

## **ABSTRACT**

AMPAW, FRIMPOMAA DAAGYE. The Effect of Labor Market Conditions and Financial Aid on Doctoral Student Retention. (Under the direction of Audrey J. Jaeger.)

Forty-three percent of doctoral students never complete their degree. This dropout is the highest among graduate and professional degree programs. Previous cross sectional studies of doctoral students' retention show the importance of financial aid in predicting degree completion. The studies however, do not estimate the labor market's effect on doctoral student retention and neglect the longitudinal nature of doctoral study and the multiple requirements that make doctoral education a three-stage process. This research study examines the effect of various factors, including financial aid and labor market conditions, on the likelihood that doctoral students will complete the three stages of doctoral education: transition, development, and research. Tinto's theory of doctoral persistence and human capital theory formed the conceptual framework for this study. The study will use longitudinal data and survival analysis to model how time influences the various factors that affect doctoral retention.

The results show 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. Students with research assistantships have the highest likelihood of degree completion compared to students with other forms of financial support. Labor market conditions are also an important factor affecting doctoral student retention. Higher assistant professor salaries motivate doctoral students in the later part of their programs to complete their degrees.

The Effect of Labor Market Conditions and Financial Aid on Doctoral Student Retention

by  
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A dissertation submitted to the Graduate Faculty of  
North Carolina State University  
in partial fulfillment of the  
requirements for the Degree of  
Doctor of Education

Higher Education Administration

Raleigh, North Carolina

2010

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## **DEDICATION**

To my parents for not blinking when I announced I was pursuing yet another degree.

## **BIOGRAPHY**

Frimpomaa Daagye Ampaw (Frim) was born on June 6, 1979 in Accra, Ghana to Kofi and Victoria Ampaw. She has one brother, Nana Kofi Ampaw, and one sister, Nana Yaa Ampaw. After completing her “O” and “A” levels at Achimota School, she enrolled at the University of Ghana and graduated with a Bachelor’s degree in Economics and Computer Science in 2001.

She began her graduate work at Northeastern University where she received a Master of Arts degree in Applied Economics and continued at the University of North Carolina at Chapel Hill where she received a Master of Science degree in Economics. While earning her degree at Northeastern, she worked at the Center for Labor Market Studies, which sparked her growing interest in higher educational research and its effects on the labor market. To further this interest, she began the doctoral program in Higher Education Administration at North Carolina State University in 2007.

In the course of her graduate studies, Frim has worked as both a research assistant and a teaching assistant, giving her the opportunity to contribute to various research projects as well as teach different courses. She is looking forward to furthering this role as a faculty member in a higher education program.

## ACKNOWLEDGMENTS

I could not have written and completed this dissertation without the contribution of many people, and I offer my sincere gratitude to all of the people who helped get me to this place. I would like to expressly acknowledge a few of these people.

As my dissertation indicates, minority students who are not integrated into a department often do not find an advisor and rarely make it past the development stage. I had an advisor who made sure I received all the benefits available to me. I would like to thank Dr. Audrey Jaeger for taking me under her wing, guiding me, and being the best mentor I ever had. I am very grateful for the way you challenged me and listened to me, even when I was going off on one tangent or another. You helped me focus, and we both know that without those “arbitrary” deadlines, I would still be writing this dissertation. You have been an outstanding model of the kind of professor I will strive to be. I look forward to continuing to build this great relationship, both professionally and personally.

I would also like to thank Dr. Gayles for her interest in my life as well as my dissertation. You were the first professor ever to approach me and involve me in your scholarly pursuits. Thank you so much for that; it reinforced my belief that I had finally found a field where I belong. Thank you for always being there and taking the practical approach to any problem I discussed with you.

I would like to extend further appreciation to Drs. Umbach and Akroyd, whose unique perspectives and feedback helped shape this dissertation and my views on quantitative research. Thank you Lewis Carson, too, for your wonderful patience. I appreciate all the work that you and your team did to provide me with the data for this

dissertation. Your insights and questions allowed me to delve deeper into the data and helped produce this work.

Beyond my committee, I would like to express my gratitude to all of the professors of the Adult and Higher Education Administration program. It has been an honor to be a part of the research and teaching endeavors of this department.

To the bright and talented colleagues I have had the pleasure of working with at NILIE, for the past three years: Toni, we started this journey together and I will never forget our conversations in 300L when we first came up with the plan to finish this program in three years. We pushed and supported each other, and I cannot believe we actually accomplished it. Thank you. Karen, I want to say thank you for being a great peer mentor and for socializing me into this field and profession. Kerri, thank you for listening to my dissertation woes, editing various drafts and pieces of my dissertation, playing an elf at Christmas, and keeping my spirits up. Dion, thank you for your encouragement throughout.

I would like to thank my parents who developed this thirst for knowledge in me and have continually supported me in my education and decisions. I will also like to thank my brother and sister for being sources of inspiration, support and encouragement.

Finally, to my friends, Saad, Nasim, Efua, Kathy, and Maura: you were always a phone call away, ready to listen to me moan or talk through any problem I was having. Thank you.

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## **Introduction**

How do economic conditions affect degree completion of doctoral students? Are research assistants more likely to complete their doctoral degrees than teaching assistants? Does having an assistantship during the first year of the program affect degree completion differently than having it during the last year? This dissertation seeks to answer these questions and help explain the low level of retention in doctoral programs.

Doctoral programs within the United States enrolled approximately 400,000 students in 2007. This represents a 21% increase in doctoral enrollment from the 1995 figure of approximately 330,000. However, the number of doctoral degrees awarded annually only increased by 2% to approximately 58,000 within the same period (Council of Graduate Schools [CGS], 2008a). Statistical figures show that only 41% of doctoral students who enroll in a doctoral program successfully complete their degree within seven years (CGS, 2008b). This number increases to 57% within the ten-year period, and completion rates vary widely by the field of study, gender, nationality, and the race/ethnic background of the student. International students in the engineering field have had the highest ten-year completion rates of 70% (CGS, 2008b).

Compared to completion rates of students in masters and professional degree program such as law and business, doctoral completion rates are horrendous. Professional programs have completion rates greater than 80% and, in the top-tiered schools, greater than 90% (Ehrenberg & Mavros, 1995). Students in masters programs have completion rates higher than 80%.

Medical education, which is somewhat comparable to doctoral education in terms of the length of study and the multiple requirements needed, has the highest graduation rates. Ninety-six percent of students who begin a medical degree program complete within ten years (Association of American Medical Colleges [AAMC], 2007), and medical residency programs have completion rates between 83 and 94%, depending on the specialization (Dodson & Webb, 2004; Van Zanten, Boulet, McKinley, & Whelan, 2002).

Decreasing public funds available for higher education have led to an increasing demand for efficiency within the institutions. Doctoral students greatly benefit their institutions by carrying out important teaching and research. Attrition undermines these benefits by adding costs to the institutions, since they have to train and rely on new, inexperienced graduate students yearly to fulfill these roles. Graduate schools have been trying different strategies to increase doctoral retention rates and decrease completion time. One strategy has been to modify and/or change the financial aid packages available to doctoral students. These financial aid changes have come in the form of time limits, work hour limits, limits on the year of the program the aid is available, and tuition remission/reimbursements. There is no analytical evidence, however, to verify the effectiveness of these initiatives.

Anecdotal evidence suggests that difficult economic conditions increase graduate school applications and enrollment rates. Articles on graduate school applications in the *Chronicle of Higher Education* present evidence of this phenomenon, with years of economic recession showing increasing applications (Blum, 1991; Schneider, 1998;

Magnan, 2002). Recent newspaper articles also bear testimonies of rising applications at individual colleges (Garbrosky, 2008; Wilcox, 2008; McCarthy, 2008).

Ehrenberg (1991) has theorized that the labor market factors that affect the decision to undertake and complete doctoral study are the forgone earnings that students will lose during the study period and the expected earnings they hope to obtain with their completed degree. Studies analyzed by Ehrenberg show that post-graduation earnings of doctorates in a particular field influence the supply of new doctorates into the field. Research has not addressed how a change in forgone earnings affects the retention rates of doctoral students.

### **The Problem of Doctoral Retention**

Attrition has hidden costs that affect not only the individual student but also the institution and society as a whole. Therefore, research is needed that will inform and help improve doctoral students' retention. Although researchers have examined doctoral education, these studies have been fraught with problems and limitations. The next sections discuss these problems, which were the main impetus for this study.

#### **The costs of attrition as a problem.**

##### ***Costs to the individual.***

The costs of embarking upon and not completing a doctoral program take a toll on individual students. The individual student who does not complete the doctoral degree will bear the largest cost for this failure (Lovitts, 2001). According to human capital theory, a student who decides to enroll in a higher education program has expectations of higher

wages after completion and is willing to relinquish present earnings and direct costs to gain this difference in lifetime earnings (Paulsen, 2001). Attrition from a degree program will cost individuals forgone earnings, any monies paid so far in pursuit of the degree and the time and energy put into the program, sometimes at the expense of their families or other aspects of their personal lives (Bowen & Rudenstine, 1992).

There are also emotional costs attached to attrition for an individual. Students who do not complete their degree program may be facing failure in an educational pursuit for the first time. As Lovitts describes it, deciding to leave a program can be “gut-wrenching... horrible, an experience that leaves non-completers shell-shocked and depressed” (p. 6). It may even lead some students to suicidal thoughts or acts (Lovitts, 2001; Smallwood, 2004). With their confidence and self-esteem shattered, non-completers have to fashion new careers for themselves, and most will begin with a low paying, blue-collar job taking a first job that is low paying and in the blue-collar sector (Lovitts, 2001).

*Costs to the institution.*

Many graduate schools focus their attention and resources on their ability to attract the best minds to their institutions, while spending little on retaining the students who enroll. Decreasing public funds available for higher education has led to an increasing demand for efficiency in the provision of education. Doctoral students who fail to complete their degree or take too long to complete it count as an additional cost to the institution. Bean (1990) has shown that retaining undergraduate students is more effective to institutions than recruiting new ones. Although Bean does not include graduate students

in his study, we can infer that the cost savings will be higher for graduate students, given the additional roles they play at institutions.

Lovitts (2001) contends that the costs of recruiting graduate students may even be greater than that of undergraduates. For graduate education, institutions may have to bear the costs of campus visits and interviews or recruitment weekends. Institutions have to enroll larger classes of funded graduate students with the expectation of retaining just about half of the students generating extra costs. Universities, departments, and faculty invest resources in doctoral students by offering small seminars, individualized advising, and supervised research that sometimes takes time away from faculty research and undergraduate instruction (Kluever, 1997). The reputations of institutions and their individual departments may also suffer if they fail to retain their graduate students (Katz, 1997).

When doctoral students depart before graduating, some as early as within their first year, their institutions fail to reap the significant benefits the students may have contributed back to the institution. Their potentially innovative research ideas and future professional endeavors might have brought recognition to the institution; their work as teaching and research assistants would have furthered the institution's educational mission. Low completion rates for institutions may also affect their reputation and thus their recruitment of new students.

### *Costs to society.*

Unsuccessful doctoral students also pose unrecoverable costs to society. Society loses the students' productivity while they are engaged in the programs full-time; taxpayers also fail to reap the benefits of the financial aid they have funded. In order to maintain its competitiveness in the current global knowledge economy, the country needs a highly educated workforce (Slaughter & Rhoads, 2004; Forest, 2002). The loss of these students and their perspectives, ideas and research agendas that graduate school could have furthered amounts to an overall detriment to society.

### **The Problem with the existing literature**

Research studies on graduate education (Golde & Dore, 2001; Austin, 2002) have focused on the reasons why students choose to enroll in graduate school and the effectiveness of graduate school in preparing future faculty members. Studies involving graduate retention have been exploratory qualitative studies that have focused on the non-completers and their reasons for leaving (Nerad & Miller, 1996; Lovitts, 2001). Other studies (Berg & Ferber, 1983; Bowen & Rudenstine, 1993) have relied only on descriptive statistics to compare percentage of completers and non-completers by race, gender, age, and field of study. A few studies have examined completion rates and the time to degree, but these studies have focused on specific fields and ignored the variances among different fields (Ehrenberg & Mavros, 1995; Gillingham, Seneca, & Taussing, 1991).

Researchers who have examined the effect of financial aid on retention have generally looked at the issue from the undergraduate level and focused more on need-based aid (Cabrera, 1990; Cabrera, Nora & Castaneda, 1992). The student's academic abilities and experiences, however, determine financial aid at the graduate level. Some researchers have examined the effect of different financial aid specifications on the completion patterns of doctoral and graduate students (Ehrenberg & Mavros, 1995; Andrieu & St. John, 1993). These studies either relied on cross-sectional data or ignored the stages of doctoral education. Such studies cannot determine whether the effects of financial aid are equal across the time it takes to complete a graduate education.

Undergraduate and some masters programs only require that individuals take and successfully pass coursework in order to earn the degree. Doctoral education goes beyond the completion of coursework. It includes taking oral and written examinations, developing, and carrying out original research (Lovitts, 2001; Bowen & Rudenstine, 1993). Students' experiences are different over time, and factors that may not be important at the initial stage may become even more important during the next stage (Tinto, 1993). It holds that doctoral students working on their dissertations are more likely to take a job in the absence of financial support, and students still taking a full load of course work will be more likely to take on loans even in a strong labor market.

The use of cross-sectional data fails to capture the nuances of the changes that occur across stages and the time-varying aspects of many of the relevant variables. Cross-sectional studies (Berg & Ferber, 1983; Nerad & Cenry, 1993) found no significant gender

differences in graduate student retention. Stiles (2003), using longitudinal data, is able to show that gender has an effect on retention in the initial years of doctoral study, but this effect disappears over time. Doctoral students may not have the same financial support over the entire study. Most institutions have time limits on the numbers of years a student may receive an assistantship. A cross-sectional study is not able to account for students who lose financial support in the fifth year and how the loss will affect their retention.

Previous research also fails to address the question of how the labor market affects the decision to remain in school. Human capital theorists believe that individuals invest in education when the benefits outweigh the costs (Becker, 1964). Individuals tend to weigh their options carefully when deciding whether to stay in school or depart, especially when a job opportunity is available. Katz (1997) proposes “economic pressures and the enticement of a wonderful job opportunity pull the doctoral student away from campus” (p. 10). Ehrenberg & Mavros (1995) include the starting salaries of doctoral recipients in their empirical doctoral retention model. However, the study fails to measure the effect of a change in forgone earnings on the retention of doctoral students. Graduate education does not occur in isolation within institutions. Changes in the economy affects graduate students, especially since the opportunity costs of attending graduate school are higher than those of undergraduate students. It is therefore necessary to include labor market conditions in a retention model.

Most of the existing research overlooks the potential influence of time on the factors that affect doctoral student retention. The increasing number of doctoral students

dropping out of programs and the costs of this attrition require a study that takes into account time as well labor market conditions. This research overcomes the limitations of previous studies by providing estimates of how the different factors that interact with time ultimately affect retention. The following sections outline the purpose, research questions, and conceptual model of the study.

### **The Purpose of the Study**

The purpose of this study is to address the limitations of the literature and establish a comprehensive economic model for discussing and examining doctoral student retention. The framework of this study includes factors that will take into account changes in the students' lifetime earnings, forgone earnings, and financial aid. The research examines the effect of financial aid packages and labor market conditions on retention of students at the different stages of doctoral education. The following research questions will guide this study.

### **Research Questions**

1. What are the effects of labor market conditions and financial aid packages on the retention of doctoral students beyond 18 credits?
2. What are the effects of labor market conditions and financial aid packages on the advancement to candidacy of doctoral students?
3. What are the effects of labor market conditions and financial aid packages on the completion of a doctoral degree?

## **Conceptual Model**

Different studies have discussed graduate education as a socialization process in which the student is fitted to a field and a professional role (Golde, 1998; Baird, 1997; Bragg, 1976). This process occurs in different stages. Nerad and Cerny (1993) outline five stages of doctoral education. The first stage involves completing the coursework, and the second stage includes preparing for oral and/or written qualifying exams. The next stage has the student finding a dissertation topic, obtaining an advisor, and presenting a proposal. The fourth stage involves writing the dissertation, and the final stage, obtaining employment. These stages suggest a linear development, yet this may not be the case. For example, students often use the coursework period to help find a dissertation topic and an advisor.

The framework for this dissertation is based on the three-stage model advocated by Tinto (1993) and Bowen & Rudenstine (1992). The stages are similar to the ones described by Lovitts (2001) and Baird (1997). Stage one is the entry and adjustment stage, which usually runs from the first year through a preliminary examination. The second is the development stage, which ends with an oral examination. The final stage is the research stage where students complete their dissertation.

Research shows that doctoral students drop out at all three stages (Bowen & Rudenstine, 1992; Golde, 1998; Lovitts, 2001). During the first stage, students can become overwhelmed with the transition process or may realize that doctoral education was not what they expected (Golde, 1998). During the development stage, interaction

plays an important role as students develop a dissertation topic and prepare for examinations. Students need to be well integrated into their program to succeed at this stage (Tinto, 1993). The dissertation stage is marked with the most frustrations (Lovitts, 2001). Baird (1997) describes the unsuccessful student as one who “has poor relationships with professors and fellow students, inadequate mastery of the forms of reasoning favored by the discipline, and little support from spouses, employers, and other groups” (p. 101).

Dividing doctoral education into these three stages allows an effective examination of its longitudinal nature. The various factors that affect doctoral student retention are also included in this conceptual model. The next sections of this chapter describe those factors.

### **Human capital theory**

Human capital theory can explain the decision process of doctoral students. Economists and higher education researchers have used the theory to explain how and why individuals decide to invest in higher education (Becker, 1962, 1964; Paulsen, 2001). Individuals choose to pursue higher education when the benefits they expect from the investment exceed the expected costs. The expected benefits can be intrinsic (such as a sense of accomplishment) and/or extrinsic (such as expected future earnings). Doctoral students have already made the decision to attend; thus, their decision to exit the process will be made when there is a change in either benefits or costs. Because intrinsic benefits and costs are personal, difficult to measure, and possibly lacking in policy or societal implications, this study focuses on the extrinsic benefits and costs that affect the students' decision-making process.

Extrinsic benefits from education, as defined by the human capital theorists, are the future earnings individuals expect to receive as they use their education in economic activity (Becker, 1962; Blaug, 1976). Expected future earnings are the sum of earnings over a lifetime, with future years discounted to reflect present day values. To take this measure, one must know the length of time the student expects to work and the total amount of future salary increases. Students almost never calculate this measure during their decision-making process, but instead proxy it by looking at the prevailing salaries for jobs they expect to obtain after completing their degree. The extrinsic costs of education include the tuition and fees paid to attain the education, plus the opportunity costs, which are the earnings the student forfeited upon undertaking full-time education. Students on financial support have these extrinsic costs subsidized by their sponsors. A loss or reduction in a student's financial aid package increases the overall extrinsic costs.

Extrinsic benefits of the degree are the expected salaries students hope to obtain after acquiring their degree and the opportunity costs are a measure of the earnings given up to enroll in the program. These concepts are included in the model as labor market conditions and their effect is measured in this study. The study incorporates the human capital factors into Tinto's longitudinal model of doctoral persistence, discussed next.

### **Tinto's longitudinal model of doctoral student persistence**

The human capital theory, though helpful in understanding the financial aspects of the decision-making process, cannot explain all of the complex processes involved in doctoral student retention. In the appendix of his work on undergraduate retention, Tinto

(1993) espouses a theory of doctoral persistence. The model based on his research on undergraduate retention and the research available at the time on doctoral retention, suggests that the more academically integrated students are in the college community, the more likely they are to persist. The factors that affect this integration process, although similar in some ways, are overall different for doctoral and undergraduate students.

