

Success is What We Make It:
Using Multinomial Logit Modelling to Explore Expanded Definitions of
Student Success for Undergraduate and Graduate Students

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ttbt.

Dedication

To anyone who ever challenged me
to do better,

and

everyone who encouraged me
along the way,

and

always Serena!

Abstract

The research in this dissertation examines the factors associated with student success in college. While the three studies explore students enrolled at both the undergraduate and graduate level, unifying the research included herein is an effort to expand our understanding of college success beyond the traditional measures employed in the existing higher education literature.

Examining three cohorts of first-year undergraduates enrolled at the University of Minnesota-Twin Cities during the 1999-2001 fall semesters (n=15,496), the first study considers the consequences of limiting our interpretation of student success to include only graduation from the institution of first-entry. Recognizing that a non-trivial number of students depart the University but continue on to completion at a different institution, a measure of multi-institutional student success is developed using data from the National Student Clearinghouse. A methodological exploration is then provided to assess the different statistical approaches suitable for accommodating the expanded completion outcomes. This methodological approach illustrates that our understanding of undergraduate student success changes when the definition of student success is expanded to include graduation beyond the institution of first-entry.

The second study revisits the multi-institutional measure of undergraduate completion developed in the first study with a particular interest in assessing the potential relationship between financial aid awards and a student's educational trajectory. Following a single cohort of first-year students at the University of Minnesota-Twin Cities (n=5,188) and incorporating institutional data related to the financial aid awards

posted to a student's financial account, this study explores and finds that the type of aid awarded to a student is associated with their decision to either persist, transfer, or drop out of college. Results suggest differential effect based on the type of financial aid type with loan aid appearing to work against an institution's retention and completion goals by encouraging students to search out alternative institutions or drop out of college entirely.

The third study changes venues and explores success at the doctoral level. Using two-years of completion data on successful doctoral students (n=787), this study develops a measure of doctoral success that considers the postcompletion plans and employment type of students and attempts to discern to what extent individual- and program-level variables affect the occupational choices of successful students. Results suggest experiences of students in graduate education are associated with certain aspects of their postcompletion plans and occupational choices; however, when it comes to producing future faculty members, program-level effects are associated with the likelihood of obtaining a tenure-track position.

Table of Contents

Acknowledgements.....	i
Dedication.....	iv
Abstract.....	v
Table of Contents.....	vii
List of Tables.....	x
List of Figures.....	xii
Chapter 1: Introduction.....	1
Chapter 2: Redefining Student Success: Applying Different Multinomial Regression Techniques for the Study of Student Graduation Across Institutions of Higher Education.....	9
Introduction.....	9
Theoretical Framework.....	11
Data and Methods.....	14
Dependent Variable: A New Definition of Student Success.....	15
Independent Variables.....	17
Methodology.....	17
Results.....	26
Binary Logit Model.....	26
Multinomial Logit Model.....	26
Multinomial Probit Model.....	33
Limitations.....	40
Discussion and Implications.....	42
References.....	48
Chapter 3: Priced out? The Relationship Between Financial Aid and Educational Trajectories of First-Year Students Starting at a Large Research University.....	52
Introduction.....	52
Background.....	55
Theoretical Perspective and Model Specification.....	58
Data and Methodology.....	62
Methods.....	65

Model Specification	65
Results.....	73
Interpretations and Implications	81
Conclusion	88
References.....	92
Chapter 4: When It’s Not Who You Are, But Where You Are From: Factors Associated with Occupational Attainment After Completion of the Ph.D.....	99
Introduction.....	99
Literature Review.....	101
Program-level factors.....	102
Individual-level factors	106
Conceptual Model.....	112
Research Questions.....	114
Method.....	114
Participants.....	114
Data.....	115
Dependent Variables: Job Commitment and Occupational Type	117
Independent Variables	120
Analyses.....	130
Results.....	132
Variables Associated with Postcompletion Plans at the Time of Completion.....	132
Variables Associated with Employment Type at the Time of Completion.....	139
Discussion.....	142
References.....	148
Chapter 5: Discussion, Conclusion, and Implications	156
Empirical Findings.....	157
Theoretical Implications	162
Policy Implications	163
Recommendations for Future Research	166
Final Thoughts	168
References.....	170

Appendix A.....	177
Survey of Earned Doctorates and Doctoral Exit Survey.....	177

List of Tables

Chapter 2

Table 1. Degree/Certificate Attainment Rates Six-Years After Entry Term for Fall 1999 to Fall 2001 Freshman Cohort.....	16
Table 2. Variable Labels and Descriptions.	18
Table 3. Descriptive Statistics of the Analysis Sample.....	21
Table 4. Binary Logit Parameter Estimates.....	25
Table 5. Multinomial Logit Parameter Estimates.....	28
Table 6. Multinomial Probit Parameter Estimates.....	33

Chapter 3

Table 1. Summary of Descriptive Statistics for New Entering Freshmen to the University of Minnesota – Twin Cities (Fall 2002); Average Financial Measures Include Non-Recipients.....	66
Table 2. Relative Risk Ratios and 90% Confidence Intervals for Factors Related to Non and Transfer-Degree Attainment of New Entering Freshmen at the University of Minnesota – Twin Cities Fall 2002.....	74
Table 3. Percentage Change in the Relative Risk Ratios Associated with Changes in the (Non-Zero) Distributions of Awards Among Aid Type Recipients	80

Chapter 4

Table 1. Participant Count of Doctoral Recipients by Program, July 1, 2008 – June 30, 2010.....	116
Table 2. Factor Loadings.....	127

Table 3. Descriptive Statistics for Independent Variables.....	129
Table 4. Odds-Ratios for Postcompletion Plans of Successful Doctoral Students at the University of Minnesota, 2008-2010.....	134
Table 5. Odds Ratios for Postcompletion Occupational Choice for Successful UMN Doctoral Students, 2008-2010.....	137

List of Figures

Chapter 2

Figure 1. Degree attainment for three cohorts of new entering freshman, fall 1999-2001.....	14
Figure 2. MNL Impacts: Admitted to First Choice College.....	35
Figure 3. MNL Impacts: Living on Campus.....	37
Figure 4. MNL Impacts: Student from Reciprocity State.....	38
Figure 5 MNL Impacts: Eligible for Pell Grants.....	39

Chapter 3

Figure 1. Estimated Effects of Changes in Unmet Need on the Predicted Probabilities of Non-Degree Attainment, Graduate (Transfer), and Graduate (Original) Within Six Years of First Enrollment for an Average UMN Student; Distribution of the Predicted Probabilities is Reflected by the Associated Rug Plot.....	83
Figure 2. Estimated Effects of Changes in Financial Aid Types (Need-, Loan-, Merit-Based) on the Predicted Probabilities of Non-Degree Attainment, Graduate (Transfer), and Graduate (Original) Within Six Years of First Enrollment for an Average UMN Student; Distribution of the Predicted Probabilities is Reflected by the Associated Rug Plots	84

Chapter 4

Figure 1. The I-E-O Model	113
Figure 2. Map of Variables to Conceptual Framework.....	120

Chapter 1: Introduction

Despite the frequency with which it is used, the term ‘student success’ is one of the most ambiguous terms utilized in the higher education literature. The ambiguity is because ‘student success,’ or ‘college success,’ is highly contextual, and as a result, means something different to people at different times, in different places, and in the level and type of degree program in which a student is enrolled. McPherson and Schapiro (2009) highlighted this problem noting that “It isn’t easy to even agree on how to define college success, much less figure out how to encourage it. The American higher education system is remarkably heterogeneous, both in terms of the students who enroll and the colleges and universities that educate them” (p. 47-48). For many college students, college success means completing the credits necessary to earn a two-year or four-year college degree. However, for others completing a first degree serves only as a first step on a longer educational journey. For other students, however, college success is less about credentialing than acquiring the skills necessary for gainful employment (Levin, 2007).

Despite the apparent heterogeneous nature of defining success in higher education, empirical research on the topic of college student success frequently ignores much of the complexity inherent in favor of a unitary interpretation of the term. This simplicity is especially the case when it comes to the quantitative literature on student success where the term has become synonymous with measures of retention and completion of a baccalaureate degree (Gansemer-Topf & Schuh, 2006; Turner & Berry, 2000; Wohlgemuth, Whalen, Sullivan, Nading, Shelley, & Wang, 2007), as well as more

advanced degrees such as the Ph.D. (Ehrenberg & Mavros, 1995; Seagram, Gould, & Pyke, 1998; de Valero, 2001). While there may be some merit to exploring the factors associated with a student's persistence and completion decision, emphasizing this interpretation of success ignores many of the complexities associated with contemporary enrollment patterns (Adelman, 2006) and over-emphasizes the importance of procedural success in college instead of actual outcomes.

Despite the fact that there is an apparent need to revise the concept of student success, the existing interpretation of student success in terms of institutional retention and completion rates has proven difficult to alter. Several factors help explain resilience of institutional-focused definitions of student success. First, increased accountability efforts have codified certain metrics of indicators as institutional performance such as institutional retention and graduation rates, which are reported annually to the Federal Government. Second, in the current competitive recruiting environment, the colleges and universities are increasingly aware of third-party ratings of college such as those provided by *U.S. News and World Report* in their annual *America's Best Colleges* edition. Relying largely on publically available data to generate rankings, inclusion of institutional retention and completion rates have reified their perceived importance within the higher education landscape.

Given these pressures, it is easy to understand the prevalence of institutionally-based definitions of student success; however, from a national policy perspective, the consequences of institutional-based interpretations of student success are potentially yielding suboptimal policy outcomes. Specifically, national trends suggest that there is a

growing disconnection between the emphasis placed on institutional retention and completion rates and the pathways that students follow to complete a college degree which frequently incorporate more than a single institution (Adelman, 2006). As the research of Adelman (2006) highlighted, “We falsely believe that beginning students drop out of higher education in appalling numbers by the end of their scheduled first academic year of attendance. In fact, about 90 percent of traditional-age beginning students turn up somewhere (maybe not at the first school attended) and at some time (maybe not in the fall term) during the subsequent calendar academic year (which we measure as July 1 through June 30)” (p. xx).

An additional challenge facing the higher education literature is that the majority of research on student success tends to overemphasize the importance of procedural success in college and graduate school. With a focus on such measures as retention, completion, and time-to-degree, the extant literature on student success appears to assume that the goal of undergraduate and graduate education is simply degree attainment. Bensimon (2007) identified a notable problem with quantitative efforts such as these that they tend to strip away important context. The researcher noted, “The reality is that underperformance, dropping out, and low degree-attainment is a problem that affects the ‘marginal’ student disproportionately, yet student success, with few exceptions, is treated as a generic phenomenon and many of the measurement instruments and analytical models do not account for the unique circumstances of ‘students at the margins’” (Bensimon, 2007, p. 449). While there was a time not-to-long ago when completing a college degree was considered the important indicator of personal

success, since postcollege success in the world of work was all but guaranteed, those days have passed. Recent estimates suggest that among recent undergraduates 10.4% were unemployed, while 19.1% were underemployed (Shierholz, Sabadish, & Wething, 2012). The pattern is perhaps even bleaker for recent doctorate recipients as data suggest that fewer than 66% report to have a commitment for a job or postdoctorate appointment at the time of completion (Fiegener, 2013). Consequently, it is important that we begin to consider more comprehensive models of student success that explore the more long-term consequence of degree attainment.

Statement of Purpose

The goal of this dissertation is to introduce two new interpretations of college success. At the undergraduate level, a multi-institutional interpretation of college success is introduced that accommodates the different paths a student may take on the way to a college degree. At the graduate level, an interpretation of student success is introduced that emphasizes the career outcomes of successful doctoral students. Predictive models are subsequently developed to help ascertain the personal, academic, financial, and experiential factors associated with these expanded measures of college success.

Organization of the Dissertation

The aim of this dissertation is to identify the factors that matter most to students, education experiences, when we eschew the traditional understanding of student success. In this research, I achieve this goal in three different ways.

In Chapter 2, the limitations of the traditional understanding of undergraduate student success as a simple dichotomy, where a student is considered successful if, and

only if, he or she completes a degree plan at the institution of first-entry within six years of first enrollment (Huesman, Brown, Lee, Kellogg, & Radcliffe, 2009; Ishitani, 2006; Levin & Clowes, 1982), are explored. Recognizing that this interpretation suffers from its inability to distinguish between noncompleters and students simply transferring to another institution, data from the National Student Clearinghouse were used to develop a measure of multi-institutional success that accommodates two new categories of success: four-year transfer completion and reverse transfer completion. To accommodate an expanded definition of success, an alternative methodological approach is necessary. The remainder of the chapter consequently applies and assesses different methodological solutions for dependent variables with polychotomous outcomes on a cohort of first-year students enrolled at the University of Minnesota-Twin Cities during Fall 2002 (Jones-White, Radcliffe, Huesman, & Kellogg, 2010).

Armed with this new multi-institutional interpretation of undergraduate student success, Chapter 3 explores if the availability of certain types of financial aid may differentially influence the degree trajectory of a cohort of first-year undergraduate students enrolled at the University of Minnesota-Twin Cities. To accomplish this, institutional finance data were analyzed to obtain a more complete picture of the financial resources students use to pay for college to assess if reliance on need-based, merit, or loan aid may encourage students to either graduate from the institution of first entry, graduate from a transfer university, or depart from the University without a degree (Jones-White, Radcliffe, Lorenz, & Soria, 2013).

In Chapter 4, the attention shifts from undergraduate to graduate education, where a definition of student success that considers the two different measures of post-completion employment outcomes of successful doctoral students is explored. Using exit survey data for a sample of successful doctoral students completing a degree program between AY2008-2010, this chapter explores how individual- and program-level may influence both a student's occupational plans and employment type. These factors include individual-level factors such as personal characteristics (Long, Allison, & McGinnis, 1993; Long & Fox, 1995), academic performance (Athey, Katz, Krueger, Levitt, & Poterba, 2007; Cole & Cole, 1973; Merton, 1942), source of financial support (Ampaw & Jaeger, 2012; Kim & Otts, 2010), and program experience (Gardner, 2010; Girves & Wemmerus, 1988; Golde, 1998, 2005); and program-level factors such as program reputation (Baldi, 1995; Hesli, DeLaat, Youde, Mendez, & Lee, 2006; Long, Allison, & McGinnis, 1979), size (Stricker, 1994), and degree production.

Chapter 5 concludes the dissertation and integrates the findings for the three separate studies. This chapter begins with a summary of the main empirical findings of the research; highlighting those findings in particular that carry through the distinct research in this dissertation. The chapter then considers the corresponding theoretical and policy implications of the research and concludes with considerations for future research.

Methodological Approach

Beyond the shared interest in alternative interpretations of student success, research in this dissertation is unified by a common methodological approach. Given the traditional approach to consider retention and graduation as a binary outcome, the application of logistic regression in the higher education literature grew rapidly in the 1990s (Peng, So, Stages, & St. John, 2000) to such an extent that it is commonplace today. Because each of the alternative measures of student success included in this dissertation includes polychotomous, or multi-categorical variable, the research in this dissertation requires the application of a less common methodological approach to studying student success: the multinomial logit model. Belonging to the family of regression models for categorical dependent variables, the multinomial logit model is a statistical method that allows for the estimation of the pairwise comparisons of nominal, or unordered categorical variables.

While applications are more common in areas such as transportation (Ortuzar & Willumsen, 1994) and voter studies (Alvarez & Nagler, 1998; Dow & Endersby, 2004), the use of categorical dependent variables has been less frequent in the higher education literature. To date, researchers have utilized categorical methods to explore questions related to enrollment choices (Engberg & Wolniak, 2010; Kim, 2012; Singell & Tang, 2012; Weiler, 1987), persistence decisions (Herzog, 2005; Porter 2002), major choice (Porter & Umbach, 2006), and tenure outcomes of faculty members (Perna, 2003, 2005). The research in this dissertation expands the use of multinomial logit modelling to two

frequently less explored areas: multi-institutional graduation outcomes and the career trajectories of successful Ph.D. students.

Chapter 2: Redefining Student Success: Applying Different Multinomial Regression Techniques for the Study of Student Graduation Across Institutions of Higher Education¹

Abstract

Current definitions of retention and graduation rates distort the picture of student success by limiting it to completion of a degree at the institution of entry. By incorporating data from the National Student Clearinghouse (NSC), a clearer picture emerges. The NSC data captures retention and graduation at both entry and transfer institutions. To accommodate this polychotomous definition of success, more sophisticated methods of modeling limited dependent variables are needed. Though multinomial logit is often considered the most accessible method, the strict assumptions it imposes may be inappropriate. We therefore compare multinomial regression techniques to assess their utility in modeling multi-institutional student success.

Introduction

Considerable theoretic and empirical effort has been given to understanding the process of student retention and graduation in higher education. For all types of institutions of higher education, accountability pressures from the federal government

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have raised the importance of identifying and removing barriers to student progress and success (U.S. Department of Education, 2006). However, these efforts have been based primarily on a narrow definition of student success. The standardized definitions of student success that followed the Student Right-to-Know (SRK) Act of 1990 were, by necessity, narrowly defined due to the complications of tracking transfer students (Burd, 2004).

Currently, four-year institutions fulfill SRK reporting requirements by completing the Integrated Postsecondary Education Data System (IPEDS) Graduation Rate Survey (GRS). Graduation rates are based on following a cohort of new full-time entering freshmen until they complete a bachelor's degree within 150% of normal time to program completion (typically six-years) at the same institution. By focusing exclusively on institution-specific graduation rates, the current IPEDS methodology distorts the true picture of student success by underestimating the actual rate of degree completion (Adelman, 1999). Data available from the National Student Clearinghouse (NSC) offers the opportunity to broaden the definition of student success to include degree completion beyond the originating school and expand understanding of factors contributing to a more expansive definition of student success. The emerging use of multi-institutional retention and graduation rates as part of the Voluntary System of Accountability (VSA) lends additional imperative to our understanding of student success in this larger context. Identifying factors leading to success across the different paths students take through higher education requires statistical techniques suited for multi-category variables. We modeled a four category outcome of student success; 1) baccalaureate degree from the

home institution, 2) baccalaureate degree from another higher education institution, 3) associate degree/certificate award from another institution, or 4) student failed to obtain a degree in the six-year period examined. The selection of the appropriate “tools” to model this expanded behavioral choice set is critical to our understanding of this broader definition of success, since multiple outcomes may indicate that different policies and intervention strategies are required to meet the needs of students pursuing different paths through the higher education system (Porter, 2003).

To this end, our paper identifies several different methodological techniques researchers can utilize to analyze multi-categorical, or polychotomous, dependent variables. Our paper is presented in five sections. The first section provides a brief overview of retention theory and the rationale for the selection of the independent variables used in the models. The second section provides an overview of the data and methodological used in this study. The third section discusses and compares the resulting models from our three distinct approach to modeling student degree attainment: binary logit model (BL), multinomial logit (MNL) and multinomial probit (MNP) models, respectively. The fourth section outlines the limitations associated with this research study. The final section discusses the implications of the findings and directions for future research.

Theoretical Framework

Our selection of factors to include in the model is based loosely on Tinto’s theory of student persistence, although the selection of independent variables is based not only on theory, but also by pragmatic criteria. The selected variables needed to have high

coverage of the cohorts in question, and be fairly easy to obtain from the central records of the study institution. It is widely understood that student's background/demographics and incoming academic ability (i.e., pre college measures) are important predictors of a student's ability to persist to graduation (Perkhounkova, Noble & McLaughlin, 2006; Ishitani & Snider, 2006; Ishitani, 2003; Tinto, 1975). Previous retention research on students at the University of Minnesota-Twin Cities (UM-TC) found that not only were background and pre-college characteristics important, but also that "academic fit," as measured by admission to a student's first-choice college and first-term academic progress, were significant predictors of academic success (Radcliffe, Huesman, Kellogg, & Jones-White, 2009; Radcliffe, Huesman, & Kellogg, 2006; DeLong, Radcliffe, & Gorny, 2007). Social integration has been theorized by Tinto (1975, 1993) to be a key contributor to student persistence, and "social fit" indicators as measured by living learning communities have shown to play a key role in our understanding of the success of students (Matthews, 1996; Tinto, 1998). The community aspects of living in a residence hall, especially during the first year, may promote social interaction which is a necessary step towards social integration (Braxton & Hirschy, 2004) and student success (Astin, 1973). Living on-campus may also be related to a student's socioeconomic/academic background; Levin & Clowes (1982) found that students who live on campus generally have higher socioeconomic status and are better prepared academically than those who do not. Ishitani (2006) found that on average, low-income students are more likely to dropout early and less likely to graduate than students from higher income families.

These previous studies illustrate the complexity of the underlying process that influences a student's choice to persist in higher education. These studies utilized multivariate statistical procedures that accounted for a number of factors related to student persistence/graduation but yet the outcomes were reduced to a simple binary alternative (with the exception of Ishitani's study which utilized NELS:88 data). Most traditional studies of student retention/persistence treat dropout/stopouts from higher education and transfers who continue their education identically by combining them into one category in their statistical analyses. A pair of researchers have expanded these definitions to examine whether freshmen return, quit, or go elsewhere for their sophomore year. Porter (2002, 2003) and Herzog (2005), making use of the NSC StudentTracker service, differentiate between stopouts/dropouts, transfer-outs, and returning students. They found the significant independent variables in their persistence models varied considerably depending on whether or not a student was a stopout or transferred. Based on these results, Porter argued that "...researchers must take into account the different choices faced by students when studying student persistence" (2002, p. 3). It seems reasonable to conclude that there are differences between these groups and our models should take into account these differences.

This study provides a statistically rigorous approach to analyzing multi-institutional degree attainment. To the extent students vary in one or more of these areas, can we identify the factors that are associated with those who earn a degree at the home institutions, those who transfer and earn a degree elsewhere versus those who do not? In the past, on average, nearly 6 in 10 students have graduated from the University of

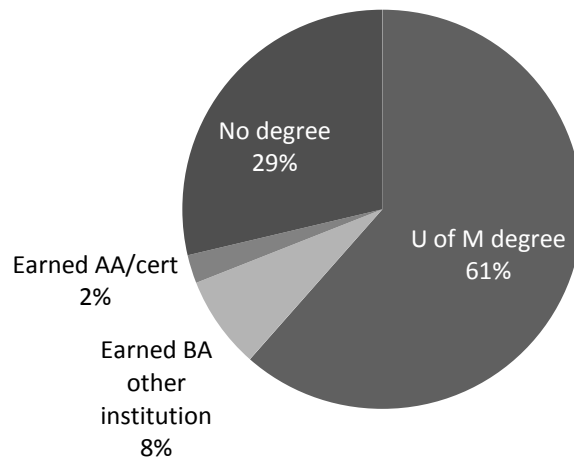


Figure 1. Degree attainment for three cohorts of new entering freshmen, fall 1999-2001.

Minnesota-Twin Cities within 150% time of entry (or six years). This, however, is not a complete picture of student success as nearly 25% of students who depart the University obtain some level of success at another higher education institution. As illustrated in Fig. 1, this amounts to an additional 10% of the entering cohort earning a post-secondary degree after starting at the University as new entering freshmen. It is our belief that the significant percentage of successful departers provides a compelling argument to justify the study of multi-institutional degree attainment of students emanating from the University of Minnesota-Twin Cities.

Data and Methods

This study utilized central student records and the StudentTracker service from National Student Clearinghouse (NSC) to examine degree attainment of three new

freshmen-cohorts from the UM-TC campus. The UM-TC is a Carnegie classified Research University with Very High Research Activity (RU/VH). The data sample consisted of 15,496 students who entered as first-time full-time degree-seeking freshmen during the 1999 through 2001 fall semesters.

Dependent Variable: A New Definition of Student Success

In order to develop a dependent variable that incorporates degree information from other institutions, we utilized the StudentTracker Service offered by the NSC, a non-profit organization that offers third party degree and enrollment verification for post-secondary institutions nation-wide. More than 3,300 colleges representing 92% of US college students have partnered with the NSC by submitting enrollment and/or degree information files which are maintained by the NSC in an electronic registry. This registry contains approximately 93 million student records (NSC, 2009). Currently the majority of institutions of higher education participate in the enrollment verification, representing 91% of the nation's college enrollment, and a smaller percentage in the degree verification, representing 68% of all U.S. college degrees (NSC presentation 4/22/2008). Participating colleges are eligible to subscribe to the StudentTracker service and query the NSC's database to identify what other institutions their students have enrolled at or graduated from.

Table 1

Degree/Certificate Attainment Rates Six-Years After Entry Term for Fall 1999 to Fall 2001 Freshmen Cohorts

Outcome		Fall 1999		Fall 2000		Fall 2001		Total	
		N	%	N	%	N	%	N	%
Earned degree	Earned UM degree	3,155	60.7%	3,003	60.6%	3,370	63.1%	9,528	61.5%
	Earned BA other institution	384	7.4%	393	7.9%	381	7.1%	1,158	7.5%
	Earned AA/cert	119	2.3%	122	2.5%	115	2.2%	356	2.3%
	Total: earned degree	3,658	70.4%	3,518	71.0%	3,866	72.3%	11,042	71.3%
No degree	Earned UM degree >6 yrs	155	3.0%	97	2.0%			252	1.6%
	Enrolled UM at 6 yr pt	82	1.6%	132	2.7%	190	3.6%	404	2.6%
	Enrolled other institution	625	12.0%	604	12.2%	605	11.3%	1,834	11.8%
	Unknown outcome	675	13.0%	606	12.2%	683	12.8%	1,964	12.7%
	Total: no degree	1,537	29.6%	1,439	29.0%	1,478	27.7%	4,454	28.7%
Total		5,195	100.0%	4,957	100.0%	5,344	100.0%	15,496	100.0%

To create our dependent variable our sample was initially divided into two groups; those who were successful at the institution of entry (61.5%) and those who were not. A total of 5,968 students were not successful by this criteria (38.5%), these records were sent to the NSC StudentTracker service to determine enrollment/degree attainment at other institutions of higher education. A six-year window was mimicked for these students, by tracking enrollment from the original fall semester of matriculation (August 15, starting year) to August 1, six years later and degree attainment through October 15, six years later. Taken together the data collected captured graduation at both entry and transfer institutions as well as enrollment at other institutions at any point in time, and included students for whom no NSC match was found (see Table 1). Based on the results, these UM-TC non-graduates received degrees from more than 275 other institutions, representing a wide variety of states and college types.

Independent Variables

The independent variables are divided into six categories that follow our theoretical model: academic performance, academic background, demographics, geography, social integration, and financial background. Table 2 provides a more detailed listing of the variables incorporated into the models and their associated coding schemes and Table 3 provides the descriptive statistics of the full data set utilized for this study.

Methodology

Relative to dropping out of college, we modeled three scenarios of student degree attainment within six years from matriculation as new entering fall freshmen;

Table 2
Variable Labels and Descriptions

Category	Variable Name	Description
	Old definition (OD): Success	Coded 1 if earned baccalaureate (BA) from University of Minnesota (UM), 0 otherwise.
Response variables:	Associates degree (AA): Other	Coded 1 if earned associates or certificate (AA), 0 if no degree, system missing if earned BA anywhere
Binary logit	Bachelors degree (BA): Other	Coded 1 if earned BA from other institution , 0 if no degree, system missing if earned BA from the UM
	Bachelors degree (BA): UM	Coded 1 if earned UM BA, 0 if no degree, system missing if earned BA/AA elsewhere
Response variable: MNL & MNP	New definition (ND): Success	Coded 1 if earned AA, 2=earned BA other institution, 3=earned BA from the UM, 0 otherwise
Academic Performance	First-term GPA	First-term Grade Point Average (GPA)
	W Count	Number of Ws (course withdrawals) first semester
	Completion Ratio	First-term credits earned to attempted (sans withdrawals)

Academic Background	ACT/SAT Score	ACT composite score/SAT converted
	General College	Coded 1 if admitted to General College, 0 otherwise
	Not admitted to 1st choice college (1 st Choice)	Coded 1 if Admitted to first-choice college, 0 otherwise
	Advanced Credit	Number of credits brought by student at matriculation (e.g. AP, CLEP, PSEO, etc.)
Category	Variable Name	Description
Demographics	Gender	Coded 1 if Female, 0 otherwise
	Asian	Coded 1 if Asian, 0 otherwise
	Underrepresented Minority (Minority)	Coded 1 if American Indian/Black/Hispanic, 0 otherwise
Demographics	Cohort Year 2000 (2000)	Coded 1 if entry term fall 2000, 0 otherwise
	Cohort Year 2001 (2001)	Coded 1 if entry term fall 2001, 0 otherwise
Geography	Reciprocity	Coded 1 if from tuition reciprocity state, 0 otherwise
	Non-reciprocity	Coded 1 if from non-tuition reciprocity state, 0 otherwise
	On-campus Housing	Coded 1 if living in residence hall first-term, 0 otherwise
Social	Living & Learning Communities (LL Communities)	Coded 1 if in living & learning community "house", 0 otherwise
Financial Need	Applied for Financial Aid (Applied FA)	Coded 1 if Submitted Free Application for Federal Student Aid (FAFSA), 0 otherwise
	Pell Grant Eligible (Pell)	Coded 1 if eligible for Pell grant, 0 otherwise

1) baccalaureate degree from home institution; 2) baccalaureate degree from another institution and 3) associate degree/certificate award from another institution.

