02***
	0.00	0.00	0.00	(0.05)	(0.05)	(0.05)	(0.04)	(0.04)	(0.04)	0.00	(0.01)	(0.01)
Graduated in top 10%	0.17***	0.17***	0.17***	0.54	0.28	0.59	-4.47***	-4.65***	-4.82***	-0.67***	-0.67***	-0.71***
	(0.01)	(0.01)	(0.01)	(0.46)	(0.47)	(0.49)	(0.36)	(0.37)	(0.37)	(0.05)	(0.05)	(0.05)
Graduate in 11-25%	0.09***	0.09***	0.09***	1.02**	1.21***	1.10***	-2.05***	-2.09***	-2.13***	-0.21***	-0.21***	-0.22***
	(0.01)	(0.01)	(0.01)	(0.40)	(0.42)	(0.42)	(0.30)	(0.32)	(0.32)	(0.04)	(0.04)	(0.04)
Not college ready (remediation)	-0.10***	-0.10***	-0.10***	0.34	0.27	0.23	4.15***	4.03***	4.18***	0.49***	0.51***	0.50***
	(0.01)	(0.01)	(0.01)	(0.41)	(0.43)	(0.46)	(0.32)	(0.33)	(0.34)	(0.04)	(0.04)	(0.04)
#Dual credit hours	0.06***	0.07***	0.06***	3.08***	2.92***	3.14***	2.24***	2.10***	2.49***	-0.44***	-0.45***	-0.45***
	(0.01)	(0.01)	(0.01)	(0.41)	(0.43)	(0.43)	(0.32)	(0.33)	(0.33)	(0.04)	(0.04)	(0.04)
Pre-college preferences												
Interested in STEM	-0.04***	-0.03***	-0.03***	4.00***	3.90***	4.17***	5.25***	4.98***	5.29***	0.02	0.01	0.01
	(0.01)	(0.01)	(0.01)	(0.52)	(0.55)	(0.55)	(0.41)	(0.42)	(0.42)	(0.05)	(0.05)	(0.05)
Interested in Agriculture/Health	0	0	0	4.39***	4.65***	4.81***	4.17***	4.24***	4.50***	-0.07	-0.06	-0.06
	(0.01)	(0.01)	(0.01)	(0.58)	(0.61)	(0.63)	(0.43)	(0.45)	(0.46)	(0.06)	(0.06)	(0.06)
Interested in Social Science/Busines	0.05***	0.06***	0.06***	-1.43***	-1.10***	-1.32***	-2.57***	-2.59***	-2.67***	-0.48***	-0.48***	-0.51***
	(0.01)	(0.01)	(0.01)	(0.40)	(0.42)	(0.43)	(0.30)	(0.31)	(0.32)	(0.04)	(0.04)	(0.04)
Part-time Proclivity	-0.07**	-0.09***	-0.11**	-2.56*	-1.99	-2.9	-0.9	-0.06	1.69	0.97***	0.96***	1.08***
	(0.03)	(0.03)	(0.05)	(1.36)	(1.42)	(2.68)	(1.25)	(1.29)	(2.18)	(0.15)	(0.16)	(0.25)
Need for work - Unknown	0	0.01	-0.01	-2.33	-3.04*	-2.19	1.06	0.48	-1.29	-0.52***	-0.51***	-0.70**
	(0.03)	(0.03)	(0.05)	(1.78)	(1.82)	(3.16)	(1.62)	(1.63)	(2.56)	(0.19)	(0.19)	(0.30)
Need for work - Low	-0.07*	-0.07*	0	0.25	-0.14	-0.58	0.59	0.72	-0.95	-0.24	-0.24	-0.53
	(0.04)	(0.04)	(0.06)	(1.85)	(1.91)	(3.69)	(1.73)	(1.77)	(3.10)	(0.21)	(0.22)	(0.36)
Need for work - High	0.01	0.01	0.10**	-3.31	-4.50**	3.77	0.13	-0.45	0.29	-0.78***	-0.77***	-0.95***
	(0.04)	(0.04)	(0.05)	(2.02)	(2.09)	(3.59)	(1.87)	(1.88)	(2.85)	(0.22)	(0.22)	(0.34)

(Table A.1: continued)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Graduation (logit marginal effects)			Total credit hours			Credit hours at graduation			Time to degree		
	All Students	Native & Vertical Transfer	Native & Lateral Transfer	All Students	Native & Vertical Transfer	Native & Lateral Transfer	All Students	Native & Vertical Transfer	Native & Lateral Transfer	All Students	Native & Vertical Transfer	Native & Lateral Transfer
Interactions												
Minority*SAT	0.02	0.02	0.02	0.32	0.83	0.42	-0.41	-0.03	-1.2	0.1	0.1	0.04
	(0.01)	(0.01)	(0.01)	(0.79)	(0.87)	(0.89)	(0.90)	(0.98)	(0.80)	(0.08)	(0.10)	(0.09)
Minority*SAT^2	0	0	0	0	-0.04	-0.02	-0.02	-0.04	0.01	-0.01*	-0.01*	-0.01
	0.00	0.00	0.00	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.04)	0.00	(0.01)	0.00
Female*starting age	0.51	0.52	1.02*	-14.09	-12.06	-27.35	28.91	25.7	31.84	0.97	0.37	1.36
	(0.47)	(0.48)	(0.52)	(29.00)	(30.10)	(35.64)	(24.75)	(25.12)	(28.74)	(2.91)	(2.99)	(3.31)
Minority*female	-0.01	-0.02	-0.01	1.15*	0.95	1.55**	-1.54***	-1.69***	-1.45**	0.05	-0.01	0.06
	(0.01)	(0.01)	(0.01)	(0.69)	(0.73)	(0.76)	(0.56)	(0.57)	(0.59)	(0.07)	(0.07)	(0.07)
Female*starting age^2	-0.01	-0.02	-0.03*	0.37	0.33	0.74	-0.78	-0.68	-0.86	-0.03	-0.01	-0.04
	(0.01)	(0.01)	(0.01)	(0.80)	(0.83)	(0.98)	(0.68)	(0.69)	(0.79)	(0.08)	(0.08)	(0.09)
Started in 2006	0.04***	0.04***	0.03***	-0.96***	-1.10***	-0.96***	-0.75***	-0.84***	-0.62**	-0.17***	-0.18***	-0.15***
	(0.01)	(0.01)	(0.01)	(0.33)	(0.35)	(0.36)	(0.26)	(0.26)	(0.27)	(0.03)	(0.03)	(0.04)
Number of students	29613	26664	25189	29613	26664	25189	17820	16482	15947	17820	16482	15947
R-squared	0.10	0.10	0.10	0.03	0.03	0.04	0.15	0.14	0.15	0.14	0.14	0.12

Note: Based on author's calculations using THECB administrative data. Significance indicated by --*: P<0.10, --**: P<0.05, --***: P<0.01.