The undergraduate and graduate models are similar in that, in both, the students' characteristics, abilities, and educational experiences affect retention. Previous research also suggests that, in both models, completion rates differ for female students as well as for international students and students of color (Bowen & Rudenstine, 1993; Ehrenberg & Mavros, 1995).

Tinto's undergraduate and graduate models differ with respect to the college community in which integration must occur. Unlike undergraduate students, who integrate at the institutional level, doctoral students integrate into their departments or fields of study. The department and/or the field of study play an important role in doctoral student retention (Tinto, 1993; Lovitts, 2001). Different fields of study have different procedures and policies that will influence retention. Departmental policies such as the number of credits and the kinds of examinations required for graduation will influence retention rates.

Figure 1 presents a framework for this conceptual model. The three stages of successful retention—transition, development, and research—are the objectives of the model. Factors affect whether the students complete each stage or not. A student who fails to complete a stage drops out of the model, and that student's information is no longer

included. Tinto and human capital model theories determine the factors affecting retention at each stage. These factors are broken into two groups; the first group consists of factors whose values are set at the start of the doctoral program and remain unchanged throughout. Their effect on retention at the three stages may nevertheless be differential. The second group consists of variables whose values may change over the educational period. The time varying nature of these variables, and their differential effects on doctoral education at the stages, form the main crux of this research study and the conceptual model.

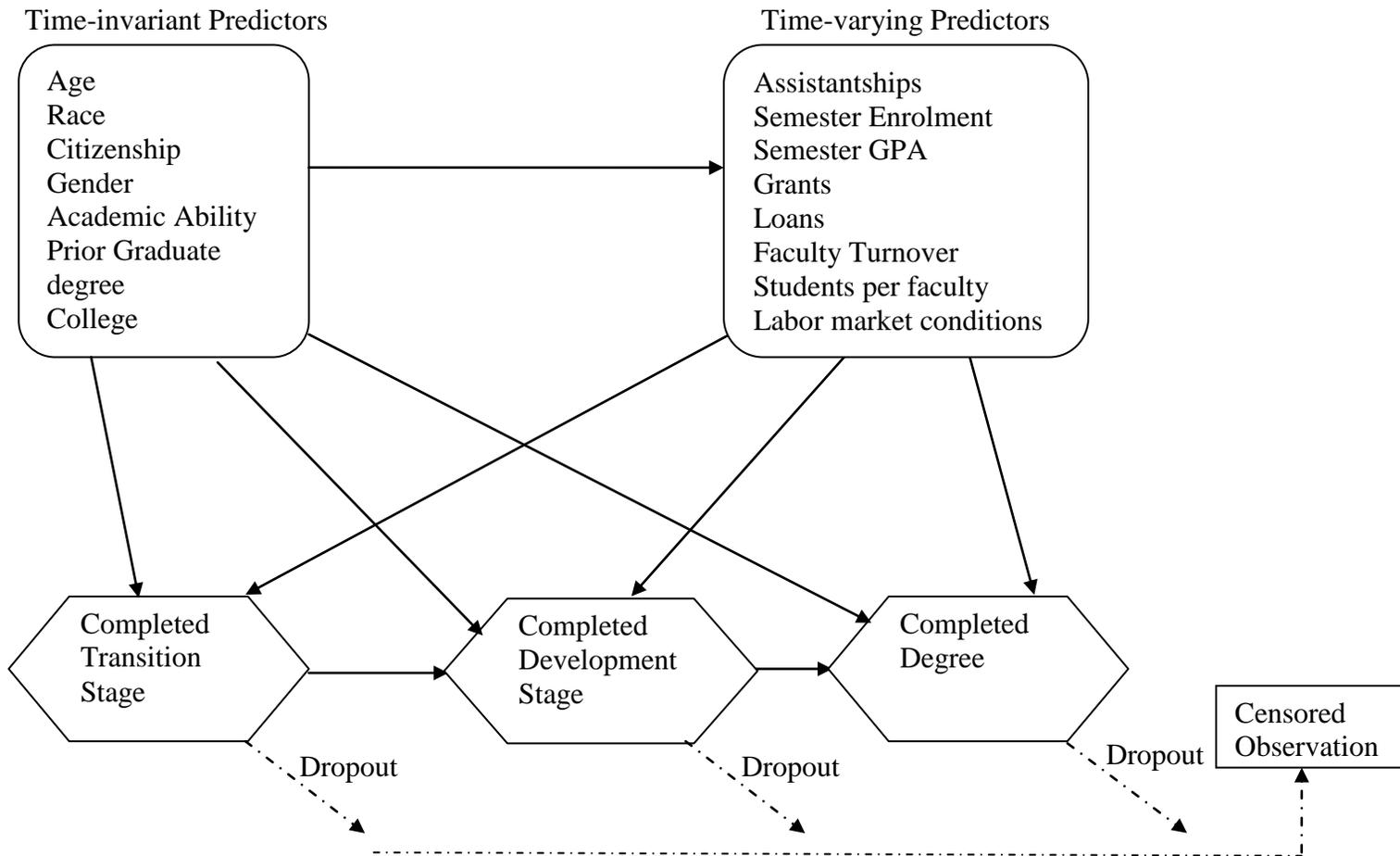


Figure 1: Conceptual Framework

### **Assumptions and delimitations of the conceptual model**

This section acknowledges assumptions and delimitations used in the conceptual model. The main assumption stemming from the human capital model is that of rational choice. It assumes that individuals faced with a decision will make a rational choice based on a costs-benefits assessment (Becker, 1993). Becker (1966) acknowledges that social scientists require the rational choice assumption in order to make a unified analysis of varied human behavior. Applied to the case of higher education, it then assumes that college-age students can accurately assess their expected future earnings and opportunity costs and will consider them when evaluating decisions to enroll or stay in college (Desjardins & Toutkoushian, 2005).

This study uses the rational choice assumption not only because it needs a uniform analysis of individual decision-making events, but also because the individuals in question are graduate students who most likely base their decision about their education on deliberations. Studies of high school and college students have shown that this is a fair assumption: more than half of the students in most cases accurately estimate their future and forgone earnings (Paulsen, 2001). The expectation is that for doctoral students this percentage will be higher. The model does not assume that the individuals have perfect information, and it acknowledges that doctoral students may change their minds if they receive information that changes their initial cost/benefit analysis.

The delimitation of the model is in the selection of factors that influence doctoral students' retention. Tinto describes some influential factors in his model that are not

included in this one due to an inability to measure the factor and the necessity of binding the research project. The student-advisor relationship is mentioned in the literature as having an important influence (Tinto, 1993; Austin, 2002; Stolzenberg, 2006) on the success of doctoral students. However, this measure is not available in the dataset of this study and thus not included in the model. The study seeks to examine an economic model based on the labor market conditions and finances of the students, and the study is bound by these factors.

### **Definition of Key Terms**

This research study uses the following definitions:

*Attrition* from a doctoral program occurs when a student fails to enroll in classes within two years of their last enrollment.

*Human capital* refers to the “knowledge, skills, competencies and other attributes embodied in individuals that are relevant to economic activity” (OECD, 1998, p.9)

*Retention* will occur at each stage of the doctoral education process when a student successfully passes the requirements laid out in Tinto’s model and is able to move to the next stage or graduate.

### **Significance of the Study**

This research expects to contribute to the understanding of doctoral student retention and to policy decisions affecting doctoral students. Considering current reductions in available funds for financial support, institutions need policies that judiciously and effectively use these funds. The current economic climate makes it

necessary to understand how the labor market affects academia, specifically, doctoral education. This study will provide information about which types of aid will be most effective at reducing the risk of graduate student attrition, and at which stage of the doctoral process a financial aid policy will be most likely to work. Understanding how labor market conditions affect doctoral student retention will help in the designing of other policies that can be used to insulate doctoral education.

This study will offer theoretical enhancements and methodological improvements that will support future research in this area. Tinto's model of doctoral persistence has not been tested adequately, and the study will provide empirical evidence examining this theory. The study will present evidence relating to how labor market conditions affect doctoral education; in the process, it will build an argument for introducing human capital theory into retention models not just for doctoral education but for undergraduate, other graduate, and professional education as well. This research will also contribute to the use of survival analysis to analyze longitudinal data in educational research.

### **Chapter Summary**

This chapter has provided a rationale for the study of doctoral student attrition. The necessity for this examination has been established. Tinto's theory of doctoral persistence and human capital theory formed the basis for the conceptual framework for this study, which the chapter introduced. The study has important significance to the practice and research of doctoral education. The breakdown for the dissertation is as follows: the next section presents the literature review guiding the study

and the next chapter the methodology used in the study. Chapter 4 presents the results of the study followed by a discussion of the results. The final chapter presents the conclusion and implications of the study.

## **Literature Review**

This literature review presents a comprehensive look at the existing research on doctoral students' retention. The review will discuss the theories and the existing literature used to frame the research.

The review first explores the two theories used to develop the theoretical framework for this study. Human capital theory, its origins and its use in higher educational is discussed first. Next is a discussion of Tinto's models of retention, beginning with the undergraduate retention model, which is the basis of the doctoral model. The review then continues with a presentation of the longitudinal model of doctoral persistence.

To illustrate the necessity of this study, the chapter continues with a review of the existing literature on doctoral students' persistence, highlighting the methodology and variables used in these studies. The chapter also includes a brief review of the extensive literature on undergraduate retention to show how it helped frame this study. Finally, this review presents an introduction to the analytical method used in the study.

### **Human Capital Theory**

#### **Background.**

The history of human capital theory starts with the works of Schultz (1961) and Becker (1960, 1964). The two researchers approached the issue with studies focused on different areas. While they both came from the field of economics, Schultz approached the

issue from his background in agricultural economics and Becker from that of labor and education economics. The researchers noted a substantial growth in the income of the United States between 1900-1960 that could not be explained by growth in physical capital and the increasing labor force. The cause was attributed to the investment in education that was intended to promote economic growth (Sweetland, 1996).

Schultz (1961) examined the issue from a macro perspective by examining the effect changes to the education's stock within the work force had on the country's total income. The research noted that education, especially higher education, was not solely for consumption but also an investment that enabled the nation to earn returns. Schultz saw higher education as an investment that improved humans' abilities to pursue goals beyond education and that included added benefits such as health services, on-the-job training, and adult study programs.

Becker (1964) on the other hand approached it from an individual's perspective. He compared the earnings of high school graduates and college graduates and determined that the latter experienced an increase in earnings that exceeded the costs of attending college. He calculated the rates of returns on a college education and determined that investment in higher education was just as profitable as investment in business capital (Becker, 1960). This new form of capital is now termed human capital.

Becker advocated that there was underinvestment in education since the indirect returns (not measurable in wages) make the rate of return even greater than other forms of return. Higher rates of return in a particular investment encourage individuals to invest

more in that item and less in other things, which in turn changes the rates of return for both items. This process ends when both forms of investment provide equal returns. Higher returns in education over other forms of investments imply structurally related problems. The structural problems may be the cost of the college education and individuals not accounting for the potential returns to society when making their educational decisions (Becker, 1964).

The theory had a controversial start. Some economists were reluctant to see college education as an investment and saw it rather as an activity undertaken to satisfy a person's wants (Shaffer, 1961). The practice of referring to humans as capital and evaluating people in monetary terms was also very distasteful to some economists (Kiker, 1969). With five Nobel prizes—which included the work of two pioneers, Schultz and Becker, and over 2000 articles on the topic (by 1976), human capital has become synonymous with investment in higher education. Becker (1993) acknowledges in the preface of the third edition to his original publication that his work has “grown from being highly controversial to one that has gained acceptance not only in economics, but also in other disciplines and among the general public” (p. xix).

### **Framework.**

Different variations on the definition of human capital exist, since neither Becker nor the other scholars have never explicitly defined it. Two samples of the definition available within the higher education literature are as follows:

1. “the productive capacities – knowledge, understandings, talents and skills possessed by an individual or society” (Paulsen, 2001, p. 56)
2. “the acquired energy, motivations, skills, and knowledge possessed by human beings, which can be harnessed over a period of time to the task of producing goods and services” (Douglass, 1997, p. 362).

Becker (1962), however, defines investing in human capital to be “activities that influence future real income through the imbedding of resources in people” (p 9).

The framework for human capital theory emerged from the two frameworks of the researchers. A production function approach measures the effect physical capital has on the growth of income in a country, and this is the framework used by Schultz (1961, 1964). Within this framework, growth in human capital through education increases wages and thereby a nation’s income. The other framework, based on the investment capital approach, measures returns to different educational pursuits by using the marginal rates of return. Becker (1964) calculated marginal rates of return on college education and compared the returns to business investment to prove underinvestment in education. The two approaches allow the effect of human capital to be determined on the macro level (the production function approach) or the micro level (the investment capital approach).

The micro framework has become increasing popular in applied fields where the individual is the basis for most research. Human capital theory helps explain decision making in education, training, and health (Paulsen, 2001; Robinson, 1993). It has spurred

cost-benefit analysis as well, since human capital gains or losses can measure the benefits or costs of any endeavor to an individual. The next section of the review discusses the use of human capital theory within higher education.

### **Human capital theory and higher education research**

Extensive studies have applied human capital theory to all forms of education, both formal and informal. Within formal education, the human capital studies have addressed K-12 through higher education. Since returns to higher education differ by the level of education, this review will focus strictly on higher education literature. This ensures a review of the essential literature that helps frame the effect of human capital on doctoral student retention and permit a better conceptualization of the nature of investment in higher education.

Higher education researchers use human capital to analyze decision making both at the aggregate macro level and at the individual micro level (Becker, 1993). Studies on the macro level focus on the need for society to help fund higher education. The studies have shown the effects of increases in human capital through higher education on the overall well-being of states, regions, and countries (Leslie & Brinkman, 1988; Paulsen, 1996, 2001).

At the individual level, the theory has been used to predict an individual's likelihood of enrolling in college. The framework used in such studies asserts that, during the decision-making process, individuals compare the expected benefits of investing in college education against the expected costs (Paulsen, 2001). The primary expected

benefits are the increase in lifetime earnings as a direct result of the change in human capital from degree attainment, and the primary expected costs are the foregone earnings and the direct costs of degree attainment (Arai, 1998; Carnoy, 1995). The research has concluded that students with expected higher increases in earnings are more likely to enroll and invest in education. Enrollment behavior also responds to decreases in the expected costs caused by the use of financial aid (Kane, 1999; Paulsen, 1998; McPherson & Schapiro, 1991; St. John, 1990).

Human capital theory rarely plays a major role in retention studies. However, this study argues that individuals make the same enrolling decision each semester they return to their course of study. Thus, changes in the expected benefits or costs of the education will play a role in persistence decision making. Retention studies especially on undergraduate students have focused on the role that financial aid plays in students' decisions (Chen, 2007; St. John, Cabrera, Nora, & Asker, 2000), which is only part of the human capital model. If changes in expected costs play an important role in retention, then changes in expected benefits should play a role as well. This should be especially true in the case of doctoral retention, where the expected monetary benefits of the degree are lower than those expected from undergraduate education (Perna, 2003).

### **Critics of Human Capital Theory**

Several studies have argued that the earnings differential experienced at the level of higher education may not be the result of increasing human capital or productivity. Several theories have emerged aimed at explaining the earnings differential. These

theories see education as a means of obtaining credentials that are favorable to the labor market but not as an increase in the productivity of the individual (DesJardins & Toutkoushian, 2005). These credentials act as “signals” that alert potential employers to an individual’s ability to perform specific tasks; the credentials also promote upward social mobility for individuals and make them better able to find jobs in different labor markets (Gullason, 1989; Riley, 1979; Spence, 1973; Doeringer & Piore, 1971).

These models postulate benefits to education that may not necessarily result in increased productivity. They focus on the benefits individuals gain from education, such as productivity (human capital theory) or the ability to get a job (the signaling hypothesis). The important point of this dissertation is that benefits accrue from education and individuals consider these benefits when deciding to stay enrolled in a program. The other theories espoused by critics provide evidence to support the claim that there are benefits to investing in education; these theories are thus compatible with human capital theory (Thomas & Perna, 2004).

Human capital theory is the chosen framework for this study because it allows research on doctoral student retention based on expected benefits and expected costs. Human capital theory has undergone several decades of analysis and brings a useful economic perspective into analyses of higher education, including doctoral education. The next section discusses Tinto’s longitudinal model of doctoral persistence, the other theory that helped frame this study.

## **Tinto's Longitudinal Model of Doctoral Persistence**

### **Background.**

Tinto (1993) proposed a model for examining doctoral persistence by building on his undergraduate retention model and the existing research on graduate students. He began by discussing the differences between undergraduate and graduate education as it influences persistence. This section of the review will thus present briefly Tinto's undergraduate model, discuss the differences between undergraduate and graduate retention, and then present the doctoral model.

### **Tinto's undergraduate model.**

Tinto's (1975, 1993) longitudinal model of institutional departure sought to revise theories of student departure to include not only individual action but also institutional actions. The model is very widely used and most cited when discussing undergraduate student departures from higher education institutions (Chen, 2007). Tinto developed the model from psychological concepts that focus on the social, economic, environmental, and organizational forces that influence student behavior (Tinto, 1993). Tinto "highlights the ways in which the social and intellectual communities that make up a college come to influence the willingness of students to stay at the college" (p. 104).

The longitudinal model focuses on interactions between the individual and the organization. Positive interactions within the institution integrate students both academically and socially, making them more likely to persist (Tinto, 1998). Academic and social integration influences students in different ways. Academic integration can be

the most important influence, but socially integration may lead to academic integration (Tinto, 1998).

Institutional and goal commitment levels are initially determined by the individual's attributes, background, and precollege experiences. The model allows for the commitments and goals to be continually shaped by the individual's interactions within the college environment. Integration then leads to students becoming even more committed to the institution and their own goals (Tinto, 1998). Students who do not integrate successfully will be more likely to depart from the institutions.

#### **Differences between undergraduate and doctoral student retention.**

Undergraduate student retention is a widely researched concept in higher education and has well-developed models for analysis (Pascarella & Terenzini, 2005). Graduate education differs significantly from undergraduate education, and before framing a doctoral student retention model from Tinto's undergraduate model, a study should note the differences between the two groups.

A main difference is the importance of institutional commitment to doctoral students. Graduate students are more likely to be committed to their field of study and department than to the institution. As Tinto (1993) notes, differences are more likely to exist between fields of study in the same institution than between same fields of study across institutions. Thus, for doctoral students, persistence will more likely occur with a commitment to their field of study and their goals. Academic and social integration must

then occur within the field of study to ensure retention, and this requires strong faculty and peer interactions.

Another difference lies in the nature of doctoral education. The goals of doctoral education differ greatly from those of undergraduate education; one goal of doctoral education, for example, is to develop independent researchers (Austin, 2002). Different goals give rise to different processes for completing the education. To obtain a doctoral degree, a student must take classes, develop and propose a research topic, carry out the research, and then report findings. It is a systematic but changing process in which the factors that were important to be successful when taking classes may be different from the factors that are important when conducting research. This may lead to different factors being important for retention at each step of the process (Tinto, 1993). Tinto's longitudinal model of doctoral persistence incorporates these differences. The next section discusses the framework of this model.

### **Framework.**

Tinto's model of doctoral persistence (1993) entails three stages. The period of transition and adjustment covers the first year. Students in this stage are influenced by their social interactions with peers and faculty in both informal and formal settings. The second stage covers the time up to candidacy (completing oral examinations or the defense of a dissertation proposal). Students acquire knowledge and develop the competencies needed to conduct doctoral research within the academic community of the department. The final stage of Tinto's model covers the period of researching and completing of the

dissertation. Individual abilities are at the forefront at this stage, as the student completes the research and writes the results.

