ABSTRACT

Title of dissertation: AN ANALYSIS OF INSTITUTIONAL CHARACTERISTICS THAT CONTRIBUTE TO EXTENDED TIME TO DOCTORAL DEGREE

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Many factors—individual, departmental and institutional—have been associated with longer time to degree and progress toward degree completion. Lengthy time to degree affects the availability of resources, advising, persistence, and degree completion. This research identified institutional characteristics that impacted extended time to degree, relative to discipline, in doctoral programs. The data were drawn from three years of Survey of Earned Doctorates (SED) data—2004, 2005, and 2006—and the National Research Council's (NRC) 2010 *A Data-based Assessment of Research-Doctorate Programs in the United States*. The sample included 18,545 student records representing 58 different fields. Extended time to doctoral degree was defined as completion equal to or greater than one standard deviation beyond the Mean, relative to discipline. The study employed descriptive statistics, Hierarchical linear models, and Analysis of Variance models to test nested student and field data against targeted independent variables in each of nine categories: socio-demographic factors, student qualities and time to degree factors, discipline and institution factors, financial support factors, support and training factors, process and procedure factors, program environment factors, research environment factors, and selectivity factors.

Key findings include writing the dissertation as a critical point for reform in doctoral programs to reduce time to degree for early, average and extended completers. Relationships between diverse students, diverse faculty, and the research environment impact time to degree differently for early, average, and extended completers, which requires additional research. Child dependents increased time to degree for all completers, and primary source of support had mixed effects for early, average, and extended completers. Five recommendations for institutional interventions and additional research were developed based on the study findings: develop programs to support timely (dissertation) writing, conduct additional research on diversity and extended time to degree, develop programs for graduate student parents, reorganize doctoral student financial support mechanisms, and establish program-level review of time to degree. The recommendations are aimed at improving the culture and climate of doctoral education for all graduate students.

AN ANALYSIS OF INSTITUTIONAL CHARACTERISTICS THAT CONTRIBUTE TO EXTENDED TIME TO DOCTORAL DEGREE

by

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LIST OF DEFINITIONS

Average time to degree
The Mean time required to complete the doctorate, calculated for this research from SED data overall and by discipline.

Early time to degree
Elapsed time to degree which is equal to or less than one standard deviation below the Mean, calculated for this research from SED data relative to discipline.

Elapsed time to degree
The total amount of time required to complete the doctoral degree from the first term of enrollment until the award of the degree.

Extended time to degree
Elapsed time to degree which is equal to or greater than one standard deviation beyond the Mean, calculated for this research from SED data relative to discipline.

Median time to degree
The point at which 50% of students have graduated, calculated for this research from SED data overall and by discipline.

Registered time to degree
The total amount of time required to complete the doctoral degree counted only by the number of terms registered.

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CHAPTER ONE

Introduction

Yale University awarded America’s first three earned Doctor of Philosophy (Ph.D.) degrees in 1861, more than 200 years after the founding of the first U.S. college. In the nearly 150 years since Yale awarded those Ph.D. degrees, American colleges and universities have awarded thousands of doctoral degrees in numerous disciplines. More than 49,010 Ph.D. degrees were awarded in 2011 by U.S. institutions, down from a high of 49,552 in 2009 (National Science Foundation (NSF), 2010; NSF, 2012). The number and diversity of disciplines that award the Ph.D. has expanded at both institutional and national levels. For instance, Yale University now boasts 45 different doctoral programs from which a combined total of 370 Ph.D. degrees were awarded in the 2011-2012 academic year (Yale University, 2013a; Yale University, 2013b), and the 2011 edition of the Survey of Earned Doctorates classifies 302 different disciplines in which doctorates are awarded. As Bent (1962) eloquently states, “the range of subjects covered by work for the Doctor’s degree encompasses the entire field of human knowledge” (p. 14). Widely recognized as the hallmark of American higher education, 412 U.S. institutions granted the Ph.D. degree in 2010-2011 (NSF, 2012). It is evident from the numbers that the pursuit and granting of Ph.D. degrees has become a complex and expansive enterprise.

The approach followed by Yale for the programs completed in 1861, and by many Ph.D. programs today, stems from a Germanic model. That model emphasized ideas of research and freedom in academic inquiry in their curriculum (Altbach, 2001). Future scholars engage in a combination of core and disciplinary coursework, comprehensive examinations, and extensive original research from which they write a dissertation (Stewart et al., 2005). The rigorous scale and scope of the curriculum and the writing of the dissertation distinguishes the Ph.D. as a research doctorate and differentiates it from other levels of academic work.

The undergraduate curriculum forms the academic foundation by exploring an introduction to multiple disciplines. The master's student focuses on a broad survey of knowledge in one discipline. The doctoral candidate explores a specialty within a discipline. Where undergraduate degrees are dominated by coursework, a defining trait of a doctoral program is expertise achieved through original research. The original research becomes the student's first significant contribution to the discipline, whether it fills a gap in knowledge, presents and synthesizes new data, argues for the application of new techniques, or represents a new and different way of thinking about the problem. To adapt a phrase attributed to British scientist Thomas Henry Huxley (1825-1895) and quoted by Mencken (1925), the distinction is that the undergraduate student must try to learn "something about everything [while the Ph.D. student must learn] everything about something." By the time they graduate, Ph.D. recipients are expected to be experts in their area of specialization, the result of a narrow focus and rigorous study in a discipline.

While the overall design and purpose of a Ph.D. may have remained relatively stable, the characteristics of doctoral programs have changed considerably over the last 150 years. Therefore, it is not surprising that time to degree has changed as well. The 7.7 year median time to degree across all fields in 2011 (NSF, 2012) dwarfs the time taken by Yale's original Ph.D. recipients, who all began their course of study in 1859 and graduated in 1861 (Rosenberg, 1961). What is surprising is a historical and ongoing disconnect between reality and the preferred and/or professed time to doctoral degree. Ziolkowski (1990) explains that in the decades after Johns Hopkins University was founded in 1876, three years for award of the doctorate was the standard, both conceptually and practically. By 1916, the Association of American Universities (AAU) had proposed three years as the ideal length for doctoral study (Ziolkowski, 1990). This ideal time to degree of three to four years was reiterated in a 1964 joint statement by the Association of Graduate Schools (AGS) and the Council of Graduate Schools (CGS) (Ziolkowski, 1990).

Described in greater detail in the next section, the conceptual notion of a shorter time to degree made a lasting impression on doctoral education. It set a context that influences institutional norms and requirements for time to degree today, regardless of institutional context, resources, discipline, or student characteristics. Yet each of these individual, institutional and environmental characteristics influence whether a student finishes the Ph.D. at all, and for those who do finish, the amount of time it takes to complete the degree. One could argue that there are advantages or disadvantages to every rate of completion: early, average, or extended. As researchers, we should not assume that faster completion is better. Moving too quickly through the doctoral program may deny the student access or adequate exposure to the research, teaching, and other scholarly opportunities that are essential to the doctoral degree. Moving too slowly through the doctoral program may intensify or exaggerate problems with the availability of resources, advising, persistence and ultimately, degree completion.