Table A.2: Mean propensity scores for transfer students (treated) and native students at nonselective four-year institutions (control) by strata and transfer type — graduation

Graduation - All Native, Vertical and Lateral Transfer

	Mean Propensity Score		Number of Observations		t Value
Strata	Transfer	Native	Transfer	Native	
1	0.0705	0.0664	190	2,772	-5.05
2	0.1052	0.1041	346	2,615	-5.98
3	0.1333	0.1335	390	2,570	-7.67
4	0.1633	0.1623	477	2,485	-6.65
5	0.1933	0.1927	569	2,394	-7.49
6	0.2269	0.2261	643	2,314	-6.66
7	0.2661	0.2659	804	2,158	-7.73
8	0.3194	0.3181	927	2,029	-9.27
9	0.3987	0.3958	1,173	1,784	-7.48
10	0.6541	0.5699	1,854	1,107	-7.15

Graduation - All Native and Vertical Transfer

	Mean Propensity Score		Number of Observations		t Value
Strata	Transfer	Native	Transfer	Native	
1	0.0232	0.0196	39	2,627	-1.69
2	0.0369	0.0364	81	2,584	-2.33
3	0.0521	0.0527	146	2,515	-3.87
4	0.0727	0.0712	183	2,483	-5.24
5	0.0931	0.0929	244	2,422	-3.96
6	0.1208	0.1204	315	2,350	-4.89
7	0.1604	0.1587	453	2,219	-2.92
8	0.2142	0.2116	594	2,067	-7.48
9	0.3011	0.2953	772	1,894	-6.63
10	0.6470	0.5243	1,597	1,069	-6.55

Graduation - All Native and Lateral Transfer

	Mean Propensity Score		Number of Observations		t Value
Strata	Transfer	Native	Transfer	Native	
1	0.0337	.0326974	82	2,394	-3.41
2	0.0485	.0485185	119	2,395	-3.42
3	0.0648	.0635072	166	2,333	-5.50
4	0.0823	.0828667	197	2,321	-4.99
5	0.1019	.1016046	260	2,251	-6.63
6	0.1193	.1190561	296	2,221	-7.50
7	0.1375	.1372698	356	2,162	-7.25
8	0.1573	.1569914	391	2,128	-6.49
9	0.1834	.1831664	468	2,041	-8.36
10	0.2509	.2429413	614	1,904	-8.52

Note: Based on author's calculations using THECB administrative data.

Table A.3: Mean propensity scores for transfer students (treated) and native students at nonselective four-year institutions (control) by strata and transfer type—total credit hours

Total Credit Hours - All Native, Vertical and Lateral Transfer

	Mean Propensity Score		Number of Observations		t Value
Strata	Transfer	Native	Transfer	Native	
1	0.0705	0.0664	190	2,772	3.46
2	0.1052	0.1041	346	2,615	3.10
3	0.1333	0.1335	390	2,570	2.00
4	0.1633	0.1623	477	2,485	2.74
5	0.1933	0.1927	569	2,394	5.02
6	0.2269	0.2261	643	2,314	3.78
7	0.2661	0.2659	804	2,158	3.44
8	0.3194	0.3181	927	2,029	4.98
9	0.3987	0.3958	1,173	1,784	6.23
10	0.6541	0.5699	1,854	1,107	3.21

Total Credit Hours - All Native and Vertical Transfer

	Mean Propensity Score		Number of Observations		t Value
Strata	Transfer	Native	Transfer	Native	
1	0.0232	0.0196	39	2,627	1.84
2	0.0369	0.0364	81	2,584	2.70
3	0.0521	0.0527	146	2,515	0.02
4	0.0727	0.0712	183	2,483	0.97
5	0.0931	0.0929	244	2,422	5.27
6	0.1208	0.1204	315	2,350	3.51
7	0.1604	0.1587	453	2,219	2.25
8	0.2142	0.2116	594	2,067	3.06
9	0.3011	0.2953	772	1,894	5.74
10	0.6470	0.5243	1,597	1,069	3.42

Total Credit Hours - All Native and Lateral Transfer

	Mean Propensity Score		Number of Observations		t Value
Strata	Transfer	Native	Transfer	Native	
1	0.0337	0.0327	82	2,394	2.96
2	0.0485	0.0485	119	2,395	3.47
3	0.0648	0.0635	166	2,333	1.64
4	0.0823	0.0829	197	2,321	1.51
5	0.1019	0.1016	260	2,251	0.54
6	0.1193	0.1191	296	2,221	3.66
7	0.1375	0.1373	356	2,162	4.60
8	0.1573	0.1570	391	2,128	4.43
9	0.1834	0.1832	468	2,041	3.87
10	0.2509	0.2429	614	1,904	3.68

Note: Based on author's calculations using THECB administrative data.