Tinto theorizes that students' attributes and prior educational experiences influence their goals and commitments. Financial resources and external commitments will then shape their participation in the program: for example, students with family responsibilities and/or limited financial resources may choose to enroll part-time and may have limited interactions in their program. These factors will have a differential impact on doctoral students' retention depending on the stage of doctoral education in which they appear. The model, however, does not delineate the impact of the variables. For that, the review examines empirical studies done on the subject.

#### **Application in higher education research.**

Few researchers have used Tinto's longitudinal model of doctoral persistence to frame their research on doctoral education. This may be due to the complex nature of the model and the extensive data that will be required to test out the model. Several dissertations (Andrews, 2004; Stolzenberg, 2006) have used select factors from the model to predict doctoral student success. Andrews (2004) examined the attrition rate from a physical therapy program using the factors of student characteristics and attributes. This research showed that the overall undergraduate Grade Point Average (GPA) and the average SAT score for the undergraduate institution could only predict student's attrition for academic reasons. The other variables in the model (demographic characteristics and GRE scores) could not predict attrition for any reason.

Stolzenberg (2006) examined the advising relationship to determine its effect on the students' expected time-to-degree and potential dropouts, controlling for background characteristics. The study showed that the advising relationship is significant in predicting a student's expectations of how much time it will take to complete the degree and the likelihood of dropping out before completion.

The next section of this review discusses the studies that have been conducted on doctoral student retention. Although these studies were not framed using Tinto's model, they provide a frame of reference for the variables used in this study.

### **Undergraduate retention theories**

As discussed above, differences between undergraduate and graduate education require undergraduate retention models to be adjusted before they can be applied to graduate retention. However, an understanding of the theories and related literature of undergraduate retention can provide a solid foundation for developing doctoral retention theory and guide this study. This section presents a brief synthesis of undergraduate retention theories and their potential effect on doctoral retention studies.

Five main forms of undergraduate retention theories exist: psychological, sociological, organizational, interactional, and economic (Braxton & Hirschy, 2005; Chen, 2007; Tinto, 1993). Psychological theories examine how students' characteristics and attributes influence the decision to stay in college. Research studies framed on these theories explore the effects of past behavior, coping behavior, self-efficacy, and locus of control beliefs on retention (Bandura, 1986; Bean, 1980; Bean & Eaton, 2000; Nora,

Cabrera, Hagedorn, & Pascarella, 1996; Weiner, 1986). Sociological theories consider the effects of students' social status on their retention. Researchers using these theories study the effects of socio-economic status, race/ethnicity, and social and cultural capital on a student's decision to leave college before obtaining the degree (Astin, 1993; Berger, 2000; Bourdieu, 1977; Walpole, 2003).

Organizational theories examine the impact that institutions have on the retention of students. Research studies framed with organizational theories determine the impact of institutional variables such as type, size, mission, and resources on retention (Bean, 1983; Carbrera, Nora, & Hengstler, 1992; Cabrera, Nora & Castaneda, 1993). Interactional theories integrate psychological, sociological, and organizational theories and examine retention as an interaction between the individual and the organization (Chen, 2007). The most widely used interactional theory is Tinto's undergraduate retention theory, already discussed in this chapter.

Most recently, economic theories have been used to explain retention. Exploring issues relating to human capital, researchers have examined the effects of financial aid and tuition on retention (Carbrera, 1990; Paulsen & St. John, 2002; St John, 1991). This study draws from all five theories by incorporating the interactional theory of Tinto's longitudinal model of persistence and the economic theory of human capital.

## **Existing Literature on Doctoral Student Persistence and Retention**

Different theories and models have framed the existing research on doctoral retention. This review synthesizes the results from these studies based on the factors from Tinto's model.

### **Student background information.**

Most of the studies have addressed the effects of students' demographic characteristics on retention. Nerad and Cerny (1993) found no significant differences in time-to-degree between men and women or minority and non-minority students. Research by Ott, Markewich, and Ochsner (1984) showed that the gender of the student does not predict graduate retention, except as an interaction term with the department/field of study.

Stiles (2003) showed that women were 16% less likely to complete their programs than men. The use of survival analysis allowed him to show that the gender effect was concentrated in the earlier years of education; after the seventh year, no significant differences in completion probability is observed. Stiles also showed that international students were more likely to complete their programs than their U.S. counterparts. Minority U.S. students were 28% less likely to complete their programs than U.S. students. The effects for race and nationality did not differ across time.

The level of academic preparation measured by undergraduate grade point average (GPA) has not been shown in the research to be a significant predictor of degree completion and retention (Girves & Wemmerus, 1988; Pyke & Sheridan, 1993). Lovitts (2001) showed that completers and non-completers had comparable undergraduate GPAs.

### **Enrolment and grade information.**

Using an empirical model to examine doctoral students' retention, Girves and Wemmerus (1988) showed that grades obtained in the graduate program could not significantly predict doctoral student retention. Ott et al. found that students who enrolled part-time were less likely to persist in the doctoral program.

### **Financial aid information.**

The literature has shown that having some form of financial support increases the probability of completing the doctoral degree (Pyke & Sheridan, 1993). The type of financial support does matter, however. Having a teaching assistantship will increase the time to degree and decrease the probability of degree completion, while a research assistantship will decrease time to degree and increase completion compared to fellowship holders (Gillingham, Seneca, & Taussig, 1991; Ehrenberg & Mavros, 1995). Andrieu & St. John (1993) found that graduate students in public institutions were .23 percentage points less likely to graduate with every \$100 increase in tuition. Subsidies on tuition did not limit this effect, as the amount of graduate assistantship stipends was negatively related to the within-year persistence of students at public universities. Financial support is thus an important variable in predicting doctoral student retention.

### **Department Information.**

The field of study has been consistently found in the literature to affect retention, degree completion, and time-to-degree completion (Bowen & Rudenstine, 1992; Girves & Wemmerus, 1988; Nettles & Millet, 2006; Ott et al., 1984). There is limited empirical

evidence, however, on the effect of other department factors on retention. Bowen and Rudenstine show that the size of the department affects degree completion and time to degree. Lovitts (2001) found a significant correlation between the faculty retention rate and students' attrition rate.

#### **Labor market conditions.**

A few research studies have investigated the effect of expected earnings on doctoral retention and completion (Andrieu & St. John 1993; Ehrenberg & Mavros, 1995). The studies show that expected earnings can predict a positive effect on the probability of completing a doctoral degree. The effects of other labor market factors have not been included in any other research studies.

#### **Limitations of the previous research.**

The research studies discussed above have some limitations that may have introduced biases into the results. First, most of the studies relied on cross-sectional data to estimate the results. The use of cross-sectional data implies that degree-completion could not be measured in most of the studies. In addition, inconsistent definitions of retention were used. The results present only a snapshot of doctoral education, since the variables did not vary by time. Ehrenberg and Mavros (1995) and Stiles (2003) used longitudinal data and survival analysis to measure the effect of different factors on degree completion. These studies did not determine the differential effects of the factors across the stages of doctoral education.

These studies were also conducted on a few select fields. Bowen & Rudenstine used information from six fields at ten major universities: English, history, political science, economics, mathematics, and physics. Stiles focused on students in the college of education at one institution. Ehrenberg and Mavros studied students in four fields at one institution: economics, English, mathematics, and physics.

### **Survival Analysis**

Survival analysis predicts the likelihood of attaining an event by an analytical sample (Allison, 1982). Originating from medical literature, the method was developed as a way to model and predict death in humans (Allison, 2009). Survival analyses allow a researcher to use longitudinal data to determine the coefficients that predict the likelihood of an event occurring while allowing the variables to change with time (Blossfeld & Rohwer, 2002).

Using survival analyses within estimations overcomes several limitations inherent in cross-sectional methods. Cross sectional methods assume the effect of a variable remains stable across the period of study, an assumption that is relaxed in survival analysis. Explanatory variables in cross sectional methods have to remain static throughout the period. Any explanatory variables that change state is modeled as a different variable, giving up a degree of freedom within the estimation. For example, since the type of assistantships received by doctoral students may change yearly, a cross sectional study will have difficulty modeling this variable, and the results presented will

only be a snapshot of the variable. Survival analyses overcome this limitation by allowing variables to change their values (Allison, 2009; Blossfeld & Rohwer, 2002).

These advantages have made survival analysis the preferred method in social research when discussing the likelihood of an event occurring and the time it takes to occur (Allison, 2009; Diggle, Liang, & Zeger, 1994). Survival analyses have slowly taken root in educational literature. They have been used in higher education research mainly to model undergraduate student departure (Chen, 2007; DesJardins, Ahlburg, & McCall, 1999, 2002a; Gross, 2008; Ishitani & DesJardins, 2003). The methodology chapter presents a further discussion of the applicability of this method to the dissertation.

### **Chapter Summary**

The preceding review has established the need to use human capital theory in doctoral student retention studies, and it has shown the methodological inadequacies of the existing literature. This study hopes to address these inadequacies by establishing a comprehensive economic model of doctoral education. The study will use longitudinal data and survival analysis to model how time influences the various factors that affect doctoral retention.

## **Methodology**

The purpose of this study is to establish a comprehensive model for discussing and examining doctoral student retention and graduation. The conceptual framework of this study includes factors that consider changes in students' lifetime earnings, unemployment in their fields of study, and subsidies toward the direct costs of graduate education. The study examines the effect assistantship types and labor market conditions have on retention of students at the different stages of doctoral education. To determine the factors that were important for retention, the research conducted estimations at each stage of doctoral education.

This chapter describes the methodology used in answering the research questions. It first presents the research questions and conceptual framework. Next is a discussion of the research design, population, sample, and data acquisition methods. The chapter then defines the variables, the analyses employed, and the methodology's inherent limitations.

### **Research Questions**

1. What are the effects of labor market conditions and financial aid packages on the retention of doctoral students beyond 18 credits?
2. What are the effects of labor market conditions and financial aid packages on the advancement to candidacy of doctoral students?
3. What are the effects of labor market conditions and financial aid packages on the completion of a doctoral degree?

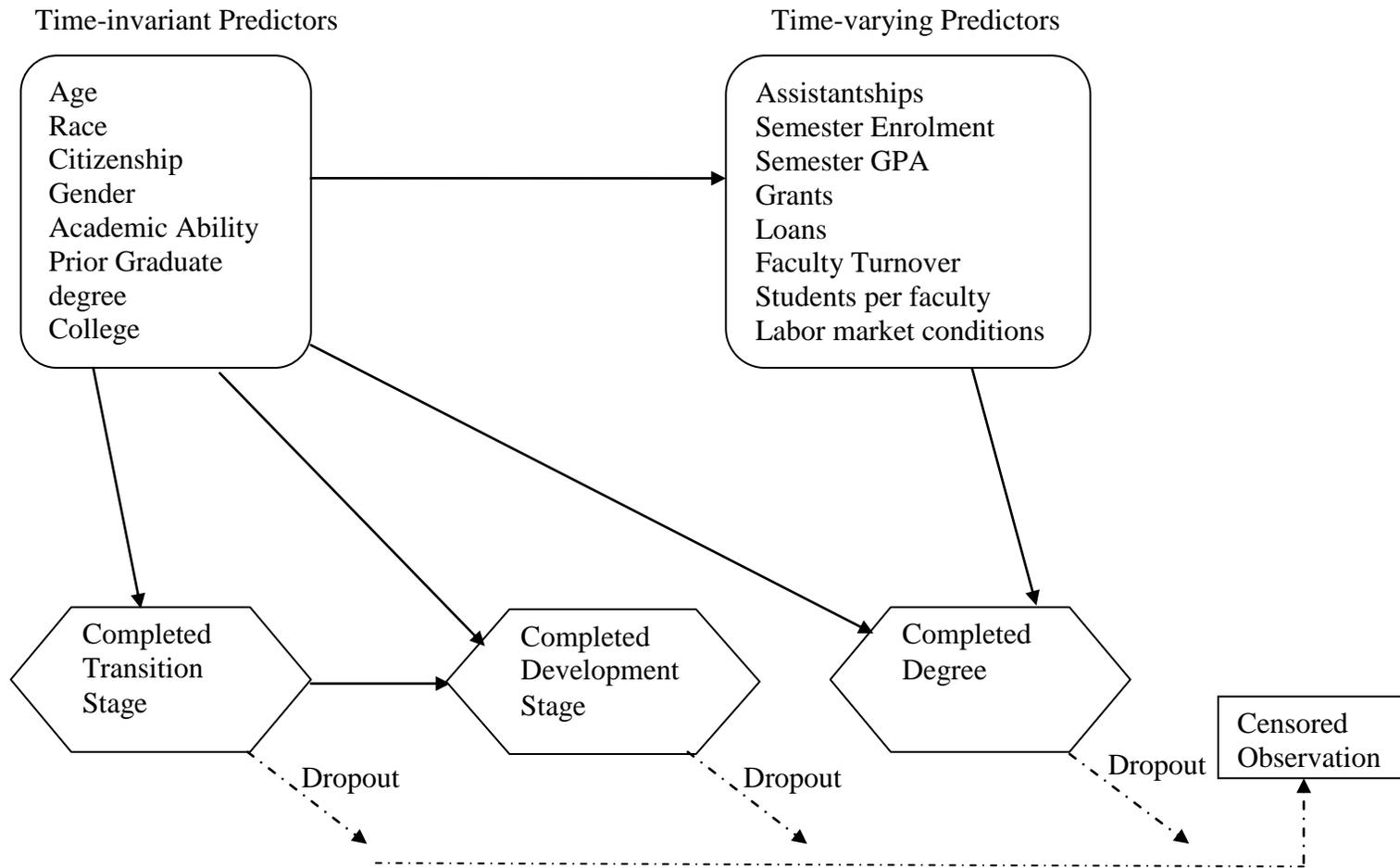


Figure 1: Conceptual Framework

## **Research Design**

Doctoral education occurs in the real world, where manipulation of the variables that affect success is not possible, and thus the study employed a non-experimental research design, specifically a longitudinal explanatory research design (Johnson, 2001). The research sought to understand doctoral student retention at various stages of the graduate program, making it appropriate to use a longitudinal design. The study was explanatory because it included economic conditions to the doctoral retention model.

## **Population and Sample**

Doctoral students in general were the focus of the study, particularly doctoral students in public institutions with very high research activity and STEM-dominant doctoral programs. One land-grant institution in the southern United States served as the site for this study. It is a large institution with an annual enrollment of about 30,000 students, 7,000 of whom are graduate students. This institution offers doctoral degrees in 61 different fields in 10 colleges. The institution conferred 400 doctoral degrees in 2008. With no medical school attached to the institution, the research concentration is within doctoral programs.

Information was obtained about doctoral students who enrolled at the institution between the academic years of 1994/95 and 1998/1999. This allows the use of data from the most recent doctoral cohorts with at least 10 years of information. The research used only five cohorts in order to reduce unmeasured variations in department and institution policies that would influence persistence between cohorts. Since the analytical period

studied is from the years 1994 to 2008, there is enough variation in economic conditions to estimate their impact on retention.

During this period, 2,075 doctoral students enrolled at the institution and were the sample for this study. Table 1 displays the breakdown of initial doctoral enrollments during the study period. Seven students matriculated at the institution but did not enroll in any classes during the study period, and thus excluded from the sample. The final analytical sample for the study was 2,068 students.

Table 1

Number of Doctoral Students Enrolled at the Institution by Year

Year	Doctoral Enrollment
1994	306
1995	392
1996	337
1997	376
1998	317
1999	347
<b>Total</b>	<b>2075</b>

### **Data Acquisition**

Three sources provided data for the study. First, the institution's research office provided data on the students and departments. The Bureau of Labor Statistics (BLS) provided unemployment and weekly earnings information for the different fields from data derived from its Current Population Study. The National Faculty Salary Survey by Discipline and Rank in Four Year Colleges and Universities administered by the College and University Professional Association for Human Resources (CUPA-HR) generated the

expected earnings information. The variables obtained from these offices fell into three categories: student information, departmental information, and prevailing economic information.

## **Variables**

These research questions have similar independent variables but differ in the operationalization of the dependent variables. The first section describes the dependent variables used in the study and the next section discusses the independent variables based on the source of information.

### **Dependent variables.**

Tinto's (1993) three-stage model is the basis of the dependent variables for the research questions answered in this study. Each stage of the model characterizes an event in the study, and students pass each stage when they complete an event. Completing the degree denotes retention at the institution at three different times during the process. Table 2 shows the breakdown for when a student attains an event.

Table 2

#### Dependent Variables

Event/Stage	Dependent Variable
Stage 1: Enrollment beyond the first year	Enrollment after completion of 18 credits
Stage 2: Candidacy attainment	Candidacy as reported by department
Stage 3: Degree completion	Graduation

The institution requires students to select an advisor and to file a plan of work after successfully completing the first eighteen credits. This study uses the filing of the plan of work to mark the end of the transition stage and the first retention period. Students who enroll full-time for their first two semesters will achieve this goal at the beginning of their second year, but students who enrolled part-time during the process may take longer to complete this stage. The date of candidacy used by this research is the date of a student's oral preliminary examination as recorded by the Graduate School. This examination marks the end of the development of a research agenda, after which the students are expected to pursue research leading to the dissertation. The completion of the degree marks the end of the final stage.

This study considered students to have “stopped out” of the institution if they fail to enroll in a particular semester(s) but re-enroll within the study period. The analyses excluded these stop out periods because students cannot attain an event during this time. The semester from matriculation used in the analyses is the actual number of semesters students enrolled at the institution. If students failed to enroll for a semester and did not re-enroll at any other time during the study period, the study considered them to have dropped out. Thirty-two students who were still enrolled at the end of spring 2009 were included in the analyses as right censored because their degree completion or drop out was not observed during the study period. This approach is appropriate for survival analysis techniques, as these students still provide valuable information to the estimations (Allison, 2009).

**Independent variables.**

This section discusses independent variables used in the analyses. Table 3 displays the complete list of variables and their operationalization. The variables fall into three categories: student information, department information, and labor market information.

Table 3

Independent Variables

<b>Independent Variables</b>	<b>Operationalization</b>
<b>Student Information</b>	
<i>Background Information</i>	
Gender	Dummy coded as 1 for female
Race	Categorical variable
Age	Continuous variable
Citizenship	Dummy coded as 1 for international
Academic ability	Categorical variable
Previous graduate degree	Dummy coded as 1 for previous graduate degree
<i>Enrolment and grade information</i>	
Semester GPA	Continuous variable
Enrolled part-time in the current semester	Dummy coded as 1 for part time
<i>Financial aid information</i>	
Research assistantship in the current semester	Dummy coded as 1 for research
Teaching assistantship in the current semester	Dummy coded as 1 for teaching
Grants	Log transformation of variable
Loans	Log transformation of variable
Cumulative loans	Log transformation of variable
<b>Department Information</b>	
Faculty turnover rate	Continuous variable
Doctoral students per faculty	Continuous variable
College	Categorical variable
<b>Labor Market Information</b>	
New assistant professor salary in the field	Log transformation of variable
Weekly earnings of skilled professionals in the field	Log transformation of variable
Unemployment rate of skilled professionals in the field	Continuous variable

*Student information.*

*Background information.*

These variables will include information on the gender, race, age, and citizenship of the student. Prior studies have shown that despite the differences in completion rates between students of different gender and race, the differences are not significant predictors of degree completion (Bowen & Rudenstine, 1992; Nerad & Miller, 1992; Seagram et al., 1998). Black, Hispanic, and Native American students are combined into a Minority race category due to their low numbers (Mertler & Vannata, 2005). Thus, three categories of race are included in the estimation: White, Asian, and Minority. Research has shown that international students are more likely to complete the doctoral degree and time to degree (Girves & Wemmerus, 1998; Stiles, 2003). The effect of citizenship on persistence after the first year and candidacy are largely unknown. A dummy for international students is included in the estimation. Research studies have mixed results for the effect of age at entry on degree completion of doctoral students. Abedi and Benkin (1987) found no effect of age on degree completion but Stiles (2003) found that older students were less likely to complete their degrees. Age at entry is included in the analysis as a continuous variable.