Traditionally, when modeling student success, our assumption of the dichotomous nature of the dependent variable lends itself well to limited dependent variable techniques such as binary logit or probit models. By now the use of binary logit techniques for modeling student retention and graduation rates is commonplace in higher educational research.² Unfortunately, the expansion of graduation outcomes utilized in this study precludes us from this traditional route. Though it is possible to run separate logit models for each of the different choice comparisons, the potential number of necessary comparisons makes such an approach confusing (Long, 1997) while the necessary partitioning of data results in inefficient parameter estimates (Alvarez & Nagler, 1998).

To better accommodate our redefined interpretation of student success, a more complicated statistical procedure may be necessary to identify reliable parameter estimates for the antecedents of success. Most educational researchers trying to estimate models with multi-categorical outcomes have utilized the multinomial logit model (Porter, 2002; Herzog, 2005; Stratton, O’Toole, & Wetzel, 2008). The MNL can be conceptualized as the simultaneous estimation of different BL models “for all possible comparisons among the outcome categories” (Long, 1997, p. 149). In fact, by simultaneously estimating all the logits, the MNL both “...enforces the logical

² See Peng, et al. (2000) for a comprehensive review and assessment of usage of logistic regression techniques in the top 3 education research journals from 1988-1999.

Table 3

Descriptive Statistics of the Analysis Sample (N=15,496)

Variable	Obs	Mean	Std. Dev.	Min	Max
OD: Success	15496	0.61	0.49	0	1
AA: Other	4810	0.07	0.26	0	1
BA: Other	5612	0.21	0.40	0	1
BA: UM	13982	0.68	0.47	0	1
ND: Success	15496	2.02	1.34	0	3
First-term GPA	15201	2.99	0.85	0	4
Completion Ratio	15226	0.94	0.18	0	1
W Count	15496	0.17	0.55	0	7
ACT/SAT	14739	24.51	4.15	9	36
General College	15496	0.18	0.38	0	1
1 st Choice	15496	0.73	0.44	0	1
Advanced Credit	15496	4.70	9.95	0	101
Female	15496	0.52	0.50	0	1
Asian	15496	0.10	0.30	0	1
Minority	15496	0.07	0.25	0	1
2000	15496	0.32	0.47	0	1
2001	15496	0.34	0.48	0	1
Reciprocity	15496	0.27	0.44	0	1
Non-reciprocity	15496	0.03	0.18	0	1
On-campus housing	15496	0.73	0.44	0	1
LL Communities	15496	0.11	0.31	0	1
Applied FA	15496	0.70	0.46	0	1
Pell	15496	0.18	0.38	0	1

relationship between the parameters and uses data more efficiently” (Long 1997 p. 151).

Greene (2008) suggests that the MNL model of individual i (with characteristics w)

selecting outcome j can be expressed as the probability model:

$$Prob(Y_i = j | w_i) = \frac{\exp(w_i' \alpha_j)}{\sum_{j=0}^k \exp(w_i' \alpha_j)}, \quad j = 0, 1, \dots, J.$$

Estimation of the different outcome probabilities is hindered, however, by what Greene (2008) identifies as an implicit “indeterminacy in the model” (p. 844). Because the probability of an outcome can be produced by more than a single set of parameter estimates, proper identification of the model requires the imposition of constraints on the parameter estimates (Long, 1997; Greene, 2008). Both Long (1997) and Greene (2008) suggest that this can be most easily resolved by setting one of the parameter estimates equal to zero. While the choice is ultimately arbitrary (Long, 1997), setting $\alpha_0=0$ is often considered the traditional solution (Greene, 2008). This yields the probability model:

$$Prob(Y_i = j | w_i) = \frac{\exp(w_i' \alpha_j)}{1 + \sum_{j=1}^J \exp(w_i' \alpha_k)}, \quad j = 0, 1, \dots, J, \quad \alpha_0 = 0.$$

Where $J=1$, this equation reduces to the traditional BL model familiar to educational researchers (Greene, 2008).

One practical benefit of this model specification is that it also allows us to calculate log-odds ratios for each of J alternatives (Greene, 2008):

$$\ln \left[\frac{P_{ij}}{P_{ik}} \right] = w_i' (\alpha_j - \alpha_k) = w_i' \alpha_j \quad \text{if } k = 0.$$

This eases interpretation by simplifying the calculation of the predicted effect of changes in the independent variables on the odds of the examined outcome occurring (Long, 1997). It is important to note that in this equation, the odds ratio of two alternatives is calculated independently of the other outcomes available. This stems from what Greene (2008) identifies as the “independence of the disturbances in the original model” (p. 844). While this seems like an obscure mathematical detail, in practice this assumption, referred to as the *independence of irrelevant alternatives* (or IIA) assumption, imposes

strict restrictions on the model specification which may or may not adhere to the data we are trying to model. Specifically, the IIA assumption states that the odds of an outcome “are determined without reference to the other outcomes that might be available” (Long, 1997, p. 182). This suggests that the decision between any pair of alternatives, P_{ij}/P_{ik} , is unaffected by the existence of other options.

In making decisions about the direction of one’s academic career, however, this assumption may not ring true. The existence of associates-level degrees, for example, seems quite likely to impact the decision of whether to continue at ones original institution, move to a different institution offering the same level of degrees, or to discontinue higher education altogether. A student who is struggling academically at the bachelors level, or who needs to enter the workforce more quickly for family or financial reasons, may well find an associates-level degree an attractive option, and the existence of that option could clearly impact the selection among other alternatives. Such logical concerns about this assumption do not necessarily mean that it is not tenable in practice (Dow & Endersby, 2004).

Ultimately, however, the appropriateness of the MNL methodology, and therefore the reliability of the results, rely on this assumption of the independence of irrelevant alternatives being upheld. If the odds of each of our definitions of student success are not independent, alternative methodological approaches become necessary as violations of the IIA assumption lead to “incorrect probability estimates” (Washington, Karlaftis, & Mannering, 2003, p. 274). An approach that is robust to violations of the IIA assumption is the multinomial probit model. MNP models are conceptually similar to MNL, but

allow for the correlations between the errors for the comparison between alternatives to be estimated, rather than assuming independence. Specifically, Greene (2008) identifies that the structural equations for the MNP model are:

$$U_{ij} = \mathbf{x}'_{ij}\boldsymbol{\beta} + \varepsilon_{ij}, \quad j = 1, \dots, J, \quad [\varepsilon_{i1}, \varepsilon_{i2}, \dots, \varepsilon_{ij}] \sim N[\mathbf{0}, \boldsymbol{\Sigma}].$$

This results in a probability for outcome q that can be expressed as:

$$Prob[choice_{iq}] = Prob[\varepsilon_{i1} - \varepsilon_{iq} < (\mathbf{x}_{iq} - \mathbf{x}_{i1})' \boldsymbol{\beta}, \dots, \varepsilon_{ij} - \varepsilon_{iq} < (\mathbf{x}_{iq} - \mathbf{x}_{ij})' \boldsymbol{\beta}].$$

Long and Freese (2006) note, however, that “The specific form of the model depends on the distribution of the error terms. Assuming the [errors] have an extreme value distribution leads to the [*multinomial logit model*] ... Assuming that the [errors] have a normal distribution leads to a probit-type model” (p. 273). Because the model estimates additional parameters, it is more computationally complex, vulnerable to convergence difficulties, and demanding in terms of available observations. In return, it can provide more precise and reliable estimates. The critical question is whether that trade-off is worthwhile.

To examine both the substantive factors which lead to student success, accounting for the possibility that students continue their education at another institution, and the methodological considerations inherent in working with that expanded definition of success, we estimate three models of student graduation.

- 1) A binary logit model using the standard definition of student success (graduation from the school of original admission within six years or not).

- 2) A multinomial logit model where the outcomes are graduating with an associates-level degree, graduating with a bachelors-level degree from another institution, graduating with a bachelors-level degree from the entry institution, or not graduating from any institution within six years of entry.
- 3) A multinomial probit model with the same outcomes as the multinomial logit model.

Table 4

Binary Logit Parameter Estimates

	OD: Success	
	Coef.	Std. Err.
First-term GPA	0.8259***	0.0321
Completion Ratio	2.0607***	0.1902
W Count	-0.6515***	0.0572
ACT/SAT	0.0060	0.0062
General College	-0.9737***	0.0623
1st Choice	0.2867***	0.0473
Advanced Credit	0.0169***	0.0025
Female	-0.0502	0.0402
Asian	0.0129	0.0712
Minority	-0.0875	0.0845
2000	-0.1388**	0.0486
2001	-0.0689	0.0482
Reciprocity	-0.3743***	0.0467
Non-reciprocity	-0.3547*	0.1521
On-campus Housing	0.5017***	0.0497
LL Communities	0.1831*	0.0709
Applied FA	0.0128	0.0427
Pell	-0.3445***	0.0533
Constant	-4.1713	0.2351

* $p < .05$. ** $p < .01$. *** $p < .001$

Note. Base category no UM degree.

Results

Binary Logit Model

The traditional binary logit model produces results consistent with previous research at the University of Minnesota-Twin Cities (see e.g. Radcliffe, Huesman, & Kellogg, 2006) and in other studies. Academic preparation and performance measures are key factors, as are measures of academic fit, geography, social integration, and financial need. While these results comport well with both logic and experience, they are blind to an important point: many of those students who are marked as unsuccessful actually did complete a degree within the standard graduation tracking window they simply did so at another institution. From the standpoint of meeting society's need for an educated citizenry, this is indeed success, and if the student found an institution that better suited their academic and social needs, it can easily be labeled an individual success as well. These results, therefore, while far from useless, are unnecessarily limited and may conceal important findings both for the institution and for citizens, legislatures, state governing boards, and others with a broader interest in higher education. Since our interest is in this broader definition of student success, we will not discuss the traditional model results in depth. The detailed results are available in Table 4.

Multinomial Logit Model

In the model estimated, the base outcome was not graduating from any higher education institution. This includes both those students who are still enrolled at the end of the observation window and those who have completely discontinued their education. It is impossible to know whether or not those students who are still enrolled will ever

complete their degrees, although a follow-up study after more time has passed would improve the likelihood that all students have reached their final level of educational attainment. The results of this model appear in Table 5.

Associate Degrees | No Degree. The outcomes for students who are “reverse transfers,” leaving the four-year study institution to obtain a two-year, associates-level degree, are more difficult to predict than for the other categories. These represent a smaller subgroup, so it may be possible that still more observations could improve the precision of the model, but it may also be that their decisions are more idiosyncratic. Perhaps most interestingly, unlike bachelor-level degree attainment, first-term academic performance as measured by first-term GPA, ratio of credits completed successfully to those attempted, and number of course withdrawals are not statistically significant predictors of associates-level degree attainment. However, measures of academic preparation and academic fit are statistically significant. All other things equal, students with higher ACT/SAT scores are less likely to complete an associates-level degree than to fail to graduate. Students who enrolled in the UM-TC’s developmental education college, known as General College, were also less likely to attain an associates-level degree than to not graduate, all other factors equal. Those students who were admitted to their first choice college at the UM-TC were also less likely to earn an associates-level degree than not to graduate. Advanced credits transferred at enrollment were not statistically significant predictors of associates-level degree attainment.

Table 5

Multinomial Logit Parameter Estimates

ND: Success	AA:no degree		BA Other:no degree		UM BA: no degree	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
First-term GPA	-0.1053	0.0898	0.4811***	0.0582	0.9337***	0.0358
Completion Ratio	0.5507	0.3393	1.7177***	0.3357	2.2870***	0.2012
W Count	0.1005	0.1144	-0.3860***	0.1022	-0.7220***	0.0613
ACT/SAT	-0.0680***	0.0182	-0.0352**	0.0117	-0.0061	0.0070
General College	-0.6863***	0.1587	-1.0206***	0.1183	-1.2135***	0.0678
1st Choice	-0.2801*	0.1284	-0.1709*	0.0845	0.2332***	0.0529
Advanced Credit	0.0060	0.0074	0.0053	0.0049	0.0185***	0.0028
Female	0.6193***	0.1215	0.4146***	0.0747	0.0916*	0.0453
Asian	-0.3279	0.1889	-0.5492***	0.1511	-0.1023	0.0769
Minority	-0.7401***	0.2433	-0.7344***	0.1769	-0.2614***	0.0902
2000	0.1344	0.1421	0.0160	0.0886	-0.1249*	0.0548
2001	0.0875	0.1436	-0.0566	0.0890	-0.0754	0.0543
Reciprocity	-0.6610***	0.1718	0.5546***	0.0825	-0.2313***	0.0543
Non-reciprocity	-0.2841	0.4707	0.5595*	0.2475	-0.2218	0.1724
On-campus Housing	0.0976	0.1328	0.3704***	0.0958	0.5814***	0.0545
LL Communities	-0.1871	0.2650	-0.1747	0.1354	0.1257	0.0820
Applied FA	0.0913	0.1292	-0.1113	0.0775	-0.0107	0.0484
Pell	-0.2716	0.1486	-0.4802***	0.1035	-0.4643***	0.0581
Constant	-1.0453	0.5245	-3.4141	0.4178	-4.0521	0.2551

Note. * $p < .05$. ** $p < .01$. *** $p < .001$.

Some demographic factors were also statistically significant predictors of associates-level degree attainment. All other things equal, female students were more likely to complete an associates-level degree, while Asian students (although only at a permissive .10 level of significance) and underrepresented minority students were less likely to complete an associates-level degree than not to graduate. Compared to other similar students, those from states within the tuition reciprocity area are less likely to

attain an associates-level degree than not to graduate. For associates-level degree attainment, none of the social integration or financial need indicators were statistically significant predictors, with the exception of a modest (.10 level) finding that students who were eligible for Pell grants were less likely to complete an associates-level degree relative to not graduating.

Baccalaureate Other | No Degree. Academic factors play a prominent role in the success of students in obtaining a bachelors-level degree from an institution other than the UM-TC. In their first term of enrollment at the UM-TC, students who have higher GPAs, successfully complete more of their courses, or withdraw from fewer courses are more likely to eventually complete a bachelors-level degree from another institution than not to graduate. As with associates-level degree attainment, higher ACT/SAT scores and enrollment in General College lead to a statistically significant decrease in the likelihood of attaining a bachelors-level degree than not graduating. Finally, being admitted to the student's first-choice college at the UM-TC reduces the likelihood of completing a bachelors-level degree at another institution compared to not graduating.

A variety of demographic factors were also statistically significant predictors of bachelors-level degree attainment from another institution. As with associates-level degree attainment, female students were more likely to graduate, while Asian students and underrepresented minority students were less likely to graduate with a bachelors-level degree from another institution than not to graduate at all. The pattern for geographic factors, however, reverses what was seen for associates-level degrees. Students from tuition reciprocity states and those from states beyond the reciprocity area

were more likely to complete a bachelors-level degree from another institution than not to graduate.

Students who lived on campus their first term were significantly more likely to graduate with a bachelors-level degree from another institution than not to graduate, suggesting the influence of social integration may extend beyond the entry institution. Financial need, however, worked to reduce the likelihood of degree attainment. Being eligible for a Pell grant again showed a negative and statistically significant impact on the probability of completing a bachelors-level degree from another institution compared to not graduating.

Baccalaureate University of Minnesota-Twin Cities | No Degree. First-term academic performance factors were also significant predictors of the probability of attaining a bachelors-level degree from the UM-TC. Students whose first term grade point average was higher, who completed more of the credits they attempted, or withdrew from fewer courses were more likely to graduate from the UM-TC relative to not graduating. Lower levels of academic preparation as measured by enrollment in General College were associated with lower estimated probabilities of graduation from the UM-TC, all other factors equal. Unlike the results for associates-level degrees and bachelors-level degrees from other institutions, the number of credits a student brought with them at admission was a statistically significant predictor of the probability of graduating from the UM-TC compared to not graduating, with additional credits transferred increasing the likelihood of graduation. However, ACT and SAT scores were not statistically significant predictors of the likelihood of graduating from the UM-TC, controlling for other factors.

The findings for academic fit also stand in contrast to the results for associates-level degrees and bachelors-level degrees from institutions other than the UM-TC. Students who were admitted to their first choice college at the UM-TC were more likely to graduate without transferring. Combined with the findings that admission to the first-choice college was negatively associated with the attainment of an associates-level degree or a bachelors-level degree from another institution, this suggests strongly that students who are admitted to their first-choice college are more likely to stay at the UM-TC and either succeed or fail, while students who were not admitted to their first-choice college were more likely to consider alternative institutions to complete their education.

Consistent with the estimates for the other outcomes, female students were more likely than others to complete their degrees at the initial institution compared to the probability of not graduating. Likewise, students who were members of underrepresented minorities were less likely than otherwise similar students to complete a bachelors-level degree at the University of Minnesota compared to not completing a degree.

Geographic factors also appear to play a role in the successful completion of a degree without moving to another institution. Students from states within the tuition reciprocity region were less likely than their otherwise similar in-state peers to complete their degree at the UM-TC. Combined with the finding that these same students were more likely than similar in-state students to complete a bachelors-level degree at another institution compared to not graduating, this reinforces the notion that students from nearby states who find the University of Minnesota is not a good fit for them

academically, socially, or financially are likely to turn to other institutions to complete their bachelors-level degree rather than discontinuing completely.

Social integration also appears to improve the likelihood of graduating from the University of Minnesota rather than not completing a degree. Students who live on campus their first term, and therefore are more likely to be enmeshed in the campus culture, are statistically significantly more likely to complete their degree at the UM-TC than otherwise similar students who lived off-campus. Financial need, however, shows a persistent pattern of lowering the likelihood of completing a degree. Controlling for other factors, students who were eligible for Pell grants were less likely to complete a degree without moving to another institution compared to students with greater financial resources.

IIA Assumption. Two avenues that can be pursued to assess the empirical significance of the IIA assumption are formal statistical tests of IIA and substantive comparisons of models that relax this assumption with those that do not. Stata provides two common tests for assessing the MNL's IIA assumption: the Hausman test and the Small-Hsiao test (StataCorp, 2005). For each test, one of the alternatives is omitted to test the sensitivity of the results to a change in the number of alternatives, and this is repeated for each alternative. For this data set, the results are consistent, with both tests failing to find statistically significant impacts. While not unequivocal, these results suggest that the IIA assumption is likely appropriate for this data.

Multinomial Probit Model

The estimates for the multinomial probit model appear in Table 6. At its most basic level, that question depends on whether potential violations of the independence of irrelevant alternatives assumption impact the model estimates. To ascertain whether that

Table 6

Multinomial Probit Parameter Estimates

ND: Success	AA: no degree		BA Other:no degree		UM BA: no degree	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
First-term GPA	0.0551	0.0500	0.3390***	0.0370	0.7303***	0.0277
Completion Ratio	0.5122	0.2033	1.2060***	0.2025	1.7629***	0.1541
W Count	-0.0133	0.0708	-0.2896***	0.0655	-0.5576***	0.0485
ACT/SAT	-0.0368***	0.0101	-0.0230**	0.0074	-0.0036	0.0055
General College	-0.5278***	0.0909	-0.7234***	0.0745	-0.9669***	0.0543
1st Choice	-0.1252	0.0722	-0.0833	0.0551	0.1987***	0.0420
Advanced Credit	0.0045	0.0040	0.0041	0.0030	0.0142***	0.0021
Female	0.3739***	0.0671	0.2621***	0.0479	0.0669	0.0355
Asian	-0.2106	0.1084	-0.3424***	0.0913	-0.0812	0.0615
Minority	-0.4378**	0.1330	-0.4811***	0.1075	-0.2135**	0.0725
2000	0.0628	0.0791	0.0085	0.0574	-0.0949	0.0430
2001	0.0357	0.0795	-0.0412	0.0574	-0.0589	0.0425
Reciprocity	-0.3461***	0.0885	0.3292***	0.0539	-0.2018***	0.0420
Non-reciprocity	-0.2017	0.2563	0.3060	0.1658	-0.2034	0.1330
On-campus Housing	0.1142	0.0753	0.2712***	0.0603	0.4609***	0.0434
LL Communities	-0.0885	0.1373	-0.0874	0.0851	0.1089	0.0623
Applied FA	0.0349	0.0711	-0.0634	0.0504	-0.0057	0.0378
Pell	-0.1956	0.0831	-0.3433***	0.0653	-0.3668***	0.0465
Constant	-1.2777	0.3021	-2.4270	0.2570	-3.1518	0.1961

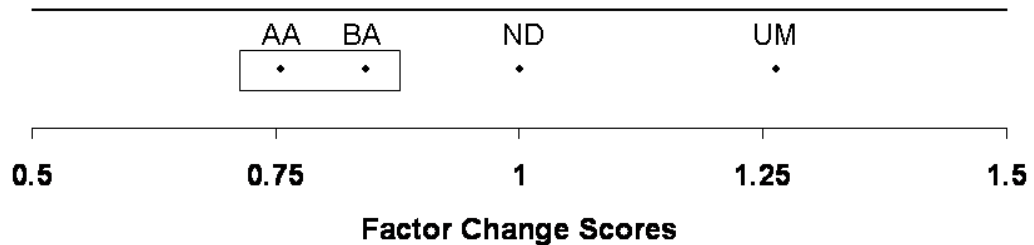
Note. * $p < .05$. ** $p < .01$. *** $p < .001$.

is an issue for this data set, one can compare the results from the MNL and MNP models. In this case, there are no substantive differences in the conclusions between the two models, and very slight differences in the estimated coefficients. There is not, therefore, a compelling reason for this study to use the more complex and demanding methodology.

One of the strengths of the multinomial logit approach is that it produces estimates that are relatively more easily interpreted than those of the multinomial probit model. The exponential of each coefficient in the model indicates the change in the odds ratio of that pairwise comparison of outcomes that results from a one-unit change in the associated independent variable. These exponentiated coefficient values are referred to as factor change scores as they indicate the factor by which the odds ratio shifts. In addition, it is fairly straightforward to calculate predicted probabilities for each outcome for any set of observations. This allows the practical impact of changes in the independent variables to be illustrated.

Selected Interpretations: Four variables in the models above tell interesting stories that can be represented through the factor change scores and predicted probabilities. These are whether the student was admitted to their first-choice college upon admission to the UM-TC, whether the student lived on campus their first term, whether the student was from a reciprocity state, and whether the student was eligible for a Pell grant in their first term of enrollment.

The influence of a student being admitted to their first choice college can be seen in Fig. 2. As mentioned above, students who were admitted to their first-choice college were more likely to graduate from the UM-TC relative to not earning a degree.



Predicted Probabilities (All other variables at means)			
Outcome	No	Mean	Yes
ND	34.0%	30.7%	29.5%
AA	2.5%	1.9%	1.7%
BA	9.3%	7.5%	6.9%
UM	54.9%	59.9%	61.7%

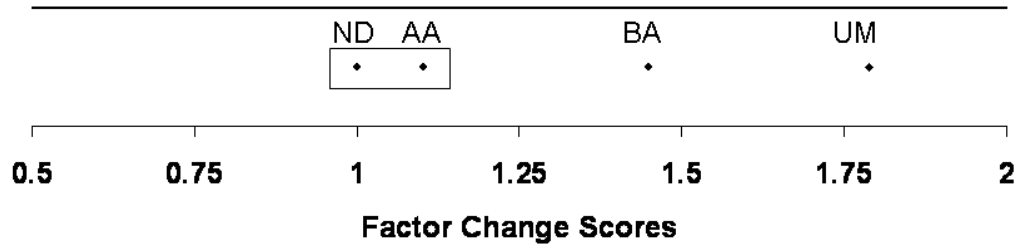
Percentage Admitted to First Choice College			
Outcome	No	Yes	Students
ND	38.8%	61.2%	3,969
AA	41.5%	58.5%	330
BA	30.9%	69.1%	1,066
UM	20.6%	79.4%	9,100

Figure 2. MNL impacts: Admitted to first choice college.

These students were, however, less likely to graduate from another institution relative to their likelihood of not graduating. This can be seen from the graph of factor change scores, as the value for UM-TC graduates (labeled “UM” in Fig. 1) is greater than one (the base outcome, labeled “ND” for no degree) and distinct. The box around the symbols for associates-level degrees (“AA”) and bachelors-level degrees from another institution (“BA”) indicate that these outcomes cannot be statistically significantly distinguished from each other. However, the base outcome and graduating from the UM- TC lie outside the box, indicating those differences are statistically significant. Substantively, then, the

influence of being admitted to one's first-choice college is similar for other institutions, and the opposite of that for graduating from the UM-TC. This suggests students who are unable to find their desired academic fit at the UM-TC may turn to other institutions, or leave higher education altogether. The predicted probabilities in Figure 1 illustrate the size of this impact, as a student who is otherwise at the mean on all other variables increases their odds of graduating from the UM-TC from 54.9% if not admitted to their first-choice college to 61.7% if they are. Likewise, the odds of our otherwise-average student graduating from another institution, at either the associates level or the bachelors level, increases if the student is not admitted to their first choice college at the UM-TC. A final perspective of these phenomena can be seen in the percentage of those in each category who had been admitted to their first choice college. While nearly 80% of those who graduated from the UM-TC were admitted to their first choice college, just fewer than 70% of those who earned a bachelors-level degree at another institution were admitted to their first choice college, and for those who earned an associates-level degree, that number drops under 60%. Clearly, academic fit matters for student success at the University of Minnesota.

Using the same set of tools, the impact of living on campus during the first term of enrollment is examined in Fig. 3. The factor change scores for ND and AA are indistinguishable, while those for the BA and UM categories are higher and statistically distinct from the other outcomes. Living on campus has a strong positive impact on the

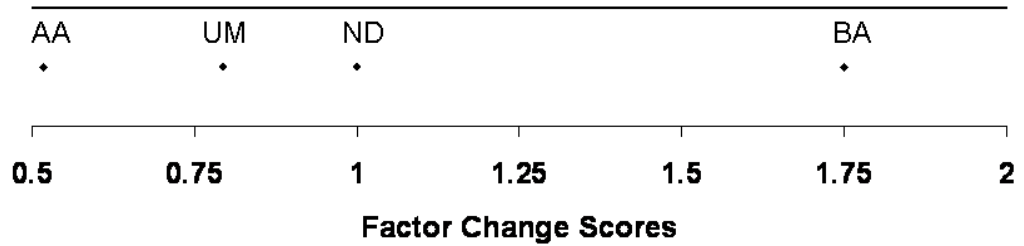


Predicted Probabilities (All other variables at means)				Percentage Living on Campus			
Outcome	No	Mean	Yes	Outcome	No	Yes	Students
ND	39.7%	30.7%	27.7%	ND	37.5%	62.5%	3,969
AA	2.3%	1.9%	1.8%	AA	37.3%	62.7%	330
BA	7.4%	7.5%	7.5%	BA	19.4%	80.6%	1,066
UM	50.6%	59.9%	63.1%	UM	20.1%	79.9%	9,100

Figure 3. MNL impacts: Living on campus.

relative odds of graduating from the UM-TC compared to all other outcomes.