Scholars who study doctoral education have found many individual factors that influence time to degree such as gender and race (Abedi & Benkin, 1987; Nettles, 1990a; Nettles, 1990b), financial support (Bowen & Rudenstine, 1992; Ehrenberg & Mavros, 1995), having children (Maher, Ford, & Thompson, 2004; Mason & Goulden, 2004), personal motivation (Kearns, Gardiner, & Marshall, 2008; Lovitts, 2005), and relationship with one's adviser (Baird, 1995; Bargar & Mayo-Chamberlain, 1983; Golde, 2000; Lovitts, 2008, Nettles & Millett, 2006). Research has also revealed the characteristics of individuals and their contexts most likely to facilitate a shorter time to degree (Berg & Ferber, 1983; Lovitts, 2005; Seagram, Gould, & Pyke, 1998). Little research has considered the factors that most impact time to degree for those who graduate last. The absence of comprehensive information regarding the factors that impact lengthy time to degree is a problem, and one which I address throughout the pages of this dissertation. In addition, given that institutions have a vested interest in helping students achieve timely degree completion, it is important to understand the institutional factors, those most under their control, that impact time to degree for extended completers. Therefore, the purpose of this dissertation is to identify probable characteristics of institutions that are likely to contribute to the phenomenon of extended time to doctoral degree (ETTD) for the graduates who take the longest to complete the Ph.D. degree, relative to their disciplinary peers.

The Ph.D. and Time to Degree: Historical Context

The foundation for the Yale University graduate school was laid during the lengthy tenure of Yale President Theodore Dwight Woolsey, 1846-1871(Rosenberg, 1961). The Sheffield Scientific School evolved in 1854 from a Department of Philosophy and the Arts, which focused primarily on undergraduate curriculum. The faculty formalized criteria for an earned Doctor of Philosophy degree in 1860. The formalization of an earned degree moved doctoral education away from honorary doctorates, which had been conferred by many of the colonial colleges since 1642 (Brubacher & Rudy, 1997).

The course of study set forth by Yale for the earned doctorate required students to engage in the study of several fields and produce a research thesis (Bent, 1962). Bent (1962) asserts that the differences between the intent of the first doctoral programs and those of present-day are superficial. Both require disciplinary study, demonstrated expertise, and a contribution to the discipline through the writing of the dissertation. The first three Ph.D. recipients followed these exact steps.

Although men were the first to receive the earned Ph.D., women quickly pushed for admission into doctoral programs (Rossiter, 1982). Institutions were slow to embrace the admission (and even the presence) of women in doctoral programs, however.

Beginning in 1868 and for more than two decades thereafter at some institutions, women were admitted to "special student" status and were never granted the Ph.D. It was not until 1877, when Boston University awarded its first doctorate to Helen Magill (White), that a woman received an earned doctorate in the United States (Dolan, 1972; Rossiter, 1982). A total of only 25 doctorates were awarded to women before 1890, when a handful of major institutions finally started to grant women official admission. Over the next decade, 1890-1900, women earned 204 doctorates compared to 2,372 earned by men (Rossiter, 1982).

The challenges experienced by Blacks seeking higher education in the United States and the growth of Black colleges and universities are well documented. The first baccalaureate degrees granted to a Black man and woman were awarded respectively in 1823 and 1862; the latter a year after Yale awarded the first Ph.D. degree (Journal of Blacks in Higher Education (JBHE), 2006). The first doctorate awarded to a Black man was granted by Yale University to Edward Bouchet in 1876, a year before Helen Magill received her doctorate at Boston University. The first Black women did not receive their doctorates until 1921, 45 years later, with the granting of doctorates by Radcliffe College to Eva Dykes, the University of Pennsylvania to Sadie Alexander, and the University of Chicago to Georgiana Simpson (Cowan & Maguire, 1995; JBHE, 2006). The conditions of access to higher education for Blacks were contentious for decades, with courts ordering institutions to admit Black students, armed protests, and riots throughout the 1950's and 1960's. In spite of onerous obstacles, many Black students found ways to achieve. The first Black doctorates in geology (1943), chemical engineering (1944), metallurgy (1950), and astronomy (1961) were awarded during these academically turbulent times (JBHE, 2006).

By the early years of the 1960's, a dialogue emerged within the graduate education community regarding the length of doctoral programs for all students. At that time, little had been done to refute the 'three years as the ideal length for doctoral study' notion which had been proposed by the AAU in 1916, even though in reality, time to degree was double or triple the time proposed by the AAU. In an essay criticizing graduate education of the day, Berelson (1962) observed that "the norm proposed [for doctoral study] is usually three to four years, and on this point almost everyone seems to agree" (p. 54). Berelson (1962) argued that if only enrolled time to degree were evaluated, as opposed to total time to degree which includes time when the student was on leave or not enrolled, then for many students, median time to degree was in fact three to four years. However, when total time to degree was evaluated, median time to degree was actually eight years in arts and science fields and 12 years in professional fields (Berelson, 1962).

The distinction between registered and total, or elapsed, time to degree is important because it changes how we evaluate the length of the program. This dissertation studies the phenomenon of extended time to degree in terms of total time to degree for two reasons:

1. A thorough, multi-institution evaluation of extended time to degree in terms of registered time to degree—including information regarding the full-time, part-time, or even stop-out status of the student—would require access to complete, student-level registration data which is not available in an existing data source at this time. Using complete data from a single university or selected institutions, while informative, would not provide the complete picture of extended time to degree across the United States.
2. Students take leaves of absence and fail to register for an infinite number of reasons. While registration is required at most institutions in order to access university resources, e.g. faculty, the library, or laboratories, one could argue that it is impossible to say with certainty that no work or progress was made by students on the dissertation and/or degree during periods of non-registration.

Therefore, this dissertation evaluates extended time to degree in terms of total time to degree in order to capture the full period of time required to complete the degree requirements and graduate.

Pressey (1962) concurred with Berelson (1962) that three to four years is the desired norm for the length of doctoral programs, but then introduced an acknowledgement by a committee of graduate school deans that reality often requires at least four years and as many as 10-15 years to complete the degree. Pressey (1962) hypothesized that efforts to shorten the length of doctoral programs would be met with resistance by graduate programs and institutions fearing a loss of academic standing. Arlt

(1963) introduced the argument that time to degree could be shortened if students were well-supported, both financially and academically, such as those funded under Title IV of the National Defense Education Act (NDEA). He argued that with financial support and significant mentoring from the faculty characteristic of degree programs for NDEA students, the doctorate could be completed after three calendar years of intensive work.

By the late 1980's, Abedi and Benkin (1987) noted that the time it takes to complete the doctoral degree was still a 'hot topic' in graduate education, yet little empirical research had addressed the factors associated with time to degree. Their study sought to identify factors that affected time to degree in doctoral programs at a single institution. Using data from University of California, Los Angeles, they used multiple regression techniques to determine which academic, financial, and demographic variables had the greatest effect on mean time to degree (Abedi & Benkin, 1987). Consistent with Arlt's (1963) argument, they found that while many variables impact time to degree, adequate financial support had the most direct impact on the rate of progress and eventual degree completion.