Tinto (1993) theorizes that student ability affects retention. To obtain measures of academic ability, the study uses proxies generated from Graduate Record Examination (GRE) verbal and quantitative scores, and undergraduate Grade Point Averages (GPA). Due to their standardized nature, GRE scores were the main measure of academic ability.

GRE scores were missing for 30% of the analytical sample and the study generated a score for the 20% who also had their undergraduate GPA not recorded.

An institutional reporting problem was the source of the missing GRE and undergraduate GPA scores. Since this was not attributable to the students, the study assumed the scores to be missing completely at random and multiple regression estimation was used to predict the missing GRE scores. The independent variables used to generate the estimates for the prediction were student background, first semester doctoral GPA, and average GRE score of the department.

To obtain one variable as a measure of academic ability and reduce the random error generated because of the prediction of missing GRE scores, the analyses used a four-group categorical transformation of the variables. The Education Testing Services (ETS) published percentage distribution of scores provided the breakdown for the GRE scores (ETS, 2003). A student's score is coded as exceptional if it fell within the top 25% of scores nationwide and low if it was within the bottom 25%. The score breakdown relating to these percentiles was reported by the ETS based on test takers' intended major field of study, and this was employed in the study. As an example, a quantitative score of 700 was categorized as being in the 50th to 75th percentile for an engineering student and thus classified as good. However, this same score would have fallen in the top 25% for a humanities student and thus classified as exceptional for this study. Conversely, a verbal score of 650 was exceptional for an engineering student but good for a humanities student. The average of the two categories generated the final categorical variable. Analytical GRE

scores were not used because their percentile breakdowns were not available in the ETS publication.

Ten percent of the analytical sample were missing GRE scores but had undergraduate GPA reported and the latter was used as the proxy for academic ability for these students. A standard grading scale was used to transform the undergraduate GPA into the four categories. GPAs above 3.67 or an A- were classified as exceptional, between 3.33 and 3.66 were classified as good, between 3.00 and 3.33 were classified as average, and below 3.0 classified as low. The next chapter presents the frequencies of these breakdowns.

*Enrollment and grade information.*

Doctoral students in the sample had varying enrollment patterns throughout their study period and could not be classified as part-time or full-time students. Part-time status was determined by a student's enrollment each semester and classified as enrollment of fewer than 9 credit hours and included in the estimation as a semester-varying dummy variable. The time-varying measure of the student's GPA each semester is included in the analyses as a further measure of academic ability during graduate study.

*Financial aid information.*

The main sources of financial aid for doctoral students are assistantships, fellowships, and loans. These variables are time varying, and for each semester, students may use any combination of the three to finance their education. Research assistantships and teaching assistantships, which are the two main types of assistantships, were dummy

coded and included in the analyses for the semester in which a student held these positions. Fellowship information was unavailable from the data set. However, grants paid through the institution were included in the analyses. Students' educational loans were included in the analysis as two measures; the loan amount in the current semester as well as the cumulative loans taken up to that semester since matriculation in the doctoral program. The analyses used natural log transformations of all the monetary measures to reduce skewness and outliers associated with these measures (Mertler & Vannata, 2005).

***Department information.***

To control for the unobserved effects of the field of study on retention, the student's college is used in the analyses over the department as a parsimonious choice. Ten colleges at the institution offered doctoral degrees, but four colleges enrolled 84% of the doctoral students in the analytical sample. The colleges were thus recoded into seven colleges by combining the College of Management (economics) students with the College of Humanities and Social Sciences, and the College of Natural Resources with the College of Textiles and the College of Design students. These colleges were combined because they have similar programs and exist in one college at other institutions. The other five colleges were Engineering, Education, Physical and Mathematical Science, Agricultural and Life Sciences, and Veterinary Medicine. Departmental factors were controlled for by the two variables in the dataset. The size of the department as it relates to doctoral students was included in the study with a continuous time-varying measure of doctoral students per

faculty member. Lovitts (2001) show a correlation between faculty retention rates and doctoral student attrition so faculty turnover rate was included in the estimations.

### ***Labor market information.***

The study used three measures of the labor market. The first was unemployment rates of skilled workers within the student's field of study, which provided measures of employment availability. The second measure was the weekly wages that students would have earned working instead of attending full time. This was used as a proxy for the opportunity costs of attending doctoral program. The final measure was the new assistant professor salaries within the field of study, which provided measures of expected earnings after degree completion. Despite the fact that not all doctoral students aspire to a professorial career after graduation, the research used this measure for expected earnings because it was the best available indicator of what doctorate holders expect to earn with their degrees.

### **Analytical Method**

This study used survival analysis as the main analytical tool to answer the research questions. This section discusses the choice of the method, key concepts, and the analytical model estimated.

### **Survival analysis.**

The study's analyses explored the impact of the financial aid and labor market conditions on doctoral retention. The main aim of the analyses was to compare the effects of the factors on retention at the different stages of doctoral education. The longitudinal

nature of the study, the censored observations, and the time-varying nature of enrollment, financial aid, and the labor market lent themselves to the use of survival analysis to answer the research questions (Cox, 1972). Survival analysis was originally developed in medical literature to study the timing of human deaths (hence the name) (Allison, 1995). Survival analysis is a flexible method that has been applied in many fields. Thus, it has gained different names: duration/transition analysis in economics and event history analysis in sociology. This paper uses the original name. The technique is slowly taking root in education literature (DesJardins, 2003) because it provides more powerful tools than logistic regression in handling longitudinal data, time-varying variables, and censoring. One major advantage of survival analysis is that it allows for the direction of causality to be explored because it includes timing within the analysis (Allison, 2009; Blossfeld & Rohwer, 2002).

***Key concepts.***

Before discussing the analytical model in depth, it is critical to describe the key concepts and terminology in survival analysis and their applicability to this study. It is important to keep in context that survival analysis was developed to model death, and thus its terminology tends to be negative. This paper is written using typical survival analysis terminology, even though the event of interest, retention, is positive.

*Censoring.*

Two main types of data censoring exist: right and left censoring. Left censoring occurs when the beginning time of an event is unknown. For this study, no left censoring

is observed since the beginning time (or date of enrollment) for all students in the study is recorded. Right censoring occurs when the end time (in this case, drop out or graduation) of an event is unknown. This type of censoring occurred in this study since there were 32 students still enrolled for whom neither graduation nor drop out was recorded. Survival analysis can differentiate these students from those who dropped out in the estimation.

*Time.*

Time is a crucial concept in survival models and is required to indicate the occurrence of an event. Survival analysis can handle both discrete and continuous measurements of time. The unit of measurement depends on the theoretical assumptions of the model as well as the availability of data. This research uses the academic semester as the appropriate measure of time. Although some students enrolled and completed stages during the summer semesters, this number was low and the information from this period was aggregated into the previous spring semesters. Thus, two semesters of enrollment equaled a full academic year in the study.

*Risk period.*

Time also allows for the definition of the risk period. This period is when the students are at risk of experiencing the event. The study also used a single semester as the risk period.

*Risk set.*

The risk set is the part of the analytical sample that is at risk of experiencing the event during any risk period. Any student enrolled in a particular semester is technically

within the risk set. The research explored different risk sets to answer the research questions, and this is discussed later in this chapter.

*Hazard rate.*

The hazard rate is the dependent variable in survival models and is the probability that an event occurs in the risk period, given that it has not occurred previously (Allison, 2009).

*Hazard ratio.*

The hazard ratio is similar to the odds ratio in logistic regression and reports the effect independent variables have on the hazard rate of an event.

***Discrete-time hazard model.***

Since the choice of the time unit, semester, was discrete, this research employed a discrete time hazard model. Another reason to use this hazard model is the large number of ties in the data. In survival analysis, ties occur when two or more people experience the event at the same time. The hazard model estimated is specified as:

$$\text{Logh}(t_j) = \sum_{t=1}^{30} \alpha_t T_t + [\beta_1 X_1 + \beta_2 X_2 + \dots + \beta_n X_n] +$$

$$[\gamma_1 Y_{1j} + \gamma_2 Y_{2j} + \dots + \gamma_m Y_{mj}] +$$

$$[\varphi_1 \log Z_{1j} + \varphi_2 \log Z_{2j} + \dots + \varphi_p \log Z_{pj}]$$

The left side of the equation features the log transformation of the hazard rate. The right side features four groups of terms in the estimation. The first group is the intercepts of the estimation, which are  $\alpha$  coefficients multiplied by the risk periods. These coefficients cannot be interpreted effectively as they represent unrealistic cases in which the explanatory variables equal zero. However, they can be thought of as the baseline of the hazard function. The second group represents the time-invariant regressors included in the estimation. The third and fourth groups are the time-varying variables. The fourth group is composed of variables that required a natural log transformation.

A Cox proportionality model estimated this hazard function. The assumption is that the hazard of student X is a fixed proportion of student Y. Despite this limitation, the study used this model because it did not require a distributional specification for the hazard rate. A marginal likelihood, with the option `exactm` in Stata, was used to handle the ties in the data set.

***The longitudinal data sets.***

Survival analysis with time-varying variables requires the data set be specified in terms of the risk set across the risk period for estimation. This requires a record for each student for every period in the risk set. This is known as the person-period (person-semester for this study) data, or the long form of the data. This research had three distinct events, which required three longitudinal data sets in which students join the risk set when they matriculate and remain in the set as long as they are enrolled and have not experienced the event. To help answer the research questions fully, two additional data

sets were created. The first assumed that a student did not enter the risk set for candidacy until he or she experienced the first event (i.e. persisted beyond the 18<sup>th</sup> credit). The other data set assumed that students entered the risk set for graduation when they attained candidacy. These additional data sets allowed the effects of the independent variables to be determined at each distinct stage. A proportional hazard model is estimated on each data set.

### **Limitations**

This section highlights several limitations of this research. First, the estimations exclude student-advisor relationships that previous studies have shown affect doctoral degree completion (Lovitts, 2001; Nyquist, 2002; Stolzenberg, 2006). The exclusion was mainly due to the use of secondary sources that did not measure the variables due to their absence in the data set

The use of a single institution limits this study. Despite the choice of an institution with comprehensive doctoral degrees, doctoral programs in all the fields of study are not available at the institution. Thus, fields such as English and History that have notoriously low completion rates and high times to degree are not included in the estimation because their doctoral programs are not present at the institution (Bowen & Rudenstine, 1992). The research also did not explore institutional policies that could influence persistence.

Another limitation of the research is the failure to control for why students were selected to receive assistantships. It is highly probable that the students offered assistantships are the ones who would have otherwise been more likely to graduate.

Failure to control for this sample-selectivity issue may overestimate the effect of the assistantships on retention. Unfortunately, although methods have been developed to control this issue, they are not compatible with survival analysis. For this study, the benefits gained from this analytical method outweighed the need to control for selection. The student academic ability measures and the GPA obtained in graduate school are included in the estimation to reduce some of the bias.

The low numbers of Black, Hispanic, and Native American doctoral students present in the analytical sample limited the analyses on this group. Despite the differences that may occur between the students of these races and ethnicities, they are included in the estimation as one group.

### **Chapter Summary**

This chapter presented the methodology used in this study to answer the research questions concerning the factors that affect doctoral student retention. The next chapter presents the results obtained using this methodology.

## **Results**

This chapter presents the results from the analyses described in the previous chapter. The chapter is divided into five sections. The first presents the descriptive analyses of all the variables used in the estimation. The next section presents life tables for the three events: persistence after 18 credit hours, attaining candidacy, and completing the degree. The subsequent section presents graphs of the hazard functions for the three events and the effect of select explanatory variables on these functions. The next section presents results from the proportional hazards estimations on the full sample for the three events, and the final section presents results from the proportional hazards estimation relating to the three stages of doctoral education.

### **Descriptive Results**

The descriptive results are in three parts. The first part provides information about the events and the data sets used to answer the research questions. The second part presents summary statistics on the time-invariant measures and some of the time-varying measures used in the estimation. The final part presents graphical representations of the time-varying research variables.

#### **Event attainment.**

The dependent variable for each research question is a hazard rate. Survival analysis calculates the hazard rates from when students attain the events. Table 4 presents a cross-sectional view of event attainment and the number of semesters needed to achieve each event.

Table 4

Number of students that attained each event and the mean, median, and maximum time to the event

Event	Person-semester	Risk set	Number attained	Percent	Semesters to Event		
					Mean	Median	Max
Persisting after 18 credits	6,622	2,068	1,823	88.2	2.3	2	10
Candidacy	15,234	2,068	1,270	61.1	6.6	6	23
Candidacy given persisting 18 credits	10,440	1,823	1,270	69.7	4.3	3	21
Graduation	18,963	2,068	1,039	50.2	9.4	9	25
Graduation given candidacy	5,106	1,270	1,039	81.2	2.9	2	19

The full sample of 2,068 students created 6,622 person-semester observations for the persistence-after-18-credits event, 15,234 person-semester observations for candidacy event, and 18,963 for graduation event. Examining the analyses by the different stages shows 1,823 students (10,440 person-semester observations) at the development stage and 1,270 students (5,106 person-semester observations) at the research stage.

Of the 2,068 doctoral students that enrolled during the study period, 88% persisted after 18 credits, 61% attained candidacy and 50% completed the doctoral degree. Over 50% of the dropouts occurred at the development stage. Once students attain candidacy, 81% complete the degree. On the average, students enroll for their 19<sup>th</sup> credit hour after 2 semesters or a year, attain candidacy at the end of 6 semesters or 3 years, and graduate at the end of nine semesters. Longitudinal views of these analyses are presented under inferential results of this chapter.

### **Independent variables.**

Table 5 reports the percentage breakdowns of all the time-invariant categorical variables. The analytical sample consisted of 61% male and 39% female. Whites make up 61% of the sample, Asians 27%, and Minorities 12%. International students made up 33% of the doctoral students enrolled. The transformation of GRE scores and undergraduate GPA into a categorical variable, academic ability led to almost an even breakdown in the four categories. Forty-five percent of the sample had masters degrees before enrolling in their doctoral programs and 55% of the sample enrolled with a bachelor's degree. The College of Engineering had the most doctoral enrollments during the period with 514 students (25%) followed by the College of Education with 413 students (20%). The College of Design has the lowest enrollment, 6 students, as it had its first doctoral matriculants during the study period.

Table 6 presents the means and standard deviations of the continuous variables. The statistics for the time-varying variables were calculated across the sample over all the periods. The average age at which doctoral students began their program was 31 years. About 58% of the students, though, were between the age of 20-29, and the oldest student was 67 years old. The mean grant received by students was \$6,182 and the mean loan students took out was \$9,462. On the average, the faculty within the departments grew by a rate of 2.8%, and there were 4 doctoral students per faculty member in a department.

Table 5

Descriptive statistics of non-time varying categorical variables

Variable	Frequency	Percent
Gender		
Male	1,266	61.2
Female	802	38.9
Race		
White	1,254	60.8
Asian	562	27.2
Black	191	9.3
Hispanic	48	2.3
Native American	9	0.4
Citizenship		
U.S. citizen/resident	1,381	66.8
International student	687	33.2
Academic Ability		
Exceptional	550	26.6
Above average	519	25.1
Average	493	23.8
Below average	506	24.5
Degree		
No masters degree	1,133	54.8
Previous masters degree	935	45.2
College		
Engineering	514	24.9
Education	413	20.0
Physical and Mathematical Sciences	405	19.6
Agriculture and Life Sciences	397	19.2
Veterinary Medicine	91	4.4
Humanities and Social Sciences	72	3.5
Natural Resources	69	3.3
Management	55	2.7
Textiles	46	2.2
Design	6	0.3

Table 6

Descriptive statistics of continuous independent variables

Variables	Mean	Standard Deviation
Age	31.1	7.8
Grants	\$6182.49	\$6136.78
Loans	\$9462.30	\$4714.99
Faculty turnover rate	-2.8	14.3
Doctoral students per faculty	4.01	5.5
Semester GPA	3.25	1.19

***Time-varying research variables.***

The variables of interest in this study were the type of assistantship held by a student and the labor-market variables. This section uses charts to show how their values change over time. Figure 2 shows the percentage of students with research and teaching assistantships in their semester. The chart shows that after the first year, the institution offers more research assistantships than teaching assistantships. This is typical of an institution with STEM-dominant doctoral programs. About 60% of doctoral students held an assistantship in their sixth semester of study, with 40% holding research assistantships and the other 20% a teaching assistantship. The percentage of students with assistantships declines gradually with teaching assistantships disappearing completely after the twentieth semester and research assistantships after the twenty-second.

Figure 3 shows the average salary of new assistant professors in the fields of the study across the period. The period shows a steady increase in the salaries of new assistant professors from an average salary just below \$40,000 to above \$60,000.

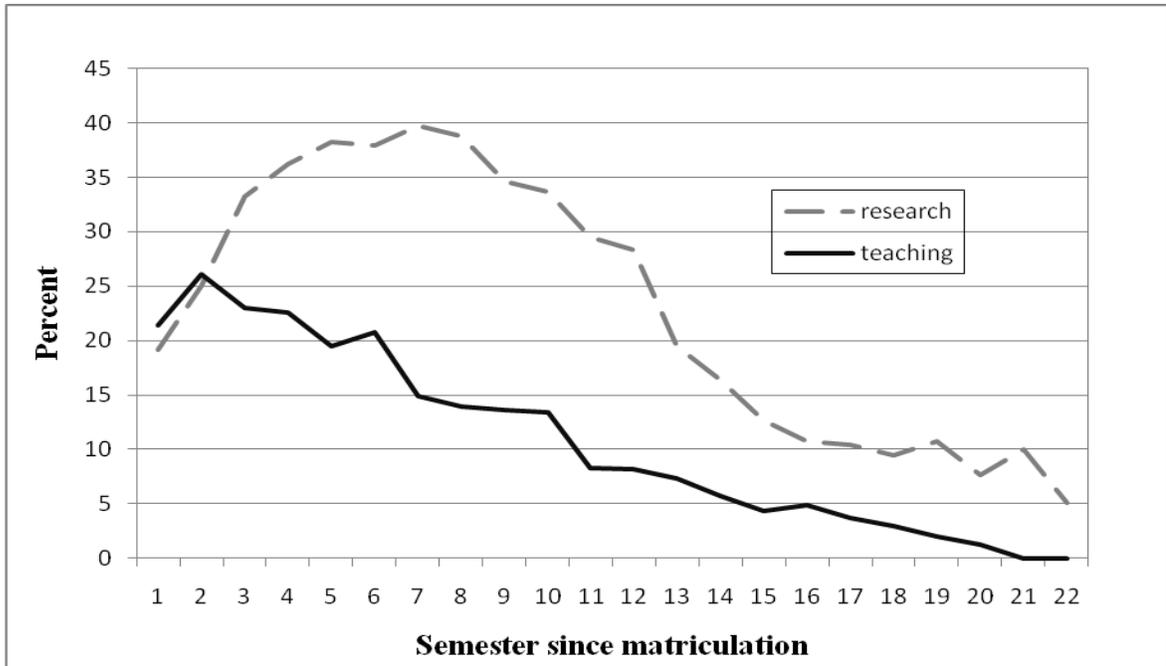


Figure 2. Percentage of students with assistantships

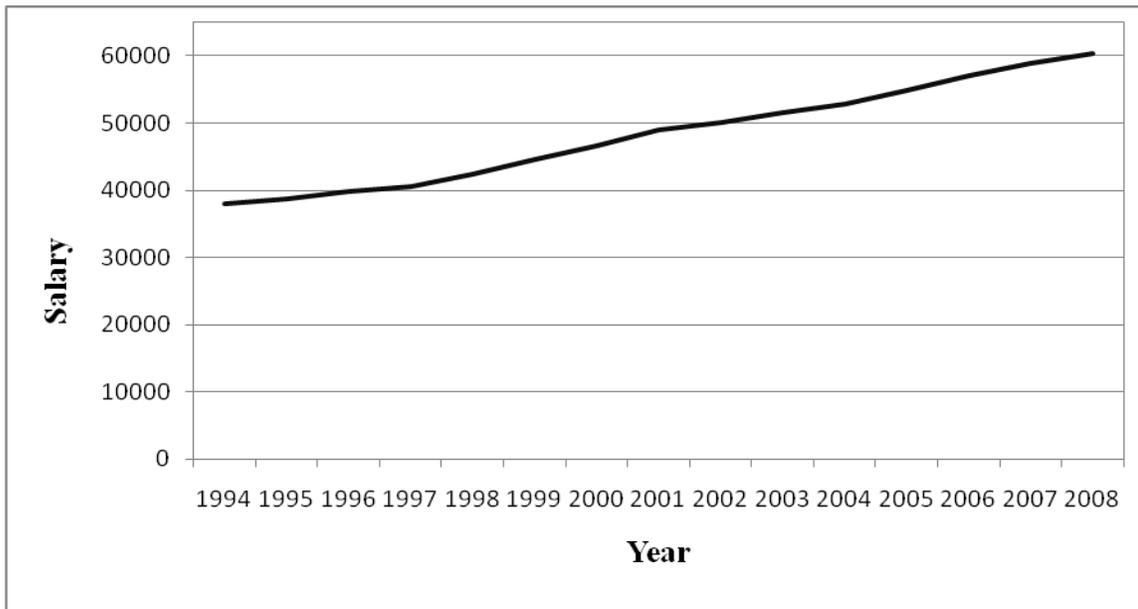


Figure 3. Average salary of new assistant professor across the study period

Figure 4 shows the average weekly earnings of professionals in the same fields as the doctoral students in the analytical sample. These earnings show a similar trend as the assistant professor salary, increasing over time. The similar trend in the two variables was a source of concern in the study. The labor market variables could be highly correlated and introduce multicollinearity into the estimations. Checks show that unemployment was not significantly correlated with the two wage variables but that weekly earnings and the professor salary variables were significantly correlated with a rho of 0.45. Further checks showed that there were no significant correlations between the two variables for any given year but that the correlation occurred across time. The two variables were sequentially entered into the regression to determine the stability of estimates and standard errors. The estimates held up, and both variables are used in the estimation.