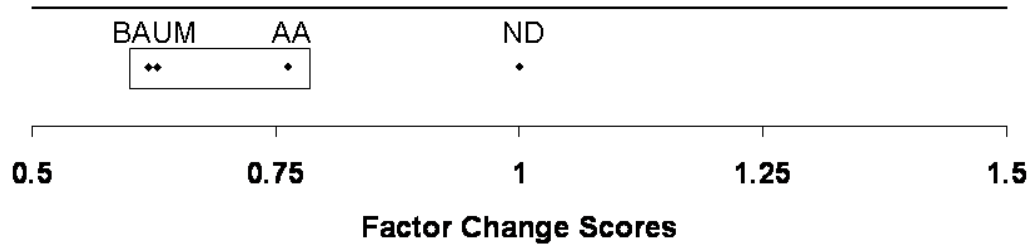
Interestingly, living on campus the first term also increases the odds of graduating from another institution with a bachelors-level degree compared to the other outcomes except staying at the UM-TC. It would appear that whether through the impact of social integration into the university community or as a proxy for greater resources, living on campus during the first term increases the odds of the attainment of a bachelors-level



Predicted Probabilities (All other variables at means)				Percentage From a Reciprocity State			
Outcome	No	Mean	Yes	Outcome	No	Yes	Students
ND	29.8%	30.7%	32.8%	ND	78.0%	22.0%	3,969
AA	2.2%	1.2%	1.2%	AA	85.4%	14.6%	330
BA	6.3%	7.5%	12.1%	BA	56.1%	43.9%	1,066
UM	61.8%	59.9%	53.9%	UM	71.6%	28.4%	9,100

Figure 4. MNL impacts: Student from reciprocity state.

degree, regardless of at which institution it is earned. Looking at the predicted probabilities, it would appear that while statistically significant, the impact for bachelors-level degrees at other institutions are small. By contrast, living on campus increases the probability of our theoretical average student graduating from the UM-TC by over twelve percentage points. The distribution of living arrangements for students in each category is striking, with roughly 80% of eventual UM-TC and other bachelors-level graduates



Predicted Probabilities (All other variables at means)				Percentage Eligible for Pell Grants			
Outcome	No	Mean	Yes	Outcome	No	Yes	Students
ND	24.3%	30.7%	33.7%	ND	73.4%	26.6%	3,969
AA	1.8%	1.9%	1.9%	AA	77.6%	22.4%	330
BA	8.3%	7.5%	7.1%	BA	86.2%	13.8%	1,066
UM	65.6%	57.2%	61.7%	UM	86.3%	13.7%	9,100

Figure 5. MNL impacts: Eligible for Pell Grants.

living on campus, while the percentages for associates-level graduates and non-graduates hover in the low 60s.

The impact of attending the UM-TC from a reciprocity state is striking in that the factor change scores of each outcome are statistically distinguishable from the others, as illustrated in Fig. 4. A clear hierarchy of relative probabilities therefore emerges.

Relative to the other outcomes, students from reciprocity states are more likely to graduate with a bachelors-level degree from another institution than their otherwise

similar peers. By contrast, they are least likely to earn an associates-level degree, and less likely to earn a degree from the UM-TC. This echoes findings from earlier studies at the UM-TC, which suggest that it struggles to achieve similar levels of success with students from reciprocity states to those of in-state students. As the predicted probabilities indicate, it is still more likely that a student from a reciprocity state will graduate from the UM-TC than that they will graduate elsewhere or discontinue, but the decline in that probability is noticeable, and the odds that an otherwise average student will graduate with a bachelors-level degree from another institution doubles when that student is from a reciprocity state rather than hailing from within Minnesota.

The last highlighted result is for students who are Pell eligible is presented in Fig. 5. Even though financial aid is available to these students, it is clear that all other things equal, they are not as successful as their wealthier peers. The picture that emerges from the factor change scores is that there is little difference in the relative likelihood of any particular successful outcome, but that all of them are less probable for a student who is Pell eligible than an otherwise similar student who is not. For a student who is otherwise average on all other observed factors, being Pell eligible raises the probability of not graduating by nearly ten percentage points. Pell eligible students are likewise more common among associates-level degree recipients and non-graduates than among bachelors-level degree recipients.

Limitations

The results of our study are limited in several recognizable ways. The first limitation stems from the generalizability of the results. This study was based on three

cohorts of freshman enrolled at a single institution between 1999 and 2001. The generalizability of the results are therefore limited to the extent that the entering freshman class at the University of Minnesota-Twin Cities accurately represent a cross-section of college freshman. As a large, Midwestern, public, selective, doctoral extensive research institution, it is almost certainly not fully representative of the vast variety of institutions of higher education. As a result, the identified relationships between the independent variables and the different outcome comparisons may not hold in other environments, suggesting the need for future research. We feel strongly, however, that this approach can be utilized at other institutions, and that differences unearthed through such research can enrich our understanding of both students and institutions.

A second limitation stems from the limited set of variables incorporated into our model. While great care was taken to incorporate independent variables cited frequently as affecting student success, we have chosen to rely exclusively on data drawn from institutional administrative systems to maximize our ability to replicate the analysis and make predictions with future student cohorts. As a result, socio-psychological factors are ignored in our research to the extent that they are independent of our other measures. This results in an incomplete model of student success.

A third limitation stems from the source of our data on third-party graduation rates. While the National Student Clearinghouse is a rich source of data on enrollment and graduation outcomes across institutions, it is not complete. As a result, it is likely there are additional students who we have categorized as failing to attain a college degree who were, in truth, successful. As we have shown, students who leave their original

institution but complete their degrees elsewhere are distinguishable from those who do not. Therefore, the classification error we seek to reduce through tracking degrees from other institutions is not completely eliminated.

A final limitation stems from our focus on student outcomes, and not on the full path students take to achieve those outcomes. While we believe utilizing data from the National Student Clearinghouse provides a way forward to more accurately model student success, our categorical dependent variable fails to distinguish more sophisticated patterns of enrollment such as swirling and double dipping. As a result, the factors associated with these more complicated patterns of enrollment that may ultimately influence student success are not included in our results. These remain important questions for future research.

Discussion and Implications

Nearly all the theory and resulting student retention literature has been built around a single institutional perspective of success. While this perspective fits a traditional, linear progression model of student enrollment and degree attainment, it does not capture the path to success now followed by many students. By expanding the definition of success beyond the single institution, the study of student retention research shifts from an institutionally focused perspective to one that is more student-centered. This shift is the critical focus of our study. We know with a great deal of certainty what factors influence student success from a single institution perspective. If we changed the perspective to a student-centered definition of success, would these same factors matter? That is, do our theoretical models still work or do we need a new framework? Further,

do we gain insights by distinguishing those students who leave their initial institution but complete their degree elsewhere from those who are not successful in attaining a college degree? Our findings suggest that existing theoretical work does still provide a solid understanding of student success viewed from this new perspective, and that it also provides us with ways of thinking about which departing students are likely to be successful at subsequent institutions.

Where change is needed is in higher education policy. Given SRK and the heavy emphasis of national rankings that incorporate graduation rates based on SRK definitions, it should not be surprising that the focus of most institutions has been on ensuring new freshman students finish their degree from their starting institution. There is an inherent mismatch between an individual institution's interest and those of students and more broadly societal interest in building an educated citizenry. Institutions typically focus their policy (assets, resources, training) on efforts determined by graduates of their own institution, as they only get "credit" for their own students' success, while if those students transfer out and graduate from another institution they do not. Students, however, succeed if they earn a degree, regardless of whether it is from their original institution. With a priority on ultimate degree attainment, policy efforts could radically shift at some institutions, as well as among the organizations that rate and evaluate them. If institutional focus was realigned with the student's interest, with a priority on degree attainment in general, then transfer policies would become more seamless, admission policies would be developed to ensure the interest of the student is aligned with the institution's offerings, and student degree attainment regardless of starting institution

would be the standard of success. Institutions would be evaluated by how effectively and efficiently they move students toward degree attainment, even if that degree was awarded by a different institution. Those institutions whose transfers are ultimately successful would be recognized for their broader societal contribution and unheralded effective programs and training would be identified. Differentiating students by those who truly drop out of the higher education system versus those who are ultimately successful at other institutions also provides an important fine tuning of every institutions' development of effective retention policies – mixing these two very different groups complicates developing effective interventions.

The NSC data collection provides an important opportunity for higher education institutions to expand their definition of student success to include enrollment and degree attainment at other institutions. With the advent of the VSA the public reporting of student success across institutions through the NSC data should give us a much better appreciation of the success of public higher education in the United States. The more complex question of “where” and “why” can also now be examined with the data available through the NSC StudentTracker service.

Using this data and appropriate methodologies for multi-category, unordered variables also provides institutions the opportunity to separate competitive disadvantages from more universal hurdles to student success. In this study, for example, we find that when students are not admitted to their first choice college there is a potential competitive disadvantage, as some appear to choose to move to another institution to complete their education, presumably one that will afford them a place in their field of interest. By

contrast, we find that Pell eligibility among our incoming freshmen impacts success at both our own and alternative institutions at similar levels, so it represents a broad barrier to student success. The University of Minnesota has taken steps to address both of these issues, increasing the role of students' college preferences in admissions decisions and instituting the Founders Free Tuition Program to provide full tuition coverage for incoming students with significant financial need.

The multi-categorical, unordered nature of multi-institutional graduation outcomes necessitates the use of alternative methodologies to the standard logit model. Options such as multinomial logit and multinomial probit are well suited to this analytic challenge. A further advantage of this approach is that it reduces known measurement error in our observations of student success, capturing information on students who successfully obtain a degree at another institution. These students would otherwise be grouped with non-graduates, but as we have shown, they differ systematically from other students who leave their institution of first enrollment. This reduction in measurement error improves the confidence we can have in our parameter estimates.

In dealing with these models, it is important to be aware of their inherent assumptions and to assess whether they are appropriate given the data and research question. A critical distinguishing feature of multinomial logit and multinomial probit models is the former's reliance on the assumption of the IIA. As we have shown, it is possible to test the validity of this assumption. Further, even if it is violated, it may not necessarily matter on a practical level. Investigation of these issues is critical in establishing the reliability of model estimates. It is also worth noting that, while it is more

computationally demanding, the multinomial probit model is by no means beyond the reach of readily available statistical software and computer hardware. It will, however, take more time to process, and care should be taken to ensure the model does not run into convergence problems.

As more data becomes available, it may be possible to further distinguish the set of student outcomes. For example, we might distinguish students who enroll at a similar institution, in our case a major research university, from those who go on to pursue a bachelors-level degree in a markedly different environment, such as a small liberal arts college. In addition, we may be able to determine the factors that lead to student success over a longer period versus those who complete their degree on schedule.

While this paper introduces several popular methods for dealing with polychotomous dependent variables, it is important to recognize that other methodological approaches are also worth exploring. Options such as nested logit, conditional logit, or structural equation modeling provide the opportunity to examine characteristics of both the student and the institutions in their choice set. There are, however, limiting issues in terms of aggregating the results to meaningful groups of institutions. The decision about which model best fits the underlying data is ultimately an empirical question. Additional work should be done to assess the appropriateness of the models presented. Monte Carlo simulations offer a potential means to test the appropriateness of the model specification and its sensitivity to changes in the underlying data.

The path to success for many students is not the simple, direct route represented by the traditional institutional graduation rate. To understand the complexities of those journeys and devise effective and efficient approaches to improving student success, an expanded definition of graduation and an alternative set of methodological tools are needed. The approach we have outlined provides a means to address these questions and establish confidence in the resulting conclusions.

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Chapter 3: Priced out? The Relationship Between Financial Aid and Educational Trajectories of First-Year Students Starting at a Large Research University³

Abstract

While the literature on postsecondary student success identifies important academic and social factors associated with student outcomes, one question that persists concerns the influence of financial aid. We use the National Student Clearinghouse's StudentTracker service to develop a more complete model of student success that accommodates opportunities for students to choose to either graduate from the university of first-entry, graduate from a transfer university, or depart from college without a degree. The multinomial regression model reveals differential effects of financial aid. Results suggest that loan aid appears to encourage students to search out alternative institutions or drop out of college entirely, and merit aid appears to increase the likelihood of students persisting and graduating from the university of first-entry.

Introduction

In response to rising college costs, financial aid has become an essential tool for keeping college affordable for many Americans. As the frequency with which students rely upon student loans to finance higher education climbs, the long-term consequences

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associated with student borrowing are frequently cited as a concern among those with a stake in higher educational outcomes (Smith, 2007; Ronstadt, 2009). Policy-makers, for example, worry that students with high debt burdens may defer important economic activity by opting to “put off life milestones such as buying a car, owning a home, getting married, or entering certain low-paying professions like teaching or social work” (AASCU, 2006, p. 2). Meanwhile, higher education administrators are concerned with findings that suggest that students with debt burdens after college may be less likely to enter graduate and professional school (Millett, 2003).

While the long-term effects of student borrowing are clearly disconcerting, the consequences of student financial aid choices also have important short-term consequences that are potentially more dire to students. The American Association of State Colleges and Universities (AASCU) suggests that “It is not uncommon for students, especially low-income students, to drop out of college only after accumulating thousands of dollars in student loan debt. Nearly one in five students who do not graduate from college leave with \$20,000 in student loan debt” (AASCU, 2006, p. 3). Dropouts who accumulate student loan debt, it is further argued, have the “worst of both worlds” because they are twice as likely to be unemployed and more than ten times as likely to default on their student loans (Gladieux & Perna, 2005). Consequently, student financial decisions pose serious and immediate challenges for students, higher education, and society.

The potential relationship between financial factors and student persistence is of particular importance to public college and university administrators who are finding that

justifications for state appropriations are increasingly tied student performance outcomes (Burke & Minassians, 2001; Zumeta, 2001). Despite heightened institutional spending on financial aid and programs targeted at improving student success, student attrition rates remain at undesirable levels at many of the nation's colleges and universities. One estimate suggests that while retention rates vary by institution, as many as four out of every ten students who enter college fail to graduate from the institution of first-entry (Horn, 2006). Consequently, it is important to consider the extent to which financial aid influences the likelihood of graduation. This topic has taken on greater significance as the increased reliance on student loans has forced students to assume a greater personal role in financing their education.

Given that for many students the path to degree completion may more than one institutions (Adelman, 2006), it is important to consider how issues of student finance may impact the shape of that path. Utilizing a measure of degree attainment that accommodates graduation outcomes beyond the university of first-entry, the purpose of this paper is to consider whether the type of student aid utilized by students affects the postsecondary trajectory toward degree completion. If it is the case that promoting borrowing behavior encourages students to more carefully consider alternative educational opportunities, then an increased emphasis on student borrowing as a means of financing college works directly against an institution's retention goals. If it is the alternative case that tuition discounts are perceived as providing students with an educational bargain that encourage students to remain enrolled until graduation, then

merit- or need-based financial aid may provide institutions with an additional tool to achieve retention and graduation goals.

To help understand how financial aid may affect trajectories toward degree completion this research addresses the following research question: Is there a relationship between the type of financial aid utilized by students to pay for college during their first-year and their subsequent trajectory toward degree completion? It is our belief that understanding how financial aid differentially influences patterns of persistence can aid administrators, trustees, and legislators in weighing the potential consequences from increased institutional investment in students or changes in tuition policy.

Background

With college costs growing substantially over the last thirty years, there has been a significant shift in the philosophy of funding higher education. As college students are required to shoulder an increasing portion of the costs associated with their education, often through student loan programs, it is important to identify whether this emerging fiscal reality is acting as a road-block to success for students. Previous literature on the impacts of financial aid has frequently explored the relationship between financial aid and the matriculation decision, too often paying little attention to persistence decisions (St. John, 2000; Singell & Stater, 2006; Pascarella & Terenzini, 2005). Focused primarily on the issue of college access, these early studies of student finance attempted to identify how the cost of college (Leslie & Brinkman, 1987; St. John, 1994; Heller, 1997), the availability of aid (Chapman, 1981), and different aid packages (Hansen, 1983; Ehrenberg & Sherman, 1984; St. John & Noell, 1989) potentially influenced an

individual's ability to attend college, as well as his or her decision about where to attend. While earlier studies did address the link between financial aid and persistence, much of the work concentrated on the role of financial need and the subsequent impacts of need-based aid programs (Voorhees, 1985; Bettinger, 2004; St. John, 1990).

As trends in financial aid began to shift away from grant-based aid in response to the rising cost of tuition and stagnation in grant award amounts, researchers became increasingly interested in the role of the other types of aid, particularly the dramatic shift toward federal lending that took place during the 1990s (McPherson & Schapiro, 2002). While early studies on financial aid identified a positive association between student loans and persistence (Astin, 1975; Voorhees, 1985; DesJardins et al., 1999), later studies challenged the perceived association between financial aid and degree attainment. Dowd's (2004) examination of the relationship between student borrowing and the likelihood of degree attainment for 1,087 students enrolled at public four-year institutions during AY 1990-91 found that "Loans have a positive effect on persistence, but not on degree attainment" (p. 23). This finding generates important moral and ethical considerations for institutions: if it is the case that student loans simply defer the departure decision to a later point in time, then the associated benefits of the additional year(s) of college must be weighed against the costs of leaving college with a sizeable debt load, yet no credential.

Just as students are reliant on financial aid to help facilitate their educational goals, institutions are increasingly relying on different forms of financial aid to help achieve their targeted enrollment goals. While both grant- and loan-based aid have been

historical tools in delivering an accessible education to students either unwilling or unable to pay the full price of college admission, concern is growing that colleges and universities are increasingly utilizing institutional grant aid to assist in the enrollment of highly desirable students. According to Heller (2006), institutionally-based aid (including scholarships and grants) are being increasingly awarded to students based on academic merit without consideration of financial need. Given the competition for highly prepared students, it is perceived that merit aid can help “students who have demonstrated high academic ability; help institutions recruit meritorious candidates for admission; may help states encourage academic excellence in high school and college attendance; and provide some relief for middle-income families who may not qualify for traditional need-based aid but feel squeezed by the continuing growth of college prices” (Redd, 2004, p. 33). While studies have identified that the availability of merit aid is likely to influence a student’s decision about which college to attend (Dynarski, 2002; Singell et al., 2004), less is certain about the long-term benefits associated with merit aid. For example, Henry et al. (2004) found that the Georgia Hope scholarship had a positive effect on graduation rates at both 4-year and 2-year institutions and persistence at 4-year institutions; however, they found no effect of the scholarship on persistence at 2-year institutions. Singell et al. (2004) found that merit aid (scholarships) had positive effects on retention for students who did not apply for financial aid and no effect on students who did file for financial aid, suggesting that “well-to-do students have a larger choice set of higher educational institutions and are better able to respond to differences in scholarship opportunities across institutions” (p. 470).

While the growing body of literature on financial aid continues to identify important associations with the retention and graduation outcomes of college students, nearly all of the existing studies have relied on a strict interpretation of college success. Specifically, the dominant assumption in the existing financial aid literature, as well as the student success literature overall, is that students are successful if, and only if, they are retained and graduated from the university of first-entry. While such an assumption provides the theoretical and methodological parsimony conducive to empirical study, we know that college students' paths to completion are more complicated than this, frequently involving multiple institutions (McCormack, 2003; Borden, 2004; Adelman, 2006). Capturing the full complexity of these patterns is beyond the scope of our study, but recognizing that the path to a degree may pass through more than one institution requires modeling outcomes beyond the traditional dichotomy of graduation and drop-out. To provide a more complete model of the relationship between financial aid and student success in college, this research suggests utilizing a measure of degree attainment that more fully incorporates the options available to students after first enrolling in college. Such a measure takes into account the variety of educational pathways students can take, thus providing researchers and policymakers with knowledge about the longer-term impacts of financial aid on overall degree attainment.

Theoretical Perspective and Model Specification

Rational choice theory has been proffered as a useful mechanism for understanding a variety of issues related to student decision making such as the decision to attend college and the calculation of which college is preferred (DesJardins &

Toutkoushian, 2005). Given that the approach focuses explicitly on how individuals employ cost-benefit analysis to maximize their utility, we find the approach to be particularly well-suited for studying the impact of financial aid as it allows for an explicit emphasis on the role of financial resources in the persistence decision (Beekhoven et al., 2002, p. 582).

Our study is designed to assess whether the forms of financial aid available to a student will influence his or her graduation trajectory by altering perceptions of the costs and benefits associated with degree attainment from the university of first-entry. Furthermore, our research stipulates that this decision is complicated by the availability of education alternatives in the form of transfer activity in ways that have not been previously explored in the extant literature. Specifically, it is the hypothesis of our study that financial aid packages that increase the costs of higher education by requiring a student to take a personal stake in paying for his or her education will work against institutional retention goals by increasing the likelihood of the student seeking out other educational alternatives beyond completion at the university of first-entry. Conversely, we expect that forms of aid that reduce the costs associated with going to college are expected to reduce the likelihood of departure by making the perceived benefits associated with success at the university of first-entry less costly.

In an effort to capture how financial aid may differentially influence the pathways toward degree completion, our study assumes that rather than a simple dichotomy of persistence or departure, a student's persistence decision involves an expanded choice set that includes a choice to graduate from other accessible institutions of higher education.

This can be expressed formally utilizing the notation used by DesJardins and Toutkoushian (2005) for the utility function:

$$U(\textit{Graduate})_{ij} = U(C_j, F_i, S_i) \quad (1)$$

where the expected utility of graduating from school j for student i is determined by the cost of completion at school j , C_j , adjusted by student i 's financial aid award, F_i , as well as any academic and social characteristics of the student that may influence the likelihood of a successful outcome, S_i . Desjardins and Toutkoushian's utility function is specified to allow for the utility calculations of graduation outcomes from any number of j institutions of higher education. However, because our study is not attempting to explain from which specific institution a student will choose to complete his or her degree, much of the associated complexity can be minimized by reducing a student's persistence decision to a choice set that includes: 1) graduation from the university of first-entry; 2) graduation from a four-year transfer university; or 3) non-degree attainment. We expect that the student will choose the path that maximizes their utility, taking into consideration their experience at their university of first-entry and whatever financial aid package is extended to them by competing institutions. If neither the university of first-entry nor the available alternatives present a viable and compelling option, the student will discontinue enrollment entirely.

We motivate this proposed choice set with the following random utility model:

$$U_a^i = D_j^i - \varepsilon_j^i \quad (2)$$

such that the utility of student i completing a four-year degree from university j can be explained as being comprised of both a deterministic, D_i , and a random, a , component. Following DesJardins and Toutkoushian (2005), we can then model student success outcomes as an unobserved latent variable reflecting the relative utility the student derives from their persistence decision. We expand on the most common approach to persistence modeling by including the option to transfer to another university. This is expressed by the following equation:

$$y^* = U_a^i - U_b^i \quad (3)$$

such that if a student's expected utility for persisting to graduation at the university of first-entry, U_a^i , exceeds that of graduating from a transfer university, U_b^i , we would expect that he or she would persist rather than transfer.

It is important to note that use of a rational choice framework does not imply that students have perfect information on their educational alternatives or are flawless in weighing the relative costs and benefits of those alternatives. Rather, students form their expectations of the utility of different choices based on the information available to them and their individual tolerance for risk, both of which are generally not observable by researchers, and we must infer their judgments about relative utility from their visible choices.

To be clear, the benefit of incorporating elements of rational choice into the theoretical perspective on college persistence is not that it can be used "to determine if the choices made by students are rational per se, but rather to understand how decisions

change when one or more of the factors affecting choice change” (DesJardins & Toutkoushian, 2005, p. 226). Given our expectation that factors associated with financial aid will alter the cost-benefit structure associated with the persistence decision, we feel this is an important insight as students increasingly rely on financial aid to help offset the rising costs of college.

Data and Methodology

To explore if factors related to student finances affect the enrollment decisions of freshmen at the University of Minnesota - Twin Cities, a large, midwestern research university classified by the Carnegie Foundation as having very high research activity (RU/VH), we utilized census data for the fall 2002 freshman cohort obtained from the University’s data warehouse. In fall 2002, the University enrolled 48,677 students, 28,103 of whom were undergraduate students. Given our explicit interest in the graduation outcomes of first-year college students, the original data sample consisted of 5,188 first-time, full-time students.

To facilitate our desire to model how factors related to financial aid may contribute to college completion beyond the university of first-entry, we utilized the StudentTracker service offered by the National Student Clearinghouse (NSC). The National Student Clearinghouse is a non-profit organization that provides third-party enrollment and degree verification for secondary and postsecondary institutions across the country. With more than 3,300 colleges participating in the Clearinghouse’s different verification services at the time of our study, the NSC data served as a rich source of data

pertaining to the educational career paths of more than 90 percent of college students in the United States (NSC, 2009).

Data from the National Student Clearinghouse has provided researchers with interesting opportunities to explore expanded choice sets for students. For example, both Porter (2002, 2003) and Herzog (2005) utilized data from the National Student Clearinghouse to construct persistence models with multiple outcomes, identifying factors associated with the likelihood of a student returning, transferring, or dropping out of college after his or her first year. While first-year retention remains an important piece of the student success puzzle, it is important to note that as institutions of higher education continue to invest more and more resources in first year retention programs, there is becoming less and less for researchers to explain in terms of first year retention outcomes.⁴

In our study we adopt a similar approach as that put forth by Jones-White, Huesman, Radcliffe, and Kellogg (2010) which employed data from the National Student Clearinghouse to create a polychotomous measure of six-year graduation outcomes across institutions of higher education. Specifically, the approach adopted in our study attempts to discern if a student completed a degree at the university of first-entry,

⁴ For example, more than 85 percent of students enrolled as freshman examined in our study returned for a second year. Of those that chose not to return after their first year, estimates from the National Student Clearinghouse suggest that as many as 62 percent of these students end up in another post-secondary institution within the next year.

completed a degree at a four-year transfer university, or failed to complete a degree all within the six-year window of first enrollment in college.⁵

To accurately identify the graduation outcomes for those students departing the University prior to obtaining a degree, the cohort was initially divided into two groups; those who graduated from the university within six years (just under 66 percent of students in our sample graduated by the end of AY2007-08) and those who did not. The list of non-graduates was sent to the National Student Clearinghouse to determine whether the students graduated within six years of first enrollment in college from any another four-year university. Graduation outcomes were identified for 440 of these students, suggesting that more than 24 percent of students who dropped out of the University of Minnesota - Twin Cities had graduated from a four-year transfer university within six years of first starting at college at the University. The result is a three outcome variable that indicates whether a student graduated from the University of Minnesota - Twin Cities (65.9%), graduated from a four-year transfer university (8.5%), or failed to graduate within the period of observation (25.6%).

⁵ Jones-White et al. (2010) also included a category for reverse transfers; however, due to sample size limitations we were unable to reproduce that category in our study. For the purpose of our study, which focuses on degree completion from a four-year institution, successful reverse transfer students were categorized as having not obtained a degree.

Methods

Because of the three outcome categories included in the dependent variable, it is necessary to identify a model specification that appropriately accommodates polychotomous choice sets. One approach to modeling expanded choice sets is to utilize the multinomial logit model, which is represented by the equation:

$$\ln \Omega_{m|b} = \ln \frac{Pr(y = m|x)}{Pr(y = b|x)} = x\beta_{m|b}, m = 1, \dots, J. \quad (4)$$

Long (1997) describes the method as “simultaneously estimating binary logits for all possible comparisons among the outcome categories” (p. 149). The model has recently been applied to various higher educational studies including first-year retention choices (Herzog, 2005; Stratton et al., 2008) and six-year graduation rates (Jones-White et al., 2010).

Model Specification

The explanatory variables utilized in our study are based on the student retention literature and reflect characteristics of a student collected both prior to admission and during their first semester. Our study is fortunate to build on the published retention studies conducted at the University of Minnesota - Twin Cities and incorporates factors related to student success identified by DesJardins, Ahlburg, and McCall (1999, 2002), Huesman, Brown, Lee, Kellogg, and Radcliffe (2009), and Jones-White, Radcliffe, Huesman, and Kellogg (2010). Table 1 provides the descriptive statistics associated with the variables utilized in the subsequent multinomial logit models and a discussion of the coding of the different variables follows.