Table A.4: Mean propensity scores for transfer students (treated) and native students at nonselective four-year institutions (control) by strata and transfer type—credit hours at graduation

Credit Hours at Graduation - All Native, Vertical and Lateral Transfer

	Mean Propensity Score		Number of Observations		t Value
Strata	Transfer	Native	Transfer	Native	
1	.0480946	.0453982	77	1,539	3.88
2	.0712264	.0702807	142	1,640	4.19
3	.0917704	.0908486	178	1,603	5.20
4	.1119396	.1117444	175	1,607	4.32
5	.1350305	.1342081	245	1,535	6.24
6	.1597068	.1586564	291	1,491	7.28
7	.1891311	.187996	352	1,427	5.69
8	.3228391	.2274774	390	1,383	6.42
9	.2916588	.2877225	470	1,309	9.43
10	.5305297	.440522	891	891	6.50

Credit Hours at Graduation - All Native and Vertical Transfer

	Mean Propensity Score		Number of Observations		t Value
Strata	Transfer	Native	Transfer	Native	
1	.0154659	.0135287	19	1,590	1.68
2	.0244479	.0243323	35	1,612	2.23
3	.0353631	.0344784	59	1,589	2.25
4	.0472242	.0466322	66	1,580	3.30
5	.0604726	.0603568	96	1,547	4.22
6	.0785762	.0776887	134	1,510	4.60
7	.1035637	.1010192	195	1,442	4.54
8	.1398503	.138666	221	1,425	4.99
9	.1999578	.1963199	319	1,328	6.98
10	.5266079	.3751966	729	919	5.53

Credit Hours at Graduation - All Native and Lateral Transfer

	Mean Propensity Score		Number of Observations		t Value
Strata	Transfer	Native	Transfer	Native	
1	.0226112	.0228765	38	1,490	2.83
2	.0336795	.0334284	61	1,486	4.24
3	.0453256	.0445152	58	1,505	2.43
4	.0578064	.057627	94	1,497	5.61
5	.0706215	.0703137	105	1,478	2.42
6	.0829295	.0829182	139	1,442	4.92
7	.0969646	.0972833	145	1,449	4.64
8	.1138988	.1136132	184	1,410	7.03
9	.1357708	.135475	222	1,369	5.99
10	.1845226	.1801369	292	1,301	8.26

Note: Based on author's calculations using THECB administrative data.

Table A.5: Mean propensity scores for transfer students (treated) and native students at nonselective four-year institutions (control) by strata and transfer type—time to degree

Time to Degree - All Native, Vertical and Lateral Transfer					
	Mean Propensity Score		Number of Observations		t Value
Strata	Transfer	Native	Transfer	Native	
1	.0480946	.0453982	77	1,539	4.61
2	.0712264	.0702807	142	1,640	5.46
3	.0917704	.0908486	178	1,603	6.08
4	.1119396	.1117444	175	1,607	4.10
5	.1350305	.1342081	245	1,535	6.06
6	.1597068	.1586564	291	1,491	7.37
7	.1891311	.187996	352	1,427	4.58
8	.228391	.2274774	390	1,383	6.11
9	.2916588	.2877225	470	1,309	7.45
10	.5305297	.440522	891	891	5.61

Time to Degree - All Native and Vertical Transfer					
	Mean Propensity Score		Number of Observations		t Value
Strata	Transfer	Native	Transfer	Native	
1	.0154659	.0135287	19	1,590	2.21
2	.0244479	.0243323	35	1,612	4.93
3	.0353631	.0344784	59	1,589	4.36
4	.0472242	.0466322	66	1,580	2.46
5	.0604726	.0603568	96	1,547	5.44
6	.0785762	.0776887	134	1,510	4.15
7	.1035637	.1010192	195	1,442	6.93
8	.1398503	.138666	221	1,425	4.19
9	.1999578	.1963199	319	1,328	6.82
10	.5266079	.3751966	729	919	4.83

Credit Hours at Graduation - All Native and Lateral Transfer					
	Mean Propensity Score		Number of Observations		t Value
Strata	Transfer	Native	Transfer	Native	
1	.0226112	.0228765	38	1,490	2.68
2	.0336795	.0334284	61	1,486	5.00
3	.0453256	.0445152	58	1,505	1.56
4	.0578064	.057627	94	1,497	5.12
5	.0706215	.0703137	105	1,478	1.70
6	.0829295	.0829182	139	1,442	3.63
7	.0969646	.0972833	145	1,449	3.95
8	.1138988	.1136132	184	1,410	7.28
9	.1357708	.135475	222	1,369	5.23
10	.1845226	.1801369	292	1,301	5.57

Note: Based on author's calculations using THECB administrative data.

Table A.6: Pstest estimates of covariate balance for all transfer and native students—graduation