Two years later, Tuckman, Coyle, and Bae (1989) studied the lengthening of time to degree specifically, and noted that the upward climb in median time degree observed in the 1970's and 1980's did not show signs of stopping. They offered six explanations for why time to degree has increased: epistemic, institutional, student preference-based, financial need-based, demographic and ability-based, and market-based (Tuckman, Coyle, & Bae, 1989). They concluded that the 20% increase in total length of doctoral program observed from 1967-1986 would soon become the top policy issue in graduate education if better information about the causes were not identified. As we now know, and as will be discussed in the next section, their prediction was correct: The increasing trend in median time to degree did not subside. Since then, several studies have been done with larger databases to understand factors that contribute to completion rates for doctoral students and time to degree (Bowen & Rudenstine, 1992; Nettles & Millett, 2006). More extensive discussion of these studies is integrated into the subsequent section of this chapter and into Chapter Two. Briefly, what these and other studies highlight is that the length of time to degree impacts the use of resources (individual, faculty, and institutional), the mentoring and advising load of the faculty, the timeliness and relevance of the research conducted by the student, and the likelihood that the student will actually persist and complete the degree (Bowen & Rudenstine, 1992; Berg & Ferber, 1983; Lovitts, 2008; Nettles & Millett, 2006).

The historical context of the Ph.D. and time to degree demonstrates that since 1861, significant changes have occurred in the population of doctoral students and the length of time it takes to complete the Ph.D. Just as significant are the changes that have occurred across the disciplines themselves (Bent, 1962). An explosion of knowledge has contributed to the emergence of elective and specialization courses within doctoral programs, from which we have seen disciplines split into sub-disciplines, which have split into specializations, which have pioneered sub-specializations (Bent, 1962; Blackburn & Conrad, 1986; Isaac, Quinlan, & Walker, 1992). That explosion of knowledge means there is simply more for a Ph.D. candidate to learn, which makes discipline a factor that undoubtedly accounts for some, but not all, of the lengthening of time to degree observed over the past 150 years.

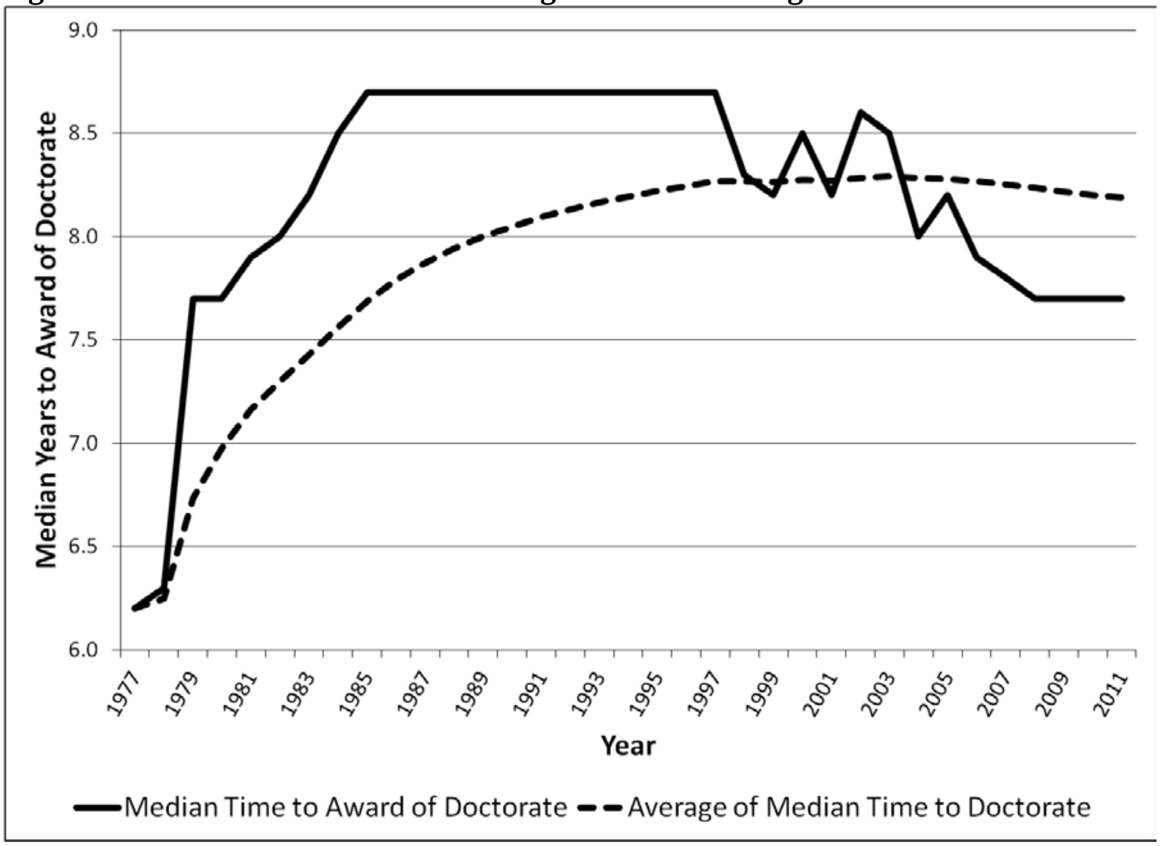
Norms and Shifts in Median Time to Degree and Completion

The individual and institutional investments of time and resources into a single doctoral student's academic career do not amount to much if it takes the student what may seem like an eternity to finish the dissertation and graduate. As recent as 2005, when median time to degree across all disciplines was 8.2 years (Hoffer et al., 2006), the Council of Graduate Schools acknowledged that it can take five to six years to complete the Ph.D. (Stewart, et al., 2005).The disconnect between published statements and the data continues to highlight the need for definitive new standards or guidelines for what the time to doctoral degree should be. Muszynski and Akamatsu (1991) assert that current policy standards for 'maximum time permitted' are in fact the outset of degree completion and that the 'maximum' is closer to the 'norm'.

More than three decades of data from the Survey of Earned Doctorates (SED) appear to support Muszynski and Akamatsu's (1991) claim. According to the student-reported SED data for all disciplines, median time to degree since first enrolling in graduate school has exceeded 8.0 years for 24 of the past 35 years (Hoffer et al., 2001; Hoffer et al., 2002; Hoffer et al., 2003; Hoffer et al., 2004; Hoffer et al., 2005; Hoffer et al., 2006; Hoffer, Hess, Welch & Williams, 2007; NSF, 2009; NSF, 2010; NSF, 2011; NSF, 2012; Sanderson & Dugoni, 1999; Sanderson, Dugoni, Hoffer, & Myers, 2000;

Sanderson, Dugoni, Hoffer, & Selfa, 1999). As illustrated in Figure 1, after a low of 6.2 years in 1977, median time to degree increased annually until it reached 8.7 years, where it remained constant for 13 years, 1985 and 1997. Since 1997, the trend in median time to degree across all disciplines showed annual fluctuations, but still remained at or above 8.0 years for eight consecutive years until 2006 when it finally dropped below the eight year mark. It is only in the six most recent years for which we have SED data, 2006-2011, that we observe a steady decline in time to degree from 7.9 to 7.7 years. It is too early to determine if the decline observed from 2006-2011 is the start of a short-term or long-term downward trend, but it is promising.