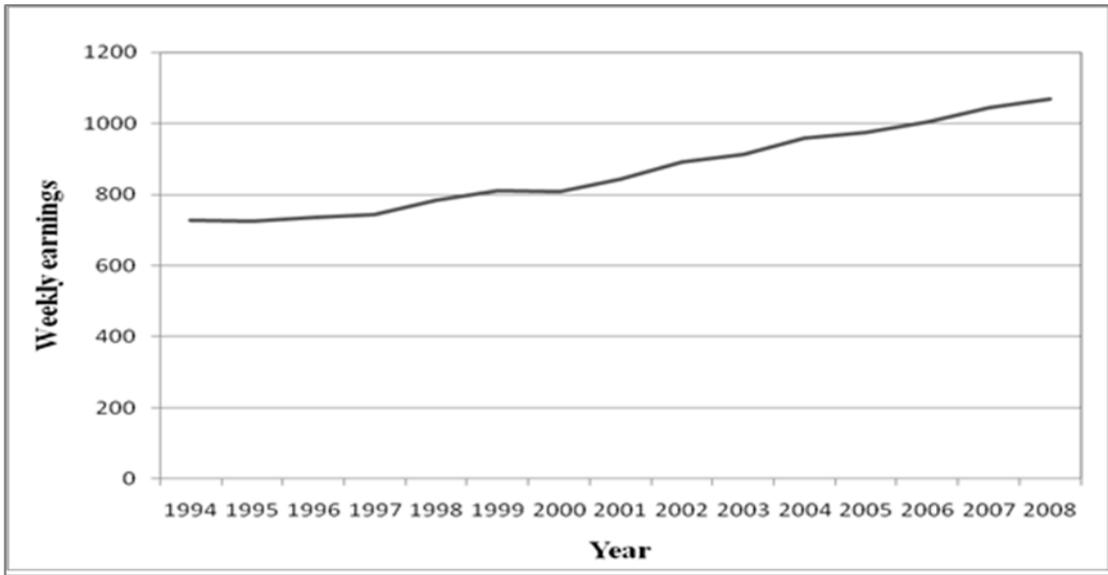


Figure 4. Average weekly earnings across the study period

Figure 5 shows the trend of unemployment rate over the study period. The national average line shows the annual unemployment rate nationwide. The data set's average trend line shows the average unemployment among professionals with bachelors and/or masters degrees in the fields of the students in the analytical sample. There was significant variation in unemployment rates over the 15-year study period. Although the two lines show similar trends, the sample unemployment rates are much lower since they are the rates of skilled professionals.

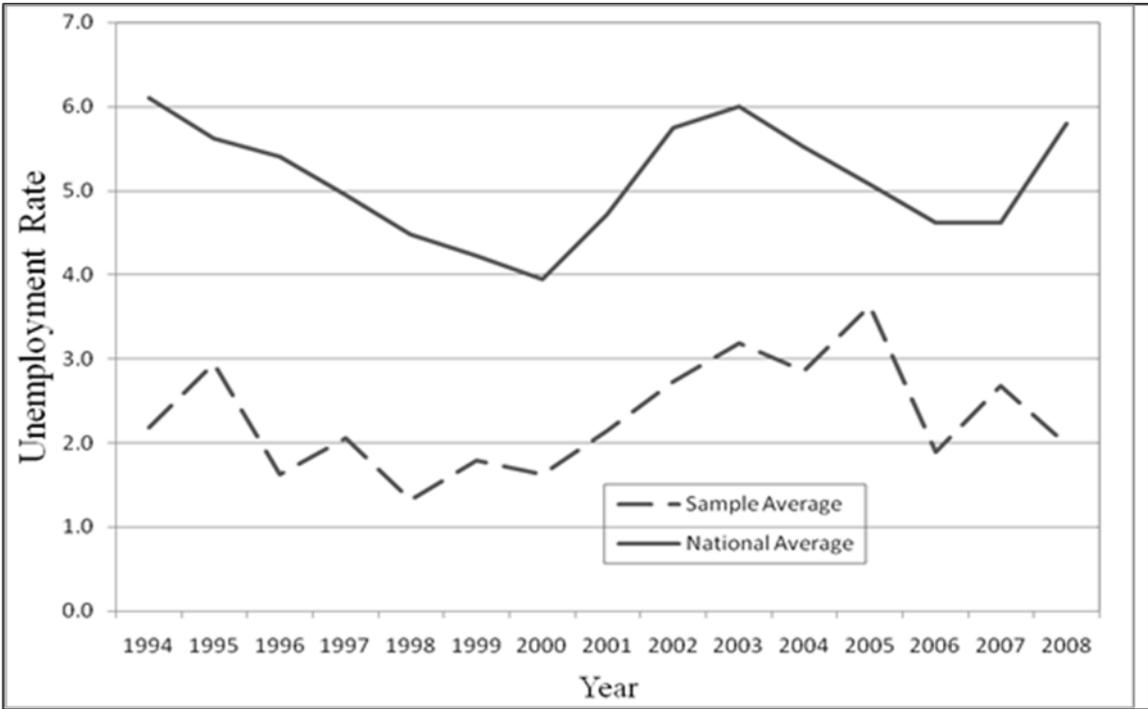


Figure 5. Average unemployment rate across the study period

## **Inferential Analyses**

This section presents the inferential results for the study. The first set of results are life tables that display all the risk periods of the event, the number of students who attained the event or dropped out during that risk period, and an estimate of the survivor function calculated using the Kaplan-Meier method. The survivor function estimates the probability of surviving (not experiencing the event and continuing to enroll) past that risk period.

The next section presents graphs of the estimates of the hazard rate across time for the three events. This will show the probability of experiencing the event within a particular interval without the independent variables. A set of graphs comparing hazard rate across time for different groups of students is also presented.

The subsequent sections present results from proportional hazards estimations. These will show how the independent variables change the hazard rates of the events. The first set of estimations will examine the effects of the explanatory variables on the full sample for each of the three events. The next set will examine the variables' effects on the three stages of doctoral education under the assumption that students do not enter a risk set for an event until they complete the previous stage. These results will thus compare the effects of the variables on doctoral student retention at the different stages.

### **Life tables.**

Table 7 reports life tables for the three events in this study. Each life table presents the number of students at risk of the event for each semester since matriculation, the

students that left at the end of semester, the students who attained the event during the semester, and the survivor function estimate for remaining in the risk set after that semester. Semester 28 is not included in the life table, as students did not attain any event or drop out during this risk period.

The life table for persistence after completing 18 credits shows 11 risk periods for the event. This implies that by the end of the eleventh semesters all students have either experienced the event or dropped out. The table shows that 80 students dropped out after the first semester and 174 students experienced the event. The majority of the students experienced the event during their third semester. By the end of the sixth semester, the probability that a student enrolled and did not experience the event is 3.8%. At this transition stage of doctoral education, 245 students dropped out and most of the dropouts occurred at the end of the second semester.

The next columns in the table present the life table for attaining candidacy. The life table covers the entire study period, since some of the 32 students still enrolled at the institution had not attained candidacy at the end of study period. The table shows that most of the students attained candidacy between their fifth and ninth semesters. By the end of the twelfth semester, the probability of not attaining candidacy or dropping out is 22%. The probability of surviving until the end of the study period is 8.5%. None of the students attained candidacy after their twelfth year, and 798 students did not attain candidacy over the study period.

Table 7

Life Table of the analytical sample showing the three events

Event Risk Period	Persisted after 18 credits				Attained Candidacy				Graduated			
	Risk Set	Left	Persisted	Survivor Function	Risk Set	Left	Attained Candidacy	Survivor Function	Risk Set	Left	Graduated	Survivor Function
1	2068	80	174	0.916	2068	85	4	0.998	2068	85	0	1.000
2	1814	102	95	0.868	1979	110	3	0.997	1985	110	0	1.000
3	1617	33	950	0.358	1866	66	20	0.986	1875	66	2	0.999
4	634	16	367	0.151	1780	92	84	0.939	1807	92	3	0.997
5	251	5	115	0.082	1604	48	194	0.826	1710	51	13	0.990
6	131	4	70	0.038	1362	78	257	0.670	1646	85	81	0.941
7	57	3	24	0.022	1027	38	175	0.556	1480	56	107	0.873
8	30	1	15	0.011	814	49	148	0.455	1317	81	159	0.768
9	14	1	9	0.004	617	35	107	0.376	1077	52	107	0.691
10	4	0	2	0.002	475	34	80	0.313	918	78	148	0.580
11	2	0	2	0.000	361	19	49	0.270	692	36	106	0.491
12					293	18	53	0.221	550	42	97	0.404
13					222	13	26	0.195	411	25	56	0.349
14					183	15	22	0.172	330	28	49	0.298
15					146	17	12	0.158	253	26	23	0.270
16					117	17	20	0.131	204	21	19	0.245
17					80	10	7	0.119	164	15	12	0.227
18					63	14	2	0.116	137	20	15	0.202
19					47	10	2	0.111	102	13	11	0.181
20					35	7	0	0.111	78	11	7	0.164

Table 7 Continued

Event Risk Period	<b>Persisted after 18 credits</b>				<b>Attained Candidacy</b>				<b>Graduated</b>			
	Risk Set	Left	Persisted	Survivor Function	Risk Set	Left	Attained Candidacy	Survivor Function	Risk Set	Left	Graduated	Survivor Function
21					28	5	3	0.099	60	9	12	0.132
22					20	7	1	0.094	39	11	8	0.105
23					12	1	0	0.094	20	3	2	0.094
24					11	1	1	0.085	15	3	1	0.088
25					9	3	0	0.085	11	3	0	0.088
26					6	2	0	0.085	8	3	1	0.077
27					4	2	0	0.085	4	2	0	0.077
29					2	1	0	0.085	2	1	0	0.077
30					1	1	0	0.085	1	1	0	0.077
		245	1823			798	1270			997	1039	

The final columns of the table present the life table of doctoral degree completion as the event. Students have a 99% probability of surviving until the sixth semester. Graduation rates are then evenly spread between the sixth and twelfth semesters. The probability of not graduating and remaining enrolled after the twentieth semester, or the ten-year mark, is 0.16. No student graduated after the twenty-sixth semester and 997 students did not graduate. This table also shows that 245 students dropped out during the transition stage, 553 students dropped out during the development stage, and 199 students dropped out during the research stage. The life tables displayed the probability of remaining enrolled at each risk period. The next section will present the hazard functions, which show the probability of attaining an event in each period provided it was not attained in a previous period.

### **Hazard functions.**

The section presents graphs of the hazard rate across time, for all the events. The first set presents the hazard function without explanatory variables for the persistence after 18 credit hours attaining candidacy and degree completion. The next set will compare the hazard functions of graduating for students grouped by gender, citizenship, race, and assistantship. To prevent the choppy nature of the hazard estimates, the Epanechnikov kernel function with the optimal bandwidth was used to smooth the graphs (Allison, 2009). The shaded area represents the 95% confidence interval.

Figure 6 presents a graph of the hazard rate of persisting after 18 credit hours. The graph shows that the likelihood of persisting after 18 credits is an increasing function of time. The hazard rates of persistence are high ranging, from 35% in the third semester, to about 55% in the ninth semester. This implies that if a student has not enrolled in his or her nineteenth credit hour by the eighth semester, the likelihood of doing so is over 50%.

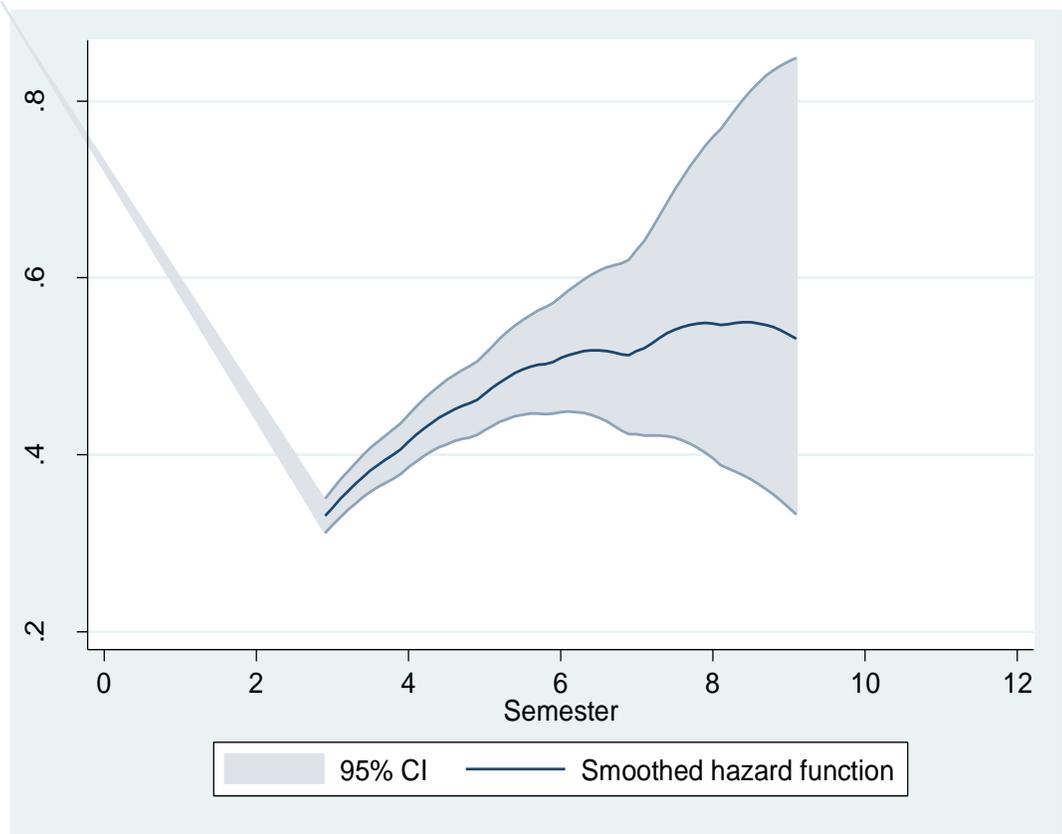


Figure 6. Smoothed Hazard Estimates of Persisting after 18 credits

Figure 7 displays the hazard rate graph of attaining candidacy. The likelihood of attaining candidacy across time is an increasing function of time up until the eleventh semester and then becomes a decreasing function of time. This suggests that if students do not attain candidacy by their eleventh semester, the likelihood of attaining candidacy decreases with every semester they remain enrolled. At the peak point, the likelihood of attaining candidacy given the event has not occurred previously is 15%.

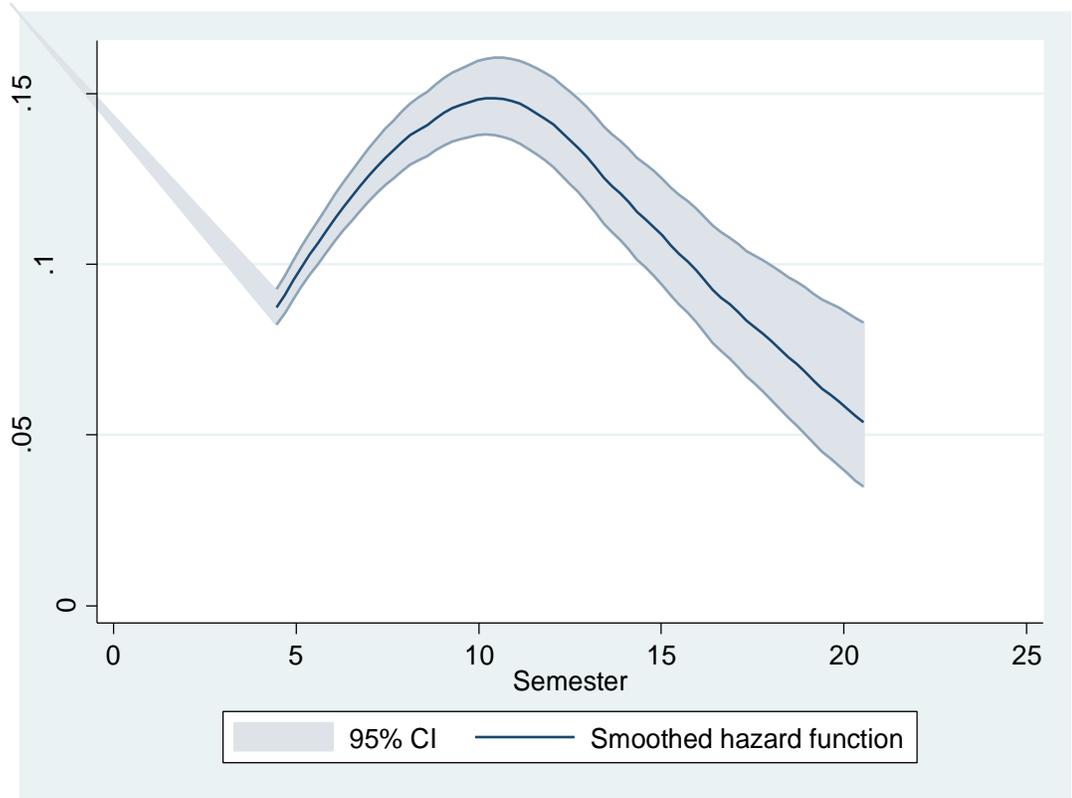


Figure 7. Smoothed Hazard Estimates of Attaining Candidacy

Figure 8 presents the hazard function of degree completion. The graph shows an increasing function of time from the sixth semester to the thirteenth semester rising from 0.06 to 0.12. Between the thirteenth and sixteenth semester, the hazard rate is at its peak, and almost constant at 0.12. Then it becomes a decreasing function of time. Thus, students who do not complete their degrees by the sixteenth semester reduce their likelihood of graduating each additional semester they remained enrolled.