Graduation - All Native, Vertical and Lateral Transfer							
Unstratified Sample							
						t-test	
Variable	Sample	Treated	Control	%bias	%reduct bias	t	p>|t|
Age of Entry	Unmatched	17.938	18.009	-11		-8.64	0
	Matched	17.979	17.979	0.2	98.6	0.08	0.932
Age^2	Unmatched	322.74	324.49	-10.4		-8.18	0
	Matched	323.49	323.47	0.1	98.6	0.08	0.935
Female	Unmatched	0.5668	0.57064	-0.8		-0.58	0.564
	Matched	0.56962	0.5648	1	-25.6	0.57	0.565
Hispanic	Unmatched	0.30368	0.31286	-2		-1.48	0.14
	Matched	0.30333	0.29626	1.5	23	0.91	0.362
Black	Unmatched	0.1142	0.15823	-12.9		-9.26	0
	Matched	0.11786	0.1204	-0.7	94.2	-0.46	0.643
Other Race/Ethnicity	Unmatched	0.2109	0.11565	26		20.61	0
	Matched	0.19925	0.19196	2	92.3	1.09	0.278
Father College Degree	Unmatched	0.33229	0.29388	8.3		6.22	0
	Matched	0.32845	0.31143	3.7	55.7	2.15	0.031
Father HS Degree/Some College	Unmatched	0.39238	0.33849	11.2		8.41	0
	Matched	0.38875	0.40909	-4.2	62.3	-2.45	0.014
Mother College Degree	Unmatched	0.31548	0.28161	7.4		5.56	0
	Matched	0.31367	0.30542	1.8	75.7	1.05	0.293
Mother HSI Degree/Some College	Unmatched	0.4294	0.36668	12.8		9.62	0
	Matched	0.42291	0.43415	-2.3	82.1	-1.34	0.18
Income Greater Than $80000	Unmatched	0.31548	0.23287	18.6		14.18	0
	Matched	0.30993	0.30208	1.8	90.5	1.01	0.314
Income between $40000 & $80000	Unmatched	0.25024	0.22653	5.6		4.18	0
	Matched	0.24404	0.25305	-2.1	62	-1.23	0.219
Income Unknown	Unmatched	0.22528	0.34636	-27		-19.5	0
	Matched	0.23615	0.23515	0.2	99.2	0.14	0.89
SAT100	Unmatched	9.5745	10.011	-26.7		-19.94	0
	Matched	9.6092	9.663	-3.3	87.7	-1.96	0.05
SAT^2	Unmatched	94.378	102.87	-26.6		-19.59	0
	Matched	94.999	95.956	-3	88.7	-1.82	0.069
Graduated in top 10%	Unmatched	0.10335	0.18584	-23.6		-16.6	0
	Matched	0.1068	0.10847	-0.5	98	-0.32	0.751
Graduate in 11-25%	Unmatched	0.17862	0.26353	-20.6		-14.8	0
	Matched	0.18332	0.18644	-0.8	96.3	-0.47	0.635
Not college ready (remediation)	Unmatched	0.48922	0.35926	26.5		19.94	0
	Matched	0.47904	0.4697	1.9	92.8	1.1	0.27
#Dual credit hours	Unmatched	0.13875	0.20967	-18.8		-13.44	0
	Matched	0.1381	0.13537	0.7	96.1	0.47	0.639
Interested in STEM	Unmatched	0.09847	0.16578	-20		-14.11	0
	Matched	0.10307	0.10927	-1.8	90.8	-1.19	0.235
Interested in Agriculture/Health	Unmatched	0.0967	0.11497	-5.9		-4.34	0
	Matched	0.09948	0.10964	-3.3	44.4	-1.96	0.05
Interested in Social Science/Business	Unmatched	0.18012	0.27271	-22.3		-15.99	0
	Matched	0.18619	0.18857	-0.6	97.4	-0.36	0.719
Part-time Proclivity	Unmatched	0.17225	0.03305	47.1		42.46	0
	Matched	0.12532	0.12627	-0.3	99.3	-0.17	0.866
Need for work - Unknown	Unmatched	0.0453	0.01709	16.3		13.73	0
	Matched	0.04565	0.04209	2.1	87.4	1.03	0.305
Need for work - Low	Unmatched	0.04625	0.00481	26.5		25.54	0
	Matched	0.02584	0.02617	-0.2	99.2	-0.12	0.903
Need for work - High	Unmatched	0.03635	0.00625	21		19.36	0
	Matched	0.02742	0.02364	2.6	87.4	1.41	0.157
Minority*SAT	Unmatched	3.6878	4.368	-14.7		-10.78	0
	Matched	3.7234	3.713	0.2	98.5	0.14	0.892
Minority*SAT^2	Unmatched	33.748	41.738	-17.3		-12.56	0
	Matched	34.109	34.215	-0.2	98.7	-0.14	0.887
Female*Starting age	Unmatched	10.155	10.255	-1.1		-0.83	0.404
	Matched	10.219	10.127	1	7.9	0.61	0.542
Minority*Female	Unmatched	0.24522	0.275	-6.8		-5.01	0
	Matched	0.24792	0.24846	-0.1	98.2	-0.07	0.941
Female*Starting age^2	Unmatched	182.09	184.39	-1.4		-1.07	0.287
	Matched	183.45	181.71	1.1	23.8	0.64	0.519
Started in 2006	Unmatched	0.50658	0.49294	2.7		2.03	0.042
	Matched	0.50273	0.48094	4.4	-59.8	2.57	0.01

(Table A.6: continued)

		Graduation - All Native, Vertical and Lateral Transfer					
		Strata 1					
						t-test	
Variable	Sample	Treated	Control	%bias	%reduct bias	t	p>|t|
Age of Entry	Unmatched	18.053	18.013	12.1		1.57	0.116
	Matched	18.049	18.037	3.6	70.4	0.36	0.717
Age^2	Unmatched	326	324.57	11.8		1.55	0.122
	Matched	325.87	325.44	3.6	69.5	0.36	0.717
Female	Unmatched	0.60526	0.57792	5.6		0.74	0.46
	Matched	0.60109	0.58825	2.6	53	0.25	0.803
Hispanic	Unmatched	0.31053	0.36869	-12.3		-1.61	0.107
	Matched	0.31694	0.35313	-7.6	37.8	-0.73	0.465
Black	Unmatched	0.25789	0.24134	3.8		0.51	0.607
	Matched	0.2459	0.24505	0.2	94.9	0.02	0.985
Other Race/Ethnicity	Unmatched	0.00526	0.01587	-10.4		-1.16	0.248
	Matched	0.00546	0.00404	1.4	86.6	0.2	0.844
Father College Degree	Unmatched	0.15789	0.15152	1.8		0.24	0.813
	Matched	0.15301	0.15423	-0.3	80.8	-0.03	0.974
Father HS Degree/Some College	Unmatched	0.19474	0.16847	6.8		0.93	0.351
	Matched	0.19672	0.17745	5	26.6	0.47	0.638
Mother College Degree	Unmatched	0.16842	0.14141	7.5		1.03	0.304
	Matched	0.16393	0.14731	4.6	38.4	0.44	0.662
Mother HSI Degree/Some College	Unmatched	0.18421	0.17208	3.2		0.43	0.669
	Matched	0.18579	0.17969	1.6	49.7	0.15	0.88
Income Greater Than $80000	Unmatched	0.06316	0.03932	10.8		1.61	0.108
	Matched	0.04918	0.03615	5.9	45.3	0.62	0.539
Income between $40000 & $80000	Unmatched	0.14211	0.12662	4.5		0.62	0.536
	Matched	0.14754	0.13742	3	34.6	0.28	0.782
Income Unknown	Unmatched	0.68947	0.73088	-9.1		-1.24	0.215
	Matched	0.69399	0.7162	-4.9	46.4	-0.46	0.642
SAT100	Unmatched	10.666	10.786	-7.8		-1.05	0.296
	Matched	10.701	10.715	-0.9	87.9	-0.09	0.927
SAT^2	Unmatched	116.1	118.65	-7.7		-1.02	0.31
	Matched	116.73	117.11	-1.2	85	-0.11	0.911
Graduated in top 10%	Unmatched	0.45263	0.45996	-1.5		-0.2	0.845
	Matched	0.45355	0.453	0.1	92.5	0.01	0.992
Graduate in 11-25%	Unmatched	0.39474	0.40873	-2.9		-0.38	0.704
	Matched	0.39344	0.40622	-2.6	8.7	-0.25	0.804
Not college ready (remediation)	Unmatched	0.12105	0.12013	0.3		0.04	0.97
	Matched	0.12568	0.12901	-1	-260.9	-0.1	0.924
#Dual credit hours	Unmatched	0.45789	0.4816	-4.7		-0.63	0.527
	Matched	0.45902	0.45449	0.9	80.9	0.09	0.931
Interested in STEM	Unmatched	0.35263	0.34957	0.6		0.09	0.932
	Matched	0.34426	0.3391	1.1	-68.5	0.1	0.917
Interested in Agriculture/Health	Unmatched	0.12105	0.13095	-3		-0.39	0.695
	Matched	0.12568	0.13349	-2.4	21.1	-0.22	0.825
Interested in Social Science/Business	Unmatched	0.43158	0.43434	-0.6		-0.07	0.941
	Matched	0.43169	0.43336	-0.3	39.9	-0.03	0.974
Part-time Proclivity	Unmatched	0	0	-	-	-	-
	Matched	0	0	-	-	-	-
Need for work - Unknown	Unmatched	0	0	-	-	-	-
	Matched	0	0	-	-	-	-
Need for work - Low	Unmatched	0	0	-	-	-	-
	Matched	0	0	-	-	-	-
Need for work - High	Unmatched	0	0	-	-	-	-
	Matched	0	0	-	-	-	-
Minority*SAT	Unmatched	5.6116	6.1736	-11.1		-1.48	0.138
	Matched	5.6262	6.0083	-7.6	32	-0.72	0.469
Minority*SAT^2	Unmatched	56.891	63.66	-12.4		-1.64	0.101
	Matched	57.123	61.284	-7.6	38.5	-0.74	0.462
Female*Starting age	Unmatched	10.905	10.393	5.8		0.77	0.442
	Matched	10.831	10.595	2.7	54	0.25	0.799
Minority*Female	Unmatched	0.33684	0.35209	-3.2		-0.43	0.67
	Matched	0.3388	0.35384	-3.2	1.4	-0.3	0.763
Female*Starting age^2	Unmatched	196.53	186.95	6		0.8	0.425
	Matched	195.19	190.86	2.7	54.8	0.26	0.796
Started in 2006	Unmatched	0.46316	0.47908	-3.2		-0.42	0.671
	Matched	0.45902	0.47055	-2.3	27.6	-0.22	0.826