Figure 1: Median Time to Doctorate Degree from Entering Graduate School



Sources: Hoffer et al., 2001; Hoffer et al., 2002; Hoffer et al., 2003; Hoffer et al., 2004; Hoffer et al., 2005; Hoffer et al., 2006; Hoffer et al., 2007; NSF, 2009; NSF, 2010; NSF 2011; NSF 2012; Sanderson & Dugoni, 1999; Sanderson et al., 1999; Sanderson et al., 2000

Another way to see the overall pattern of median time to degree is to impose a trend line which depicts the average of the annual data during the period 1977-2011. The dashed line on Figure 1 thus shows both the rise in median time to degree over the past three decades and the point in 1994 where that average exceeded and remained above the 8-year mark. While both lines in Figure 1 articulate important information about annual and the average of median time to degree, neither provides insight regarding the time to degree statistics for the Ph.D. graduates who took the longest to finish the degree, the institutional characteristics and environment experienced by the student, or the factors that contributed to their longer time to degree.

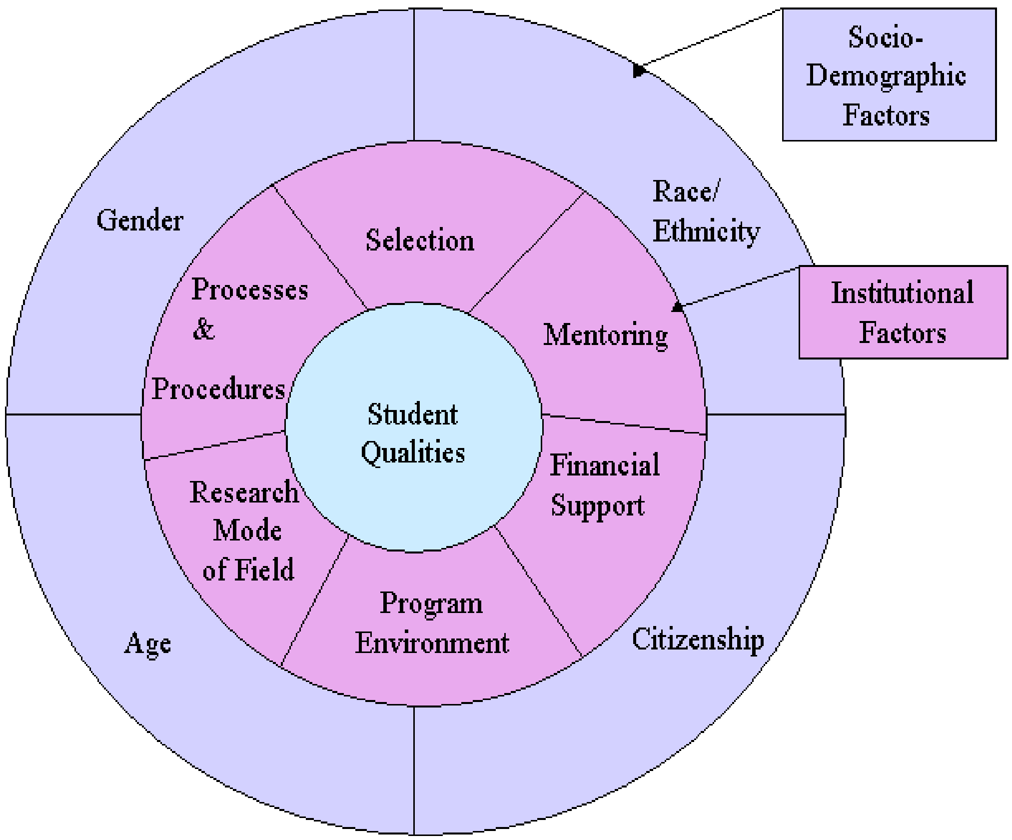
The study of time to degree among doctoral students has been explored at several levels, but as Nelson (2001) points out, firm data regarding the overall increase in time to degree during the past three decades is elusive. Frequently studied in connection with research on program completion, the relationship between program completion and time to degree is complex. At the most basic level, any analysis of time to degree requires that students are retained by the institution, persist to complete the program, and graduate. Bowen and Rudenstine's (1992) study of these topics, which focused on six fields at ten universities, set a standard upon which much of the subsequent program completion and time to degree research is modeled. Their study highlights two components of time to degree research: 1) that only 50 percent of students who enroll in a doctoral program will complete the degree; and consistent with the discussion above, 2) the three- to four-year desired duration for the Ph.D. does not reconcile with the six- to ten-year reality observed at most institutions (Bowen & Rudenstine, 1992). More recent data from the Council of Graduate Schools' Ph.D. Completion Project (2007) estimates the completion rate is closer to 57 percent, but that is only marginally higher than the Bowen and Rudenstine (1992) data. Nettles and Millett (2006) address both completion and time to degree, with results indicating that a more optimistic 62 percent of their survey respondents completed the doctoral degree. Regardless of the statistics behind extended time to degree, none of the major studies on doctoral education have explored influencing factors for the Ph.D.

recipients who take the longest to complete the degree relative to their disciplinary peers. The next section provides a conceptual framework to study this group.

Factors that Influence Time to Degree: A Conceptual Framework

Many factors—individual, departmental and institutional—have been associated with longer time to degree (Isaac et al., 1992; Lovitts, 2008; Nettles & Millett, 2006), and progress toward degree completion (Girves & Wemmerus, 1988; Maher et al., 2004; Rodwell & Neumann, 2008). The theoretical framework for this study is influenced by a model developed by the Council of Graduate Schools (2004) in preparation for their own research project on factors associated with Ph.D. completion and attrition (not time to degree). Researchers at Council of Graduate Schools developed a three-ringed model, Figure 2, to characterize and categorize the internal and external factors of Ph.D. completion (CGS, 2004). From the outside to the inside of the CGS model, the three rings are socio-demographic factors, institutional factors, and student qualities. Each ring of the kaleidoscope represents a different layer and potential degree of impact of the student, for the student, and on the student. In the context of this study, the kaleidoscope framework is used with a non-Hierarchical approach to organize existing research on organizational behavior, graduate student socialization, graduate student persistence, and doctoral completion and attrition.

Figure 2: The Ph.D. Completion-Attrition Kaleidoscope



Source: CGS, 2004, p. 12

Previous research has established that individual student qualities and socio-demographic factors influence doctoral retention, attrition, and time to degree (Abedi & Benkin, 1987; Golde, 2000; Lovitts, 2001; Seagram et al., 1998). Likewise, individual characteristics have been found to interact with institutional and organizational factors (Cook & Swanson, 1978; Nettles & Millett, 2006). Factors represented by the middle ring of the kaleidoscope (and known to impact both failure to complete the Ph.D. and the lengthening of time to degree) include student financial support, faculty and mentoring relationships, peer interaction, socialization, program culture and environment, and the research and writing of the dissertation (Gardner 2008; Gardner, 2009a; Girves & Wemmerus, 1988; Isaac et al., 1992; Nettles & Millett, 2006). In the context of the research for this dissertation, the kaleidoscope model pictured above was used to help define and organize the variables for discussion and analysis. It is not the goal of this research to assert a hierarchy to either the order or directionality of the three rings, rather to use the framework notion of the three sets of characteristics—individual, institutional, and socio-demographic—which might impact extended time to degree in doctoral study. The goal is to establish the characteristics of the person within his or her environment, and to determine whether the presence or absence of certain institutional factors impacts extended time to degree. By using the theoretical framework to understand the individual and institutional factors known to impact time to degree generally, the research then focuses on and addresses how institutional factors affect extended time to degree for the students who take the longest to graduate relative to their disciplinary peers.