Cost of attendance. Given that our sample includes only students from a single institution, operationalizing cost of attendance, (C_j), requires us to move beyond including simply the University’s “sticker price” in the model. To attempt to capture the unique cost of attendance for each student in our sample, our study relies instead on the amount of unmet financial need the

Table 1

Summary of Descriptive Statistics for New Entering Freshman to the University of Minnesota – Twin Cities (Fall 2002); Average Financial Measures Include Non-Recipients

	Mean	SD	Min	Max
Cost (in\$1000)				
Unmet Need (in \$1000s)	2.038	3.711	0.000	26.347
Financial Aid Package (in \$1000)				
Need Aid (in \$1000s)	0.948	1.619	0.000	9.186
Loan Aid (in \$1000s)	1.543	2.234	0.000	12.792
Merit Aid (in \$1000s)	0.168	0.538	0.000	6.818
Student Characteristics				
Demographics				
Female	0.534	0.499	0.000	1.000
Underrepresented Minority	0.079	0.269	0.000	1.000
Asian	0.110	0.313	0.000	1.000
First Generation	0.364	0.481	0.000	1.000
Age > 19	0.019	0.137	0.000	1.000
Geographic Origin				
Out-of-State	0.061	0.240	0.000	1.000
Reciprocity State	0.248	0.432	0.000	1.000
Academic Background				
Composite ACT	24.462	4.862	11.000	35.000
No. AP Credits	3.153	6.671	0.000	59.000
Remedial Course Taken	0.083	0.275	0.000	1.000
First Semester Academic Performance				
Course Completion Ratio	91.857	20.288	0.000	100.000
C Count	0.691	0.898	0.000	5.000
D Count	0.130	0.387	0.000	4.000

(continued)

	Mean	SD	Min	Max
Academic and Social Integration				
First Choice College	0.704	0.457	0.000	1.000
Living on Campus	0.621	0.485	0.000	1.000
Living Learning Community	0.139	0.346	0.000	1.000
Athlete	0.041	0.198	0.000	1.000

student has after adjusting for the student aid award. Consequently, it provides an estimate of the personal cost of attendance for the student and is calculated utilizing both *Free Application for Federal Student Aid* (FAFSA) data and internal award and budget information.⁶

Financial aid. One important contribution associated with our study is its ability to utilize more accurate financial aid data than other existing studies in the literature. For example, a cursory examination of the literature on student success quickly demonstrates that PELL eligibility is frequently substituted for a variety of student finance measures;

⁶ Due to the reliance on information obtained from a student's completed FAFSA in our study's empirical model, it was important for us to consider exactly how to best deal with missing data that was produced when students failed to submit a FAFSA. Out of our initial sample of 5,188 students, 1,021 students (or 19.7%) appeared to have failed to fill out a FAFSA and as a result have missing values for the unmet need variable. Believing that both listwise deletion and assuming that individuals who failed to submit a FAFSA had \$0 in unmet need were both undesirable, our study employed regression-based missing value imputation (using STATA's `mi impute` command) to estimate values for individuals with no FAFSA.

however, it has long been recognized to possess a number of shortcomings. Where scholars have been interested in financial aid packaging they have frequently incorporated either award information or self-reported survey data. While each provides useful information pertaining to the perceived financial aid patterns of students they are not void of significant measurement error issues as students may either not accept all of the aid offered in a financial aid offer or accurately recall or report their financial aid decisions. Our study overcomes this issue by utilizing measures of first-term financial aid awards that were disaggregated from the University's financial records system. By identifying and categorizing each of the payments and expenditures associated with a student's financial account, our study is able to provide a more accurate picture of the financial aid utilized by students to pay for college and distinguish between merit-, loan-, and need-based aid forms.

To discern the independent effects associated with of each of the forms of financial aid available, our study grouped different financial aid variables into three broad financial aid types: need-based grant aid, loan aid, and institutional merit aid. Need-based grant aid is a continuous variable that measures the total amount of need-based aid awarded to the student from the following sources: (1) the federal Pell Grant program, (2) the federal SEOG grant program, (3) the Minnesota - Twin Cities state grant program, and (4) institutional need-based awards offered by the University's Office of Student Finance. In fall 2002, more than 39 percent (n=2,035) of new high school students received some form of need aid with the average first-term need award among recipients being \$2,417.05. Of the 2,035 need-based awards allocated to students, 49.5% (n=1,008)

included money from federal grant programs, 59.0% (n=1,200) included money from the state grant program, and 49.9% (n=1,107) included money from institutional resources. The second financial aid variable included in our model is the amount of loan aid the student accepted. It is important to note that while this value reflects all loan aid processed through the institution it is unable to measure loans given directly to the student and/or his or her parents. Approximately 46 percent (n=2,371) of freshman enrolled during fall 2002 accepted a loan award, with the average first-term loan award *among borrowers* totaling \$3,376.69.

The third and final financial aid variable included in our model is scholarship aid. This variable identifies whether the student accepted aid offered through the admissions office in the form of a merit-based scholarship. Just over 12 percent (n=631) of students in our sample received merit-based aid with an average first-term award amount of \$1,383.46 for *students accepting merit aid*.

Student characteristics.

Demographic characteristics. In addition to variables controlling for the student's financial resources, we also include several dichotomous variables to control for the potential influence of demographic characteristics. Female is a dichotomous variable coded 1 if the student was a woman, 0 if not. Underrepresented minority is a dichotomous variable to indicate whether the student is from one of the historically underrepresented racial/ethnic groups in higher education: Native American/American Indian, African American, or Hispanic. Because the University of Minnesota - Twin Cities also has a significant population of Asian students (11.0 percent), a separate

dichotomous variable was also created. First generation student is a dichotomous variable that captures whether the student is the first in their family to attend college. Age > 19 attempts to identify and control for potential effect of being a nontraditional student by indicating if a student is 20 years old or older at the time of freshman enrollment.

Geographic origin. One of the important features of the University of Minnesota - Twin Cities is that the state of Minnesota participates in a heavily-used reciprocal pricing program with its neighboring states: Wisconsin, North Dakota and South Dakota. These reciprocity agreements allow for students in these states to enroll at institution in the reciprocity area under in-state tuition pricing. The reciprocity state variable attempts to control for the potential impacts of this reduced pricing system (coded 1 if the student originated from a reciprocity state, 0 if not). A second geographical origin variable, called out-of-state, was created to capture all other out-of-state students (coded 1 if the student originated from out-of-state, 0 if not). Consequently, in-state students are the reference group.

Academic background. This group of variables attempts to control for the precollege academic ability and preparedness. The composite ACT score variable reports the score on the ACT examination. Where students submitted SAT rather than the ACT scores, we computed an equivalent score based on the concordance table provided by the

College Board.⁷ Advanced Placement credit is a count of the number of credits new high school students were able to transfer in via Advanced Placement testing. Remedial course taken is a dichotomous variable identifying whether the student was enrolled in a remedial mathematics course during their first semester and is a proxy for academic preparation.

First semester academic performance. According to previous research on retention and graduation, first-term GPA is often strongly associated with student success (Pascarella & Terenzini, 1991, p. 388). However, while GPA is a powerful predictor, it does not directly capture how student academic performance impacts progress toward a degree. That is, two students with identical GPAs could be in very different positions in their academic program depending on the distribution of their course grades. In terms of student persistence, failure to complete courses or earning marginal grades that may not be accepted in their major program represent significant challenges. To capture these experiences, we utilize several alternative measures of a student's first semester academic performance employed previously by Huesman, Brown, Lee, Kellogg, and Radcliffe (2009), and Jones-White, Radcliffe, Huesman, and Kellogg (2010). The first academic performance measure is the ratio of credit hours earned-to-attempted by student during their first semester of enrollment. To help with inference, this ratio was multiplied by 100

⁷ Administrative records did not contain either ACT or SAT scores for six students.

Rather than exclude these individuals from our study, we used regression-based missing value imputation to produce score estimates.

so that a unit change reflects a 1/100th change rather than a change across the total scale and can be interpreted as the completion rate for courses a student registered for during their first semester. We also include independent measures of the counts of Cs, and Ds received by the student during the first term.

Academic and social integration. In recent decades, integrationist theory (Spady, 1971; Tinto, 1975) has provided important insights into understanding why some students persist to graduation while others do not, positing that students are more likely to persist in college when they are able to successfully integrate their academic and social interests with campus offerings. Because the University of Minnesota - Twin Cities allows students to apply to more than one of the University's seven different freshmen-admitting academic colleges (e.g. College of Liberal Arts, College of Biological Sciences), we created a dichotomous variable to identify whether the student was admitted to their first-choice college or not. Its explanatory role is to determine a student's level of academic integration by gauging the initial congruence (or lack thereof) between a student's academic and career goals and the academic offerings available to the student at the University. Additionally, three measures of social integration are also included in the model. The first variable is living on-campus, which is a dichotomous variable measuring whether or not a student either lives in one of the University's residence halls. The second variable is living learning community participation, which identifies students participating in one of the University's living learning communities. Given both their communities of shared experiences and resources available to help student-athletes succeed, a third variable identifies if a student is a student-athlete or not.

Results

The multinomial logit model results estimating the relationship between financial aid packaging and six-year student success were produced with RStudio version 0.97.237 using the multinom function from the *nnet* package (Venables & Ripley, 2002). Table 2 presents the relative risk ratios and associated standard errors from our proposed multinomial logit model of multiinstitutional student completion. Relative risk ratios are calculated by exponentiating the logit coefficients and represent “the ratio of the probability of choosing one outcome category over the probability of choosing the baseline category” (ATS, 2012). They were calculated using the `mlogit.display` function from the *epicalc* package in R (Chongsuvivatwong, 2012) and are interpreted such that values greater than 1 are indicative of the greater risk of an outcome while values less than 1 are indicative of lower risk of an outcome.

A categorical dependent variable with three outcomes yields six potential outcome comparisons; only three of the outcome comparisons are unique and therefore reported in this analysis. Given the focus on relative risk we chose to present the following three

Table 2

Relative Risk Ratios and 90% Confidence Intervals for Factors Related to Non and Transfer-Degree Attainment of New Entering Freshman at the University of Minnesota – Twin Cities Fall 2002

	NoDegree Original RRR	Original 90% CI	Transfer Original RRR	Original 90% CI	NoDegree Transfer RRR	Transfer 90% CI
Cost (in \$1,000)						
Unmet Need	1.0165	(0.9974,1.036)	1.0329*	(1.0090,1.0574)	0.9841	(0.958,1.011)
Financial Aid Award (in \$1,000)						
Need Aid	1.0384	(0.9957,1.0829)	0.9639	(0.9017,1.0303)	1.0773#	(1.0036,1.1565)
Loan Aid	1.0747***	(1.0443,1.106)	1.0659**	(1.0259,1.1075)	1.0083	(0.9666,1.0517)
Merit Aid	0.5809***	(0.4782,0.7055)	0.6447*	(0.4853,0.8566)	0.901	(0.6477,1.2533)
Student Characteristics						
Demographics						
Female	0.8191*	(0.7209,0.9307)	1.4581***	(1.2174,1.7464)	0.5618***	(0.4606,0.6851)
Underrep. Minority	1.4512*	(1.1311,1.862)	0.9371	(0.6306,1.3927)	1.5487#	(1.0284,2.3324)
Asian American	1.0561	(0.8576,1.3007)	0.6188*	(0.4333,0.8836)	1.7071*	(1.1724,2.4856)
First Generation	1.3993***	(1.2273,1.5955)	1.0513	(0.8753,1.2627)	1.331*	(1.0885,1.6277)
Age > 19	3.6135***	(2.3684,5.5132)	1.102	(0.4803,2.5281)	3.2795*	(1.4467,7.4342)
Geographic Origin						
Out-of-state	1.079	(0.8307,1.4015)	1.9405***	(1.4003,2.6893)	0.5561**	(0.3867,0.7996)
Reciprocity State	0.9214	(0.7847,1.0819)	1.8786***	(1.5415,2.2895)	0.4905***	(0.3908,0.6156)
Academic Background						
Composite ACT	1.0195#	(1.0025,1.0367)	0.9816	(0.9604,1.0034)	1.0385*	(1.0134,1.0643)

(continued)

	NoDegree Original		Transfer Original		NoDegree Transfer	
	RRR	90% CI	RRR	90% CI	RRR	90% CI
No. AP Credits	0.9623***	(0.9495,0.9752)	0.9754*	(0.9586,0.9924)	0.9865	(0.9667,1.0068)
Remedial Crse.	2.8861***	(2.3059,3.6124)	1.0666	(0.7138,1.5939)	2.7051***	(1.8047,4.0548)
First Semester Academic Performance						
Crse. Comp. %	0.9598***	(0.9562,0.9634)	0.979***	(0.9737,0.9843)	0.9804***	(0.9757,0.9851)
C Count	1.4934***	(1.3986,1.5945)	1.1428*	(1.0364,1.2601)	1.3067***	(1.177,1.4507)
D Count	1.9195***	(1.6463,2.2381)	1.5959***	(1.2809,1.9884)	1.2028	(0.9725,1.4875)
Academic and Social Integration						
First Choice Coll.	0.8766	(0.7622,1.0081)	0.8752	(0.7197,1.0643)	1.0016	(0.8093,1.2395)
Live on-campus (no LLC)	0.7737**	(0.6598,0.9073)	0.8423	(0.6642,1.0683)	0.9185	(0.7121,1.1849)
Living Learning Comm.	0.7356*	(0.5834,0.9274)	0.7306	(0.5266,1.0136)	1.0067	(0.6992,1.4494)
Athlete	0.529**	(0.3699,0.7565)	0.6242#	(0.3919,0.9944)	0.8474	(0.4929,1.4569)

Note. *** p < 0.001. ** p < 0.01. * p < 0.05. # p < 0.10.

outcome comparisons: 1) the risk of non-degree attainment relative to graduation from the university of first-entry (departure | graduation (original)), 2) the risk of graduation from a four-year transfer university relative to graduation from the university of first-entry (graduation (transfer) | graduation (original)) and 3) the risk of non-degree attainment relative to graduation from a four-year transfer university (non-completion | graduation (transfer)).

While the model incorporates an extensive set of variables to control for the factors commonly associated with student success, this discussion will be limited largely to the exploration of the effects of cost and financial aid on student's graduation decisions except to note the following two things. First, the results presented in Table 2 are consistent with the existing literature on student success as well as with previous findings reported for the University of Minnesota - Twin Cities⁸ and confirm our expectations about the educational decisions of students given the expectations that follow from a rational choice approach to understanding student success in college.

Second, the varying patterns of risk and statistical significance across the different outcome comparisons supports the suggested approach to modeling student success outcomes as a multi-categorical outcome variable rather than the traditional success-failure dichotomy. That is to say, the different impact on the relative risk ratios across all

⁸ The only exception is the effect of composite ACT score which is reported to increase the risk of non-degree attainment relative to completion at the university of first-entry.

three contrasts demonstrates that variables differentially affect the risk of whether a student fails to complete a degree or completes a degree at a four-year transfer university rather than completing a degree at the university of first-entry.⁹ Take for example a student's geographical origin from a state with a reciprocal tuition agreement. While originating from a reciprocity state does not appear to affect the risk of non-degree attainment relative to graduation from the university of first-entry in a statistically meaningful way (RRR = 0.9214, SE = 0.0976), it does increase the relative risk of graduation from a transfer university (RRR=1.8786, SE=0.1203) by approximately 88%, a relationship that is obfuscated by modeling student success as the traditional completion/non-completion dichotomy.

In terms of the student's perceived cost, C_j , the personal cost associated with college attendance (as estimated by a student's amount of unmet need) appears to increase the risk of student departure both in terms of non-degree attainment relative to graduation (original) and graduation (transfer) relative to graduation (original), however, only the impact of the later (graduation (transfer) | graduation (original)) is statistically

⁹ Only if none of the variables in the contrast NoDegree | Graduate (Transfer) were statistically significant would we believe that the categories completion (transfer) and non-degree attainment could be combined (Long, 1997). The Wald test serves as the formal test for combining alternatives and the results support our treatment of different outcomes for transfer success and departure as each of the resulting χ^2 values were statistically different from zero.

significant (RRR = 1.0329, SE = 0.0143). Specifically, the model estimates suggests that every \$1,000 increase in unmet need increases the risk of graduation (transfer) relative to graduation (original) by approximately 3.29%, holding all else constant. This is consistent with the expectations of our model that students facing greater personal educational costs will be more sensitive to those costs, and so compared with students with similar academic performance, demographic characteristics, and levels of engagement, those with greater unmet need appear to be more likely to explore alternative, and presumably less expensive, educational opportunities.

The model estimates also suggest that the types of financial aid awarded, Fi, effect the student success outcomes in differential ways. First, the estimated effect of need aid on the risks of departure is generally neutral. According to the model estimates, need aid does not significantly impact the risk of either non-degree attainment relative to graduation (original) or graduation (transfer) relative to graduation (original), suggesting that students receiving need aid are neither more nor less likely to be successful than their counterparts. It does, however, differentiate between non-degree attainment and transfer success (RRR=1.0773, SE=0.0431) as every \$1000 increase in need aid is expected to increase the risk of non-degree attainment relative to graduation from a transfer university by approximately 7.73%, all else constant.

Second, the estimated impact of student loan aid on the risks of departure is distinctively positive. According to model estimates, loan aid is significantly associated with the higher risk of non-degree attainment relative to graduation (original) (RRR=1.0747, SE=0.0175) and the higher risk of graduation (transfer) relative to

graduation (original) (RRR=1.0659, SE=0.233). For every additional \$1,000 in a student's first-year debt burden the risk of non-degree attainment is expected to increase by approximately 7.47% while the risk of graduation from a transfer university by is expected to increase by approximately 6.59%, all else constant.

Third, the estimated impact of merit aid on the risk of departure is distinctively negative. According to model estimates, merit aid is significantly associated with lower risks of non-degree attainment relative to graduation (original) (RRR = 0.5809, SE = 0.1182) and lower risk of graduation (transfer) relative to graduation (original) (RRR=0.6447, SE=0.1728). Specifically, every \$1,000 increase in merit aid awarded the student is expected to reduce the risk of both non-degree attainment and transfer completion by 41.91% and 35.53% respectively, all else constant.

While the differences in the relative risk ratios between the different financial aid variables are sizeable, it is important to recall that the range of observed values for the different financial aid measures are also quite distinct (see Table 1). As a result, simply contrasting the magnitude of the relative risk ratios fails to reflect the full complexity of the impacts of the different aid forms on the risk of non-completion and transfer success, particularly between students receiving loan aid and merit aid. To provide a more nuanced picture of the impact of each financial aid variable on the risk of departure, Table 3 estimates the percentage change in the relative risk ratios at five points across the

distribution of each financial aid variable, all else constant.¹⁰ Specifically we calculate the ceteris paribus change in relative risk at the 5th-, 25th-, 50th-, 75th-, and 95th-percentile values of each of the three financial aid variables and find that while the magnitude of change in relative risk is initially large, the difference in magnitudes in effect size between loan and merit aid erodes substantially as we move through the distribution.

Table 3

Percentage Change in the Relative Risk Ratios Associated with Changes in the (Non-Zero) Distributions of Awards Among Aid Type Recipients

	NoDegree Original			Transfer Original		
	Need Aid	Loan Aid	Merit Aid	Need Aid	Loan Aid	Merit Aid
5th percentile	0.95%	7.36%	-23.79%	-0.92%	6.49%	-19.70%
25th percentile	3.01%	9.78%	-41.92%	-2.85%	8.61%	-35.53%
50th percentile	8.15%	22.32%	-41.92%	-7.37%	19.51%	-35.53%
75th percentile	15.38%	44.65%	-55.73%	-13.03%	38.63%	-48.23%
95th percentile	22.44%	70.12%	-74.29%	-17.93%	60.02%	-66.62%

¹⁰ Percentage change in the odds are calculated by exponentiating the product of the logit coefficient and the specific aid value at each of the five distinct points in the associated distribution. For need aid these values are (in \$1000s): 0.25, 0.787, 2.079, 3.794 and 5.37. For loan aid (in \$1000s): 0.985, 1.294, 2.794, 5.12 and 7.369. For merit aid (in \$1000s): 0.5, 1, 1, 1.5, and 2.5.

Interpretations and Implications

While an important benefit of the relative risk ratio rests in its ability to provide an interpretation of the effects of variables “all else held equal,”¹¹ it is important to remember that the substantive interpretation of the relative risk ratio is highly dependent upon its location on the probability curve. To help better illustrate the expected impact of unmet need on the different student success probabilities, in this section we utilize the effects package in R (Fox and Hong, 2009) to plot changes in the predicted probabilities associated with changes in the financial aid variable for the ‘average student’¹² entering the University of Minnesota – Twin Cities during Fall 2002.

¹¹ The relative risk, or odds-ratio, is calculated by taking the exponential of the beta coefficient, $\exp(\beta_i)$. Demaris (1992) suggests that “Interpreting logistic regression results in terms of odds rather than probabilities confers certain advantages. Most important among these is that $\exp(\beta_i)$ is a single summary statistic for the partial effect of a given predictor on the odds, controlling for other predictors in the model. There is no comparable statistic for the probability. That is, it is not possible to summarize the impact on the conditional probability of a unit increase in a given predictor, net of the others. The reason for this is that the model is nonlinear, and therefore nonadditive, in the probabilities” (48).

¹² The choice of starting values for calculating predicted probabilities is subjective. For the purposes of this analysis, we construct a hypothetical average student by setting each of the independent variables at their mean value. While this does not represent the

Figure 1 plots the changes in the associated probabilities as unmet need increases from the minimum to the maximum for an average student. Two important themes emerge. First, as illustrated by the decreasing area associated with completion at the university of first-entry (dark gray area), the larger the level of unmet need facing the student during their first academic year the less likely they are to complete their degree at the university of first-entry. Second, the relative stability of the dropout probabilities (white area) combined with the increasing area associated with transfer completion (light gray area) suggests that as a student's level of unmet need increases they are increasingly likely to search for alternative educational opportunities that are presumably more affordable. This suggests that students who could very well be successful at the University of Minnesota - Twin Cities are departing prematurely because of their inability to pay for college.

Figure 2 plots the predicted probability of each educational outcome associated with changes in the level of financial aid award for a hypothetically average student. Changes in the size of an average student's need award (Figure 2a) appear to have little impact on the probability of success at the university of first-entry (dark gray area); however, as need increases so too does the probability of non-degree attainment (white area) at the expense of transfer completion (light grey area). The lack of significant impact of increasing need aid awards on the probability of completion from the university

predicted probability for any individual existing student, it represents the student body in the aggregate.

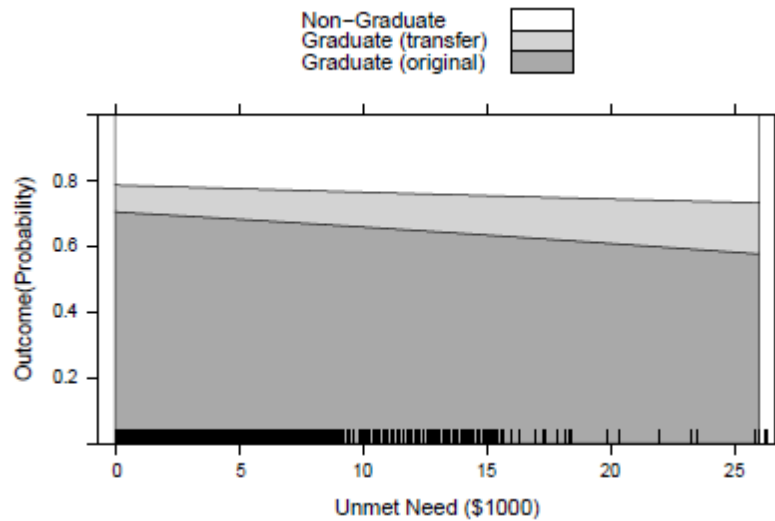


Figure 1. Estimated effects of changes in unmet need on the predicted probabilities of non-degree attainment, graduate (transfer), and graduate (original) within six years of first enrollment for an average UMN student; distribution of the predicted probabilities is reflected by the associated rug plot.

of first-entry suggests that the University’s need aid system is sufficient to level the odds of completion for students at different levels of need. The impact of unmet need noted above, however, indicates that there are still students it has not been able to reach with its need aid programs who might benefit. The shift between the likelihood of completion at a transfer institution relative to non-completion, however, suggests that students receiving higher need awards may not be able to find alternatives that provide equivalent support, and are therefore less mobile. It is also possible they have less flexibility geographically, and so have a more restricted set of viable alternatives. Since need aid is not a

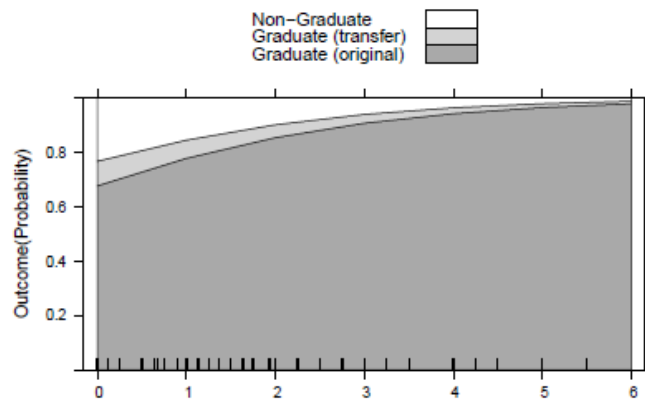
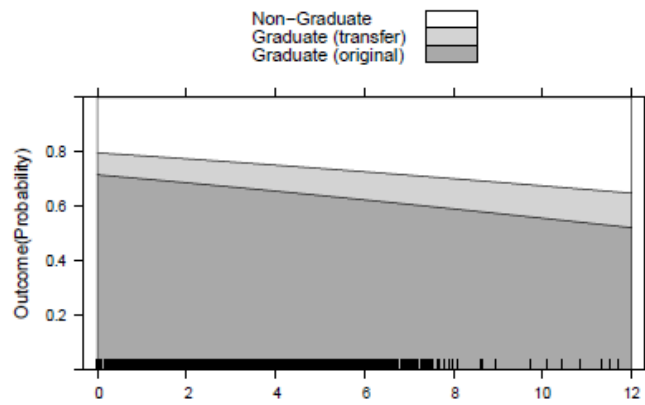
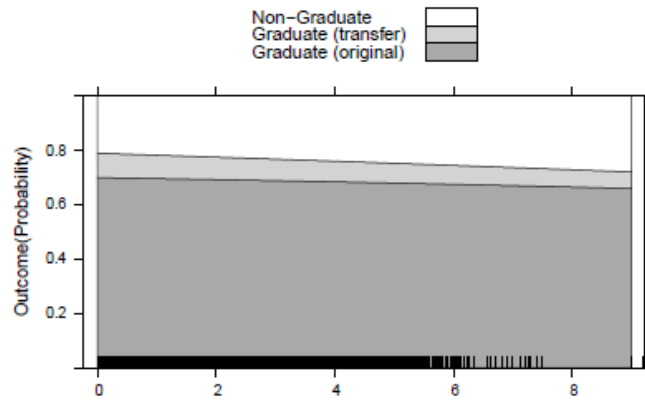


Figure 2. Estimated effects of changes in financial aid types (need-, loan-, merit-based) on the predicted probabilities of non-degree attainment, graduate (transfer), and graduate (original) within six years of first enrollment for an average UMN student; distribution of the predicted probabilities is reflected by the associated rug plots.

statistically significant differentiator between completion at the university of first-entry and completion at a transfer institution, it is difficult to untangle these possibilities.

Increasing student debt burdens as measured by changes in student loan awards (Figure 2b), in contrast, lead to steadily declining probabilities of completion at either the University of first-entry (dark gray area) or a four-year transfer university (light gray area), while the estimated probability of dropping out grows (white area). Reliance on large loan packages work against both the institutional interest in retaining students through graduation, and the student and societal interest in improving completion. All other things equal, students who are facing large loan debts are more likely to feel that college completion is not a financially viable option for them than a comparable student unburdened by student loan debt. Additional subsidization or forgiveness of loans could potentially ameliorate some of this impact, as could expanded need-based aid alternatives or cost controls at institutions to improve affordability. At the University of Minnesota - Twin Cities, in addition to a substantial institutional aid program for low-income students, increasing attention has been given to need-based financial aid for middle-income families in an attempt to control the growth of student loan debt.