(Table A.6: continued)

		Graduation - All Native, Vertical and Lateral Transfer					
		Strata 10					
						t-test	
Variable	Sample	Treated	Control	%bias	%reduct bias	t	p>|t|
Age of Entry	Unmatched	17.78	17.883	-15.7		-4.11	0
	Matched	17.786	17.823	-5.7	63.8	-1.69	0.091
Age^2	Unmatched	316.59	320.19	-15.4		-4.03	0
	Matched	316.78	318.07	-5.5	64.1	-1.65	0.099
Female	Unmatched	0.57066	0.56549	1		0.27	0.784
	Matched	0.57416	0.5766	-0.5	52.7	-0.15	0.883
Hispanic	Unmatched	0.29885	0.33243	-7.1		-1.88	0.06
	Matched	0.30225	0.30576	-0.8	89.4	-0.23	0.82
Black	Unmatched	0.06904	0.07678	-3		-0.79	0.43
	Matched	0.07191	0.06538	2.5	15.7	0.77	0.441
Other Race/Ethnicity	Unmatched	0.38819	0.41102	-5.1		-1.34	0.181
	Matched	0.37528	0.36452	2.2	56.7	0.66	0.506
Father College Degree	Unmatched	0.33881	0.32159	3.9		1.02	0.309
	Matched	0.33883	0.33045	1.9	51.3	0.56	0.575
Father HS Degree/Some College	Unmatched	0.44606	0.42999	3.2		0.85	0.394
	Matched	0.44326	0.43716	1.2	62.1	0.37	0.714
Mother College Degree	Unmatched	0.32416	0.31075	2.9		0.76	0.449
	Matched	0.32135	0.3107	2.3	20.6	0.68	0.495
Mother HSI Degree/Some College	Unmatched	0.48852	0.46522	4.3		1.12	0.262
	Matched	0.48427	0.4818	0.5	88.4	0.15	0.883
Income Greater Than $80000	Unmatched	0.39428	0.37037	4.9		1.29	0.196
	Matched	0.39607	0.39195	0.8	82.8	0.25	0.801
Income between $40000 & $80000	Unmatched	0.26587	0.23848	6.2		1.62	0.105
	Matched	0.25618	0.2518	1	83.7	0.3	0.764
Income Unknown	Unmatched	0.12891	0.15808	-8.3		-2.22	0.027
	Matched	0.13315	0.13744	-1.2	85.3	-0.37	0.708
SAT100	Unmatched	8.8934	8.8347	3.6		0.93	0.353
	Matched	8.9382	8.8841	3.3	78	0.95	0.344
SAT^2	Unmatched	82.011	80.558	5		1.31	0.191
	Matched	82.753	81.887	3	40.5	0.86	0.39
Graduated in top 10%	Unmatched	0.05825	0.05059	3.4		0.88	0.378
	Matched	0.05955	0.05014	4.1	-22.8	1.23	0.217
Graduate in 11-25%	Unmatched	0.10356	0.09666	2.3		0.6	0.547
	Matched	0.10618	0.0878	6.1	-166.3	1.85	0.064
Not college ready (remediation)	Unmatched	0.66073	0.70732	-10		-2.63	0.009
	Matched	0.65787	0.66937	-2.5	75.3	-0.73	0.468
#Dual credit hours	Unmatched	0.13215	0.07227	19.9		5.06	0
	Matched	0.12978	0.11349	5.4	72.8	1.49	0.137
Interested in STEM	Unmatched	0.02751	0.06504	-17.9		-4.97	0
	Matched	0.0264	0.02382	1.2	93.1	0.49	0.623
Interested in Agriculture/Health	Unmatched	0.05983	0.0822	-8.9		-2.4	0.017
	Matched	0.0618	0.06923	-2.9	67.5	-0.9	0.37
Interested in Social Science/Business	Unmatched	0.08087	0.09214	-4.2		-1.11	0.266
	Matched	0.08371	0.08818	-1.6	62	-0.48	0.634
Part-time Proclivity	Unmatched	0.61273	0.42096	39.1		10.31	0
	Matched	0.59663	0.59265	0.8	97.9	0.24	0.809
Need for work - Unknown	Unmatched	0.1192	0.14092	-6.5		-1.72	0.086
	Matched	0.12303	0.12857	-1.6	74.5	-0.5	0.618
Need for work - Low	Unmatched	0.18393	0.09214	26.8		6.83	0
	Matched	0.17697	0.17239	1.3	95	0.36	0.719
Need for work - High	Unmatched	0.13588	0.09846	11.5		2.98	0.003
	Matched	0.13539	0.13728	-0.6	94.9	-0.16	0.869
Minority*SAT	Unmatched	3.0355	3.3663	-7.9		-2.1	0.036
	Matched	3.0899	3.0325	1.4	82.6	0.42	0.678
Minority*SAT^2	Unmatched	26.23	29	-7.2		-1.9	0.057
	Matched	26.753	25.964	2.1	71.5	0.62	0.536
Female*Starting age	Unmatched	10.121	10.094	0.3		0.08	0.936
	Matched	10.189	10.265	-0.9	-185	-0.26	0.795
Minority*Female	Unmatched	0.22977	0.23668	-1.6		-0.43	0.667
	Matched	0.23371	0.23898	-1.2	23.6	-0.37	0.711
Female*Starting age^2	Unmatched	179.75	180.4	-0.4		-0.11	0.913
	Matched	181.05	182.99	-1.2	-196.3	-0.37	0.714
Started in 2006	Unmatched	0.54585	0.47787	13.6		3.59	0
	Matched	0.54101	0.53218	1.8	87	0.53	0.597