Factors that Influence Time to Degree: Individual Characteristics

Previous research explains the implications of and interactions between the individual, departmental and institutional characteristics of the conceptual model and kaleidoscope framework. Among the individual factors known to impact degree completion and time to degree include having a child, financial issues or household income (Maher et al., 2004), leaving campus or relocation and personal motivation (Lovitts, 2008), and even self-sabotage (Kearns et al., 2007). While this study did not explicitly study the impact of these individual characteristics on extended time to degree, it is important to understand their interaction with institutional factors.

Gender can impact time to degree. Research has shown that students had the best interactions with faculty of the same sex where there are fewer women to act as mentors (Mason & Goulden, 2002). Women in science fields have been found to experience a lack of support for their maternal choices during their doctoral studies (Berg & Ferber, 1983). Students of either sex are thus disadvantaged in fields dominated by faculty of the opposite sex, and women face the potential for further disadvantage as a result of their family planning decisions. Seagram, Gould, and Pyke (1998) found that significantly higher numbers of women were negatively impacted and experience delays toward degree progress than their male counterparts, and Bowen and Rudenstine (1992) found that time to degree for women exceed that of men across all disciplines in every cohort within their study. Although Berg and Ferber (1983) do not specifically tie sex to either mentoring or program environment and time to degree, subsequent discussion will show the critical links between these factors and degree completion. Maher, Ford, and Thompson (2004) do link the findings from their study of women's degree progress to time to degree. They found that the degree progress of women, and their rate of progress, was critically impacted by financial support, having a supportive academic adviser, research opportunities, and the status of marital problems, family dynamics, or health issues.

Having dependents and family dynamics can impact time to degree. According to Abedi and Benkin (1987), the number of dependents supported by the doctoral student, had an even greater impact on time to degree than gender. Nettles and Millett (2006) not only reached a similar conclusion about the negative impact of children on time to degree, but went so far as to declare young children the “enemy of speedy time to degree” (p. 220). Institutions are starting to recognize the need for family-friendly policies, such as maternity/paternity leave that stops the time limit clock to accommodate students with dependents (Mason & Goulden, 2004).

A student’s age can impact time to degree. For many Ph.D. students, their child-bearing and/or child-rearing years coincide precisely with the period of enrollment in the doctoral program inextricably linking time to degree to yet another socio-demographic characteristic: age. Unlike having dependents, which is almost universally demonstrated to slow the rate of degree progress, age can work for or against time to degree. Pressey (1962) found that students who complete the degree at a younger age and with faster time to degree were more likely to reap better professional rewards and acknowledgement for their academic achievements through disciplinary society presidencies and chairmanships. Nettles and Millett (2006) found that older students in their sample exhibited faster time to degree, but acknowledged that their findings were in direct contradiction to research by Tuckman, Coyle and Bae (1990).

Citizenship status can impact time to degree. International citizenship interacts with time to degree in a unique way compared to the other student qualities and socio-demographic characteristics. Unlike U.S. domestic students and permanent residents, international students must demonstrate ability to pay for each year of their academic program at a U.S. institution, they must obtain the proper time-limited visas, and they must maintain continuous enrollment to be in compliance with guidelines enacted in the post-9/11 era. Both Nettles and Millett (2006) and Abedi and Benkin (1987) found that international students had faster time to degree than their U.S. domestic peers. The Council of Graduate Schools' Ph.D. Completion Project findings concur that international students finished the degree in fewer years, but not necessarily at a higher rate overall (Denecke, Frasier, & Redd, 2009).

Race and/or ethnicity can impact time to degree. Findings for underrepresented domestic minority students are less positive. Already marginalized by a history of segregation, many underrepresented minorities are still struggling to achieve equal access and opportunity in higher education. More than three decades ago, Hartnett and Katz (1977) argued that graduate education opportunities for minorities were still not equal to those afforded to students in the racial/ethnic majority and that many students were missing out on important components of doctoral training. Even if access is achieved, persistence is still an issue for many minority students. In 1988, one decade after Hartnett and Katz's (1977) work, minority students—Blacks, Hispanics, and Asians—accounted for only 11.9 percent of awarded doctorates (Bowen & Rudenstine, 1992). In more recent terms, Chen and DesJardins (2010) found that minority students experienced higher rates of unmet need at the undergraduate level with regard to federal financial aid which resulted in higher drop-out rates than their White peers, thereby eliminating the possibility that they would ever attend graduate school let alone persist to degree completion. At the graduate level, Nettles and Millett (2006) found that the tendency for underrepresented minorities to have lower GRE scores and undergraduate GPAs makes them less competitive for the best research assistantships and mentoring assignments in doctoral programs. The resulting effect of such a scenario is that underrepresented minority students lose the research opportunities known to positively impact time to degree, as will be discussed later.

The literature on the academic persistence of minority students indicates that multiple factors influence the likelihood of degree completion including family support and home environment, difficulty knowing when to seek and in seeking help, social support within the institutional and academic environment, faculty and staff interactions, socio-cultural pressures, the perception of racism in the environment, and the stability of both mentoring and program support (Jackson, Smith, & Hill, 2003; Palmer, Davis, & Hilton, 2009). Identification of factors known to affect academic persistence of minority students is only one piece of the degree completion puzzle. Equally critical, and consistently observed throughout the literature, is the assertion that the advising dialog at higher education institutions needs to be expanded to address issues of “loneliness, negative peer pressure, and the risks of acculturation and bicultural identity—especially racism” (Jackson, Smith, & Hill, 2003, p. 561). Reason (2009) notes that if the organizational structures and responses implemented by an institution to meet these challenges are systematically implemented, such as, the placement of undergraduate students in graduate schools, then the benefits to students and the likelihood of persistence increases. The more thorough discussion found in Chapter Two addresses issues of access and persistence for minority students in terms of time to degree and degree completion.

Factors that Influence Time to Degree: Institutional and Program Factors

The theoretical framework for this study is guided by literature on organizational behavior in higher education and extant research on graduate student socialization, retention and success. The underlying framework for understanding the interaction between doctoral students and their institutions is drawn from research on how time to degree is influenced by institutions and graduate programs in relation to the six factors identified in the institutional ring of the Ph.D. kaleidoscope: selection, mentoring, financial support, program environment, research mode of the field, and process and procedures. I discuss each in turn, briefly.