As the dollar amount of merit-based scholarships (Figure 2c) increases from the minimum to the maximum, the probability of successfully completing a degree at the University increases (dark gray area), while the probability of either nondegree attainment (white area) and completion at a four-year transfer university a degree at another institution (light gray area) decrease. The declining lift in the probability of completion from larger merit aid awards suggests that merit aid is influenced by ceiling

effects, as the probability of completion either at the university of first-entry or at a transfer university quickly nears certainty. This suggests that at least from the standpoint of increasing the likelihood of graduation, the funds devoted to large merit awards could be redirected to other purposes with a greater impact. However, the number of instances of large merit awards at the University of Minnesota - Twin Cities is not large, so the practical impact of such a shift might be limited.

Limitations

Our study has several important limitations. The first concerns the limited generalizability of the study that results from investigating the enrollment trajectories of a single cohort of first-year students from a single institution of higher education. While we certainly agree that, at its best, high quality research should be both reproducible and generalizable; the notion that multi-institutional studies are inherently more generalizable than single institution studies, however, is quite overstated as multi-institutional studies frequently rely on survey research and subsequently face significant challenges associated with the nonrandomness of missing data that severely limits the generalization of such studies. As a result, we put forward that in practice, single institution studies utilizing institutional records data, such as ours, minimize this problem by relying effectively on institutional census data. Additionally, by utilizing the National Student Clearinghouse's StudentTracker service to follow students enrollment patterns after departure distinguishes our study from most single institution studies.

A second limitation concerns the nature of the data obtained from the National Student Clearinghouse. As Goldrick-Rab and Harris (2010) point out, data from the NSC

“is not as clean or complete as it might seem” (p. 1). Specifically, they note that searches involving Social Security Numbers are prone to false positives while the name/date of birth searches are prone to yield false negatives. Given this choice between these potential types of errors or inaccuracies, our study relied on the name/date of birth search. This was based on our belief that the potential to underreport the number of departing students who may have obtained a degree during the period of study would work against our hypothesis and thus reduce the potential for bias.

Another limitation of our study is its concentration of financial aid packaging only at the time of entry. With the rise in popularity of event history modeling, recent work in the area of financial aid has focused on the importance of the timing of aid (DesJardins et al., 2002). While we agree that the time-varying effect of financial aid has important consequences on a student’s persistence decision, it is important to remember that this does not preclude the form of financial aid package utilized to pay for the first year of college to be related to their retention and graduation decisions. While changes in financial aid packages are likely to produce changes in enrollment patterns, the results of our study suggest clearly that how the “table is set” during the first semester also clearly matters.

Finally, we recognize that the representation of multi-institutional persistence and graduation in our study does not fully capture the complexity of student educational pathways. The “swirling” patterns of repeated transfer, simultaneous enrollment, reverse transfer, discontinuous enrollment and other pathways followed by many students are an important phenomenon in their own right (Adelman, 2006; Borden, 2004;

McCormack, 2003). However, the results of our study indicate that relevant insights can be gained from examining the impact of financial aid in the first year of enrollment. Additionally, as McCormack (2003) describes the wide variety of forms of multi-institutional enrollment, he finds that more than 40% of college graduates who began at a four-year institution and attended more than one institution during their career still completed their degree at the university of first-entry, so much of the “swirling” activity does not alter the location of completion. Additional research could explicate the degree to which financial aid influences the choice of specific combinations of enrollment types.

Conclusion

Most existing studies on student retention utilize a strict dichotomy to characterize student success: students either persist or depart. While parsimonious, this interpretation of student success does not accurately reflect the different options available to students in their pursuit of a college degree and generally produces inefficient parameter estimates as a result of sizable measurement error in the dependent variable. Recognizing that students often have educational career paths that lead them to graduation beyond the institution of entry, the results from our study demonstrate how utilizing data from the National Student Clearinghouse, combined with a methodological approach that accommodates the estimation of relationships across nominal outcomes, allows for both a more comprehensive and more accurate understanding of how factors, such as financial aid, are associated with success in higher education.

Additionally, by utilizing a multinomial logit approach to estimate the factors associated with students' decisions to either persist until graduation, graduate as a transfer student, or drop out, our study found significant differences in the way variables influence the different choices available to students that were once obfuscated by the failure to distinguish between transfer and drop-out behavior. These different influences are explored in the context of the results concerning financial aid. While policy-makers, college administrators, and educational researchers often consider financial aid as a homogenous form of support, capable of expanding college access to millions of students marginalized by the rising costs of college, our study confirms what millions of students and parents already know: not all financial aid packages are created equally.

The most significant implication is simple but sobering. Despite the challenges, the most powerful way for institutions to address the impact of financial pressures on college completion would be to reduce those pressures, whether through expanded financial aid or by reigning in the rising cost of tuition. To that end, the University of Minnesota successfully negotiated with the State of Minnesota for a two-year freeze in tuition for resident undergraduate students in exchange for an increase in its annual appropriation that offset much of the rising cost of instruction without passing that cost on to students. However, such broad-based strategies are not always feasible, and limited resources must be invested in specific forms of aid. The results of our study suggest that both the size and type of student's aid awarded to the student affect the odds of college completion in very different ways. Some forms of financial aid appear to clearly benefit the student; for example, merit aid awards significantly reduce the risk of student

departure and as a consequence promote institutional retention and graduation rates. Specifically, this finding suggests that where colleges and universities of first-entry invest in students with merit-based financial aid, students are likely to persist until graduation which may help explain recent shifts in institutional aid to more merit-based aid awards (Heller, 2006; Doyle, 2010). Results from our study suggest; however, that their may be an upper limit to these benefits as the probability estimates suggest that each additional dollar is less effective than the one before and generally confirms the research that suggest large merit awards are inefficient as they are frequently providing assistance to students that are already on the path to success (Heller & Marin, 2004).

Other forms of aid, however, are potentially detrimental to a student's educational goals. Accepting a financial aid package heavily reliant upon student loans significantly increases the risk of student departure. Given the increased pressures associated with the higher costs of college attendance that encourage students to borrow, this is extremely important as it directly undermines institutional retention goals. While previous studies have identified differential effects based on the type of loan awarded to the student (Singell et al., 2004; Chen & DesJardins, 2010), the results of our study suggest that it may be less about the type of loan a student is accepting than the amount that is influencing their likelihood for success. This is likely due to the limits placed on student loans and the prioritization of Perkins and/or subsidized Stafford loans over unsubsidized loans. Those relying on the largest loan packages are then accepting packages generally including loans with less advantages terms which increase the financial burden on students in both the short and the long term.

In addition to detrimental effects of large student debt burdens, the results of our study also confirm previous research that found high levels of unmet need reduce the likelihood for success (Porter, 2002). The results of our study provide an interesting nuance into our understanding, however, in that findings suggest that increasing levels of unmet need act by pushing a small segment of future college graduates to search for better “deals” in the higher education marketplace. What’s more, the results of our study suggests that need aid awards do not contribute to improving the likelihood of student completion in a statistically meaningful way. One possible interpretation of this finding is that the need aid acts only to equalize the chances for success, reducing the likelihood of departure of students who would have otherwise have a large unmet need burden. Recent research by Rubin (2011); however, suggests a second possibility: that the rising costs of college have outpaced that of need-based aid and has consequently reduced its effectiveness in helping students be successful.

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Chapter 4: When It's Not Who You Are, But Where You Are From: Factors Associated with Occupational Attainment After Completion of the Ph.D.

Introduction

Writing about the Graduate Review & Improvement Process (GRIP) at the University of Minnesota-Twin Cities, Flaherty (2012) highlighted a key challenge associated with the assessment of doctoral education, noting that “Given the complexities of graduate education, it can be hard to measure program success in meaningful ways. Traditional, external reviews track things such as time to degree and completion rates every 5 to 10 years at large research institutions, but students and faculty are rarely asked deeper questions about curriculum relevance and program goals” (2012, December 17). Despite the growing national concern about doctoral student outcomes, there is currently no standard metric of doctoral student success.

For some who study graduate education, doctoral student success refers to the ability of students to complete their doctoral program and/or a program's associated completion rate. For others, doctoral success is more about completing a program in a timely manner than it is about completion, per se. As a consequence, the existing literature on doctoral student success is overwhelmingly process-oriented, emphasizing the importance of successfully navigating the seas of doctoral education rather than exploring the outcomes of doctoral education. A less explored, but arguably more compelling, interpretation of doctoral success focuses on the occupational outcomes of the doctoral students after they have completed their degree.

The current (over-)emphasis on aspects of procedural success of doctoral education is especially unfortunate as the purpose of graduate education is not merely to produce good graduate students, but rather to prepare “the scientists and engineers needed by industry, government and universities to conduct the nation’s research and development; [educate] the scholars in the humanities, social sciences, and the arts who preserve and enlarge our understanding of human thought and human condition, and [develop] the scholars in all disciplines who become the faculties of the nation’s colleges and universities” (Association of American Universities, 1998, p. 2). While the successful navigation of the doctoral process may be a necessary condition for certain employment opportunities, it is not a sufficient condition of occupational attainment as current estimates suggest that fewer than two-thirds of successful doctoral candidates report having a job commitment at the time of completion (Jaschik, 2012, December 6). What’s more, limited job openings and low wages have resulted in an increasing number of Ph.D. recipients opting for careers outside academia (Weissman, 2013, February 20).

The goal of this study is to move beyond the current conceptualization of doctoral student success as a simple process-oriented metric by developing a measure of success that focuses on the postdoctoral occupational outcomes of successful doctoral students. In this way, the current study departs from the existing literature about doctoral education in that it is not concerned with identifying factors associated with the successful navigation of the doctoral education process, but rather seeks to explore what factors influence the postgraduate outcomes of successful doctoral students. By focusing on both the occupational attainment and career choice of doctoral students at the time of degree

completion, this study advances the discourse on doctoral success to better focus on the actual outcomes of doctoral education rather than the degree attainment process itself. To this end, this study examines the factors associated with both the postdoctorate plans reported by students at the time of completion as well as the *career choice* made by those students with postcompletion employment plans at the time of completion.

The working hypothesis of this study is that while individual ability certainly contributes to the success of students in graduate school, when it comes to the occupational outcomes made by successful doctoral students, the academic structures in which students are prepared for their careers play an equally, if not more, important role in shaping both the job prospects that a student has and the career path a student chooses after completing her or his degree. More specifically, the importance of the interaction between the student and program structure is explored in hopes of discerning to what extent students reporting successful interactions with her or his academic department are more likely to pursue academic careers, while those dissatisfied with their interactions with their academic department are less likely to pursue academic careers.

Literature Review

Previous research in the area of doctoral education has explored the relationship between characteristics of both doctoral programs and individuals that may be associated with different interpretations of student success. These interpretations include retention, completion, time-to-doctorate, and occupational attainment. This section explores the chief findings in these areas of doctoral success first at the program level and then at the individual level.

Program-level factors. The early research into the career outcomes of doctoral students, originating in the field of sociology, focused extensively on program-related characteristics that influenced the career success and outcomes of doctoral students (Blackburn, Chapman, & Cameron, 1981; Long & McGinnis, 1985; Reskin, 1979). This research emphasizes four ways in which programs or departments may influence a variety of different outcomes of their doctoral students. The *first* emphasized the role of the advisor, sponsor or mentor and suggested that the success of a doctoral student can frequently be traced back to the success of his or her mentor or advisor. Reskin's (1979) study of 238 doctoral chemists recognized the importance of the influence of sponsor or mentor on doctoral success noting that "Being trained by a productive sponsor and collaborating with one's sponsor during graduate school were both associated with greater predoctoral productivity" (p. 142). Examining the placement of successful doctoral students within the academy, Blackburn, Chapman, and Cameron (1981) identified that the mentor influence extends beyond simply the antecedents of career success: actually acting to influence the placement and career development of doctoral students in higher education. Recognizing the importance of the large variance in levels of success of doctoral students within the same department, Long and McGinnis (1985) tested the possibility of mentor effects on different aspects of recent biochemistry doctorates' academic careers and found that mentor productivity "is a significant factor in determining the prestige of a student's appointment, although this effect operates only for those students who collaborated with their mentor" (p. 278).

While existing research has identified the importance of the mentor influence on postcompletion success of doctoral students, less resolved, however, is a comprehensive understanding of the functional mechanism through which mentors influence the outcome of their doctoral students. On the one hand, some assert that mentor influence on career outcomes reflects an underlying ascriptive process, whereby successful doctoral students are largely being rewarded for the work of their mentors (Blackburn et al., 1981; Reskin, 1979). On the other hand, other researchers argue that mentors are allocated to graduate students through a more universalistic process, whereby a student's aptitude or ability is believed to attract the attention of a mentor who then decides to invest greater resources in providing mentoring functions to this student (Green & Bauer, 1995).

A *second* way a program or department may influence the success of their doctoral students examines the role of program-level characteristics, such as program size and financial resources. For example, de Valero's (2001) study of completion rates and completion times at a public research university found that "department orientation and advising and attitudes toward students" were the factors differentiating high- and low-completion rate departments (p. 360), while "financial support and the relationship between course work and research were the factors where differences were found between" departments with short- and long- completion times (p. 360). Stricker's (1994) study of potential institutional factors which influence the time to the doctorate emphasized the importance of department size and student/faculty ratio in correlating success; however, the researcher cautioned that this finding emerged for only one of the

three programs studied (psychology) and “relationships differed from discipline to discipline” (p. 581).

A *third* way in which programs or departments may influence the success of doctoral students focuses on the process of ascription utilized by hiring academic departments during the hiring phase for Ph.D. graduates, whereby information asymmetries about the potential of prospective employees are reduced by assigning to the student characteristics of their departments. For example, studies of the academic career have previously explored the relationship between program- or department-level factors and the success of doctoral students in obtaining their first academic job. In their study about entering into an academic career, Long, Allison, and McGinnis (1979) attempted to identify the factors that were associated with doctoral students who landed jobs in prestigious programs. Following a cohort of 239 male biochemists, their study found “Doctoral prestige clearly has the strongest effect, followed by a moderate but significant effect of the mentor’s prestige and a slightly weaker effect of the baccalaureate selectivity” (Long, Allison, & McGinnes, 1979, p. 819). The importance of program-related factors was further buttressed by their result suggesting that there was no identifiable relationship between the productivity of the individual and the prestige of her or his first job placement. As a consequence Long, et al. (1979) suggest that academic hiring is an ascriptive rather than particularistic process, implying that hiring is based more on the quality or prestige of program that an individual came from than the abilities or achievements of the individual.

The importance of doctoral-program prestige on occupational placement has been reconfirmed across multiple disciplines in several subsequent studies. For example, in her study of the first academic job placement of new doctoral recipients in the field of sociology, Baldi (1995) obtained results consistent with those of Long and his associates (1979), which suggest that Ph.D. granting department prestige has the strongest effect on prestige of the hiring department. Similarly, in their study of the success of doctoral students in political science, Hesli, DeLaat, Youde, Mendez, and Lee (2006) found that students from prestigious universities were more likely to obtain a faculty position at a Ph.D. granting institution than their counterparts. While there seems to be significant evidence that programs attempt to recruit faculty from programs with similar reputational rankings, Youn (1988) identified that in times of tight labor markets “there is a general downward mobility in the prestige of newly recruited Ph.D.s” (p. 195).

A *fourth* way emphasizes the role of socialization. Described as the process “in which a newcomer is made a member of a community – in the case of the graduate students, the community of an academic department in a particular discipline” (Golde, 1998, p. 56), the process of socialization is expected to influence doctoral student outcomes in important ways. For example, Weidman and Stein’s (2003) study of 83 active Ph.D. students in sociology and education identified “the importance of social interaction among both students and faculty as well as collegiality among faculty for creating a supportive climate for doctoral study” (p. 641). Girves and Wemmerus’s (1988) study of 486 graduate students at a major Midwestern university identified the importance of the advisor in the socializing process noting that “[b]eing treated as a

junior colleague by the advisor accounts for much of the variability in degree progress. He or she serves as a role model and becomes the primary socializing agent in the department” (p. 185). Additionally, Gardner’s (2010) case study contrasting high- and low- completion academic departments emphasized the particular importance of student support, noting that “the lower completing departments were often those with the least supportive environments” (p. 75).

Given the recognized importance of socialization on the doctoral student experience, the literature has attempted to spotlight different socializing forces. For example, in Tinto’s (1993) reflections upon a possible theory of doctoral persistence, he echoes the importance of the socialization effects of graduate school and suggests that exploring the impacts of factors related to social integration provides an interesting opportunity to better understand student success at the doctoral level. Gardner and Barnes’s (2007) discussions with 10 doctoral students explored the importance of doctoral student involvement and found that while conceptualizations of involvement vary and evolve, “Regardless of the type and scope of involvement, however, all of the participants recognized the importance of involvement to their professional goals and success in their future careers” (p. 382).

Individual-level factors. Where early sociological studies of the doctoral student outcomes emphasized the importance of program-related factors, contemporary studies originating from the field of higher education have shifted to an almost single-sighted interest in the individual-level characteristics that may be associated with graduate education outcomes (Golde, 2000; 2005). For faculty members, the ability of the student

to successfully complete graduate school is attributable almost entirely to the abilities and motivations of the student (Gardner, 2008). How could it not be? Recognizing that they themselves had worked hard in graduate school and consequently earned their doctorate, those less successful must have either not worked hard enough or simply lacked ‘what it takes’ to be successful.

The importance of individual-level factors contributing to doctoral success and failure characterizes a substantial amount of recent literature on the doctoral student experience (Golde 2000, 2005). Consequently, a considerable body of literature has focused on identifying traits that are associated with student success in hopes of increasing enrollment efficiencies in the admissions process (Golde, 2005). In particular, the current literature recognizes three ways in which individual-level factors may influence the career choices of successful graduate students. The *first* emphasizes the role of human capital focusing on such factors as individual ability and achievement. For example, research dating back to the 1970s exploring the “social organization of science” focused explicitly on the scientific career and explored the extent to which scientific disciplines were organized around the principle of universalism, a principle which suggests that merit or individual achievement determines the successful placement of recent Ph.D. students in the academy. Robert Merton ([1942], 1973) wrote about the “normative structure of science” and constructed a logical argument supporting a vision of the scientific enterprise that emphasized universalism, communism, disinterestedness, and organized skepticism. Specifically, Merton ([1942], 1973) describes a normative structure of science that is predominantly merit based where new ideas “are to be

subjected to *preestablished impersonal criteria*: consonant with observation and with the previously confirmed knowledge. The acceptance or rejection of claims entering the lists of science is not to depend on the personal or social attributes of their protagonists; his race, nationality, religion, class and personal qualities are as such irrelevant” (p. 270).

The scientific emphasis on “preestablished impersonal criteria” does not mean that the system is free from inequality. Inequities do emerge, but as Cole and Cole’s (1973) research in the area of physics suggested “In almost all cases where science departs from the ideal we find the process of accumulative advantage at work. People who have done well at time 1 have a better chance of doing well at time 2, independently of their objective role performance” (p. 235). Evidence does maintain the principle of accumulative advantage, suggesting that in academia it is frequently success that begets success. The human capital approach to understanding occupational outcomes remains prevalent today and is concerned with understanding those “activities that influence future real income through the imbedding of resources in people” (Becker, 1962 p. 9) For example, a study of students enrolled in economics Ph.D. programs at the University of Chicago (n=229), Harvard University (n=177), MIT (n=147), Princeton University (n=217), and Stanford University (n=259) between 1990 and 1999 found that “First-year grades in core required courses are a strong predictor of economics graduate students’ job placement” (Athey, Katz, Krueger, Levitt, & Poterba, 2007, p. 517). Studying the rank advancement of male and female biochemistry faculty members, Long, Allison, and McGinnis (1993) found that the most important factors associated with rates of

promotion was the number of publications produced by a faculty member along with his or her time in rank.

While the principles of universalism and accumulative advantage are easily understood in the context of academia as a “marketplace of ideas,” the *second* major area of research focuses on the inefficiencies in the market, highlighting how individual achievement alone is not enough to explain why some individuals are successful in the academy while others are not. For example, substantial research has identified that the benefits of scientific careers are not awarded equally across racial and gender lines. In particular, given the disparity between women and minority Ph.D.s and their underrepresentation in the upper echelons of the academy, there has been substantial attention given to the role of race and gender in the career trajectories of new faculty members. From their review of the literature, Long and Fox (1995) concluded that “It is clearly established that women and most minorities are less likely to participate in science, have less prestigious positions, have lower productivity and have less recognition” (p. 67). Consequently, Long and Fox (1995) determined that principles of particularism, which “involves the consideration of functionally irrelevant characteristics such as race or sex in the allocation of resources and rewards” (p. 53), are more likely to govern the development of the scientific career than principles of universalism. For example, Long et al. (1993) found that the gender-related difference extend later into the academic career as promotion rates “are lower for women than men for promotion to associate and for promotion to full professor” (p. 719).

Research has attempted to explore if these observed racial and gender differences might rather be a function of other factors frequently associated with gender, race, and class than explicit discrimination. For example, Rosenfeld and Jones (1987) utilized a sample of academic psychologists to explore if “sex differences in geographic mobility patterns might underlie some of the sex differences in career patterns” (p. 494). Researchers found that in the years immediately following the completion of the doctorate, women were less geographically mobile than their male counterparts, which puts them at a particular disadvantage as “Psychologists who moved from the city or town in which they earned their Ph.D.s were more likely to get first jobs that were on tenure track” (Rosenfeld & Jones, 1987, p. 511). The role of marriage and family is also found to contribute to these differences. Evidence from Mason and Goulden’s (2004) study of 8,500 active faculty members at the University of California suggested that gender itself is not the culprit but rather that “women may be more successful in obtaining academic careers if they forgo or delay marriage and childbirth” (p. 100). More specifically, Wolfinger, Ginther, and Goulden’s (2008) study of more than 30,000 doctoral recipients from 1973 to the present identified that the “leak in the pipeline” is specifically at the time of obtaining a tenure-track position as “Marital status and the presence of children under six account for the gender differences in obtaining tenure-track positions” (p. 398).

Contemporary research also suggests a *third* potentially important link between the individual and doctoral outcomes that represents issues of personal finance and doctoral success and occupational attainment. For example, the type of financial aid

available to the student appears to play an important role in doctoral success. Kim and Otts (2010) identified that “the type of financial support students receive in graduate school influences time to degree completion” (p. 22). Considering the three stages of doctoral career (transition, development, and research), Ampaw and Jeager (2012) found that “although financial aid as a whole is important, the type of financial aid received is even more significant and has differential impacts on doctoral students’ retention at each stage” (p. 641). More specifically, in their meta-synthesis of the research on doctoral student attrition and persistence Bair and Haworth (2004) identified a number of doctoral dissertations demonstrating consistently positive relationships between fellowships, teaching assistantships, and research assistantships and doctoral completion. Benkin (1984) summarized this relationship noting that “It seems clear that students who have the types of support that either require no work (fellowships and grants or that reward students for doing the type of research that leads to a degree (research assistantship) will be more likely to progress rapidly toward a degree. In contrast, students who have to work at positions not directly related to their research, whether on or off campus, will be more likely to progress more slowly or not at all” (as cited in Bair & Haworth, 2005, p. 501). Additionally, research on the influence of debt has found that large debt burdens are likely to influence the career paths of students. For example, Schenkein and Best’s (2001) study of doctoral students in the field of dentistry found that high levels of indebtedness and concerns about income were the largest factors pushing individuals out of choosing a career in academic dentistry.

Conceptual Model

Research related to doctoral student outcomes tends to emphasize either of two potential areas of influence on doctoral student career choices. The first emphasizes the association between environment-level (or department-level) factors and graduate education outcomes, while the second explores the association between individual-level factors and graduate education outcomes. Consequently, the theoretic framework of this study is grounded in the *Input-Environment-Output* (IEO) model (Figure 1) developed by Alexander Astin (1984, 1993). Specifically, Astin's IEO model puts forward the idea that student development is a function of student involvement and can be explained by both characteristics of students and their interaction with the institutional environment. As Astin (1993) explained, "*Inputs* refer to the characteristics of the student at the time of initial entry to the institution; *environment* refers to the various programs, policies, faculty, peers, and educational outcomes to which the student is exposed; and *outcomes* refers to the student's characteristics *after* exposure to the environment" (p. 7). Consequently, this study explores the career choices of successful doctoral students as a function of *both* individual- and program-level characteristics.

Tinto (1993) emphasized the importance of both inputs and environment in his longitudinal model of doctoral persistence. In terms of *inputs*, his "model posits that

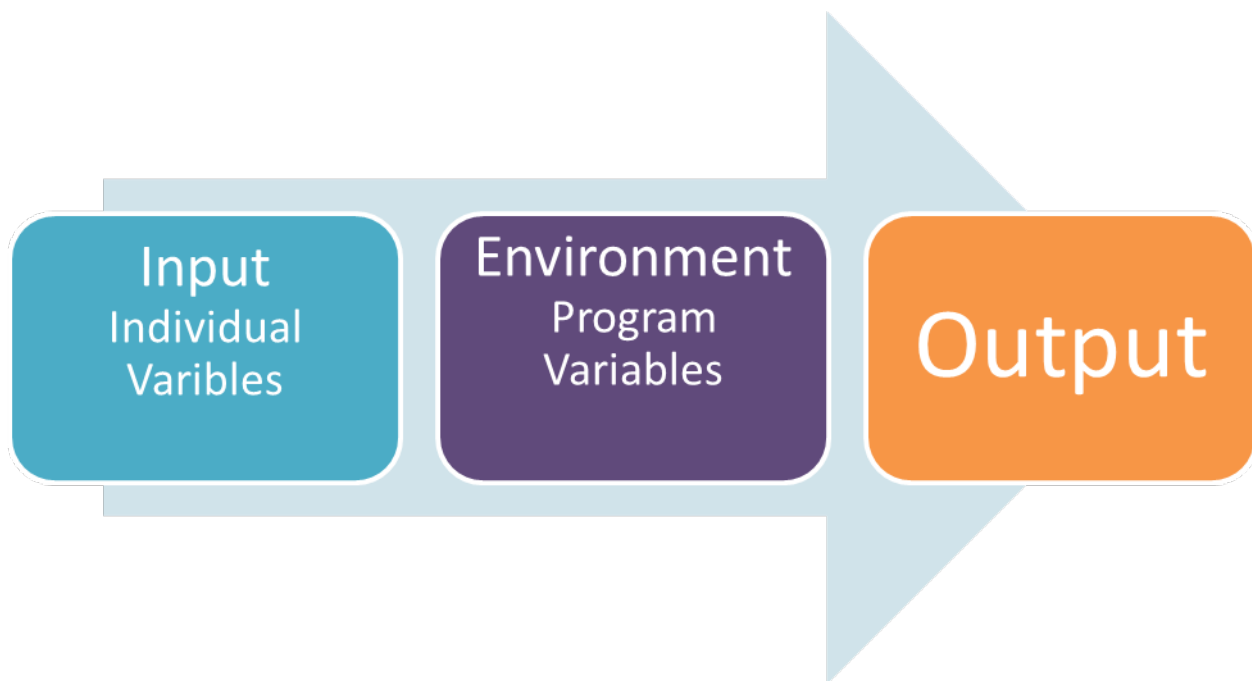


Figure 1. The I-E-O model.

individual attributes, most notably gender, age, race, ability and social class, and individual educational experiences prior to entry into graduate school help shape individual goals (educational and career) and commitments (goal and institutional) at entry” (Tinto, 1993, p. 239). In terms of *environment*, Tinto’s model recognizes that doctoral students experience their graduate education in three distinct stages (transition, competency, and research) during which an individual’s interaction with varying aspects of the program environment (i.e., program, faculty/advisor, classmates) works to shape his or her persistence decision (Tinto, 1993, p. 235). While Tinto’s proposed model sequence is appropriate when considering graduate student departure, this longitudinal complexity associated with stages in Tinto’s proposed model is unnecessary when the focus is on the outcomes of successful graduate students. Because completion of their

doctoral degree suggests that all of the subjects of this study completed the three stages, this study eschews this temporal distinction, choosing to rely instead on the subjects' retrospective evaluations of their interactions as well as characteristics of the program as measures of the environment.