Note: Based on author's calculations using THECB administrative data.

Table A.7: Pstest estimates of covariate balance for all transfer and native students—time to degree

		Time to Degree - All Native, Vertical and Lateral Transfer Unstratified Sample				t-test	
Variable	Sample	Treated	Control	%bias	%reduct bias	t	p>|t|
Age of Entry	Unmatched	17.989	18	-13.8		-7.67	0
	Matched	18	18.001	-0.3	97.8	-0.12	0.903
Age^2	Unmatched	322.04	324.13	-13.1		-7.31	0
	Matched	324.18	324.22	-0.3	98	-0.1	0.919
Female	Unmatched	0.61974	0.61565	0.8		0.43	0.666
	Matched	0.615	0.61003	1	-21.3	0.38	0.703
Hispanic	Unmatched	0.25631	0.28578	-6.6		-3.37	0.001
	Matched	0.25583	0.25764	-0.4	93.9	-0.15	0.877
Black	Unmatched	0.08035	0.13752	-18.4		-8.82	0
	Matched	0.08504	0.0878	-0.9	95.2	-0.37	0.714
Other Race/Ethnicity	Unmatched	0.14762	0.08714	18.9		10.47	0
	Matched	0.13097	0.12395	2.2	88.4	0.79	0.432
Father College Degree	Unmatched	0.37714	0.32781	10.3		5.36	0
	Matched	0.37567	0.37455	0.2	97.7	0.09	0.931
Father HS Degree/Some College	Unmatched	0.38773	0.35136	7.5		3.89	0
	Matched	0.38751	0.38784	-0.1	99.1	-0.02	0.98
Mother College Degree	Unmatched	0.35316	0.31296	8.5		4.42	0
	Matched	0.35486	0.35323	0.3	95.9	0.13	0.899
Mother HSI Degree/Some College	Unmatched	0.42697	0.37888	9.8		5.07	0
	Matched	0.42124	0.42247	-0.3	97.4	-0.09	0.926
Income Greater Than $80000	Unmatched	0.3706	0.26326	23.2		12.28	0
	Matched	0.3667	0.36369	0.7	97.2	0.23	0.815
Income between $40000 & $80000	Unmatched	0.24977	0.24184	1.8		0.95	0.343
	Matched	0.23933	0.24214	-0.7	64.5	-0.25	0.806
Income Unknown	Unmatched	0.20399	0.30817	-24		-11.83	0
	Matched	0.21098	0.21166	-0.2	99.3	-0.06	0.95
SAT100	Unmatched	9.7967	10.2	-25.2		-13.11	0
	Matched	9.9235	9.9348	-0.7	97.2	-0.27	0.785
SAT^2	Unmatched	98.817	106.48	-24.9		-12.67	0
	Matched	100.82	101.14	-1	95.9	-0.39	0.696
Graduated in top 10%	Unmatched	0.13547	0.22623	-23.7		-11.48	0
	Matched	0.14029	0.14891	-2.3	90.5	-0.91	0.361
Graduate in 11-25%	Unmatched	0.2099	0.28174	-16.7		-8.33	0
	Matched	0.2178	0.2293	-2.7	84	-1.03	0.303
Not college ready (remediation)	Unmatched	0.40237	0.29653	22.3		11.73	0
	Matched	0.37854	0.37412	0.9	95.8	0.34	0.733
#Dual credit hours	Unmatched	0.16848	0.24061	-18		-8.84	0
	Matched	0.16111	0.1722	-2.8	84.6	-1.11	0.267
Interested in STEM	Unmatched	0.08938	0.15744	-20.8		-9.94	0
	Matched	0.09939	0.10143	-0.6	97	-0.25	0.8
Interested in Agriculture/Health	Unmatched	0.10402	0.11329	-3		-1.51	0.131
	Matched	0.1098	0.10595	1.2	58.5	0.46	0.643
Interested in Social Science/Business	Unmatched	0.18468	0.29092	-25.1		-12.3	0
	Matched	0.1995	0.20605	-1.6	93.8	-0.61	0.543
Part-time Proclivity	Unmatched	0.14606	0.02581	43.9		29.72	0
	Matched	0.03732	0.03167	2.1	95.3	1.15	0.248
Need for work - Unknown	Unmatched	0.03862	0.01116	17.7		11.23	0
	Matched	0.02117	0.01567	3.5	80	1.53	0.127
Need for work - Low	Unmatched	0.04267	0.00439	25.3		18.54	0
	Matched	0.00215	0.00269	-0.4	98.6	-0.41	0.684
Need for work - High	Unmatched	0.02429	0.00582	15.2		9.98	0
	Matched	0.01148	0.00994	1.3	91.6	0.56	0.576
Minority*SAT	Unmatched	3.0444	4.0145	-21.1		-10.54	0
	Matched	3.1308	3.1826	-1.1	94.7	-0.43	0.665
Minority*SAT^2	Unmatched	28.509	39.072	-22.8		-11.25	0
	Matched	29.603	30.186	-1.3	94.5	-0.49	0.625
Female*Starting age	Unmatched	11.09	11.061	0.3		0.17	0.863
	Matched	11.048	10.955	1.1	-215.2	0.4	0.692
Minority*Female	Unmatched	0.21675	0.26942	-12.3		-6.17	0
	Matched	0.2178	0.21985	-0.5	96.1	-0.18	0.853
Female*Starting age^2	Unmatched	198.6	198.8	-0.1		-0.07	0.948
	Matched	198.56	196.82	1.1	-768.8	0.41	0.681
Started in 2006	Unmatched	0.51666	0.50024	3.3		1.69	0.092
	Matched	0.5131	0.51147	0.3	90.1	0.12	0.903