Program environment and disciplinary socialization can impact time to degree. Bolman and Deal (1997) assert that human organizations are “exciting and challenging places” marked by complexity, surprises, deception and ambiguity (p. 22). Higher education institutions are certainly complex, surprising and ambiguous organizations. To many looking “in” from the outside, institutions are perhaps a bit deceptive as well. U.S. colleges and universities operate in a manner unlike most businesses or government entities. Although structures vary, institutions are often guided by shared governance between professional administrators and the academic faculty. The balancing act required to effectively manage a college or university is a reflection, as Birnbaum (1988) argues, of the strength and consistency of an institution's structure, rules and goals. Stated simplistically, the institution's core function and effectiveness is heavily impacted by the multiple and competing interests of the administration, the faculty who are there for teaching and research but are protected by the benefits of the tenure system and academic freedom, and the students who have come to learn. Additional stakeholders, such as alumni, legislative bodies that fund public institutions, different government agencies or entities at all levels, and the various industries served by the institution, are similarly invested in the success of the institution. Any and all of these stakeholders, as well as those not identified here, could be expected to bring pressure to bear if their interests are not being adequately met. The environment of constraints which ensues creates an atmosphere wrought with challenges of centralized vs. decentralized control, bureaucracy vs. autonomy, and power vs. policy (Birnbaum, 1988; Morgan, 1997; Senge, 1990). The premise of much of the research on the organizational behavior of higher education institutions is that the functioning of these organizations matters to student success and time to degree. Extended time to degree will be impacted by the characteristics of the student's institutional environment and his or her interactions within that environment.

The sphere of the institution includes the characteristics of the discipline and graduate program or department. Time to degree differs greatly both within and across institutions by broad field or discipline (Bowen & Rudenstine, 1992; NSF, 2009). Golde

(2005) found that the effects of discipline and department are inextricably linked together in how the doctoral student interprets his or her “fit” with the graduate program. Furthermore, there are critical links between academic integration through faculty mentoring, discussed later, and socialization to the program environment for the doctoral student to feel comfortable as a member of the academic community (Golde, 2000). The department is the local embodiment of the discipline where individuals are socialized into academic norms and expectations. The customs or norms of the discipline might be attributed to the college within the institution and/or the broader field beyond the institutional boundaries. Research demonstrates that integration into the culture and norms of the department are critical components for retention, persistence, completion and time to degree of doctoral students (Ferrer de Valero, 2001; Gardner, 2009a; Girves & Wemmerus, 1988; Golde, 2000). These nuances and differences do not negate or contradict the value of institution-level analysis of characteristics that impact extended time to degree, but they make the case to disaggregate the analysis to the program level (Golde, 2005). Golde’s (2005) argument for disaggregation of the analysis by department in order to highlight differing impact of institutional policies, practices and characteristics is consistent with both the conceptual and theoretical models for this research.

Selection and fit can impact time to degree. Susan Gardner’s (2009a) recent finding that high completion rates in doctoral programs are one result of high selectivity at admission provides the foundation for the next piece of the theoretical framework. While one might expect characteristics such as high intelligence, ambition, self-direction, or high grades and test scores to be adequate predictors of success, Gardner (2009a) argues that these traits represent natural talent—which is external to the program—and should not comprise the sole basis of the admission decision. In fact, Nettles and Millett (2006) found that students with high verbal scores on the Graduate Record Examination (GRE) actually took longer to complete the Ph.D., and Lovitts (2001) found that neither grade point average (GPA) nor GRE score significantly impacted program completion. Another important factor from the admissions arena which impacts degree completion is admission to and attendance at the student's first choice of doctoral program (Nettles & Millett, 2006). The literature emphasizes the importance of selection and "fit" between students and faculty, research and expectations, as the most important criteria in the graduate admissions process (Lovitts, 2001; Nelson & Lovitts, 2001; Nettles & Millett, 2006).

The existence and quality of a mentoring relationship can impact time to degree. An extensive body of literature links mentoring, the third factor from the institutional ring of the Ph.D. kaleidoscope, to doctoral degree completion. According to Baird (1995), the role of the doctoral mentor includes "providing career advice and an understanding of the role to which the protégé aspires, as well as promoting sponsorship, visibility, and collaboration" (p. 30). Mentoring of doctoral students is not merely chairing the dissertation committee. The doctoral mentor is a critical contributor to the student's socialization within the department and the discipline. Gardner (2008) argues that the mentor helps the student develop his or her academic identity, integrates the student into the culture of the discipline, and helps the student gain independence as a researcher. Even the extent to which a faculty member is connected to or engaged in disciplinary societies can impact a student's sense of connection (Gardner & Barnes, 2007). Nettles and Millett (2006) found that having a mentor made a small, yet significant, impact on degree completion in engineering, social sciences and education, but more important for the purpose of this research, it shortened time to degree in the humanities and social sciences. Lovitts (2008) found that having an adviser from whom the doctoral student could seek and take advice was a common characteristic among distinguished completers. Furthermore, the student's perception of his or her faculty mentor's interest in their work, and other characteristics such as care and encouragement, are attributed to degree completion overall and better time to degree (Ferrer de Valero, 2001; Golde, 2000; Lovitts, 2001).

Financial support, and particularly the research assistantship, has been found to impact doctoral degree completion and time to degree. In their single institution study, Ehrenberg and Mavros (1995) observed completion rates and mean time to degree were affected by different types of student financial support. In much larger studies, Bowen and Rudenstine (1992) and Nettles and Millett (2006) found that money has a high degree of impact and clearly matters with regard to doctoral degree completion. For their part, Bowen and Rudenstine (1992) found that having financial support was more important than the type or form of financial support, and that for students using their own resources, attrition and long time to degree were more common than among their supported peers.

For their part, Nettles and Millett (2006) noted that for many doctoral students, support is literally cobbled together from many sources, not just a single fellowship or traineeship. They also found that students with support exhibited greater research productivity, better connections with a mentor, and more complete academic integration, all of which lead to retention and improved time to degree.

Exposure to and integration and assimilation to the research mode of the field can impact time to degree. The ability to conduct independent research is an important hallmark of the Ph.D. degree. Research is conducted differently within and between disciplines, and doctoral students must learn how to navigate and conform to those scholarly standards. Lovitts (2008) found that success in the coursework phase of the doctoral program was not an automatic indicator of success in the research phase. While she discusses systematic differences between those who have great success, marginal success, and total failure in the research phase, her outcomes are tied to completion, not time to degree. Isaac, Quinlan, and Walker (1992) discuss the observed increase in time to degree across all disciplines in terms of increased complexity within the field of research, higher volume of material that must be learned, the student's independent contribution to research, and even the increased numbers of students pursuing doctoral degrees. They also note that the writing of the dissertation itself may be a factor impacting the increase in time to degree. The responsibility of researching and writing a book-length dissertation at the beginning of one's academic career, as opposed, perhaps, to publishing several smaller articles in a respected disciplinary journal weighs heavily on many Ph.D. candidates as an onerous and insurmountable task (Spriestersbach & Henry, 1978). Nerad and Cerny (1991) likewise found that degree completion and time to degree were impacted by the intricacies and disciplinary complexities of the dissertation. Perhaps most significant among recent research, Nettles and Millett (2006) found that higher levels of research productivity increased the likelihood of degree completion across all fields. Students who presented papers at conferences or published were more likely to complete the degree (Nettles & Millett, 2006).