Research Questions

This research study addresses two related research questions pertaining to the relationship between a doctoral student's experience in graduate school and his or her postcompletion occupational outcomes. The first question (R1) asks to what extent are individual- and program-level factors associated with a student's occupational plans at the time of completion as reflected in his or her a) commitment to a postdoctoral position, b) commitment to employment, or c) continued search for employment options? The second question (R2) concerns only those students with employment commitment at the time of completion and asks to what extent are individual- and program-level factors associated with a student's occupational obtainment as defined by accepting either tenure-track, non-tenure-track, or position in business, industry, or government?

Method

Participants

The population for this study was all doctoral students who completed their Ph.D. between July 1, 2008 and June 30, 2010 at the University of Minnesota-Twin Cities. Participants in this study included any individual from the target population that, at the time of completion, completed the University of Minnesota's administration of the NSF's *Survey of Earned Doctorates*. One thousand one-hundred and eighty three individuals

were identified and account for more than 89% of doctoral recipients for the associated time period. To reduce the number of level-2 singletons (or a level 2 unit with a single observation) and thus reduce the potential for “bias in the variance estimates” (Bell, Ferron, & Kromrey, 2008), the analysis in this study is limited to programs producing three or more doctorates in the period between July 1, 2008 and June 30, 2010.

Additionally, due to the interest in program related factors such as program prestige, the associated sample is limited to those programs which were considered in the National Research Council’s *A Data-Based Assessment of Research-Doctorate Programs in the United States* (Ostriker, Kuh, & Voltuk, 2011). The result is a sample of 901 doctoral recipients from 59 programs, yielding an average level-one sample size of 15.3 (range 5 to 50). Table 1 provides the initial count of participants, by program, considered for this study.

Data

Data for this proposed study came from four sources. First, institutional records data from the University of Minnesota were utilized to provide information about the demographic characteristics of the student as well information about the enrollment status of the student. Second, responses students provided to the *Survey of Earned Doctorates* at the time of completion were utilized to ascertain information about how a student funded her or his doctoral degree as well as the postcompletion plans of successful doctoral students. Because of a special agreement between the University and the National Science Foundation, SED data for the time period of this study were collected

Table 1

Participant Count of Doctoral Recipients by Program, July 1, 2008 - June 30, 2010

Program	Count	Program	Count
Aerospace Engr and Mech	12	History	27
American Studies	12	Hlth Srv Rsrch/Policy/Adm	10
Anthropology	8	Kinesiology	10
Applied Economics	6	Linguistics	5
Applied Plant Sciences	13	Mass Communication	10
Astrophysics	5	Materials Sci/Engr	11
Biochem/MBiol/Biophys	21	Mathematics	28
Biomedical Engineering	17	Mechanical Engr	21
Biostatistics	7	Medicinal Chemistry	10
Chemical Engineering	38	Microb/Immun/Cancer Biol	24
Chemistry	50	Mol/Cell/Dev Biol/Gen	19
Child Psychology	8	Music	5
Civil Engineering	15	Natural Resources Sci/Mgt	11
Communication Studies	7	Neuroscience	15
Comp & Molec Biosciences	9	Nursing	17
Compar Stydy Diserse/Soc	9	Nutrition	12
Computer Science	34	Pharmaceutics	6
Conservation Biology	17	Pharmacology	19
Ecology, Evolution & Behav	12	Philosophy	5
Economics	48	Physics	28
Electrical Engineering	43	Plant Biological Sciences	11
English	17	Plant Pathology	5
Environmental Health	8	Political Science	23
Epidemiology	9	Psychology	47
Family Social Science	13	Sociology	12
Food Science	7	Statistics	7
Geography	14	Theatre Arts	6
Geology	10	Veterinary Medicine	8
Hisp/Luso Brazil Lit/Ling	14	Water Resources Science	6

by the University of Minnesota prior to submission to NORC, which subsequently allowed the researcher to link it back to other institutional record data. The third source of data comes from the University of Minnesota's Doctoral Exit Survey. Developed in conjunction with the Association of American Universities Data Exchange (AAUDE) and administered at the same time as the *Survey of Earned Doctorates*, the University of Minnesota's Doctoral Exit Survey asks students more than 50 questions designed to solicit feedback about their overall satisfaction with their doctoral experience. Both the SED and Minnesota Doctoral Exit Survey are included in Appendix A. The final source of data is the National Research Council's Assessment of Research Doctorates and serves as the primary source of data about the program-level variables.

Dependent Variables: Job Commitment and Occupational Type

The primary dependent variables of this study concern two related aspects of the postcompletion occupational trajectory of successful Ph.D. students: postcompletion plans and occupational attainment. To ascertain the postcompletion plans of successful doctoral students, this study relied on the responses provided by students about his or her postcompletion plans on the *Survey of Earned Doctorates (SED)*. At the time of completion, students completing the SED are asked a series of questions about their postcompletion plans including: where they plan to live, what type of employer they will be working for, the name of their employer, and if their plans involve accepting a "postdoc" position.

To address this study's question pertaining to the respondent's postcompletion plans (R1), the SED question asking "what is the status of your postgraduate plans"

(Question B3) was utilized to create a polychotomous variable separating respondents (n=836) into three groups: 1) those who were still seeking employment or study, 2) those who had selected a postdoc position, and 3) those who had obtained employment.¹³ Survey results suggest that for students in the sample approximately 20.3% of respondents were still seeking employment or study opportunities, 33.5% had selected a postdoc position, and 46.2% had secured a job or job commitment at the time of completion.

To address this study's question related to the occupational sector (R2), selected by individuals opting for employment (n=386) responses to the SED inquiry "What best describes your (within the next year) postgraduate plans" (Question B6) were utilized to classify those individuals into a dichotomous variable coded '1' for those who obtained a job in the education sector (n=210) and '0' for all other job sectors (n=177). For those respondents not working in the education sector, approximately 80.2% indicated working in the private sector (business, industry or non-profit), 9.0% in government, and 10.7% other (self-employed or employment sector not identified). To address the question about

¹³ Individuals responding that the intention to not to work or study (n=4) or enroll in another full-time degree program (n=16) were excluded from the dataset due to their small sample size. Sixty-three respondents chose the response 'Other.' Qualitative information in the form of an open-ended response to the option 'Other' was utilized to classify 53, or 84.1%, of these respondents into the different categories of the dependent variable.

the type of position available to those working in the education sector, this study relied on responses to the SED question “If your current employment is in education, what type is it?” (Question B12). Question B12 was utilized to identify those respondents who accepted a tenure-track position versus those who accepted a non-tenure-track position (including staff positions and position in K-12).

While an interpretation of doctoral student success that emphasizes the postdoctorate occupational outcomes of students largely departs from the way the current research considers what it means to be successful in graduate school, there are several reasons to prefer this interpretation over more traditional measures of doctoral student success such as completion of milestones or time-to-doctorate. First, it coincides with the way many doctoral programs and advisors conceptualize student success as the placement of their students. For example, in their study of 62 mentors of doctoral students, Blackburn, Chapman, and Cameron (1981) observed that “Mentors overwhelming nominated as their most successful protégés those whose careers were essentially identical to their own” (p. 315). Second, the initial placement of doctoral students frequently impacts their likelihood to be successful later down the road. In their study of the relationship between the departmental prestige and the scholarly productivity, Allison and Long (1990), who studied “the antecedents and consequences of 179 job changes by chemists, biologists, physicists, and mathematicians,” found that job placement matters as “the effect of departmental affiliation on productivity is more important than the effect of productivity on departmental affiliation” (p. 469).

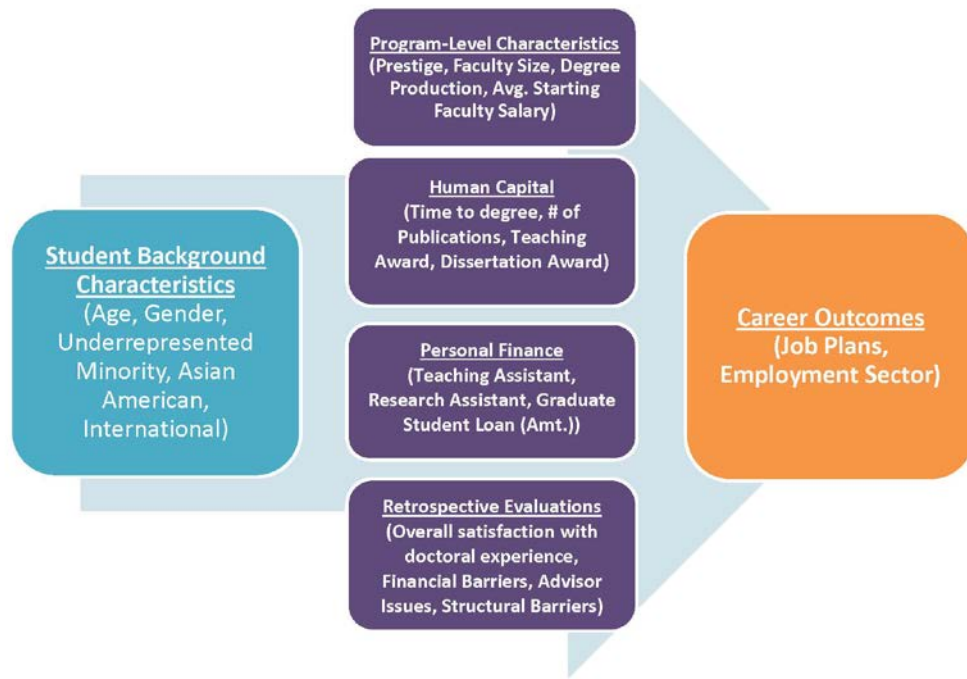


Figure 2. Map of variables to conceptual framework.

Independent Variables

Program-level variables. Figure 2 maps the variables to the conceptual framework for each of the variables included in this study. This study also incorporates four program-level variables or characteristics at the environment stage of the conceptual model expected to influence the likelihood of degree success and reflect the influence of program-level effects on post-completion outcomes.

Program characteristics. Three variables are included to assess the relationship between characteristics of a doctoral program and postcompletion success. Previous

research suggests that the most important departmental-level factor associated with the placement of successful Ph.D. students is the reputation or prestige of a program (Long, et al., 1979; Baldi, 1995). To assess the prestige of a program this study utilizes information from the R-ranking developed by the National Research Council. Originally published in September 2010,¹⁴ the NRC's study entitled *A Data-Based Assessment of the Research-Doctorate Programs in the United States* was a multi-year study "from over 5000 doctoral programs in 62 fields at 212 universities" in the United States (Ostricker, Kuh, & Voytuk, 2011, p. xi). In contrast to previous iterations of the NRC rankings, the 2011 release eschewed a single numerical ranking of programs. In its stead were the R- and S-rankings and a range of values (from the as the 5th and 95th percentile estimates) for each program. While both the R- and S-rankings utilized the same data, they relied on different weighting schemes to produce the estimates of the 5th to 95th percentile range. For the R-rankings faculty members were assigned a random list of programs in their field that they were asked to rank. Regression analytic techniques were then applied to these rankings to determine the respective weights of each of the 20 variables¹⁵ utilized in

¹⁴ The NRC released an update in April 2011 designed to correct for errors in the original database. Data from the revised rankings are used in this study.

¹⁵ The 20 variables utilized to produce the NRC R- and S-rankings included: publications per allocated faculty, cites per publication, percent of faculty with grants, percent faculty interdisciplinary, percent non-Asian minority faculty, percent female faculty awards, per allocated faculty, average GRE, percent 1st year students with full support, percent 1st

the model. For the S-ranking, faculty members were provided with the list of 20 variables and asked to rank them in order of importance to their respective fields. While the S-ranking probably results in the more objective of the two measures, it is the R-ranking's emphasis on the reputational rankings of doctoral programs to establish variable weights that makes it preferable for this study. These reflect two very different approaches to assessing program quality. Specifically, this study utilizes the 5th percentile ranking (or lower bound) estimate of the R-ranking as its measure of program reputation.

In addition to program reputation, a second program-level measure, included to accommodate program-level effects associated with characteristics of the program, is the total count of tenure and tenure-track faculty members affiliated with a program. Its inclusion is meant to control for the differences in occupational outcomes that may be related to program size. To prevent double-counting, faculty members with appointments in more than a single program were assigned to the program responsible for the largest share of his or her salary. The third measure is a count of the number of degrees produced by a program during the period AY2008-2010. While obviously associated with size, because students are often competing for the same jobs, its inclusion is meant to capture

year student with external support, percent non-Asian minority students, percent female students, percent international students, average Ph.D.s 2002 to 2006, percent completing within 6/8 years, time to degree full and part-time, percent students in academic positions, student work space, health insurance, and number of student activities offered.

the potential effect of doctoral student supply on a student's job prospects at the time of completion.

Program specific academic market conditions. In addition to degree production, it was important to also include a measure of market demand for degrees in each program. To develop estimates for market demand for each program, this study uses data from the AAUP faculty salary survey submitted to the Association of American Universities Data Exchange (AAUDE) for the years between 2008 and 2010. In particular, this study utilizes the average salary of new assistant professors included in the AAUP survey as a measure of market demand for recent graduates. Measured at the six-digit CIP level, these values were able to be mapped back to each of the programs in the dataset to provide an estimate of the anticipated salary a new doctorate might expect if entering the professorate as a tenure-track new assistant professor at a major research university.

Individual-level variables. In contrast to the program characteristic variables which all occur at the *environment stage*, the individual-level variables occur at both the input and environment stage. At the *input stage*, this study includes five variables associated with an individual's *demographic characteristics*. Dichotomous variables for individuals identifying as an underrepresented minority, female, or Asian American are included to control for potential inequalities in the market place associated with race and gender observed in previous research (Long, Allison, & McGinnis, 1993; Long & Fox, 1995). A fourth dichotomous variable identifying international students is also incorporated into the model. Its inclusion is meant to accommodate any differentials in

hiring patterns that may be associated with a student's lack of U.S. citizenship status. The final demographic variable is the respondent's age at the time of completion and is included to control for potential differences in postcompletion plans for respondents completing a degree later in their life. Taken together, these variables are included largely as control measures meant to help the model accommodate for differences in hiring patterns based on demographic characteristics observed by previous researchers.

The 11 student-level variables included at the *environmental stage* attempt to identify the potential relationship between occupational attainment of successful students and three thematic areas reflecting the interaction between the individual and her or his doctoral program: 1) human capital, 2) personal financial resources, and 3) retrospective evaluations of the doctoral experience. Taken together, the variables in these categories attempt to capture the important interactions between the individual and his or her doctoral program.

Human capital. In relation to the *human capital* perspective, this study incorporates four variables that are meant to capture the academic performance of students while enrolled in a doctoral program. The first two come from the University of Minnesota's Doctoral Exit Survey and measure whether the student was awarded a teaching or dissertation award (local or external) while enrolled in his or her doctoral program; coded 1 if yes and 0 if no. Their inclusion is meant to identify high performance students. The third variable also comes from the Exit Survey and is a self-reported count of the number of articles in which the student was the primary author that were published while the student was enrolled in his or her doctoral program and ranges from 0 to 7. Its

inclusion is meant to accommodate for the importance placed on publication record by many hiring departments, particularly in academia. The final measure is the elapsed time-to-doctorate which measures the time between first enrolling in the student's current doctoral program and completing the associated degree, counted in years. This measure was obtained from institutional records and its inclusion attempts to identify the potential effect of lingering in graduate school as opposed to completing a degree expediently.

Personal finance. In terms of *personal finance*, this study utilizes three measures developed from the responses students gave to inquiries on the Survey of Earned Doctorates about how his or her doctoral education was financed. The first two are dichotomous measures, and are meant to identify if the student reported that either a teaching assistantship or research assistantship was identified as the greatest source of financial support while enrolled in his or her doctoral program, coded '1' if yes and '0' if no. Their inclusion is designed to allow us to discern to what extent those sources of institutional support that provide doctoral students with distinct professional development opportunities may influence a student's postcompletion occupational outcomes. The third variable is an ordinal variable (1-8) measuring the amount of graduate student debt a student has accumulated while enrolled in his or her doctoral program.¹⁶ Its inclusion is

¹⁶ Measured in \$10,000 up to \$70,000+, such that \$10,000 or less = 1, \$10,001 - \$20,000 = 2, \$20,001 - \$30,000 = 3, \$30,001 - \$40,000 = 4, \$40,001 - \$50,000 = 5, \$50,001 - \$60,000 = 6, \$60,001 - \$70,000 = 7, \$70,001 or more = 8.

meant to explore to what extent a student's financial obligations in the form of debt burden may influence her or his postcompletion occupational choices.

Retrospective evaluation of program experiences. The *retrospective evaluations* of the graduate school experience come from responses to the University of Minnesota's Doctoral Exit Survey. To help reduce the information contained in this section into a smaller number of factors (or latent variables), this study utilized an exploratory factor analytic approach to data reduction. Not all items were considered for inclusion in the factor analysis as items with an open-ended response were excluded as were any variables with bivariate correlations greater than 0.9. The inclusion criteria for the remaining items included both the perceived uniqueness of the item (the item asked about a unique aspect of graduate student experience) and the lack of missing values (number of missing values less than 10%). Eighteen of the potentially 50 items included in the Exit Survey were retained resulting in a ratio of observations to items of 58:1 (n=1,049) exceeding the 20:1 ratio frequently used in the literature (Costello & Osborne, 2005). Factor extraction of the 18 items was conducted via principal axis factoring of the correlation matrix. The Kaiser criterion (Kaiser, 1960), or the retention of factors with eigenvalues greater than 1, was utilized to evaluate factors and produced a four-factor solution that explained approximately 65% of the variance in the original data. Under the assumption that different aspects of the graduate experience would be related, an oblique rotation method (Oblimin, Delta=0) was utilized to assist in identifying and naming of the four latent factors. Table 2 provides the pattern matrix for the associated four-factor solution. Eleven items had significant loadings ($|x| > 0.30$) on the first factor (Eigenvalue

= 7.1). These items highlight a multitude of aspects about the graduate experience, and taken together appear to represent an overall measure of satisfaction with the doctoral experience.

Table 2

Factor Loadings for Variables Associated with Retrospective Evaluations of Program Experiences

	Factor			
	Satisfaction with doctoral experience	Financial barriers	Advisor issues/ challenges	Structural barriers
Overall program quality (1: Poor - 5: Excellent)	.869	.078	.056	-.068
The overall quality of the graduate curriculum (1: Poor - 5: Excellent)	.853	.065	-.050	-.028
Overall quality of graduate level teaching (1: Poor - 5: Excellent)	.764	.164	-.032	-.057
Your academic experience at this university (1: Poor - 5: Excellent)	.641	.055	-.222	-.018
Coursework, ... , etc. adequately prepared me for candidacy ... (1: Strongly Disagree - 5: Strongly agree)	.614	-.142	-.049	.025
Your student life experience at this university (1: Poor - 5: Excellent)	.607	-.081	-.005	.035
Students in my program are treated with respect by faculty (1: Strongly Disagree - 5: Strongly agree)	.586	.052	-.057	-.152
Interaction with peers in program (1: Poor - 5: Excellent)	.547	-.059	-.011	-.029
The opportunity to interact intellectually across disciplines (1: Poor - 5: Excellent)	.465	-.012	-.235	-.066
Work/financial commitments (1: Not an obstacle - 4: A major obstacle)	-.015	.856	-.009	.042
Family obligations (1: Not an obstacle - 4: A major obstacle)	.118	.521	.076	.112
Students in my program are adequately funded (1: Strongly Disagree - 5: Strongly agree)	.370	-.389	.047	.040

(continued)

	Factor			
	Satisfaction with doctoral experience	Financial barriers	Advisor issues/challenges	Structural barriers
Quality of mentoring provided by your faculty advisor (1: Poor - 5: Excellent)	.079	-.020	-.897	.076
Overall, my dissertation advisor performed the role well (1: Strongly Disagree - 5: Strongly agree)	-.042	.022	-.860	.033
Quality of academic advising and guidance (1: Poor - 5: Excellent)	.313	.016	-.626	.033
Availability of faculty (1: Not an obstacle - 4: A major obstacle)	-.037	.152	.431	.264
Program structure or requirements (1: Not an obstacle - 4: A major obstacle)	.008	.027	-.056	.705
Course scheduling (1: Not an obstacle - 4: A major obstacle)	-.138	.034	.005	.666

Three items related to the financial experiences of a student had significant loadings on the second factor (Eigenvalue = 1.9), and taken together appear to represent the level of financial stress experienced by the student. Four items associated with advising and faculty interaction had significant loadings on the third factor (Eigenvalue = 1.4) and appear to represent a measure of advisor satisfaction; however, given the direction of the factor loading the measure is best described as advising challenges. Two items had significant loadings on the fourth factor (Eigenvalue = 1.1), and taken together reflect the respondent's perception that program structure impeded their progress.

There is a strong similarity between the factors that emerged from the factor analysis employed in this study and the six thematic areas identified by the Council of Graduate Schools *Ph.D. Completion Project* (Sowel, Zhang, Bell, & Kirby, 2010) as areas for successful interventions for doctoral student success which included: selection and admissions; mentoring and advising; financial support; research mode of the field;

curricular and administrative processes and procedures, and program environment. The high degree of congruence between these lists provides some validity that the identified factors in this study represent more universal dimensions of the doctoral student experience.

As previously noted, data for this study came from four sources: institutional records data from the University of Minnesota, the *Survey of Earned Doctorates*, the University of Minnesota's *Doctoral Exit Survey*, and the National Research Council's *Assessment of Research Doctorate Programs*. To help summarize the data utilized in the

Table 3

Descriptive Statistic and Data Source for Independent Variables

Variable	Obs	Mean	Std. Dev.	Min	Max
Demographic Characteristics					
Underrep. Minority	750	0.040	0.196	0.000	1.000
International Student	750	0.352	0.478	0.000	1.000
Asian American	750	0.047	0.211	0.000	1.000
Female	750	0.444	0.497	0.000	1.000
Age	750	-0.028	6.278	-8.135	28.195
Personal Finance					
Teaching Assistant	750	0.296	0.457	0.000	1.000
Research Assistant	750	0.397	0.490	0.000	1.000
Graduate Debt	750	0.983	1.994	0.000	8.000
Human Capital					
Publications: 1st Author	750	2.011	1.937	0.000	7.000
Teaching Award	750	0.123	0.328	0.000	1.000
Dissertation Award	750	0.185	0.389	0.000	1.000
Time to degree	750	-0.009	2.281	-4.041	14.999
Retrospective Evaluations					
Satisfaction with Doctoral Experience	750	0.004	0.954	-3.523	1.467

(continued)

Variable	Obs	Mean	Std. Dev	Min	Max
Financial Barriers	750	0.003	0.833	-1.465	2.147
Advisor Issues	750	-0.007	0.947	-1.032	3.205
Program Barriers	750	0.002	0.817	-0.973	3.070
Program Characteristics					
NRC R-ranking 5th (Relative)	750	0.220	16.593	-16.615	67.416
Program Faculty count: 2009-10	750	-0.056	20.343	-35.721	56.279
Degrees awarded: 2008-2010	750	0.180	14.988	-21.705	31.295
New Assistant Professor Salary: Average	750	0.120	11.032	-16.589	25.788

model, Table 3 lists each of the variables considered in this study and the associated descriptive statistics.¹⁷

Analyses

As Smith (2011) described, “Human behavior can be conceptualized as being influenced by three factors: (1) a person’s prior personal dispositions ... ; (2) the impingement of social environment on that person; and (3) the interactions between the predisposing and environmental factors. These factors imply a multilevel analysis of at least two levels, that of the individual (referred to as level-1) and that of the environment (referred to as level-2)” (p. 3). Given the findings from previous research, it is clear that a multi-level or nested structure represents the data explored in this study, as both individual- and departmental-level factors have been found to be associated with doctoral student outcomes. To accommodate the multi-level, or nested, structure of the data, this study’s analytic approach stems from a class of statistical models referred to as hierarchical generalized linear models (HLM).

¹⁷ Each of the continuous measures in model was grand mean centered.

To date, the advantages associated with the application of hierarchical models to educational datasets have been demonstrated by numerous scholars including Raudenbush and Bryk (1986), Bryk and Raudenbush (1992), Phillips (1997), Lee and Loeb (2000), Porter (2005), and Stewart (2008). Specifically, failing to employ a multi-level analytic approach when analyzing data with an inherent nested structure results in three common problems: “aggregation bias, misestimated standard errors and heterogeneity of regression” (Raudenbush & Bryk, 2002, p. 99-100). In the context of this study then, the inability to accommodate the fact that the base likelihood associated with the different occupational outcomes vary by program would undermine the analytic results of this research. To avoid these issues and to accommodate dependent variables that are categorical in nature, this study adopts a two-level hierarchical nonlinear model for its methodological approach.

Given that the two dependent variables are polychotomous variables, each with three outcomes (R1: Seeking/Postdoc/Employment and R2: Tenure-track/Non-tenure-track/Industry), this study employs a multilevel multinomial model where the level-1 (or student-level) structural model can be summarized by the equation:

$$\eta_{mi,j} = \beta_{0j(m)} + \sum_{q=1}^{Q_m} \beta_{qj(m)} X_{qi,j}$$

for $m = 1, \dots, m-1$, where m is the number of response categories, or in the context of this study $m=3$ (Raudenbush & Bryk, 2002). In this equations, $\beta_{0j(m)}$ represents the average log-odds of outcome m in program j , $\beta_{qj(m)}$ represents the change in the log-odds of attaining outcome m associated with a one-unit change in independent variable

X_{qij} for variable q for student i in program j . The proposed level-2 (or program-level) model is represented by the equation:

$$\beta_{qj(m)} = \gamma_{q0(m)} + \sum_{s=1}^{S_q} \gamma_{qs(m)} W_{sj} + u_{qj(m)}$$

for $q = 0, \dots, Q_m$. While this specification allows for both random intercepts and random slopes, this study employs a random intercept model that allows for the likelihood of an outcome occurring to vary by program. To estimate the associated random intercept multilevel multinomial logit models, data analysis for this study was conducted utilizing the *gllamm* statistical package developed by Rabe-Hesketh, Skrondal, and Pickles (2004, 2005) for Stata 13.1 (Stata, 2013). Developed to allow for the estimation of generalized linear latent and mixed models by maximum likelihood, *gllamm* provides users with a robust set of tools for the modeling of nominal data (Skondral & Rabe-Hesketh, 2003).

Results

Variables Associated with Postcompletion Plans at the Time of Completion

Table 4 provides the odds-ratios associated with a random intercept multilevel multinomial logit model of a successful student's job plans at the time of completion. Results represent the change in the odds of the associated outcome relative to a reference category. At the individual level, results identified statistically significant differences on three of the demographic controls included in the model. First, the odds of accepting a postdoc position relative to having an employment commitment were 2.19 times greater ($p < 0.01$) for international students in the sample than U.S. students. Second, the odds of having accepted a postdoctoral position relative to still seeking employment were

reduced by 65.4% ($p < 0.10$) for students identifying as Asian American. Third, results suggest that there is a negative relationship between age and the willingness to accept a postdoctoral position as model results suggest that each additional year in age is expected to reduce the odds of accepting a postdoctoral position relative to still seeking employment by 6.1% ($p < 0.05$) and reduces the odds of accepting a postdoc relative to having an employment commitment by 6.4% ($p < 0.01$).

Of the three personal finance variables incorporated in the model, only the variable estimating the impact of being financially reliant on a teaching assistantship was found to be associated with a student's postcompletion plans. Model estimates suggest that for those students indicating a position as a teaching assistantship was the primary source of financial support to fund their doctoral education were less likely to accept a postdoctoral position than either still seeking or having an employment commitment. Specifically, model estimates suggest a 56.3% reduction ($p < 0.05$) in the odds of accepting a postdoctoral position relative to continuing to seek employment and a 57.1% reduction ($p < 0.01$) in the odds of accepting a postdoc relative to having an employment commitment.