(Table A.7: continued)

Time to Degree - All Native, Vertical and Lateral Transfer

Strata 1

Variable	Sample	Treated	Control	%bias	%reduct bias	t-test t	t-test p>|t|
Age of Entry	Unmatched	18.013	18.005	3.9		0.26	0.796
	Matched	18.014	18.012	0.7	81.5	0.06	0.948
Age^2	Unmatched	324.48	324.24	3		0.2	0.842
	Matched	324.5	324.46	0.5	82.9	0.05	0.964
Female	Unmatched	0.63636	0.60819	5.8		0.49	0.621
	Matched	0.63514	0.62136	2.8	51.1	0.17	0.863
Hispanic	Unmatched	0.33766	0.33203	1.2		0.1	0.919
	Matched	0.33784	0.33932	-0.3	73.7	-0.02	0.985
Black	Unmatched	0.35065	0.32359	5.7		0.49	0.621
	Matched	0.35135	0.32543	5.5	4.2	0.33	0.741
Other Race/Ethnicity	Unmatched	0	0	-	-	-	-
	Matched	0	0	-	-	-	-
Father College Degree	Unmatched	0.18182	0.16374	4.8		0.42	0.677
	Matched	0.17568	0.18511	-2.5	47.8	-0.15	0.882
Father HS Degree/Some College	Unmatched	0.24675	0.22872	4.2		0.37	0.714
	Matched	0.24324	0.23173	2.7	36.1	0.16	0.87
Mother College Degree	Unmatched	0.23377	0.16369	17		1.56	0.12
	Matched	0.21622	0.19613	5	70.5	0.3	0.765
Mother HS Degree/Some College	Unmatched	0.20779	0.22027	-3		-0.26	0.796
	Matched	0.21622	0.22142	-1.3	58.3	-0.08	0.939
Income Greater Than $80000	Unmatched	0.09091	0.02989	25.7		2.94	0.003
	Matched	0.06757	0.06739	0.1	99.7	0	0.997
Income between $40000 & $80000	Unmatched	0.1039	0.16439	-17.8		-1.41	0.159
	Matched	0.10811	0.13483	-7.9	55.8	-0.49	0.622
Income Unknown	Unmatched	0.63636	0.65562	-4		-0.35	0.729
	Matched	0.64865	0.63923	2	51.1	0.12	0.906
SAT100	Unmatched	10.687	10.708	-1.4		-0.12	0.905
	Matched	10.604	10.677	-5	-245.7	-0.31	0.755
SAT^2	Unmatched	116.22	116.98	-2.4		-0.2	0.844
	Matched	114.35	116.12	-5.5	-130.9	-0.35	0.728
Graduated in top 10%	Unmatched	0.45455	0.50942	-11		-0.94	0.348
	Matched	0.44595	0.48401	-7.6	30.6	-0.46	0.645
Graduate in 11-25%	Unmatched	0.35065	0.36257	-2.5		-0.21	0.832
	Matched	0.35135	0.3633	-2.5	-0.2	-0.15	0.88
Not college ready (remediation)	Unmatched	0.11688	0.1345	-5.3		-0.44	0.658
	Matched	0.12162	0.1297	-2.4	54.2	-0.15	0.883
#Dual credit hours	Unmatched	0.42857	0.48278	-10.9		-0.93	0.353
	Matched	0.41892	0.46434	-9.1	16.2	-0.55	0.581
Interested in STEM	Unmatched	0.37662	0.39311	-3.4		-0.29	0.773
	Matched	0.36486	0.37885	-2.9	15.2	-0.17	0.861
Interested in Agriculture/Health	Unmatched	0	0	-	-	-	-
	Matched	0	0	-	-	-	-
Interested in Social Science/Business	Unmatched	0.54545	0.54646	-0.2		-0.02	0.986
	Matched	0.55405	0.55182	0.4	-122.2	0.03	0.978
Part-time Proclivity	Unmatched	0	0	-	-	-	-
	Matched	0	0	-	-	-	-
Need for work - Unknown	Unmatched	0	0	-	-	-	-
	Matched	0	0	-	-	-	-
Need for work - Low	Unmatched	0	0	-	-	-	-
	Matched	0	0	-	-	-	-
Need for work - High	Unmatched	0	0	-	-	-	-
	Matched	0	0	-	-	-	-
Minority*SAT	Unmatched	6.8195	6.6051	4.4		0.38	0.707
	Matched	6.9243	6.695	4.7	-7	0.29	0.773
Minority*SAT^2	Unmatched	69.775	67.528	4.3		0.36	0.717
	Matched	70.424	68.346	3.9	7.5	0.24	0.808
Female*Starting age	Unmatched	11.468	10.938	6.1		0.52	0.605
	Matched	11.446	11.195	2.9	52.7	0.17	0.862
Minority*Female	Unmatched	0.44156	0.40481	7.4		0.64	0.522
	Matched	0.45946	0.42138	7.7	-3.6	0.46	0.644
Female*Starting age^2	Unmatched	206.66	196.74	6.3		0.54	0.591
	Matched	206.28	201.73	2.9	54.1	0.18	0.861
Started in 2006	Unmatched	0.41558	0.47109	-11.2		-0.95	0.341
	Matched	0.43243	0.45788	-5.1	54.1	-0.31	0.757