Navigating the requirements of the degree can impact time to degree. Golde and Dore (2001) link degree progress to the timing of academic process, such as the qualifying exam, and the manner in which those processes are used to move the student toward degree completion. Rodwell and Neumann (2008) argue that degree progress and labeling of time to degree as ‘timely’ or ‘untimely’ must also take into consideration the processes of the graduate program and the approach taken by the student, for instance full-time vs. part-time enrollment. Nerad and Cerny (1991) recommend progress evaluations as a mechanism to keep the student engaged in the department and to promote degree progress and eventually, completion. Bowen and Rudenstine (1992) found that the critical transition points in the doctoral program, for instance moving from coursework to examinations to research, each represent key points at which degree progress can be derailed or prolonged. These studies demonstrate the critical role that the processes and procedures of the doctoral program play in helping or hindering students as they progress through the degree.

Factors that Influence Time to Degree for ETTD Students

While the research described above provides a foundation for and a framework in which to discuss time to degree in doctoral study, it is what is missing that is most notable. None of the aforementioned research seeks to evaluate or identify the institutional characteristics that impact extended time to degree for the students who take the longest, relative to their discipline, to complete the Ph.D. Significant progress has been made in understanding factors influencing failure to complete and factors influencing time to degree for all Ph.D. students, yet little to no research has examined the conditions for those students most at risk of not finishing—those who take the longest to finish compared to their disciplinary peers. That is not to say that lengthy time to degree has gone unnoticed. Rodwell and Neumann (2008) reference delayed completion as problematic, and Maher et al. (2004) study what they refer to as constrained degree progress or late-finishing groups among women. But research has not specifically addressed the factors most important for those most at risk. Furthermore, as Gardner (2009a) points out, the existing literature reflects the conditions at the "most prestigious and elite institutions" and thereby fails to provide the whole picture of the time to degree experience at U.S. institutions (p. 400). While research is needed at all levels (individual, program and institutional) on extended time to degree students, this study focuses on institutional factors.

Research Questions and Data

The primary research question is:

1. What institutional characteristics contribute to extended time to degree in doctoral programs with regard to:
    a. Discipline & Institutional Factors
    b. Financial Support Factors
    c. Support and Training Factors
    d. Processes & Procedures
    e. Program Environment
    f. Research Environment
    g. Selection Factors

To address these questions, this study uses several data sources. The primary dataset was provided by the National Science Foundation from the Doctorate Record File (DRF) of the Survey of Earned Doctorates (SED). This dataset is collected via institution-level administration of a nationally standardized survey and contains student-level information regarding personal characteristics, academic information about the degree and discipline, student support information, and time to degree data for annual recipients of U.S. doctorates from all institutions since 1958. This study looked at data for the SED years 2004, 2005, and 2006 in order to coincide with the collection period for the supplemental data used to identify program characteristics and factors. Supplemental data on institutional and program characteristics are taken from the National Research

Council's *A Data-based Assessment of Research-Doctorate Programs in the United States*. These data were collected in academic year 2005-06 for the assessment originally released in September 2010 and then re-released in April 2011, and contain information about program-level factors such as program size, faculty appointments, program resources and environment, and research activity of the program. By using SED data for the three-year period defined above, the analysis in this study evaluates the extended time to degree factors for students who graduated in the year immediately preceding, the year of, and the year immediately following the program environment and institutional characteristics as described during the 2005 data collection for the NRC study. The parallel between the two datasets will permit the analysis to generate profiles of the institutional characteristics that impacted extended time to degree within that specific time period.

The statistical analysis for this study is quantitative. The study uses Hierarchical linear modeling (HLM) to identify institutional factors that are likely to impact or contribute to extended time to degree for the students who take the longest to complete the doctorate and graduate, relative to their disciplinary peers. The dependent variable is extended time to degree as calculated for each discipline according to the NRC taxonomy. Independent variables, which will be discussed more thoroughly in Chapter Three, include student to faculty ratios in the doctoral program, program environment and resources, financial support for doctoral students, the availability of student training and assistantships, academic discipline, and institution type (i.e. public or private). The research controls for demographic characteristics such as age, sex, citizenship, and race/ethnicity.

Significance and Limitations

The literature on doctoral education addresses topics such as retention, attrition, persistence, and completion that offer multiple viewpoints of the doctoral experience. These studies make significant contributions to what we know about degree completion and time to degree. Furthermore, a systematic review of these resources in the next chapter not only unpacks what we know about many of the factors that impact time to degree broadly, but it also establishes the foundation for this study of factors associated with extended time to degree. The review of literature in Chapter Two exposes the absence of extensive research within the current literature on extended time to degree factors, which makes it difficult to know what causes and what can counteract the phenomenon. The goal of this research was to identify factors that institutions can influence or control in order to reduce extended time to degree, and more significantly, to fill the void in the current literature.

From a policy perspective, the research for this dissertation is both timely and relevant. First, within and across disciplines, time to degree varies as do institutional policies regarding the permitted length of doctoral programs. Although the goal of this research was not to define what constitutes acceptable time to degree, the outcomes from this study are intended to identify the institutional factors associated with extended time to degree. Access to such information will aid institutions as they review their campus policies and procedures to improve doctoral completion rates and reduce time to degree. Second, the descriptive statistics generated through the analysis of SED and NRC data provide a picture of extended time to degree in doctoral programs that is not currently available. As a result of this research, institutions, doctoral students, and researchers will be able to identify different fields and populations impacted by the phenomenon of extended time to degree and thereby make more informed decisions about timely degree completion efforts. Third, economic circumstances have challenged colleges and universities faced with budget cuts and the need to eliminate services. Deciding which services to keep and which to cut, which fees to increase and which courses or even graduate programs to eliminate, requires detailed and nuanced information particularly in light of the disciplinary variation for program completion rates and time to degree (Rodwell & Neumann, 2008).

Bair and Haworth (2004) state quite bluntly that “the longer a student spends in graduate school, the greater the chance that the student will drop out prior to completion” (p. 520). They argue that the increased time in the doctorate and likelihood of attrition underscore the need for better institutional policies and practices to decrease time to degree (Bair & Haworth, 2004). For students, the problem of extended time to degree is evidenced in a variety of ways, notably the loss of productive work years after receiving the Ph.D. degree. Furthermore, a student’s ability to productively enter the workforce upon degree completion may be affected by the relevance and/or responsiveness of the student’s research topic to current market conditions. These are policy and procedure decisions with broad academic and environmental impacts that must be informed by as many sources as possible, including which services negatively impact time to degree. The information may not save every service, but it could help to save some doctoral students from taking longer and longer to complete the Ph.D. degree.