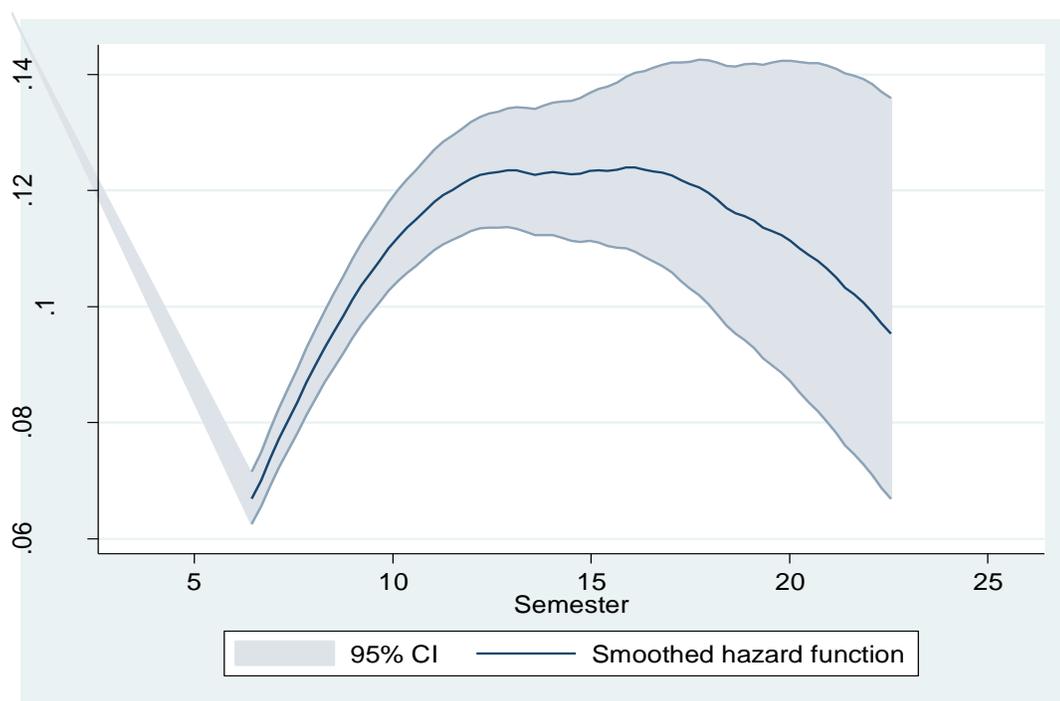


Figure 8. Smoothed Hazard Estimates of Degree Completion

The next four graphs look at how the hazard function of degree completion differs for students of different groups. It uses a Cox test of equality to determine the statistical significance of the observed differences.

Figure 9 compares the hazard function of degree completion by gender. The two genders exhibit different shapes in their hazard functions. A Cox test of equality rejects the null hypothesis that the two curves are equal, with a chi-squared of 10.39. Until the thirteenth semester, the two hazard functions exhibit a similar increasing pattern to the full sample, with male students having higher likelihoods of degree completion. The functions then start to decrease for both groups, but the female students' hazard function takes a divergent route: It starts to increase again. By the nineteenth semester, female students have a higher likelihood of degree completion than their male counterparts. Thus, females have an increasing likelihood of degree completion even after their sixteenth semester of study.

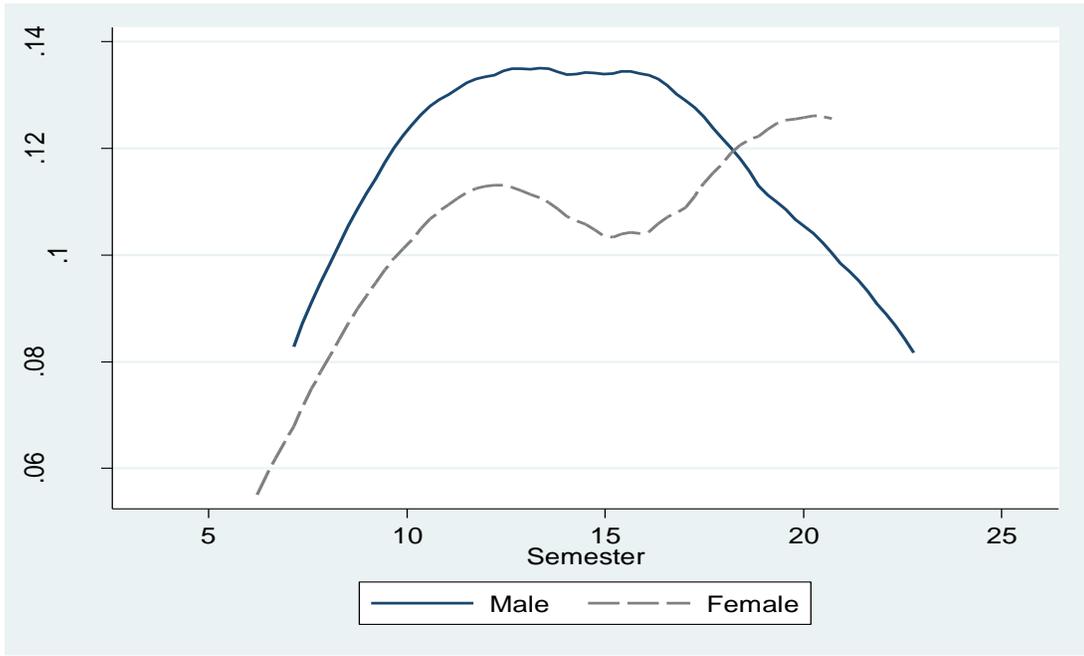


Figure 9. Smoothed Hazard Estimates of Degree Completion by Gender

Figure 10 displays the hazard functions of degree completion by students' citizenship. The Cox test of equality gives a chi-squared of 150.02, rejecting the null hypothesis. The chart shows that international students have higher hazard rates of degree completion than the U.S. citizens and residents. The chart also shows that although both groups experience an increasing hazard function of time during the earlier semesters, international students have a much steeper gradient (that is, the function increases at an increasing rate). The peak period for international students occurs much earlier, and there is not enough information to estimate their hazard function beyond the twentieth semester, implying that very few international students remained enrolled after that period.

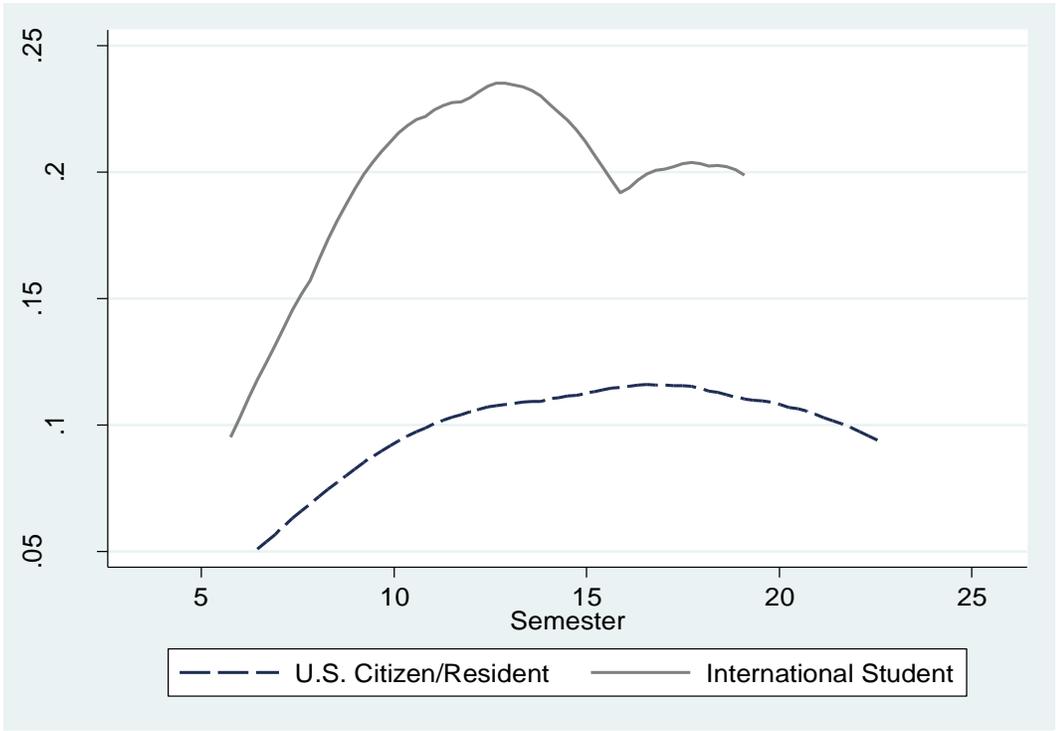


Figure 10. Smoothed Hazard Estimates of Degree Completion by Citizenship

Figure 11 presents the hazard of degree completion by race for all students. A Cox test of equality rejects the null hypothesis that the three curves are equal with a chi-squared of 66.41. The hazard estimates show that Asians have the highest likelihood of degree completion across all semesters, and they do not experience any significant decrease in this likelihood. The likelihoods of degree completion are similar for White and Minority students, with the former group having a slight edge until the twelfth semester, the peak semester for minority students. Then the gap starts to widen significantly. The peak semester for White students occurs much later during the seventh semester.

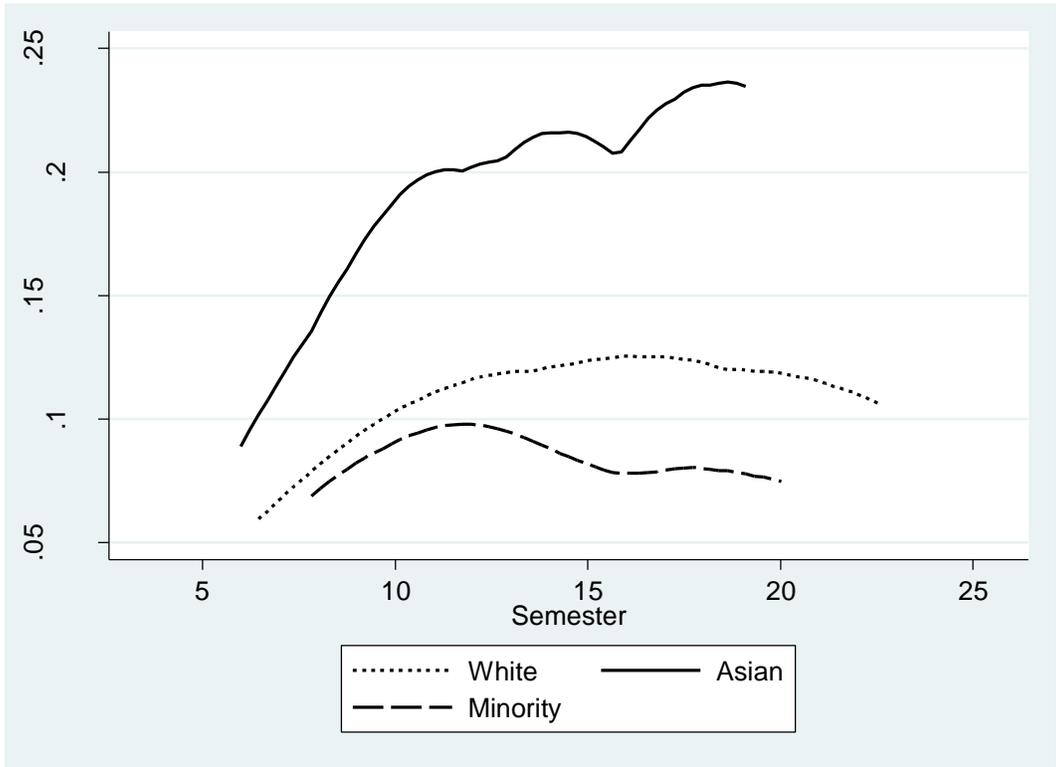


Figure 11. Smoothed Hazard Estimates of Degree Completion by Race

The final figure in this section, figure 12, presents the hazard estimates of degree completion by assistantships. The chi-squared result for the Cox test of equality is 66.81, rejecting the null hypothesis of equality of the three curves. The curves show that students with an assistantship have hazard functions that increase with time for a longer period; the dip in the function that occurs at later semesters is diminished. Students with research assistantships have the highest likelihood of degree completion until after the fifteenth semester, when the hazard function of students with teaching assistantships bypasses them.

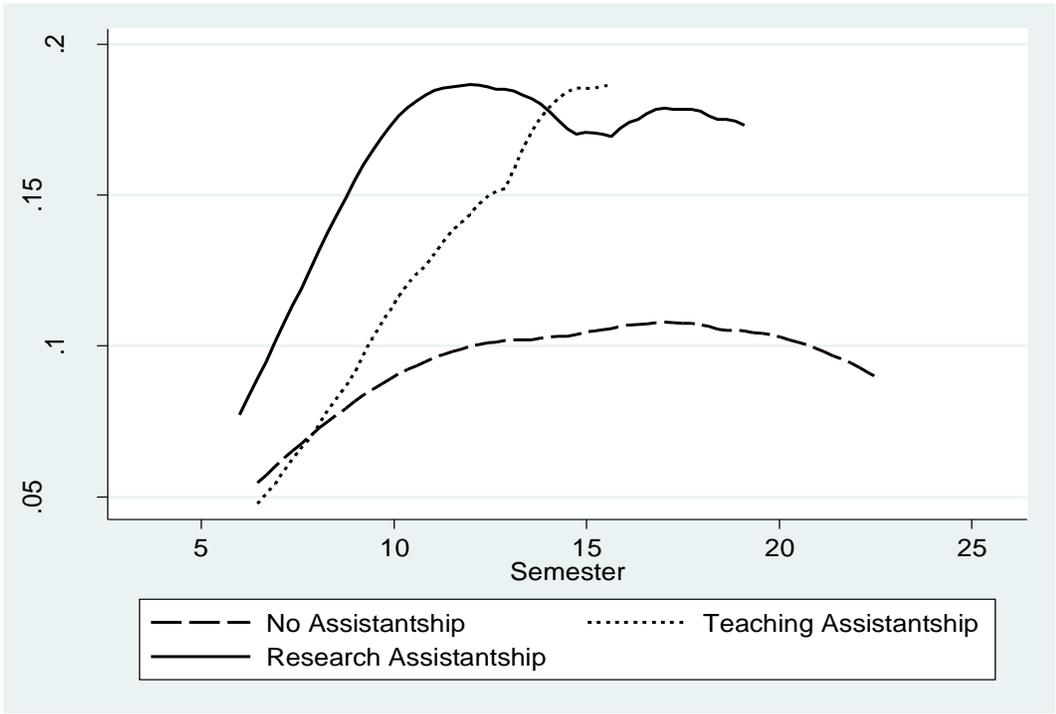


Figure 12. Smoothed Hazard Estimates of Degree Completion by Assistantships

This section used bivariate analyses to compare the effect of various categorical variables on the hazard functions of degree completion. The next will report results from the multivariate analyses, Cox proportional regressions, with all the explanatory variables.

### **Proportional hazards regressions.**

This section reports two sets of regression results on the three events. The first set of estimations covers the full sample for the events. The risk set for each of these estimations consists of the 2068 students in the analytical sample and all of the semesters they were enrolled until they dropped out or attained the event. The next set of estimation results examines the effects of the independent variables at the three stages of doctoral education. Students enter the risk set for a subsequent stage when they complete the previous stage. The risk set for each set of estimation varies and the risk periods included in the estimation are the semesters in which a student was enrolled at the particular stage.

### ***Proportional hazards results for event attainment.***

Table 8 displays the results of the proportional hazard regressions for persisting beyond the eighteenth credit hour, attaining candidacy, and completing the degree. The results show that gender does not affect the likelihood of attaining any events. A one-year increase in the age of the student decreases his or her hazard rate of persisting after 18 credits by 1.8%, attaining candidacy by 2.3%, and degree completion by 2.6%. Being an international student increases the hazard rate of persisting after 18 credits by 65.8% and attaining candidacy by 67.2%; it also makes the student 1.5 times more likely to complete the doctoral degree.

Table 8

## Results of Proportional Hazards Model for Event Attainment

Event	Persistence after 18 credits		Candidacy		Graduation	
Variable	Hazard Ratio	Standard Error	Hazard Ratio	Standard Error	Hazard Ratio	Standard Error
<i>Student Characteristics</i>						
Female	0.915	0.070	1.029	0.073	1.086	0.077
Age	0.982***	0.005	0.977***	0.005	0.974***	0.005
International student	1.658***	0.213	1.672***	0.195	2.442***	0.269
Asian student	0.851	0.110	0.765**	0.088	0.760**	0.083
Minority student	1.151	0.127	0.767**	0.081	0.849	0.089
Academic ability-good	1.030	0.098	1.178	0.108	1.146	0.106
Academic ability-average	0.985	0.106	1.128	0.112	1.066	0.106
Academic ability-below average	0.756**	0.089	1.079	0.110	1.038	0.106
Previous master degree	0.848**	0.067	0.858**	0.060	0.960	0.066
<i>Enrollment Information</i>						
Semester GPA	3.426***	0.168	1.000***	0.000	1.000***	0.000
Part-time	0.680***	0.057	1.406***	0.113	2.983***	0.315
<i>Labor Market information</i>						
Unemployment rate	1.113***	0.040	1.056**	0.024	1.059***	0.021
New assistant professor salary (log)	0.491	0.233	0.843	0.384	3.565***	1.647
Earnings (log)	0.473	0.255	2.272**	0.926	2.764**	1.107

Table 8 Continued

Event	Persistence after 18 credits		Candidacy		Graduation	
Variable	Hazard Ratio	Standard Error	Hazard Ratio	Standard Error	Hazard Ratio	Standard Error
<i>Financial Aid information</i>						
Research assistantship	2.139***	0.247	1.741***	0.169	1.694***	0.174
Teaching assistantship	1.753***	0.209	1.316**	0.149	1.123	0.150
Cumulative loan (log)	1.102***	0.036	0.959***	0.013	0.997	0.011
Grant (log)	0.982	0.012	1.071***	0.013	0.979	0.012
Loan (log)	0.930**	0.034	1.023	0.018	0.971	0.016
<i>Department Information</i>						
Doctoral students per faculty member	0.973***	0.009	0.977**	0.010	0.985	0.011
Faculty turnover	0.997	0.002	0.998	0.002	1.000	0.002
<i>College (Engineering)</i>						
Education	0.594**	0.156	1.929***	0.400	2.449***	0.501
Physical and Mathematical Sciences	0.978	0.205	0.642***	0.106	1.346	0.215
Agriculture and Life Sciences	0.701	0.165	1.314	0.231	1.922***	0.330
Veterinary Medicine	0.698	0.225	1.666	0.448	1.177	0.346
Humanities and Social Sciences/Management	0.845	0.249	0.882	0.161	0.936	0.162
Natural Resources/Textiles/Design	0.591**	0.148	0.969	0.201	1.736***	0.341
Note: Significance *** p<0.01, ** p<0.05						

The race of a student does not affect change his or her hazard rate of persisting after 18 credits. However, Asian and Minority students are less likely to attain candidacy, and Asian students are less likely to complete the degree. Academic ability has no significant effects on the hazard rates of the three events, except for students with below-average academic ability, who are 25% less likely to persist beyond 18 credits. Having earned a previous master's degree reduces the hazard rate of persisting and attaining candidacy but has no significant effect on the likelihood of degree completion. A 0.01-point increase in the semester GPA, however, increases the likelihood of persisting by 2.4%. Students with part-time status in risk periods are 32% less likely to persist beyond the 18 credits but 40% more likely to attain candidacy and 1.9 times more likely to complete the degree.