In terms of the measures of human capital, or achievement, time to doctorate is associated with the lower likelihood of accepting a postdoctoral position. Model estimates suggest that each additional year is associated with a 16.4% reduction ($p < 0.05$) in the odds of starting a postdoc relative to seeking employment and a 12.6%

Table 4

Odds Ratios for Postcompletion Plans of Successful Doctoral Students at the University of Minnesota, 2008-2010

Level 1: Student Level							
	Postdoc Seeking			Employed Seeking		Postdoc Employed	
	OR	SE		OR	SE	OR	SE
<i>Demographic Characteristics</i>							
Underrep. Minority	1.020	0.579		0.642	0.332	1.588	0.914
International Student	1.539	0.427		0.704	0.184	2.186	0.565 ***
Asian American	0.346	0.196	*	0.594	0.262	0.581	0.318
Female	0.732	0.178		0.859	0.188	0.853	0.194
Age	0.939	0.025	**	1.004	0.020	0.936	0.024 ***
<i>Personal Finance</i>							
Teaching Assistant	0.437	0.144	**	1.018	0.277	0.429	0.133 ***
Research Assistant	0.952	0.276		0.988	0.272	0.963	0.250
Graduate Debt	0.985	0.061		0.950	0.047	1.037	0.061
<i>Human Capital</i>							
Publications: 1st Author	1.048	0.075		1.003	0.062	1.044	0.068
Teaching Award	0.736	0.263		0.711	0.219	1.035	0.364
Dissertation Award	1.665	0.510		1.080	0.309	1.543	0.418
Time-to-degree	0.836	0.059	**	0.956	0.047	0.874	0.060 **
<i>Retrospective Evaluation</i>							
Factor 1: Satisfaction	0.780	0.133		0.914	0.135	0.854	0.133
Factor 2: Financial Barriers	1.441	0.254	**	1.107	0.165	1.348	0.217 *

(continued)

	Postdoc Seeking		Employed Seeking		Postdoc Employed				
	OR	SE	OR	SE	OR	SE			
Factor 3: Advisor Issues	0.804	0.121	0.816	0.109		0.984	0.139		
Factor 4: Program Barriers	0.771	0.133	0.842	0.128		0.915	0.146		
Level II: Program Level									
NRC R-ranking 5th (Relative)	0.992	0.010	0.985	0.008	*	1.006	0.012		
Program Faculty count: 2006	1.007	0.009	0.973	0.008	***	1.035	0.013	***	
Degrees awarded: 2008-2010	1.001	0.015	1.022	0.012	*	0.979	0.019		
New Assistant Professor Salary: Average	1.006	0.017	1.000	0.013		1.005	0.020		
_cons	1.451	0.494	2.851	0.816	***	0.506	0.176	*	
Random Effect									
Variance Component		0.582 (0.310)		0.273 (0.170)			1.577 (0.550)		
level 1 units	2250								
level 2 units	58								
log likelihood	-680.13								

Note. Odds-ratios are relative to still seeking employment at the time of completion. All continuous variables were mean centered at the sample mean.

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

reduction ($p < 0.05$) in the odds of starting a postdoctoral position relative to having an employment contract.

Of the four retrospective evaluation measures, only the factor measuring a student's perception of financial barriers or stress was associated with a student's postcompletion plans. Specifically, model estimates suggest that for every unit (or standard deviation) increase in the financial barrier factor is associated with 44.1% increase ($p < 0.05$) in the odds of starting a postdoctoral position relative to seeking employment and a 34.8% increase ($p < 0.10$) in the odds of starting a postdoctoral position relative to having an employment commitment at the time. It would be interesting to discern to what extent these feelings of financial stress may be associated with having accepted a postdoctoral position; unfortunately, this research is unable to address this question.

In terms of program-level variables, model results suggest that three program-level characteristics are associated with the postcompletion plans of successful doctoral students: program ranking, faculty size, and number of degrees awarded. Model estimates suggest that for every percentage increase in a program's relative 5th percentile R-ranking¹⁸ is associated with a 1.5% reduction in the odds of employment relative to seeking employment suggesting that individuals from less regarded programs are more likely to be seeking a job than having a job commitment at the time of completion. In

¹⁸ In our model, an increase in rank reflects the lower reputational assessment of doctoral programs as higher R-rankings are associated with lower quality doctoral programs.

Table 5

Odds-Ratios for Postcompletion Occupational Choice for Successful UMN Doctorate, 2008-2010

Level 1: Student Level									
	Industry Tenure			NonTenure Tenure			Industry NonTenure		
	OR	SE		OR	SE		OR	SE	
Demographic Characteristics									
Underrep. Minority	0.275	0.295		0.228	0.213		1.206	1.429	
International Student	3.047	1.589	**	0.397	0.199	*	7.677	4.391	***
Asian American	4.500	4.383		1.770	1.577		2.542	2.213	
Female	1.694	0.735		2.020	0.757	*	0.838	0.372	
Age	0.977	0.035		0.998	0.033		0.979	0.035	
Personal Finance									
Teaching Assistant	0.295	0.158	**	1.458	0.677		0.202	0.109	***
Research Assistant	1.185	0.630		1.574	0.868		0.753	0.411	
Graduate Debt	0.822	0.084	*	0.932	0.082		0.882	0.093	
Human Capital									
Publications: 1st Author	0.992	0.114		0.924	0.113		1.074	0.134	
Teaching Award	0.521	0.347		1.195	0.607		0.436	0.284	
Dissertation Award	0.439	0.262		1.681	0.829		0.261	0.153	**
Time-to-degree	1.127	0.115		1.049	0.101		1.074	0.103	
Retrospective Evaluation									
Satisfaction with Doctoral Experience	1.946	0.558	**	1.320	0.330		1.474	0.418	
Financial Barriers	1.143	0.341		0.961	0.267		1.189	0.369	

(continued)

	Industry Tenure			NonTenure Tenure			Industry NonTenure	
	OR	SE		OR	SE		OR	SE
Advisor Issues	1.919	0.589	**	2.022	0.539	***	0.949	0.269
Program Barriers	1.435	0.410		1.141	0.295		1.257	0.377
Level II: Program Level								
NRC R-ranking 5th (Relative)	1.046	0.021	***	1.045	0.017	***	1.001	0.016
Program Faculty count: 2009-10	1.025	0.020		1.024	0.015		1.002	0.017
Degrees awarded: 2008-2010	0.989	0.026		1.012	0.017		0.977	0.022
New Assistant Professor Salary: Average	1.132	0.034	***	1.016	0.025		1.114	0.031
Intercept	1.864	0.978		0.657	0.333		2.839	1.506
Random Effect								
Variance Component				1.563 (0.888)			0.156 (0.237)	
level 1 units	933						0.713 (0.596)	
level 2 units	55							
	-							
log likelihood	227.898							

Note. Odds-ratios are relative to still seeking employment at the time of completion. All continuous variables were mean centered at the sample mean.

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

terms of program size, model estimates suggest that each additional tenure/tenure-track faculty member is associated with a 2.7% reduction ($p < 0.05$) in the odds of employment relative to seeking employment and a 3.5% increase ($p < 0.01$) in the odds of accepting a postdoc relative to an employment commitment at the time of completion. When it comes to degree output, model estimates predict a 2.2% increase in the odds of employment relative to seeking a commitment for each additional degree produced by a program.

Variables Associated with Employment Type at the Time of Completion

Table 5 provides the associated odds ratios resulting for the model predicting the occupational outcomes of individuals who reported to have a job or job commitment at the time of completion. Model estimates identified two statistically significant differences associated with demographic characteristics of individuals in the sample. First, international students reporting to have an employment commitment at the time of completion were far more likely to have accepted a position in business or industry than to have accepted a tenure- or non-tenure-track position in academia. Specifically, the odds of accepting an industry position relative to tenure-track position was 3.05 times greater ($p < 0.05$) for international students, while the odds of accepting an industry position relative to a non-tenure-track position was 7.78 times greater ($p < 0.01$). For those international students with academic employment at the time of completion, a tenure-track position was their more likely destination as model estimates predict a 60.3% reduction in the odds ($p < 0.10$) of accepting a non-tenure-track position relative to a tenure-track position. Consistent with the literature on gender-based difference in the

professoriate, model estimates identified a significant difference in the type of academic positions available to women at the time of completion. Specifically, results in Table 5 suggest the odds of accepting a non-tenure-track position relative to a tenure-track position were 2.02 times greater ($p < 0.10$) for women in than their male counterparts.

In terms of the three measures of personal finance, students relying on a teaching assistantship as their primary source of financial support were less likely to accept a position in business or industry than an academic position. Specifically, model results suggest that those individuals indicating that a position as a teaching assistantship was the primary source of support for his or her doctorate experienced a 70.5% reduction ($p < 0.05$) in the odds of accepting an industry position relative to a tenure-track position and a 79.8% reduction ($p < 0.01$) in the odds of accepting an industry position relative to a non-tenure-track position. For each unit change in graduate debt, the odds of accepting an industry position versus a tenure-track position are expected to be reduced by 17.8% ($p < 0.10$), suggesting that individuals going into the professoriate are more likely to rely on borrowing to finance their doctorate than their business sector counterparts.

When it comes to program experiences among students with employment commitments at the time of completion, those reporting challenges with their advisor were more likely to wind up with a non-tenure-track or industry position than a tenure-track position. Specifically, model estimates suggest that a one unit (or one standard deviation) increase in advisor dissatisfaction is expected to produce an increase in the odds of industry employment versus tenure position by a factor of 1.92 ($p < 0.05$) and an increase in the odds of non-tenure-track employment versus tenure-track employment by

a factor of 2.02 ($p < 0.01$). Curiously, overall program satisfaction was found to be associated with a greater likelihood of obtaining employment in business or industry. Specifically, a one-unit (or one standard deviation) increase in overall satisfaction measure is expected to increase the odds of industry employment relative to tenure-track position by a factor of 1.95 ($p < 0.05$).

Two program-level effects also were significant in predicting the employment outcome of successful doctorates with a job commitment at the time of completion. First, model estimates suggest that program prestige is strongly associated with job outcomes. In particular, every unit increase in a program's relative rank is expected to increase the odds of business sector employment by approximately 4.6% ($p < 0.01$) and the odds of non-tenure-track employment by approximately 4.5% ($p < 0.01$) relative to tenure-track position. Put another way, as the esteem of a program declines so does its ability to place individuals in tenure-track positions. Second, average salaries for new assistant faculty salary is positively associated with employment in the business and industry sector; giving credibility to the conventional wisdom that in certain fields with competitive private sector employment opportunities, higher salaries are necessary to attract top talent into the professoriate. Specifically, model estimates suggest that every \$1,000 increase in average salary is associated with 13.2% increase ($p < 0.05$) in the odds of business and industry employment versus tenure-track employment, and 11.4% increase ($p < 0.01$) in the odds of business and industry employment versus non-tenure-track employment.

Discussion

This study explored the postcompletion plans of 787 successful doctoral students earning a degree from the University of Minnesota-Twin Cities between July 1, 2008 and June 30, 2010. Utilizing data from the Survey of Earned Doctorates and the University of Minnesota Doctoral Exit Survey, this study explored how the experiences doctoral students encounter in graduate school influence the occupational path and job choices they choose at the time of completion. The two primary contributions of this study center on its extension of doctoral student success to include the postcompletion plans of successful doctoral students and the inclusion of a methodological approach appropriate to accommodate the variety of choices students have at the time of completing his or her doctorate.

Currently, much of the academic research involving doctoral student success is largely concerned with explaining the procedural success of doctoral students, focusing largely on a student's ability to either successfully traverse the different milestones to the doctoral completion (Girves & Wemmerus, 1988; Golde, 1998; Gardner, 2010) or complete the process in a timely manner (Ampaw & Jaeger, 2012; Kim & Otts, 2010; Stricker, 1994; de Valero, 2001). While completing the doctorate is obviously a notable achievement, it is the position of this research that the true value of a doctorate comes after completion. Given the country's need for qualified academics, researchers, and scientists, this research develops a measure of doctoral student success that explores the postcompletion plans and occupational choices of successful doctoral students and

explores how the doctoral experience may potentially influence the likelihood of these outcomes.

Three important conclusions can be drawn from this research. First, results from this study support the working hypothesis that the experiences of students in graduate education are associated with certain aspects of their postcompletion plans and occupational choices. In particular, results suggest the potential for students reporting negative experiences in graduate school may be funneled to into certain occupation outcomes. For example, when it comes to postcompletion plans, results from this study suggest that students who encountered financial obstacles or experienced financial stress during his or her doctoral studies were more likely to have accepted a postdoctoral position than continue their job search at the time of completion. While obviously not a problem if these students had a preexisting preference for a postdoctoral position; if however, these students are opting into a postdoc in order to mitigate financial burdens (such as loan repayment or the necessity for a paycheck to support a family), a different picture emerges. Results additionally suggest that the impact of reporting a negative experience in relation to one's advisor is similarly associated with certain employment opportunities. Specifically, results suggest that students reporting issues or challenges associated with their advisor were significantly less likely to obtain a tenure-track position than they were to obtain a non-tenure-track position or a job in business/industrial sector, implying a linkage between the relationship with one's advisor and the ability to secure a tenure-track job. While the possibility exists that reports of negative experiences with an advisor may reflect the respondent's dissatisfaction with

their occupational outcomes at the time of completion, it should be noted that none of the items loading on the advisor issues factor ask specifically about job prospects or outcomes, but instead on the quality of advising or mentoring received by the student.

Second, results from this study support the belief that aspects of the doctoral experience associated with personal finance contribute to a student's postcompletion plans. After controlling for other factors, students reporting that their primary source of financial support came in the form of a teaching assistantship were significantly less likely to enroll in a postdoc (relative to seeking employment or being employed) or opt for employment in the business or industrial sector (relative to tenure-track or non-tenure-track employment). This would tend to suggest that the postcompletion trajectories of students with teaching assistantships are pretty well-defined as some form of academic employment. While this is not necessarily a problem if students are self-selecting into teaching assistantship positions, the implications are considerably different if this decision is being determined for them by his or her program, especially if this observed relationship results in a potential mismatch between the job skills possessed by teaching assistants and the demands necessitated by nonacademic employment. Results additionally suggest that experiences of financial stress during their doctoral experience are associated with an increased likelihood in opting for a postdoctorate position (relative to seeking employment or being employed) suggesting that the security of continued education may deter some from considering to enter the job market.

Third, when it comes to producing future faculty members, results from this study suggest it might be less about who you are than where you are from, as model results

identified strong program-level effects associated with the likelihood of obtaining a tenure-track position. In particular, the results of this study support existing research which suggests that program reputation appears to play a strong role in determining a student's likelihood in obtaining a tenure-track position (Baldi, 1995; Hesli, DeLaat, Youde, Mendez, & Lee 2006; Long, Allison, & McGinnis, 1979; Youn, 1988). All else held constant, the odds of employment in either an industry position or non-tenure-track position increases by 6.1% and 5.6%, respectively, for every unit decline in a program's reputational ranking as measured by the NRC's R-ranking. To give some perspective, programs in this study had relative 5th percentile NRC rankings R-ranging from the 4th percentile all the way to 88th percentile. While approximately one-quarter (24.6%) of students in this sample were enrolled in programs ranked in the top 10% in their associated field, another quarter (24.9%) were enrolled in programs ranked 25th percentile or lower. Taken together with the fact that none of the individual ability measures were associated with employment outcomes, a pretty clear picture emerges about the likelihood of obtaining a tenure-track job being largely predetermined by the reputation of your graduate program.

This study has several recognizable limitations. First, the study is limited to two graduating classes from a single university. While reliance on graduating classes does allow for a broader cross-section of students than following entry cohorts, the ability to make generalizations to larger populations is certainly constrained by the small sample and short event window. This lack of generalizability is further exacerbated by missing

data as non-response to items on the survey reduced the number of potential participants by approximately 13%, from 901 to 787 and opened the study to issues of selection bias.

Second, the study is additionally limited by its focus on successful doctoral students. The result of focusing exclusively on the successful student is a truncated picture of how the doctoral student experience may influence the career paths of students. Current estimates suggest that as much as 50% of students who start a doctoral degree leave without finishing (Cassuto, 2013, June 1). This current research does not address how program- and individual-level factors may influence the attrition patterns of these students. Consequently, the findings associated with research should be considered within the context of those students who choose to persist until completion.

Third, the study may be limited in its treatment of postcompletion outcomes inasmuch that it treats postdoctoral appointments as an end in itself, rather than a means to an end. The postdoctoral position is understood as “a short-term apprenticeship immediately following the completion of doctoral work that is designed to further prepare new Ph.D.s to become independent researchers” (Davis, 2009, p. 100). As such, for many individuals the postdoctorate position is less an outcome of doctoral education than an extension or prolonging of their career training. As the postdoctoral experience becomes both more common in its frequency and lengthier in term (Davis, 2009; Stephan & Ma, 2005) it may be important to assess to what extent these experiences influence the career trajectories of this subset of successful doctoral students. Unfortunately, because many of these students accept positions at either other research institutions or within industry this research is unable to answer questions such as these.

Fourth, the study is further limited by its reliance on self-reported data. For the measures attempting to assess ability this study relied on measures such as the number of publications and awards reported by the student. While students have few incentives to lie on the SED/Exit Survey, lack of validation is certainly a concern. This problem is perhaps even more acute when it comes to the items asking students to reflect on the quality and satisfaction of their doctoral program. Since the items are distributed to the student at the time of completion, the potential for significant halo effects are impossible to rule out.

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Chapter 5: Discussion, Conclusion, and Implications

The existing research on student success in college too often utilizes an overly narrow interpretation of student success that reduces success to a simple dichotomy, such as: enrolled versus not enrolled, retained versus not retained, graduated versus not graduated, et cetera (Gansemer-Topf & Schuh, 2006; Turner & Berry, 2000; Wohlgemuth, Whalen, Sullivan, Nading, Shelley, & Wang, 2007). The research in this dissertation highlights how expanding the interpretation of student success in college beyond the familiar success-failure dichotomies provides new insights into the differential effects of factors on a student's educational and occupational trajectories. In particular, the research in this dissertation highlights how using only simple dichotomies, where expanded choice sets are in place, prevents researchers from observing more complicated patterns of relationships between independent variables and the choices that students make.

Examining students at both the undergraduate and graduate level, this dissertation addressed two closely related questions. First, can a measure of student success be developed that incorporates a greater range of choices available to students than is included in traditional interpretations of success in the higher education literature? Second, does the development of an expanded measure of student success allow for new insights to be discovered about the factors that influence the choices students make about their future, both educationally and occupationally? Each of the studies presented in this dissertation confirms that the effort to expand student outcomes to better accommodate

the different options and opportunities available to students yields important insights into the results of educational choices made by students.

Empirical Findings

While specific results for each of the three distinct pieces of research included in this dissertation can be found in Chapters 2, 3 and 4, this section synthesizes the results of each of these works to provide a summary of both the empirical findings and resulting implications for higher education theory and practice.

Finding 1: Simple dichotomies of success frequently obfuscate what factors contribute to student success.

The origination of the dissertation began with a simple desire to utilize data from the National Student Clearinghouse to develop an expanded definition of success that included a measure of multi-institutional completion. Armed with this new measure, my colleagues and I began exploring how the existing understanding of undergraduate student success might change when such an expanded measure of success was applied. While the existing findings associated with student integration and academic performance remained unchallenged, the expanded measure of multi-institutional success did help to highlight the influence of several factors previously unnoticed in retention and graduation studies conducted at the University of Minnesota-Twin Cities. Specifically, in terms of this dissertation's research on undergraduate student success, the application of a categorical variable of student success that tracks multi-institutional completion allows researchers to distinguish between those factors that influence completion across all institutions, versus those factors that only effect the institution of first-entry and

subsequently represent a comparative advantage or disadvantage, depending on the relationship.

Additionally, in each of the studies in this dissertation, eschewing the traditional dichotomies of success has led to a more student-focused approach to understanding college success. For example, using a multi-institutional interpretation of student success dramatically alters the dynamics of our understanding of the college experience; abjuring the institutional focus inherent in traditional discussions of retention, completion, and placement rates in favor of a more student-centered approach. Similarly, by expanding our interpretation of doctoral student success beyond the completion and/or placement rates traditionally reported by academic programs, we are able to begin to identify linkages between an individual's experience in graduate school and the occupational trajectories they later follow.

Finding 2: The role of an individual's financial resources plays a powerful role in his or her academic and occupational choices.

A second important theme emerging from the studies in this dissertation is the influence of financial factors on the educational and occupational choices made by students. At the undergraduate level, findings from this dissertation suggest that the type of financial aid used to pay for college clearly influences a student's educational trajectory. While the initial findings provided in Chapter 2 suggest that the role of the PELL grant had a negative effect on completion, when more complete financial aid information was included in the predictive models of Chapter 3, the findings became much more nuanced. Specifically, the role of need appears to equalize the odds of

completing at the institution of first-entry, as recipients are neither more nor less likely to complete than nonrecipients. Where need aid does appear to make a difference is in the transfer probabilities, as need aid recipients are less likely to transfer, suggesting that those relying on need aid are potentially constrained in their educational trajectories by his or her ability to pay. Put another way, results from this dissertation suggest that for students relying on need aid to subsidize his or her education, transferring to another institution is a luxury he or she cannot afford. On the other side of the figurative balance sheet, institutional grants in the form of merit aid appear to increase the odds of graduation from the institution of first entry, even after controlling for student ability. This would seem to suggest that an institution's ability to offer tuition discounts in the form of merit scholarship may help support institutional retention and graduation goals.

The findings in this dissertation also suggest that the reliance on loans to pay for college is potentially limiting the opportunities for students. At the undergraduate level, this relationship is especially stark as a greater reliance on student loans to pay for college is associated with a lower probability to complete a degree at the institution of first entry. That model predictions suggest that these students are frequently finishing a degree at a transfer university suggests that the personal cost of college attendance at the University of Minnesota-Twin Cities may encourage students reliant on loan aid to search for better educational deals. The impact of borrowing behavior at the doctoral level is less apparent. Results in Chapter 4 suggest that borrowing behavior has little discernable impact on the postcompletion plans of success doctoral students. Where debt burdens appear to matter is among individuals with employment commitments at the time of

completion. In particular, model results suggest that students with larger graduate school debt burdens are less likely to be employed in business and industry than in either a tenure-track or non-tenure-track academic job.

Beyond the direct impact of a student's debt burden, research from this dissertation suggests that an important role a student's perception of financial security plays in influencing the postcompletion occupational trajectories of doctoral students. Specifically, results from Chapter 4 suggest that students reporting greater perceptions of financial barriers to completion during their doctoral experiences were more likely to accept a postdoctorate position than either having a job offer or be searching for employment at the time of completion. This would seem to suggest that the impact of loans may be mediated by an individual's tolerance for debt, but more research needs to be conducted to explore this possibility.

Finding 3: The experiences a student has in college influence his or her educational and occupational trajectory.

The research produced in this dissertation both supports the existing literature about the relationship between college experiences and educational outcomes and begins to expand this to the doctoral level. At the undergraduate level, beyond the obvious influence of the academic experiences, results from Chapter 2 and Chapter 3 highlight the importance of factors, like living on campus, in helping a student achieve a degree either from the institution of first-entry or a transfer university, suggesting that the experience of living on college campus is potentially translating into a desire to complete a college degree from somewhere.

While the research in Chapter 4 does not explore the doctoral completion, results from this chapter suggest that experiences that a student has in his or her doctoral program appear to influence their postcompletion occupational choices. As described previously, students encountering barriers to completion in the form of financial and family obligations were more likely to have committed to a postdoctoral position than to have accepted a job offer or be on the job hunt. While the design of this study prevented fully understanding this relationship, the potential that economic insecurity may be delaying entry into the labor force is worth further study, especially if it is associated with the desire to defer student loan repayment. The research in this dissertation also suggests that for those students who have a job commitment at the time of completion, program experiences influence the type of job he or she accepts. Students who expressed dissatisfaction with the performance of their mentor or adviser were more likely to take a position in either an industry or non-tenure-track position than a tenure-track job.

Finding 4: For successful doctoral students with tenure-track aspirations, escaping the gravitational pull of your department's reputation is difficult.

In terms of doctoral education, one of the important findings associated with this dissertation concerns the influence of program effects on the placement of successful doctoral student in the academic labor market. The evidence provided in Chapter 4 suggests that for Ph.D. students with a commitment for employment at the time of completion, the odds of that commitment including a tenure-track position in academia are significantly lower for those students enrolled in doctoral programs with lesser perceived prestige at least as represented by the National Research Council's R-ranking.

Oft considered the preferred placement outcome for successful doctoral students, tenure-track positions in academia are in relative short supply as institutions of higher education have shifted to flexible faculty appointments for a variety of reasons, both internal and external (Gappa, 2002). Meanwhile, the number of doctorates awarded in the United States reached an all-time high in 2012 at 51,008 (Fiegener, 2013). With doctoral output growing while the number of available tenure-track positions remains scarce, the relative importance of program reputation in influencing the occupation outcomes of successful doctoral students is of both theoretical and practical importance.

While it is impossible to completely rule out elements of self-selection at play here, the importance of program ranking after controlling for factors associated with an individual's experiences and ability would tend to suggest that it may not be enough for an individual to be a promising doctoral recipient as your doctoral pedigree appears to play an equally, if not more, important role in determining an individual's likelihood of obtaining a tenure-track position. If it is the case that students in low-ranking programs are aware of this relationship and recognize that opportunities for a tenure-track position are limited, then this may not be much of a concern. However, if it is the case that students believe (or are being led to believe) that they may be able to outperform the reputation of his or her program, then it is important that we address the source of these unrealistic expectations as they serve neither the student's nor the program's best interest.

Theoretical Implications

Results from the research in this dissertation suggest that the theoretical justification for considering student success an all-or-nothing dichotomy should be

revisited. While a variety of factors preclude moving completely beyond an institutional interpretation of student success, the results of the studies incorporated in this dissertation highlight how such simple interpretations of student success both misrepresent the realities of a student's path toward a degree and beyond and potentially obfuscate our understanding of the factors associated with student success.

Second, the empirical results from Chapter 3 suggest the need to reconsider the current assumptions underlying the value of a college degree. With the decline of state support, public institutions of higher education have increasingly relied on higher tuition to fill the associated budget deficits. As a result, the cost of attending college is rising faster than the rate of inflation (Kirshstein, 2012). The assumption has long been that students would continue to absorb these costs as the life-long value of a college degree outweighed the short-term cost of attendance. The results from Chapter 3 introduce the potential for an upper bound to this assumption. Specifically, the research on the influence of financial aid on undergraduate student success suggests that when the cost of college are passed on directly to the students in the form of student loans they are more likely to alter their educational trajectories to include completion from an institution other than the institution of first-entry.

Policy Implications

The results from this dissertation provide several implications for higher education policy. First, the empirical findings from Chapter 2 and Chapter 3 have demonstrated that an institutional definition of student success that emphasizes the importance of completion from the institution of first-entry oversimplifies the choice set

available to undergraduates. To better reflect the current reality of today's undergraduates, policy makers and administrators should consider a multi-institutional interpretation of student success that accommodates both traditional and transfer completion. At the national level, we have seen progress in this area as part of Voluntary System of Accountability's *College Portrait of Undergraduate Education*. Developed as an initiative to improve transparency with the public, the VSA's *College Portrait* allows individuals to obtain and compare data, including multi-institutional completion rates, for more than 300 public colleges and universities.

While an important step, additional applications of multi-institutional completion rates are necessary at both the state and institution level. At the state level, where legislatures frequently tie state support to academic performance measures, such as retention and graduation rates, utilization of a multi-institutional metric of student completion ensures that institutions would not be penalized in cases where students choose to pursue and complete a degree from another institution that may better served his or her needs. At the institutional level, the ability to distinguish between students who are transfer successes versus those who drop out of higher education entirely allows opportunities for colleges and universities to identify potential areas of comparative disadvantage.

Second, the results from Chapter 3 suggest that increasing tuition to compensate for rising costs and declines in state support may be an unsustainable strategy, as it increases the incentives for students to transfer and complete their education at an alternative institution with a lower price. While it is possible that some institutions may

be impervious to these limitations, particularly in markets where lower priced alternatives are unavailable, the existence of an upper bound where students may begin considering alternative higher education institutions should be remembered when considering tuition pricing. Additionally, despite the moral considerations associated with merit-based tuition discounting (Heller, 2006), institutional assistance in the form of modest merit based scholarships may be an effective mechanism to help increase persistence and graduation rates.