(Table A.7: continued)

Time to Degree - All Native, Vertical and Lateral Transfer							
Strata 10							
						t-test	
Variable	Sample	Treated	Control	%bias	%reduct bias	t	p>|t|
Age of Entry	Unmatched	17.747	17.88	-21	|	-4.44	0
	Matched	17.771	17.791	-3.1	85.2	-0.62	0.533
Age^2	Unmatched	315.41	320.05	-20.5	|	-4.33	0
	Matched	316.25	316.94	-3	85.2	-0.61	0.543
Female	Unmatched	0.63412	0.61616	3.7	|	0.78	0.434
	Matched	0.62837	0.63647	-1.7	54.9	-0.35	0.729
Hispanic	Unmatched	0.21437	0.22783	-3.2	|	-0.68	0.494
	Matched	0.2204	0.23126	-2.6	19.3	-0.54	0.592
Black	Unmatched	0.0404	0.0404	0	|	0	1
	Matched	0.04103	0.03411	3.5	.	0.75	0.452
Other Race/Ethnicity	Unmatched	0.25701	0.26038	-0.8	|	-0.16	0.871
	Matched	0.25557	0.27149	-3.6	-372.9	-0.75	0.456
Father College Degree	Unmatched	0.39394	0.39282	0.2	|	0.05	0.961
	Matched	0.39859	0.38575	2.6	-1044.5	0.54	0.587
Father HS Degree/Some College	Unmatched	0.41575	0.43322	-2.7	|	-0.57	0.566
	Matched	0.41383	0.41482	-0.2	92.7	-0.04	0.967
Mother College Degree	Unmatched	0.36027	0.37262	-2.6	|	-0.54	0.589
	Matched	0.3646	0.3582	1.3	48.2	0.27	0.784
Mother HSl Degree/Some College	Unmatched	0.47138	0.46689	0.9	|	0.19	0.85
	Matched	0.46542	0.46437	0.2	76.8	0.04	0.966
Income Greater Than $80000	Unmatched	0.47363	0.50505	-6.3	|	-1.33	0.185
	Matched	0.47948	0.46779	2.3	62.8	0.48	0.629
Income between $40000 & $80000	Unmatched	0.2312	0.21661	3.5	|	0.74	0.46
	Matched	0.21454	0.22501	-2.5	28.2	-0.52	0.602
Income Unknown	Unmatched	0.1358	0.1156	6.1	|	1.29	0.199
	Matched	0.13951	0.14629	-2	66.4	-0.4	0.689
SAT100	Unmatched	9.0177	9.0199	-0.1	|	-0.03	0.977
	Matched	9.0723	9.0562	1	-635.9	0.2	0.842
SAT^2	Unmatched	84.239	83.635	2.1	|	0.45	0.651
	Matched	85.179	84.712	1.7	22.8	0.33	0.744
Graduated in top 10%	Unmatched	0.07856	0.06622	4.8	|	1.01	0.315
	Matched	0.08089	0.06695	5.4	-12.9	1.1	0.271
Graduate in 11-25%	Unmatched	0.11336	0.09989	4.4	|	0.92	0.357
	Matched	0.11723	0.09501	7.2	-65	1.49	0.136
Not college ready (remediation)	Unmatched	0.5881	0.61167	-4.8	|	-1.02	0.31
	Matched	0.5803	0.59407	-2.8	41.6	-0.58	0.564
#Dual credit hours	Unmatched	0.15376	0.08642	20.8	|	4.39	0
	Matched	0.1524	0.12085	9.8	53.1	1.9	0.058
Interested in STEM	Unmatched	0.01908	0.05724	-20	|	-4.22	0
	Matched	0.01641	0.01447	1	94.9	0.33	0.745
Interested in Agriculture/Health	Unmatched	0.06622	0.07969	-5.2	|	-1.09	0.275
	Matched	0.06917	0.08172	-4.8	6.8	-0.98	0.327
Interested in Social Science/Business	Unmatched	0.06958	0.07744	-3	|	-0.64	0.525
	Matched	0.07268	0.06548	2.8	8.3	0.59	0.558
Part-time Proclivity	Unmatched	0.49485	0.29834	41	|	8.65	0
	Matched	0.47479	0.4713	0.7	98.2	0.14	0.885
Need for work - Unknown	Unmatched	0.11785	0.09989	5.8	|	1.22	0.224
	Matched	0.12075	0.12694	-2	65.5	-0.39	0.698
Need for work - Low	Unmatched	0.15376	0.07071	26.5	|	5.6	0
	Matched	0.14771	0.14051	2.3	91.3	0.42	0.672
Need for work - High	Unmatched	0.07744	0.06285	5.7	|	1.21	0.228
	Matched	0.08089	0.07569	2	64.4	0.4	0.69
Minority*SAT	Unmatched	2.0865	2.2459	-4.2	|	-0.89	0.372
	Matched	2.1532	2.1927	-1	75.2	-0.22	0.828
Minority*SAT^2	Unmatched	18.137	19.648	-4.4	|	-0.92	0.355
	Matched	18.748	18.999	-0.7	83.4	-0.15	0.88
Female*Starting age	Unmatched	11.208	10.985	2.6	|	0.54	0.586
	Matched	11.125	11.295	-2	23.8	-0.41	0.683
Minority*Female	Unmatched	0.16386	0.16835	-1.2	|	-0.25	0.799
	Matched	0.16882	0.17587	-1.9	-57.1	-0.39	0.7
Female*Starting age^2	Unmatched	198.35	196.07	1.5	|	0.31	0.754
	Matched	197.23	200.69	-2.2	-51.5	-0.47	0.64
Started in 2006	Unmatched	0.56453	0.5275	7.4	|	1.57	0.117
	Matched	0.56272	0.55547	1.5	80.4	0.3	0.763

Note: Based on author's calculations using THECB administrative data

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Vita

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