Higher unemployment rates in the student's field increases his or her hazard rates of attaining the three events. Expected earnings in terms of assistant professor salaries do not change the hazard rates of persisting after 18 credits or attaining candidacy. However, it does increase the likelihood of degree completion. Increases in forgone earnings do not affect the hazard rates of persistence after 18 credits but increase the likelihood of attaining candidacy and degree completion.

Students with research assistantships have a higher likelihood of persisting after 18 credits; they are 74% more likely to attain candidacy and 69% more likely to complete their degree over students with no assistantships. Teaching assistantships increase the likelihood of persisting after 18 credits by 75% and attaining candidacy by 32%. There is, however, no statistically significant difference between students with teaching

assistantships and those with none for the hazard rates of degree completion. Grants increase students' likelihood of attaining candidacy but have no significant effect on the other two events. Loans reduce the likelihood of persisting after 18 credits but have no effects on attaining candidacy or degree completion. Total loans accumulated during the doctoral program increase the likelihood of persisting after 18 credits, reduce the likelihood of attaining candidacy, and have no significant effect on graduation.

Faculty turnover has no significant effects on the likelihood of attaining any events. The more doctoral students per faculty member in a department reduces the likelihood of persisting after 18 credits and attaining candidacy but has no significant effect on degree completion. Students in the College of Education, Natural Resources, Textiles, and Design are less likely to persist after 18 credits than students in the College of Engineering. Previous research studies have shown that students in Engineering have higher completion rates and thus the College of Engineering is used as the omitted category (Bowen & Rudenstine, 1992). The other colleges have no statistically significant difference in their hazard rates in comparison to the students in the College of Engineering. Students in the College of Education are 93% more likely to attain candidacy and 1.5 times more likely to complete their degree than students in the College of Engineering. Students in the College of Physical and Mathematical Sciences are 36% less likely to attain candidacy than their counterparts in the College of Engineering. Students in the College of Agricultural and Life Sciences, Natural Resources, Textiles, and Design are more likely to complete their degrees than students in the College of Engineering.

***Proportional hazards results for the stages of doctoral education.***

Table 9 presents the results for the proportional hazard regressions of the three stages of doctoral education: transition stage, development stage, and research stage. The results for the transition stage are the same as those of persisting beyond the eighteenth credit hour, since the risk set or the risk periods do not change despite the reclassification. The results are re-presented to allow for ease in comparing the stages. The results show that gender has no effect on the likelihood of completing any stage. Age has a negative effect on completing the transition and development stages but not on the research stage. International students have a 66% increased likelihood of completing the transition stage, 56% increased likelihood of completing the development stage, and 68% increased likelihood of completing the transition stage.

The only statistically significant race result occurs in the development stage, where Minority students are 25% less likely to complete the stage. Students with below average academic ability are 25% less likely to complete the transition stage; however, the other categories of academic ability are not significantly different from each other in completing the stages. Semester GPA has significant effects in the completion of the transition stage and development stage, albeit a lower marginal effect, but no significant effects on the completion of the research stage. Students with part-time status are less likely to complete the transition stage, but more likely to complete the development stage and research stage.

Table 9

## Results of Proportional Hazards for the Stages of Doctoral Education

Stage	Transition Stage		Development Stage		Research Stage	
Variable	Hazard Ratio	Standard Error	Hazard Ratio	Standard Error	Hazard Ratio	Standard Error
<i>Student Characteristics</i>						
Female	0.915	0.070	1.039	0.075	0.986	0.072
Age	0.982***	0.005	0.978***	0.005	0.989	0.006
International student	1.658***	0.213	1.562***	0.188	1.683***	0.194
Asian	0.851	0.110	0.799	0.095	0.841	0.095
Minority student	1.151	0.127	0.752***	0.081	0.947	0.107
Academic ability-good	1.030	0.098	1.156	0.108	0.980	0.095
Academic ability-average	0.985	0.106	1.126	0.114	0.899	0.093
Academic ability-below average	0.756**	0.089	1.078	0.111	0.949	0.100
Previous master degree	0.848**	0.067	0.865**	0.061	1.055	0.074
<i>Enrollment Information</i>						
Semester GPA	3.426***	0.168	1.000***	0.000	1.000	0.000
Part-time	0.680***	0.057	1.425***	0.117	2.298***	0.261
<i>Labor Market information</i>						
Unemployment rate	1.113***	0.040	1.064***	0.025	1.037	0.022
New assistant professor salary (log)	0.491	0.233	0.834	0.389	6.573***	3.097
Earnings (log)	0.473	0.255	2.351**	0.973	1.950	0.823

Table 9 Continued

Stage Variable	Transition Stage		Development Stage		Research Stage	
	Hazard Ratio	Standard Error	Hazard Ratio	Standard Error	Hazard Ratio	Standard Error
<i>Financial Aid information</i>						
Research assistantship	2.139***	0.247	1.758***	0.174	1.285**	0.133
Teaching assistantship	1.753***	0.209	1.297**	0.151	1.034	0.139
Cumulative loan (log)	1.102***	0.036	0.959***	0.013	1.012	0.011
Grant (log)	0.982	0.012	1.071***	0.013	0.938***	0.012
Loan (log)	0.930**	0.034	1.024	0.018	0.965**	0.017
<i>Department Information</i>						
Doctoral students per faculty member	0.973***	0.009	0.983	0.010	1.014	0.021
Faculty turnover	0.997	0.002	0.997	0.002	1.001	0.002
<i>College (Engineering)</i>						
Education	0.594**	0.156	1.952***	0.412	2.274***	0.474
Physical and Mathematical Sciences	0.978	0.205	0.620***	0.105	1.986***	0.327
Agriculture and Life Sciences	0.701	0.165	1.333	0.239	1.713***	0.304
Veterinary Medicine	0.698	0.225	1.533	0.418	0.703	0.194
Humanities and Social Sciences/Management	0.845	0.249	0.908	0.167	0.882	0.159
Natural Resources/Textiles/Design	0.591**	0.148	0.931	0.198	1.893***	0.378
Significance *** p<0.01, ** p<0.05						

Higher unemployment rates in a student's field increases his or her hazard rate of completing the transition stage and the development stage. Increases in assistant professor salary increase the likelihood of completing the research stage, and increases in forgone earnings increase the likelihood of completing the development stage

Students with research assistantships have a higher likelihood of completing all three stages, whereas students with teaching assistantships have a higher likelihood of completing the transition and development stages but not the research stage. Grants increase students' likelihood of completing the development stage but reduce the likelihood of completing the research stage. Total loans accumulated during the doctoral program increase the likelihood of completing the transition stage but reduce the likelihood of completing the development stage, whereas the loans taken in a semester reduce the likelihood of completing the transition and research stages.

Faculty turnover has no significant effects on the likelihood of completing any stage, but the ratio of doctoral students to faculty members in a department reduces the likelihood of completing the transition stage. Students in the College of Education, Natural Resources, Textiles, and Design are less likely to complete the transition stage than students in the College of Engineering. Students in the College of Education are more likely to complete the transition stage, while students in the College of Physical and Mathematical Sciences are less likely to complete the development stage over their counterparts in the College of Engineering. Students in the College of Education, Physical

and Mathematical Sciences, Agricultural and Life Sciences, Natural Resources, Textiles, and Design are more likely to complete the research stage than the College of Engineering.

### **Chapter Summary**

This chapter presented the descriptive and inferential results carried out in the analyses of this dissertation research. The results show that students with research assistantships are more likely to complete the three stages of doctoral education. Minority students are less likely to attain candidacy or complete the degree. Students who enroll part-time are less likely to be retained beyond 18 credits but more likely to attain candidacy and complete the degree. The next chapter will discuss these results in the context of the explanatory variables and the research questions.

## **Discussion**

The purpose of this study was to establish a comprehensive economic model for discussing and examining doctoral student retention. The study examines the effects of assistantships and labor market conditions on the doctoral students' retention at the different stages of doctoral education. The following research questions were the focus of this study:

1. What are the effects of labor market conditions and financial aid packages on the retention of doctoral students beyond 18 credits?
2. What are the effects of labor market conditions and financial aid packages on the advancement to candidacy of doctoral students?
3. What are the effects of labor market conditions and financial aid packages on the completion of a doctoral degree?

This chapter will discuss the results of this study with respect to the study's purpose and the research questions posed. The chapter is divided into two main parts. The first part discusses the effects of the control variables used in the estimation of doctoral student retention. The second part focuses the effects of financial aid and labor market conditions and answers the research questions.

## **Control Variables**

### **Student characteristics**

The bivariate results showed that the hazard rates of females are lower than those of males, but the multivariate analyses show no significant differences in the hazard rates for females. This is consistent with the studies in the literature that show a gender gap in degree completion (Bowen & Rudenstine, 1992; Stiles 2003) when using bivariate measures. Studies that have used multivariate analyses show similar results to this study in that there are no gender differences in degree completion once assistantships and the field of study are controlled (Ehrenberg & Mavros, 1995; Nerad & Cerny, 1993). This implies that females are as likely to be retained at the institution as males, but the observed gender differences in degree completion emanate from the assistantships received and the field of study chosen. For assistantships, the difference implies that females are more likely to receive either teaching assistantships or no assistantships, which reduces their degree completion. The results may also imply that females are more likely to enroll in fields of study that have lower degree completion rates.

The student's age at entry significantly affects all three stages of the doctoral education process. Older students are less likely to persist, attain candidacy, or complete the degree. Stiles (2003) found no significant effects of age on persistence in the earlier years of doctoral study but significant negative effects in the later years. This study found that the effect is significant only at the transition and development stages and has no

significant effect at the research stage. Thus, the difference in age is more critical earlier in a student's career and has no significant impact on degree completion.

International students are more likely to be retained and to complete their doctoral programs. Most studies of doctoral degree retention have found this result (Bowen & Rudenstine, 1992; Ehrenberg & Mavros, 1995; Stiles, 2003). There has been some speculation in the literature as to why international students appear to be graduating at higher rates than U.S. students. These reasons include policies such as visa requirements, international students' better preparation, and/or the social isolation faced by the students (Aslanbeigui & Montecinos, 1998; Stiles, 2003). International students are also required to maintain continuous full-time enrollments at their institution thus reducing stop-outs.

The effect of race on doctoral retention showed interesting results. First, because the race variable was not exclusive to U.S. citizens, the bivariate analysis showed higher hazard rates for Asian students—they were more likely to complete the degree. However, since 90% of the Asians in the sample were international students, the positive effects of being Asian disappeared in the multivariate analysis. For Asian U.S. citizens, their likelihood of attaining candidacy and completing the degree was significantly lower than that of White students. However, they did not differ from White students with respect to the stages of doctoral education. This implies that once the Asian U.S. citizen enters a stage, he or she is as likely to complete the stage as a White student. However, considered cumulatively, they are less likely to attain candidacy and graduate than the White students.

Most research studies on doctoral retention have had low numbers of minority students and have not included the variable in their estimations. Stiles (2003) in his study of education students at one institution did show that minority students were less likely to complete their degrees. This study shows that Minority students have similar hazard functions to White students early in the program, but these changes further into the program. The multivariate analyses reveal that the main difference occurs at the development stage and attainment of candidacy. This implies that Minority students are not different from White students during the transition stage in their doctoral programs, and once they attain candidacy, they are as likely to graduate.

The observed differences in White and Minority students in degree completion are occurring mainly at the development stage, where the students are expected to develop a research agenda. Research studies on minority students in doctoral programs show that these students experience isolation, marginalization, and an inability to have effective interactions with program faculty (Ellis, 2001; Gay, 2004; Jaeger, Levin, Haley, Ampaw, & Cox, 2009). Morelon-Quainoo et al (2009)'s study showed that doctoral students of color believe that developing a collegial relationship with their faculty contributes to success in their work. Anderson (1990) also found that for STEM minority students, the curriculum becomes a source of alienation due to the lack of diverse viewpoints and perceived irrelevance to their society. Thus, the development stage, which requires students to develop interests in an area of their field to choose a dissertation topic, may

prove troublesome for minority students. If the students do find a topic, they may have further problems finding an advisor who will be willing to work with them.

The study shows that students with below-average academic ability are less likely to persist after 18 credits; however, this effect does not hold through candidacy and degree completion. This result is consistent with previous studies that show that if the estimation controls for department/field of study, then admission test scores and undergraduate GPA have no effect on degree completion (Bowen & Rudenstine, 1992; Ehrenberg & Mavros, 1992; Stiles, 2003). Semester GPA attained during the doctoral program is a significant predictor of a student is completing the transition and development stages but not the research stage. This result is not surprising, because students at the research stage enroll in dissertation research credits that do not affect their GPAs. The significant positive effect of the semester GPA is observed on the likelihood of attaining candidacy and completing the degree, though the effect is small.

Enrolling part-time has a negative effect on persistence in the early stage; however, it has a positive effect on attaining candidacy and degree completion. The positive effect of part-time status on completing the development and research stage is counter intuitive. It is contradictory to other research studies that have shown that part-time enrolment reduces the likelihood of degree completion (Bowen & Rudenstine, 1992; Seagram, Gould & Pyke, 1998). Undergraduate retention studies have also established that

part-time students are more likely to drop out of their degree programs (Bean & Metzner, 1985; Pascarella & Terenzini, 2005; O'Toole, Stratton, Wetzel, 2003).

The doctoral studies, however, treated part-time enrollment as a static variable and determined at one point in time, typically the start of the program. However, as the data for this study showed, doctoral students move in and out of part-time status every semester and part-time needs to be modeled as time varying to determine accurately its effects on retention. The results imply that for doctoral education, when the goals of completing the stage go beyond completing coursework, part-time students may be better positioned to attain the event.

Human capital perspective can also help to explain the increased likelihood of completing the degree for part-time students. Part-time students are more likely to be working full-time and thus have reduced opportunity costs of education. Thus, increases in the other costs of the education or reductions in the benefits from education do not affect them as much as full-time students for whom a loss in financial aid may be detrimental to their study. This human capital perspective also sheds light on the results of students who earn a masters' degree prior to their enrollment in the doctoral program.

Students with a previous masters' degree are less likely to persist in the first year or attain candidacy than students who enrolled in the doctoral program with a bachelor's degree. The two groups are not statistically significantly different when it comes to degree completion. This result is counter intuitive when you consider that a master degree should

enable students to adjust better to doctoral work, increasing their persistence and candidacy attainment. However, a human capital perspective provides an explanation. Students with master degrees have higher forgone earnings and more likely to be affected by changing labor market conditions. Increases in earnings will increase these forgone earnings for students with masters degrees and holding their financial aid constant will make the students more likely to drop out to pursue full time employment in the early stages of their doctoral work.

### **Department information**

The department results showed that students from the College of Education were less likely to persist after 18 credits but more likely to attain candidacy and complete the degree. There is, however, no context for this result because the other research studies on retention either do not include students from the College of Education (Bowen & Rudenstine, 1992; Ehrenberg & Mavros, 1995; Seagram, Gould, & Pyke, 1998) or focus solely on education students (Stiles, 2003). Students in the College of Engineering have been shown to have the best degree completion rates (Bowen & Rudenstine, 1992; De Valero, 2001). This study shows that students in the College of Agricultural and Life Sciences, Natural Resources, Textiles, and Design are more likely to complete their degrees than students in the College of Engineering.

Analyses by Bowen and Rudenstine (1992) found that smaller departments have higher rates of degree completion. This study shows that the large departments (as

measured by doctoral students per faculty member) reduce the likelihood of persisting after 18 credits and attaining candidacy. They had no significant effect on degree completion, however.

### **Research Variables**

The section will discuss the research variables for the study to answer the following research questions:

1. What are the effects of labor market conditions and financial aid on the retention of doctoral students beyond 18 credits?
2. What are the effects of labor market conditions and financial aid on the advancement to candidacy of doctoral students?
3. What are the effects of labor market conditions and financial aid on the completion of a doctoral degree?

The two sets of research variables are financial aid and labor market conditions. Financial aid was determined by assistantships, grants, and loans; labor market conditions by unemployment rate, expected earnings, and forgone earnings. The effects of these variables are discussed below.

#### **Financial aid**

Financial resources have consistently been shown to be an important factor affecting doctoral degree completion (Abedi & Benkin, 1987; Baird, 1997; Bowen & Rudenstine, 1992; Ehrenberg & Mavros, 1995; Tuckman, Coyle, & Bae, 1990). The

research has established that students who receive financial assistance in the form of assistantships are more likely to complete their degrees than students who rely on their own resources. Most of this research has treated all types of financial assistance as the same and as having similar effects. Bowen and Rudenstine (1992) bivariate analyses showed that completion rates tend to be higher for students with teaching assistantships than for students with fellowships, at least in the humanities and social sciences. Ehrenberg and Mavros (1995) showed that students with teaching assistantships or support from other sources (loans and personal support) are less likely to complete a degree than students with fellowships and research assistantships.

The results from this study are consistent with these findings but also include the effects of assistantships across the different stages of doctoral education. Students with research assistantships are more likely to complete each stage of doctoral education than students with any other type of financial support. Students with teaching assistantships, on the other hand, are more likely to persist after 18 credits and attain candidacy than are students with other support. Students with teaching assistantships are no different, however, than students who have other forms of support with respect to the likelihood of completing a degree.

Grants increase a student's likelihood of completing the development stage and attaining candidacy, but they have no significant effects on the other stages or events. The effects of loans on doctoral student retention have not been explored within the literature

except when grouped with other forms of support. This study shows that loans have an effect on increasing persistence after 18 credits but no significant effects afterward. Accumulated graduate school loans reduced the likelihood of attaining candidacy but had no effects on degree completion.

### **Labor market conditions**

Breneman (1976) developed an economic model of degree completion. He theorized that improvement in labor market conditions should increase degree completion. Research on doctoral student retention has for the most part ignored this theory. Ehrenberg and Mavros (1995) included in their estimations academic salaries and the proportion of new doctorates in the field seeking academic employment nationally, but they found little significance for these variables. This study shows that labor market conditions do affect retention and doctoral degree completion. Higher unemployment rates increase the likelihood of attaining all the events within doctoral education. Faced with the higher likelihood of unemployment, students will remain in doctoral programs. Assistant professors' salaries have no effect early in a program, but significantly increase completion of the research stage and the degree. This is in line with human capital theory, in that higher expected benefits will motivate students and increase their likelihood of degree completion.

The results of forgone earnings, though, are counter indicative to human capital theory. The increase in these opportunity costs increases the likelihood of candidacy

attainment and degree completion. The expectation from the theory is that increases in opportunity costs increases the costs of education for doctoral students and will lead students to seek employment and drop out of the program. Increases in foregone earnings implies an increase in opportunity costs and should increase attrition and reduce the likelihood of candidacy.

### **Chapter Summary**

This chapter showed that labor market conditions are an important factor affecting doctoral student retention. Higher assistant professor salaries motivate doctoral students in the later part of their program to complete their degrees, yet high unemployment rates will keep doctoral students in school. The study also found that though 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.