Third, the results from Chapter 4 provide at least two policy implications for education at the doctorate level. First, programs should be more transparent with students about the likelihood of obtaining a tenure-track position. One way to accommodate this would be to make completion and placement rate information available to students. There is perhaps a tendency for doctoral programs to highlight successful tenure-track placements when recruiting students leading to the assumption that the likely outcome of the doctorate is a tenure-track job. However, as competition for tenure-track positions becomes increasingly fierce and these positions are frequently allocated to individuals from the top programs, providing information on completion and placement rates would help rectify some of the misconceptions about the value and trajectory of doctorate. Second, programs should reconsider an approach to doctoral education that focuses exclusively on training individuals for future tenure-track positions. With the days of an ensured tenure-track position at the time of completion have long passed, continuing to utilize doctoral curriculum designed for training the professoriate is somewhat counterintuitive. While it is difficult to discern what the future of doctorate of education

should entail, there appears to be an opportunity here for innovation, particularly for programs with less success in placing individuals in tenure-track positions.

Recommendations for Future Research

The research included in this dissertation was designed to explore how new interpretations of student success may revise our understandings of how the experiences in college may affect students. While the results have provided several important insights into the higher education experience, several avenues for future research exist at both the undergraduate and graduate level.

First, while the research related to undergraduate student success expanded student success to include multiple institution completion, it remains situated within a single institution. As such, it is unclear precisely how well the associations observed related to the educational trajectories of undergraduate students represent all undergraduates rather than be unique to those student enrolled at the University of Minnesota – Twin Cities. This is an important question and future research should attempt to explore this by either testing the model across multiple institutional settings or developing a multi-institutional database of students, their financial aid, and their educational trajectories.

Second, while the reinterpretation of student success to include completion beyond the institution of first-entry represents a noticeable shift in the approach to understanding the student experience in college, it remains a procedural approach to understanding the college experience. While the act of completing college is indeed an important accomplishment, the value of a college degree is not the diploma you are

awarded at graduation, but rather the postcompletion opportunities that become available, such as employment and educational opportunities limited to college graduates. Because ultimately these are outcomes of interest to most administrators and policy-makers, an important avenue of future research would explore the individual- and program-level factors that influence the occupational outcomes of undergraduate students. The recent development of the Minnesota Statewide Longitudinal Data System (SLEDS) provides a unique opportunity to address questions such as these.

At the graduate level, an obvious next step for research would be to explore the potential relationships between individual- and program-level variables on the postcompletion plans of doctoral students across multiple institutions. One opportunity for this would involve using the data from the National Science Foundation's *Survey of Earned Doctorates*. Because the *Survey of Earned Doctorates* is provided to all students across the nation, it is an obvious starting place as it represents the largest existing database of successful doctoral students in the country. However, due to the *SED's* current lack of inquiries pertaining to the retrospective evaluations of the graduate school experience, such an effort would not be able to address questions specifically related to how the student experience a doctoral program may influence his or her postcompletion plans. To address such questions, opportunities may exist to collaborate with other participating institutions in the Association of American Universities Data Exchange (AAUDE) and allow for the pooling of *SED/Exit Survey* data to develop a multi-institutional model that incorporates information about the experiences of students in their doctoral program.

A second avenue of research at the doctorate level would be to begin to incorporate data related to advisor-level effects. While the model included in Chapter 4 adjusted for the nesting of students in program with 2-level hierarchical model, in reality, doctoral students can be thought of as operating in a 3-level nested setting where students (level 1) are nested with advisors (level 2) who are nested within programs (level 3). Developing a 3-level model that includes advisor-level effects would allow for researchers to begin differentiating between the program-level and advisor-level effects that may influence the occupation choices and opportunities of students.

Final Thoughts

It is important to note that the studies included in this dissertation are embedded in the context of institutional research. Understood as the “research conducted within an institution of higher education to provide information which supports institutional planning, policy formation and decision making” (Saupe, 1990, p. 1), the practice of institutional research is somewhat distinct from more traditional research on higher education. Saupe (1990) explains this difference noting that

Institutional research can be distinguished from research on postsecondary education which has as its purpose the advancement of knowledge about and practice in postsecondary education generally. The subject of institutional research is the individual college, university, or system. While institutional research can involve data and analyses which contribute to wider knowledge about how colleges and individuals function, this type of result generally is not sought for its own sake (p. 2).

While Chapters 2 and 3 have been previously published in the journal *Research in Higher Education*, the original intent of each of the studies incorporated in this dissertation was not to advance the understanding of higher education in some general way, but rather to develop sophisticated understanding of the processes and experiences that may be associated with student success within the setting of the University of Minnesota-Twin Cities.

The result of the contextual origination of the research explored within this dissertation is an obvious epistemological trade-off. Focusing exclusively on exploring new interpretations of student success within a single institution (and further constrained to a relatively narrow period of time) significantly undermines the ability to discern to what extent the knowledge gained by this research is generalizable to a broader higher education context. That said, an obvious benefit associated with the research is its ability to provide administrators, stakeholders, and policy-makers within the University of Minnesota – Twin Cities with sophisticated, yet contextualized data analysis to help inform and support decision-making.

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Appendix A

Survey of Earned Doctorates and Doctoral Exit Survey

Graduate School - Exit Survey

Page 1 of 6



Exit Survey University of Minnesota Doctoral Graduates

Part A - EDUCATION

A1. What is the title of your dissertation?

Please check this box if the title below refers to a performance, project report, musical or literary composition required instead of a dissertation

Title:

A2. Please write the name of the primary field of your dissertation research.

Name of field

Number of field: [View the field study list](#)

If your dissertation research was interdisciplinary, list the name and number of your secondary field.

Name of field

Number of field: [View the field study list](#)

If there were more than two fields, list the name and number of the additional field(s)

Additional field 1:

Name of field

Number of field: [View the field study list](#)

Additional field 2:

Name of field

Number of field: [View the field study list](#)

A3. Please name the department (or interdisciplinary committee, center, institute, etc) of the university that supervised your doctoral studies.

Department/Committee/Center/Institute/Program

A4. If you received full or partial tuition remission (waiver) for your doctoral studies, was it:
(Select only one)

- I did not receive any tuition remission
- for less than 1/3 of tuition
- between 1/3 and 2/3 of tuition
- more than 2/3 of tuition, but less than full
- full tuition remission

A5. Which of the following were sources of financial support during graduate school?
(Select one for each item, if "yes", enter number of years)

- | | | |
|---|--|---------------------|
| a. U.S. government fellowship | <input type="radio"/> Yes <input type="radio"/> No | No. of years: _____ |
| b. External (to university) nongovernment fellowship | <input type="radio"/> Yes <input type="radio"/> No | No. of years: _____ |
| c. University funded fellowships | <input type="radio"/> Yes <input type="radio"/> No | No. of years: _____ |
| d. Grant | <input type="radio"/> Yes <input type="radio"/> No | No. of years: _____ |
| e. Graduate teaching assistantship or instructorship | <input type="radio"/> Yes <input type="radio"/> No | No. of years: _____ |
| f. Graduate research assistantship | <input type="radio"/> Yes <input type="radio"/> No | No. of years: _____ |
| g. Administrative Fellow | <input type="radio"/> Yes <input type="radio"/> No | No. of years: _____ |
| h. Traineeship | <input type="radio"/> Yes <input type="radio"/> No | No. of years: _____ |
| i. Internship, clinical residency | <input type="radio"/> Yes <input type="radio"/> No | No. of years: _____ |
| j. Loans (from any source) | <input type="radio"/> Yes <input type="radio"/> No | No. of years: _____ |
| k. Personal savings | <input type="radio"/> Yes <input type="radio"/> No | No. of years: _____ |
| l. Faculty academic position at other institution | <input type="radio"/> Yes <input type="radio"/> No | No. of years: _____ |
| m. Other teaching position at the University | <input type="radio"/> Yes <input type="radio"/> No | No. of years: _____ |
| n. Other research position at the University | <input type="radio"/> Yes <input type="radio"/> No | No. of years: _____ |
| o. Other employment at the University | <input type="radio"/> Yes <input type="radio"/> No | No. of years: _____ |
| p. Other off-campus employment | <input type="radio"/> Yes <input type="radio"/> No | No. of years: _____ |
| q. Spouse's, partner's, or family's earnings or savings | <input type="radio"/> Yes <input type="radio"/> No | No. of years: _____ |
| r. Employee benefit or employer funding | <input type="radio"/> Yes <input type="radio"/> No | No. of years: _____ |
| s. Foreign government fellowship | <input type="radio"/> Yes <input type="radio"/> No | No. of years: _____ |
| t. Other foreign (non-U.S.) support | <input type="radio"/> Yes <input type="radio"/> No | No. of years: _____ |
| u. Other (Please specify) | <input type="radio"/> Yes <input type="radio"/> No | No. of years: _____ |

A6. Which TWO sources listed in A5 provided the most support?

1. Primary source of support

2. Secondary source of support Select One

Please check this box if there is no secondary source

A7. When you will receive your doctoral degree, how much money will you owe that is directly related to your undergraduate and graduate education?
(Select one for each column)

UNDERGRADUATE

- None
 - \$10,000 or less
 - \$10,001 - \$20,000
 - \$20,001 - \$30,000
 - \$30,001 - \$40,000
 - \$40,001 - \$50,000
 - \$50,001 - \$60,000
 - \$60,001 - \$70,000
 - \$70,001 or more (Please specify)
- \$ _____

GRADUATE

- None
 - \$10,000 or less
 - \$10,001 - \$20,000
 - \$20,001 - \$30,000
 - \$30,001 - \$40,000
 - \$40,001 - \$50,000
 - \$50,001 - \$60,000
 - \$60,001 - \$70,000
 - \$70,001 or more (Please specify)
- \$ _____

A8. The next few questions ask about the degrees you have received. Please provide the following information for this doctoral research degree, your most recent master's degree, and your first bachelor's degree in the appropriate columns below.

a. Please provide the following information for this research doctorate degree.

Have you received a degree of this type? Yes No

If yes,

Month/Year degree granted	Select One	(YYYY)
Month/Year you started your degree	Select One	(YYYY)
Primary field of study		
Number of field	View the field study list	
Institution Name		
Branch or City		
State or province		
Country	USA	

b. Please provide the following information for your most recent master's degree (e.g. MS, MA, MBA) or equivalent

Have you received a degree of this type? Yes No

If yes,

Month/Year degree granted	Select One	(YYYY)
Month/Year you started your degree	Select One	(YYYY)
Primary field of study		

Number of field	View the field study list
Institution Name	
Branch or City	
State or province	
Country	

c. Please provide the following information for your first bachelor's degree (e.g. BA, BS, AB) or equivalent

Have you received a degree of this type? Yes No

If yes,

Month/Year degree **granted** (YYYY)

Month/Year you **started** your degree (YYYY)

Primary field of study

Number of field	View the field study list
Institution Name	
Branch or City	
State or province	
Country	

A9. Excluding those above, have you attained any additional postsecondary degrees?

- Yes (Skip to [question A9a](#))
- No (Skip to [question A10](#))

A9a. Please list the degree information for additional degree 1

Degree Type	View the field study list	
Degree Field		
Field Number		
Month/Year degree granted		Select One <input type="text"/> (YYYY)
Institution		
Branch or City		
State or Country		

If there are no more degrees to be listed, please skip to [question A10](#)

A9b. Please list the degree information for additional degree 2

Degree Type

Degree Field	
Field Number	View the field study list
Month/Year degree granted	Select One <input type="text"/> (YYYY)
Institution	
Branch or City	
State or Country	

If there are no more degrees to be listed, please skip to [question A10](#)

A9c. Please list the degree information for additional degree 3

Degree Type	
Degree Field	
Field Number	View the field study list
Month/Year degree granted	Select One <input type="text"/> (YYYY)
Institution	
Branch or City	
State or Country	

If there are no more degrees to be listed, please skip to [question A10](#)

A9d. Please list the degree information for additional degree 4

Degree Type	
Degree Field	
Field Number	View the field study list
Month/Year degree granted	Select One <input type="text"/> (YYYY)
Institution	
Branch or City	
State or Country	

A10. Was a master's degree a prerequisite for admission to your doctoral program?

- Yes
- No

A11. In what month and year did you first enter graduate school in any program or capacity, in any university?

Month/Year Select One (YYYY)

A12. How many years were you:

- a. taking courses or preparing for exams for this doctoral degree (including a master's degree, if that was part of your doctoral program)? Years (round to whole)

b. working on your dissertation after coursework and exams (non-course related preparation, writing and defense)? years) Years (round to whole years)

A13. Was there any time from the year you entered your doctoral program and the award of your doctorate that you were not working on your degree (that is, not taking courses or working on your dissertation)?

- Yes
- No

If yes, please provide the number of years Years (round to whole years)

A14. Did you earn college credit from a community or two-year college?

- Yes
- No

A15. Are you earning, or have you earned, an MD or a DDS?

- Yes
- No

[Continue](#)



Exit Survey

University of Minnesota Doctoral Graduates

Part B - POSTGRADUATION PLANS

B1. In what country or state do you intend to live after graduation (within the next year)?

- in U.S. **If in US, State:**
- not in U.S. **If not in U.S, Country:**

B2. Do you intend to take a "postdoc" position?

(A "postdoc" is a temporary position primarily for gaining additional education and training in research, usually awarded in academe, industry, or government.)

- Yes
- No

B3. What is the status of your postgraduate plans (in the next year)?

(Select only one)

- Returning to, or continuing in, predoctoral employment
- Have signed contract or made definite commitment for a "postdoc" or other work
- Negotiating with one or more specific organizations *(Skip to the bottom and press continue)*
- Seeking position but have no specific prospects *(Skip to the bottom and press continue)*
- Other full-time degree program (e.g., MD, DDS, JD, MBA, etc.) *(Skip to the bottom and press continue)*
- Do not plan to work or study (e.g., family commitments, etc.) *(Skip to the bottom and press continue)*
- Other *(Please specify)* *(Skip to the bottom and press continue)*

B4. What best describes your (within the next year) postgraduate plans?

(Select only one)

"POSTDOC" OR FURTHER TRAINING

- "Postdoc" fellowship
- "Postdoc" research associateship
- Traineeship
- Intern, clinical residency

Other training *(Please specify)*

EMPLOYMENT

Employment (other than postdoc or further training) *(Skip to B6)*

Military Service *(Skip to B6)*

Other Employment *(Please specify)* *(Skip to B6)*

B5. What will be the main source of financial support for your "postdoc" or further training within the next year?
(Select only one)

U.S. government

Industry/business

College or university

Private foundation

Nonprofit, other than private foundation or college

Foreign government

Other *(Please specify)*

Unknown

B6. What type of principal employer will you be working for (or training with) in the next year?
(Select only one)

EDUCATION

U.S. 4-year college or university other than medical school

U.S. medical school *(including university-affiliated hospital or medical center)*

U.S. university-affiliated research institute

U.S. community or two-year college

U.S. preschool, elementary, middle, secondary school or school system

Foreign educational institution

GOVERNMENT (other than educational institution)

Foreign government

U.S. federal government

U.S. state government

U.S. local government

PRIVATE SECTOR (other than educational institution)

Not for profit organization

Industry or business *(for profit)*

OTHER

Self-employed

Other *(Please specify)*

B7. Please name the organization and geographic location where you will work or study.

Name:

State (if U.S.):

Country (if not U.S.):

B8. What will be your basic annual salary for this principal job (in the next year)? Do not include bonuses or additional compensation for summertime teaching or research. If you are not salaried, please estimate your earned income.

\$

If you prefer not to report an exact amount, please indicate into which range you expect your salary to fall:
(Select only one)

- \$30,000 or less
- \$30,001 - \$35,000
- \$35,001 - \$40,000
- \$40,001 - \$50,000
- \$50,001 - \$60,000
- \$60,001 - \$70,000
- \$70,001 - \$80,000
- \$80,001 - \$90,000
- \$90,001 - \$100,000
- \$100,001 - \$110,000
- \$110,001 or above
- Don't know

B9. How many months does this salary cover?

Number of months:

B10. What will be your primary and secondary work activities?
(Select one for each)

a. PRIMARY

- Research and development
- Teaching
- Management or administration
- Professional services to individuals
- Other (Please specify)

b. SECONDARY

- Research and development
- Teaching

- Management or administration
- Professional services to individuals
- Other *(Please specify)*
- Please check this box if there are no secondary work activities

B11. What is the term of your current employment or postdoc?

- Full-time appointment for more than 2 years
- Full-time appointment for 2 years or less
- Part-time
- Term unknown

B12. If your current employment is in education, what type is it?

- Tenure track
- Non-tenure track
- Other college staff
- K-12

B13. Do you expect [or is] the position indicated above to be directly related to your graduate training?

- Not at all related
- Somewhat related
- Directly related
- Not sure

B14. Does this position meet your career expectations at this stage of your life?

- Yes
- No
- Not sure

Continue



Exit Survey

University of Minnesota Doctoral Graduates

Part C - BACKGROUND INFORMATION

C1. Are you -

- Male
- Female

C2. What is your marital status?
(Select only one.)

- Married
- Living in a marriage-like relationship
- Widowed
- Separated
- Divorced
- Never married

C3. Not including yourself or your spouse/partner, how many dependents (children or adults) do you have - that is, how many others receive at least one half of their financial support from you?

Write in number

- a. 5 years of age or younger
- b. 6 to 18 years
- c. 19 years or older

Please check this box if there are no dependents

C4. What is the highest educational attainment of your mother and father?
(Select one for each parent)

- a. MOTHER Select One
- b. FATHER Select One

C5. What is your place of birth?

State (if U.S.): _____

OR

Country (if not U.S.): _____

C6. What is your date of birth?

Month

Day

Year

C7. What is your citizenship status?
(Select only one)

U.S. CITIZEN

Since birth (Skip to C9)

Naturalized (Skip to C9)

NON-U.S. CITIZEN

With a Permanent U.S. Resident Visa ("Green Card")

With a Temporary U.S Visa

C8. Of which country are you a citizen? (If a non-U.S. citizen)

Specify country of present citizenship _____

C9. In what state or country was the high/secondary school that you last attended?

State (if U.S.): _____

OR

Country (if not U.S.): _____

C10. Are you a person with a disability?

Yes

No (Skip to C12)

C11. Which of the following categories describes your disability(ies)?
(Select one or more)

Blind/Visually Impaired

Deaf/Hard of Hearing

Physical/Orthopedic Disability

Learning/Cognitive Disability

- Vocal/Speech Disability
- Other (Please specify) _____

C12. Are you Hispanic or Latino?

- Yes
- No (Skip to C14)

C13. Which of the following describes your Hispanic origin or descent?
(Select only one)

- Mexican or Chicano
- Puerto Rican
- Cuban
- Other Hispanic (Please specify) _____

C14. What is your racial background?
(Select one or more)

- American Indian or Alaska Native

Please specify tribal affiliation(s)

- Native Hawaiian or other Pacific Islander
- Asian
- Black or African-American
- White

C15. Please fill in the last four digits of your Social Security Number:

XXX | XX _____

C16. In case we need to clarify some of the information you have provided, please list an e-mail address and telephone number where you can be reached.

E-mail Address

Daytime or Cell Telephone

C17. Please provide your address and the name and address of the person who is likely to know where you can be reached.

a. YOUR CURRENT ADDRESS

Street Address

City

State

Country

Zip or Postal Code:

b. CURRENT ADDRESS OF A PERSON WHO IS LIKELY TO KNOW WHERE YOU CAN BE REACHED

Name

Street Address

City

State

Country

Zip or Postal Code:

Comments about parts A, B, and C of this survey:



Exit Survey

University of Minnesota Doctoral Graduates

Part D - Satisfaction with your graduate studies experience

1. Please rate your overall satisfaction with each of the following:

(Select one for each item)

- a. Your academic experience at this university
 - Excellent
 - Very Good
 - Good
 - Fair
 - Poor
- b. Your student life experience at this university
 - Excellent
 - Very Good
 - Good
 - Fair
 - Poor
- c. Your overall experience at this university
 - Excellent
 - Very Good
 - Good
 - Fair
 - Poor

2. If you were to start your graduate/professional career again:

(Select one for each item)

- a. Would you select this same university?
 - Definitely
 - Probably
 - Maybe
 - Probably not
 - Definitely not
- b. Would you select the same field of study?
 - Definitely
 - Probably
 - Maybe
 - Probably not
 - Definitely not
- c. Would you enroll in the same doctoral program?
 - Definitely
 - Probably
 - Maybe
 - Probably not
 - Definitely not
- d. Would you recommend this university to someone considering your program of study?
 - Definitely
 - Probably
 - Maybe
 - Probably not
 - Definitely not

3. Please rate the following aspects of your graduate program:

(Select one for each item)

- a. Overall quality of graduate level teaching
 - Excellent
 - Very Good
 - Good
 - Fair
 - Poor
- b. Quality of academic advising and guidance
 - Excellent
 - Very Good
 - Good
 - Fair
 - Poor
- c. Assistance in finding employment
 - Excellent
 - Very Good
 - Good
 - Fair
 - Poor
- d. The opportunity to interact intellectually across disciplines
 - Excellent
 - Very Good
 - Good
 - Fair
 - Poor

- e. Overall program quality Excellent Very Good Good Fair Poor
- f. The overall quality of the graduate curriculum Excellent Very Good Good Fair Poor
- g. Assistance by faculty in developing your research skills Excellent Very Good Good Fair Poor
- h. Assistance by faculty in developing your writing skills Excellent Very Good Good Fair Poor
- i. Interaction with faculty outside of the classroom Excellent Very Good Good Fair Poor
- j. Quality of mentoring provided to you by faculty advisor(s) Excellent Very Good Good Fair Poor
- k. Interaction with peers in program Excellent Very Good Good Fair Poor

4. To what extent do you agree or disagree with each of the following statements?
(Select one for each item)

- a. Students in my program are treated with respect by faculty Strongly Agree Agree Ambivalent Disagree Strongly Disagree
- b. Overall, the climate* of my program is positive Strongly Agree Agree Ambivalent Disagree Strongly Disagree
- c. Overall, my dissertation advisor performed the role well Strongly Agree Agree Ambivalent Disagree Strongly Disagree
- d. Coursework, seminars, labs, reading courses, etc., adequately prepared me for candidacy/comprehensive examinations Strongly Agree Agree Ambivalent Disagree Strongly Disagree
- e. Students in my program are adequately funded Strongly Agree Agree Ambivalent Disagree Strongly Disagree

* Prevailing attitudes, standards, or environmental conditions of your program.

5. Rate the extent to which the following factors were an obstacle to your academic progress:
(Select one for each item)

- a. Work/financial commitments Not an obstacle A minor obstacle A moderate obstacle A major obstacle Not applicable
- b. Family obligations Not an obstacle A minor obstacle A moderate obstacle A major obstacle Not applicable
- c. Availability of faculty Not an obstacle A minor obstacle A moderate obstacle A major obstacle Not applicable
- d. Program structure or requirements Not an obstacle A minor obstacle A moderate obstacle A major obstacle Not applicable
- e. Course scheduling Not an obstacle A minor obstacle A moderate obstacle A major obstacle Not applicable
- f. Immigration laws or regulations Not an obstacle A minor obstacle A moderate obstacle A major obstacle Not applicable
- g. Other (please identify) Not an obstacle A minor obstacle A moderate obstacle A major obstacle Not applicable

6. Please indicate whether you participated in any of the following activities during your graduate experience. If you engaged in the listed activity please mark your level of satisfaction:
(Select one for each item)

- | | | | | | | |
|---|---------------------------------|--------------------------------------|--|-------------------------------|---|---|
| a. Received advice on career options within academia | Select one <input type="text"/> | <input type="radio"/> Very Satisfied | <input type="radio"/> Somewhat Satisfied | <input type="radio"/> Neutral | <input type="radio"/> Somewhat Dissatisfied | <input type="radio"/> Very Dissatisfied |
| b. Received advice on career options outside academia | Select one <input type="text"/> | <input type="radio"/> Very Satisfied | <input type="radio"/> Somewhat Satisfied | <input type="radio"/> Neutral | <input type="radio"/> Somewhat Dissatisfied | <input type="radio"/> Very Dissatisfied |

7. To what extent do you feel your U of M graduate studies enhanced your abilities in the following areas?
(Select one for each item)

- | | | | | | |
|---|-------------------------------|--------------------------------|-----------------------------------|----------------------------------|--------------------------------------|
| a. Write effectively in your field | <input type="radio"/> Greatly | <input type="radio"/> Somewhat | <input type="radio"/> Very little | <input type="radio"/> Not at all | <input type="radio"/> Not applicable |
| b. Speak effectively in your field | <input type="radio"/> Greatly | <input type="radio"/> Somewhat | <input type="radio"/> Very little | <input type="radio"/> Not at all | <input type="radio"/> Not applicable |
| c. Critically analyzing technical writing from your field | <input type="radio"/> Greatly | <input type="radio"/> Somewhat | <input type="radio"/> Very little | <input type="radio"/> Not at all | <input type="radio"/> Not applicable |
| d. Learning independently | <input type="radio"/> Greatly | <input type="radio"/> Somewhat | <input type="radio"/> Very little | <input type="radio"/> Not at all | <input type="radio"/> Not applicable |
| e. Critically analyzing the research literature (or performance products) from your field | <input type="radio"/> Greatly | <input type="radio"/> Somewhat | <input type="radio"/> Very little | <input type="radio"/> Not at all | <input type="radio"/> Not applicable |
| f. Applying research to problems in your field | <input type="radio"/> Greatly | <input type="radio"/> Somewhat | <input type="radio"/> Very little | <input type="radio"/> Not at all | <input type="radio"/> Not applicable |
| g. Applying quantitative principles and methods to problems in your field | <input type="radio"/> Greatly | <input type="radio"/> Somewhat | <input type="radio"/> Very little | <input type="radio"/> Not at all | <input type="radio"/> Not applicable |
| h. Defining and solving problems in your field | <input type="radio"/> Greatly | <input type="radio"/> Somewhat | <input type="radio"/> Very little | <input type="radio"/> Not at all | <input type="radio"/> Not applicable |
| i. Working cooperatively in a group | <input type="radio"/> Greatly | <input type="radio"/> Somewhat | <input type="radio"/> Very little | <input type="radio"/> Not at all | <input type="radio"/> Not applicable |
| j. Understanding different philosophies and cultures | <input type="radio"/> Greatly | <input type="radio"/> Somewhat | <input type="radio"/> Very little | <input type="radio"/> Not at all | <input type="radio"/> Not applicable |
| k. Understanding the interaction of society and environment | <input type="radio"/> Greatly | <input type="radio"/> Somewhat | <input type="radio"/> Very little | <input type="radio"/> Not at all | <input type="radio"/> Not applicable |
| l. Recognizing your ethical responsibilities, rights, and privileges as a professional | <input type="radio"/> Greatly | <input type="radio"/> Somewhat | <input type="radio"/> Very little | <input type="radio"/> Not at all | <input type="radio"/> Not applicable |
| m. Preparing for a career | <input type="radio"/> Greatly | <input type="radio"/> Somewhat | <input type="radio"/> Very little | <input type="radio"/> Not at all | <input type="radio"/> Not applicable |

8. How would you rate the reputation of:
(Select one for each item)

- | | | | |
|---------------------------|---------------------------------|--|---------------------------------|
| a. the U of M as a whole? | <input type="radio"/> Declining | <input type="radio"/> Remaining stable | <input type="radio"/> Improving |
| b. your doctoral program? | <input type="radio"/> Declining | <input type="radio"/> Remaining stable | <input type="radio"/> Improving |

9. How many research presentations (including poster presentations) have you made at research conferences while in your doctoral program?

On-campus (here or at other schools)

Regional, national or international meetings

10. How many research publications have you authored or co-authored before and during your graduate studies? (e.g., Refereed articles, book chapters, reviews, books or edited volumes)

Before | During

Of these how many were you the primary author?

Before | During

11. During your doctoral studies did you receive a:
(Select one for each item)

- a. teaching award(s) Yes No
- b. dissertation award(s) (Graduate School or external organizations) Yes No

12. Which aspect of your graduate/professional program pleased you the most?

13. Were there aspects of your graduate/professional program that you found problematic?

Submit the survey!