## **Conclusions and Implications**

The study used longitudinal data of doctoral students who enrolled at a public land grant institution between the academic years 1994/95 and 1998/1999 to establish a comprehensive model for discussing and examining doctoral student retention and graduation. The research examined the effects of demographic factors, financial aid, and labor market conditions on doctoral student retention at the different stages of doctoral education. Tinto's three stages of doctoral education: transition, development, and research, framed the study. During the transition stage, doctoral students first enter the program, take classes, and adjust to their new roles. After this adjustment period, students enter the development stage, where they select an advisor, choose a dissertation topic, and present a proposal for research. This stage ends when the student attains candidacy. In the final, research stage, students carry out their research and write their dissertations.

This research study shows that demographic factors such as age and citizenship status have similar effects on doctoral student retention across all three stages. The impact of other factors such as race and part-time enrollment depend on the doctoral student's stage of education. Financial aid and labor market conditions have differential impacts on retention, and among all financial aid types, students with research assistantships have the highest likelihood of completing the degree.

## **Implications for Practice and Policy**

The results presented a comprehensive look at financial aid packages and their effects on doctoral student retention. Although the importance of assistantships has been identified in previous studies (Baird, 1997; Bowen & Rudenstine, 1992; Ehrenberg & Mavros, 1995; Tuckman, Coyle, & Bae, 1990), the data for the study showed that on average only 40% of doctoral students received a teaching or a research assistantship. The third year of the study period had the highest percentage of students with assistantships. Only 60% of the students still enrolled had an assistantship during this year. The percentage of enrolled doctoral students receiving assistantships reduced gradually after this year, despite the high attrition of students enrolled each year. This implies that students were less likely to receive assistantships later on in a program. This phenomenon is in line with the results of the study, since the effects of assistantships were higher in the transition and development stage. However, research assistantships still had a large and significant effect on degree completion during the research stage. This suggests that departments, colleges, and universities to improve their graduate degree completion can use research assistantships. Teaching assistantships, however, had no effect on completion rates during the research stage. This suggests that as tools to aid in persistence, teaching assistantships should be awarded to students who are in the transition and/or development stages. If teaching assistantships must be awarded during the research stage, a program can duplicate those working conditions of research assistantships shown by this study to

have a positive effect on degree completion (for example, students working closely with faculty members or assigning classes that fit the student's research interests).

Although a gender gap exists in doctoral degree completion (Bowen & Rudenstine, 1992), this study shows that gender is not a significant predictor of doctoral retention. Lower degree completion rates for females may be stemming from gender differences in the other variables in the model. This implies that females have lower access to research assistantships, may be more likely to attend part-time during the transition stage, or enrolling in colleges with lower degree completion rates. Practices aimed at closing the gender gap should focus on increasing the access of females to these variables. One such practice could entail increasing the number of research assistantships available to females. Another practice change could entail designing support for females that would enable them enroll full-time during the transition stage.

The study also showed that Minority students are more likely to drop out during the development stage of their doctoral education. At the development stage, students are expected to choose an advisor, select a topic, and write a proposal. To be successful during this period, students have to be well integrated in their department/field of study. According to Baird (1997), sustained relationships with faculty are critical to a student's successful integration to a program and a department culture. Minority students are not different from their White counterparts during the transition stage, when students adjust and take classes. They are also similar to other students during the research stage, when

students work with one advisor to complete their research. Taken together, these facts imply that minority students are not getting integrated into their departments and may be having trouble selecting a dissertation topic and/or an advisor who matches their interest. In order to increase the degree completion rates of minority students, programs might have to find ways to better integrate minority students and provide support that will help them achieve the goals of this stage.

Gasman et al. (2009) suggests ways institutions can improve minority students' success in STEM fields that can be applied to students in all fields. The first is providing a support system that brings minority doctoral students together to build a supportive community for each other. Developing an inclusive curriculum and improving the learning experience for minority students is the next recommendation. Gasman et al. see an inclusive curriculum as one, which is "diverse, relevant, and engaging" (p. 71) The curriculum also eliminates "gatekeeping" courses meant to weed out students early in the program. These courses band students together into workgroups, which is usually the only way to pass the courses. The unintended consequence is that alienates students of color who are "excluded from these groups because of their perceived inferior academic ability" (p. 70).

Part-time enrolment reduces persistence during the transition stage but increases both candidacy attainment during the development stage and degree completion during the research stage. Graduate schools and individual programs should consider residency

requirements during the transition stage, which could reduce the early attrition rates and increase degree completion rates. Programs can then relax requirements for students who wish to enroll part-time over the development and research stage. Policy makers should also consider allowing students to enroll part-time but be considered full-time during the research stage for the purpose of receiving financial aid and insurance benefits.

### **Implications for Theory**

The model that resulted from the research is the study's main contribution to theory. The framework for this study was derived from Tinto's (1993) longitudinal model of doctoral retention. This study confirms the applicability of Tinto's longitudinal model of doctoral persistence and shows that any discussion of doctoral student retention and degree completion should take place within a longitudinal context. The varying effects of factors on the three stages of doctoral education imply that a model of doctoral retention should include the multiple degree requirements that create different stages of the process.

The study also incorporated human capital theory (Becker, 1964) into the framework to explain the labor market's effect on doctoral student retention. Human capital plays a role in the retention of doctoral students and needs to be sufficiently modeled. For example, the differential impact of the type of assistantships and grants on doctoral retention shows that the effects of assistantships exceed those relating to subsidizing the direct costs of education. Labor market conditions also have a direct impact on doctoral student retention and should be included in the model. This implies

that the human capital perspective is an important aspect to be considered when discussing retention of students especially doctoral students.

The revised model based on this study for doctoral student retention is a theoretical implication for the study. Figure 13 presents this revised framework for doctoral student retention. Gender and academic ability are not present in the framework since the study showed no significant effects on doctoral retention and degree completion beyond its effects on other variables showed no significant effects from these variables on doctoral retention. Two types of factors affect doctoral retention: time invariant demographic characteristics and time-varying enrollment, financial, department, and labor market variables.

The time invariant measures that have an effect on doctoral retention are the age of the student, their race, citizenship status, and whether they held a master's degree prior to enrolment. These variables have time-varying effect on the three stages of doctoral education; a prior master's degree affects the first two stages but not the final stage. The financial aid variables of types of assistantships, loans, and grants also have stage-varying effect on the three stages of doctoral education. These results show that the variables that affect doctoral education have varying influences on the stages of doctoral education. Doctoral retention theories should be examined longitudinally and in stages as the multiple requirements for the degree suggest.

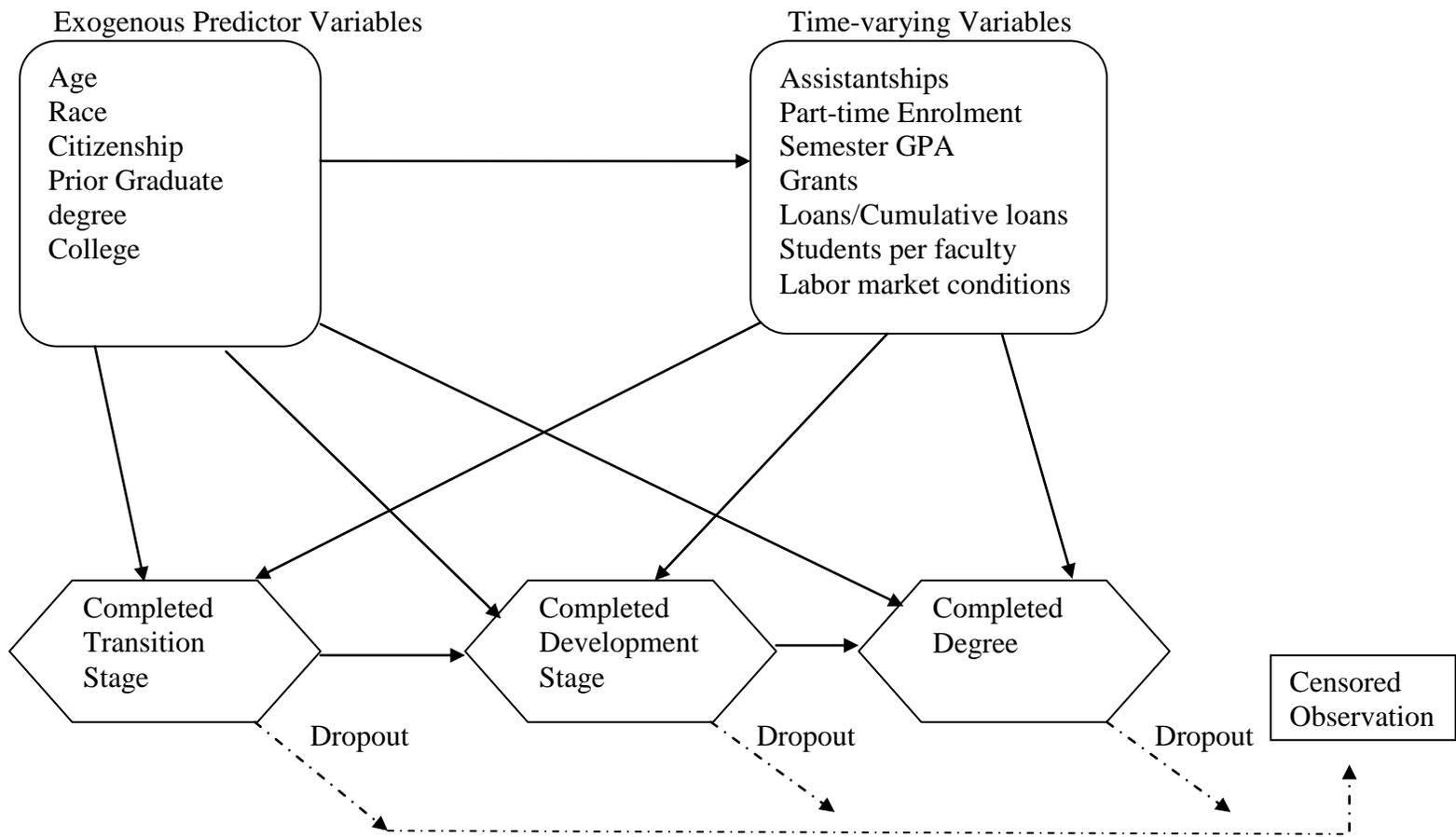


Figure 13: Revised Model of Doctoral Student retention

## **Implications for Research**

Although this study answered the research questions, it also raised other questions that will be examined in future studies. First, new research studies should examine the limitations of the dataset in this study to ensure a more comprehensive model of doctoral student retention. The main limitation of this study was the exclusion of several important variables that were not available in the data set and thus to the researcher. One such variable not addressed in this data set relates to the student-advisor relationship. This relationship has been shown in previous studies to affect doctoral degree completion (Lovitts, 2001; Nyquist, 2002; Stolzenberg, 2006). The student-advisor relationship has implications for retention at the development stage as a student develops a research topic and agenda. It is especially important during the research stage as successful completion of a dissertation is determined by the working relationship a student develops with a dissertation chair. The previous studies have not examined the effect over the stages of doctoral education. Future research could examine how the student-advisor relationship affects persistence across the stages.

Another limitation of the study was the use of doctoral students enrolled at one institution. Although the institution had varied fields, it was still dominated by Science, Engineering, and Mathematical doctoral programs. The use of national data set with multiple institutions will allow the model to be tested across different institutional types and include more fields of doctoral study. Multiple institutions will also allow the effect of institutional policies on doctoral retention to be determined.

Several questions, not related to data limitations, arose from the study that future research could examine. Enrolling part-time during the development and research stages had a positive effect on doctoral students' retention. This counterintuitive result needs to be explored further to determine why part-time enrollment might make it more likely that a student will attain candidacy and complete the degree.

Another result that needs to be explored further is the reduced likelihood for Minority students to complete the development stage. Although some studies have researched the minority graduate student experience in academia (Ellis, 2001; Gay, 2004; Jaeger, Levin, Haley, Ampaw & Cox, 2009), these studies do not explore specifically the doctoral student experience at the developmental stage of a degree. Future studies need to focus on how minority doctoral students are integrated within departments and what influence their race has on selecting a dissertation advisor and topic, two key elements of the development stage.

Future research studies will also explore how doctoral students are integrated into a department as well as how department policies influence the retention of doctoral students. Departmental and student factors need to interact so that researchers can determine the role of the department in doctoral student retention. Future studies could use a hierarchical linear model to ascertain how students, departments, and the interactions between them affect doctoral student retention.

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## **APPENDIX**

## **APPENDIX A: DATA USAGE AGREEMENT**

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### **DATA USE AGREEMENT**

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Data on five cohorts of doctoral students who first enrolled in a doctoral degree program at North Carolina State University for the academic years 1994/95 to the year 1998/99 is sought from the University Planning and Analysis Office. This data will be used to study the retention of doctoral students for my dissertation work. Statistical analysis will be performed on the data and results disseminated from the study will be aggregate statistical measures. A breakdown of the data requested is detailed below:

#### **STUDENT BACKGROUND INFORMATION**

Gender, race, age, citizenship

#### **ADMISSION INFORMATION**

Undergraduate institution, undergraduate GPA, undergraduate major, masters institution (if applicable) GRE/GMAT or other similar test scores, year graduated from institutions

#### **ENROLLMENT INFORMATION**

Credit hours enrolled every semester, GPA, date of graduation, data attained candidacy, final degree obtained

#### **FINANCIAL INFORMATION**

Assistantships (type, stipend amount), grants, fellowships, graduate student support plan, other external/internal scholarships, loans if any (type and amount)

#### **DEPARTMENT INFORMATION**

Department, Field of Study, number of doctoral, masters and undergraduate students in department, number of faculty (broken down by type i.e. tenure track assistant professors, etc)

I will work with the University Planning and Analysis Office to make sure the data released will not contain individual identifiable information. The confidentiality and security of the data will be maintained at all times and the data will not be disclosed to any third party. The data files will be stored by the principal investigator (PI) in drives that will be encrypted with a 64-bit password known only to the PI. At the end of the research project, this data will be destroyed.



(typed/printed name) (signature) (date)

As the faculty sponsor, my signature testifies that I have reviewed this application thoroughly and will oversee the research in its entirety. I hereby acknowledge my role as the **principal investigator of record**.

**Faculty Sponsor:**

\_\_\_\_\_\*\_\_\_\_\_  
(typed/printed name) (signature) (date)

**\*Electronic submissions to the IRB are considered signed via an electronic signature**

PLEASE COMPLETE AND DELIVER TO:  
[joe\\_rabiega@ncsu.edu](mailto:joe_rabiega@ncsu.edu) or Institutional Review Board, Box 7514, NCSU Campus  
(Administrative Services III, Room 245)

\*\*\*\*\*  
\*\*\*\*\*

*For SPARCS office use only*

**Regulatory Compliance Office Disposition**

Exemption Granted

Not Exempt, Submit a full protocol

Exempt Under:  b.1

b.2

b.3

b.4

b.6

\_\_\_\_\_  
IRB Office Representative

\_\_\_\_\_  
Date

**Project Description:** *(Describe your project by providing a brief summary and answering the requests for information below).*

1. Project Summary. Please make sure to include the purpose and rationale for your study as well as all study activities:

*The purpose of this study is to establish a comprehensive economic model for discussing and examining doctoral student retention. The conceptual framework of this study will include factors that will take into account changes in the students' lifetime earnings, forgone earnings and the direct costs. These conditions will be estimated for different stages of graduate education to determine the economic factors that are important for retention at each stage. The study will examine the effect of demographic and department information, financial aid packages and labor market conditions on retention of students at the different stages of doctoral education and on the time to degree for doctoral students.*

*Statistical analysis will be performed on the data and results disseminated from the study will only be aggregate statistical measures. Results will not be disseminated for any aggregate that contains less than 5 percent of the sample*

2. Description of participant population, including age range, inclusion/exclusion criteria, and any vulnerable populations that will be targeted for enrollment.

*Doctoral students who enrolled at North Carolina State University between the academic years of 1994/95 and 1998/1999*

3. Description of how potential participants will be approached about the research, and how informed consent will be obtained. Alternatively, provide an explanation of why informed consent will not be obtained.

*The data will be obtained from the University Planning and Analysis office and the Bureau of Labor Statistics*

4. Description of how identifying information will be recorded and associated with data (e.g. code numbers used that are linked via a master list to subjects' names). Alternatively, provide details on how study data will be collected and stored anonymously ("anonymously" means that there is no link whatsoever between participant identities and data).

*The University Planning and Analysis Office will strip the data of identifying information i.e. the name, social security number/PID number and addresses of the students. The master list will be only available to the University Planning and Analysis Office and a new code will be created for each student with the sole purpose of linking different data files together. The data files will be stored by the*

*principal investigator (PI) in drives that will be encrypted with a 64-bit password known only by the PI.*

5. Description of all study procedures, including topics that will be discussed in interviews and/or survey instruments.

*The data to be obtained from the University Planning and Analysis Office will include information on doctoral students from their enrollment and transcript records, demographic information and financial records*

6. Will minors (participants under the age of 18) be recruited for this study:  
No
7. Is this study funded? No If yes, please provide the grant proposal or any other supporting documents.
8. Is this study receiving federal funding? No
9. Do you have a significant financial interest or other conflict of interest in the sponsor of this project? N/A
10. Does your current conflicts of interest management plan include this relationship and is it being properly followed? N/A

**11. HUMAN SUBJECT ETHICS TRAINING**

\*Please consider taking the [Collaborative Institutional Training Initiative](#) (CITI), a free, comprehensive ethics training program for researchers conducting research with human subjects. Just click on the underlined link.

**12. ADDITIONAL INFORMATION:**

- a) If a questionnaire, survey or interview instrument is to be used, attach a copy to this proposal.
- b) Attach a copy of the informed consent form to this proposal.
- c) Please provide any additional materials (i.e., recruitment materials) that may aid the IRB in making its decision.

*\*If a survey instrument or other documents such as a consent form that will be used in the study are available, attach them to this request. If informed consent is not necessary, an information or fact sheet should be considered in order to provide subjects with information about the study. The informed consent form template on the IRB website could be modified into an information or fact sheet.*

**The Following are categories the IRB office uses to determine if your project qualifies for exemption** (a review of the categories below may provide guidance about what sort of information is necessary for the IRB office to verify that your research is exempt):

**Exemption Category:** (Choose only one of the following that specifically matches the characteristics of your study that make this project exempt)

- 1. Research conducted in established or commonly accepted educational settings, involving normal educational practices, such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.
  
- 2. Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.  
**\*Please Note- this exemption for research involving survey or interview procedures or observations of public behavior does not apply to research conducted with minors, except for research that involves observation of public behavior when the investigator(s) do not participate in the activities being observed.**
  
- 3. Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) require(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.

- 4. Research, involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available, or if the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects.
  
- 5. Not applicable
  
- 6. Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed, or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the Food and Drug Administration, or approved by the Environmental Protection Agency, or the Food Safety and Inspection Service of the U.S. Department of Agriculture.

**NC STATE UNIVERSITY**

Sponsored Programs and

Regulatory Compliance

Campus Box 7514

2701 Sullivan Drive

Raleigh, NC 27695-7514

919.515.7200

919.515.7721 (fax)

From: Joseph Rabiega, IRB Coordinator  
North Carolina State University  
Institutional Review Board

Date: December 19, 2008

Project Title: The effect of labor market conditions and financial aid packages on doctoral student retention

IRB#: 653-08-12

Dear Frim:

The research proposal named above has received administrative review and has been approved as exempt from the policy as outlined in the Code of Federal Regulations (Exemption: 46.101.b.4). Provided that the only participation of the subjects is as described in the proposal narrative, this project is exempt from further review.

NOTE:

1. This committee complies with requirements found in Title 45 part 46 of The Code of Federal Regulations. For NCSU projects, the Assurance Number is: FWA00003429.
2. Any changes to the research must be submitted and approved by the IRB prior to implementation.
3. If any unanticipated problems occur, they must be reported to the IRB office within 5 business days.

Sincerely,