This study had several limitations. First, the study made use of existing datasets. The analysis was conducted within the definitions and dimensions of those data. The database includes and the study controls for socio-demographic characteristics of the individual student including age, sex, citizenship, and race/ethnicity. However, the database does not include other personal information or data on Ph.D. student perceptions regarding their doctoral education, or other individual factors potentially influencing extended time to degree. Nor does the data include information regarding the full- or part-time status (or stop-out status) of the student throughout the course of their doctoral program, or faculty rank of the exact mentor(s) with whom the student worked to complete the degree requirements and graduate. Those explanatory factors and dimensions would enhance a future study, but are not possible within the context of this study. Second, statistical analysis on a national dataset reveals general characteristics and identifies broad factors that affect extended time to degree, resulting in a set of factors that impact overall, not local, time to degree trends and tendencies. Interpretation of the research and adjustments to any factors at the institution or program level to shape policy changes should be addressed with care and in light of a local study. Third, although the statistical approach was useful to identify those factors most likely to affect extended time to degree, it is important to acknowledge that this is neither a definitive nor an exhaustive analysis. For every institutional factor that was identified and included in the analysis, many other factors could just as easily have been evaluated. While the analysis evaluated many of the identifiable institutional factors, it would have been impossible to address every characteristic of every institution in a study of this scale. Fourth, the study does not incorporate faculty or administrative perceptions about the policies and procedures of the academic program or the institution. These cultural attitudes define the unique characteristics of the people who provide doctoral education, mentor the students, and manage university policy. In a similar study at an institutional level, these perceptions would undoubtedly provide context and 'institutional memory' to explain why policies, services and procedures operate as they do.

The limitations described above serve to define not only the parameters for this research, but when taken into consideration with the outcomes of the study, will inform recommendations for future research.

Summary

Understanding whether a factor, such as primary funding as a teaching assistant, increases or decreases extended time to degree permits the development of recommendations and models for institutions to evaluate resources that support graduate students on their own campuses. Rodwell and Neumann (2008) argue that "the most useful systems to help HDR [higher degree research or Ph.D.] students are likely to be institutionally based" (p. 67), so it is critical that solutions focus on extended time to degree students. Hierarchical linear modeling permits the research to highlight trends in the national data that institutions can in turn use to evaluate university policies and practices along each line of the theoretical model. In summary, the purpose of this study is to determine the institutional factors that affect extended time to degree in doctoral study. The study evaluates the characteristics, policies and procedures of institutions that affect the specific subset of students experiencing extended time to degree. The ultimate goal is to identify research-based factors from which institutions can develop strategies to reduce extended time to degree with recommendations for institutional policy, practice, and future research. The next chapter provides a more extensive review of the literature on graduate education and time to degree as a foundation for this study.

CHAPTER TWO

Review of Literature

The purpose of this literature review is to provide context for the study of extended time to degree and the theoretical framework upon which this study is designed through a more in depth discussion of related research. The theoretical framework for this study is constructed using a three-ringed kaleidoscope model. The three rings represent the different constructs and factors which have potential to interact and to impact the degree progress, the rate of progress, and the time to degree of doctoral candidates. The center of the kaleidoscope represents the individual qualities of the doctoral student. While these qualities are unique to the student, the literature shows that they can be influenced by the institution and its representatives. The outer ring represents the socio-demographic characteristics of the individual student. The factors are fixed characteristics of the student and cannot be changed or influenced by the institution, yet the literature demonstrates significant interactions between socio-demographic characteristics and time to degree. The center ring of the kaleidoscope represents a set of factors that exist within a sphere of influence and control by the institution. The focus of this dissertation is this center ring and identifying which institutional factors have a higher probability of impacting extended time to doctoral degree.

In order to sufficiently establish the strength of the theoretical framework as a mechanism to study the institutional factors that impact extended time to degree, this chapter is divided into several sections. The first section of this chapter examines research related to the relationships and interactions between the individual characteristics of the student and Ph.D. completion. Sub-sections review research on gender, age, race, citizenship, and marital/parental status of the student. The next five sections examine in turn the six institutional characteristics of the Ph.D. Completion Kaleidoscope: selection, mentoring, financial support, program environment, processes and procedures (grouped together due to significant overlap in the literature), and research mode of the field and discipline. The next section of this chapter examines existing research on what those authors have referred to as lengthy, long, elongated, untimely and/or constrained time to degree, all of which are closely related to extended time to degree. The final section of the review of literature synthesizes and summarizes what is known about Ph.D. completion and time to degree, and formalizes the rationale for the study of extended time to degree.

Research on Student Qualities and Socio-Demographic Characteristics

The qualities of individual doctoral students and the socio-demographic characteristics which define them represent the central focus of a substantial body of research on attrition from doctoral programs, degree completion, and time to doctoral degree. With regard to student qualities, the theoretical model for this dissertation relies on the work of Lovitts (2008). In her work, Lovitts (2008) identified six theoretical constructs—five of which are characteristics of students—that are not only unique to that individual but impact the individual’s ability to transition to independent research and ultimately complete the doctoral degree. The five individual characteristics—intelligence, knowledge, thinking style, personality, and motivation—correspond to the innermost ring of the completion-attrition kaleidoscope (p. 301). Drawn from her analysis of focus groups with high-producing Ph.D. faculty, Lovitts (2008) carefully details the relationship between the qualities of an individual and his or her ability to complete the doctoral degree. Anecdotal comments often attribute a student's inability to complete the Ph.D. to a lack of one or more of these personal qualities. Yet Lovitts (2008) notes that according to her research, "students who had difficulty with the transition to independent research were not lacking in analytical intelligence" (p. 302). Doctoral students are smart, but according to Lovitts (2008), being a successful researcher requires more than just analytical intelligence. Lovitts (2008) found that students who successfully transitioned to independent research demonstrate practical and/or creative intelligence which enabled the student to problem-solve or formulate good ideas. Students who were less successful in making the transition were not unintelligent, but their intellectual strengths were not necessarily practical or creative and therefore did not aide their efforts to become researchers (Lovitts, 2008).

Most scholars agree that the combined breadth and depth of one's knowledge are essential when conducting original research. The ability to use one's intellectual gifts to learn and develop disciplinary expertise is an important piece of the Ph.D. puzzle, but Lovitts (2008) suggests that the knowledge gained is not necessarily the most important piece. Rather, it is the ability to use knowledge to construct a logical, rational argument or an accurate synthesis of information that differentiates the expert from the apprentice.

To do so is a skill that requires both formal (or ‘taught’) knowledge and informal (or ‘caught’) knowledge of the discipline (Lovitts, 2008). Those who demonstrate skill ‘catching’ informal knowledge that does not come from books or journal articles—such as tips about how to function within the discipline—were perceived to progress with greater ease through the independent research phase of the doctoral degree (Lovitts, 2008).

How one uses knowledge relates to one’s style of thinking. The faculty in Lovitts’ (2008) study felt that those students who experienced a greater degree of difficulty with independent research “did not think in a way that [was] congruent with the tasks of independent research or becoming a professional in their discipline” (p. 308). This is not to say that the student’s thinking style is wrong, more that certain styles are perhaps more dominant within or conducive to different disciplines. Nor does Lovitts (2008) suggest that an individual’s thinking style restricts one to the study of only certain disciplines given that people within all disciplines possess a variety of thinking styles. What is important to note from Lovitts’ (2008) study is that how one thinks, and how the faculty help teach a student to think about the subject matter within a discipline, impacts an individual’s ability to conduct original research and succeed in doctoral study.

The fourth individual characteristic identified by Lovitts (2008) as a quality which impacts a student’s ability to conduct independent research is personality. Itself a conglomeration of hundreds, perhaps thousands, of traits, an individual’s personality is characterized by their level of patience, willingness to work hard, initiative and persistence, intellectual curiosity, self-esteem and self-confidence (Lovitts, 2008). Faculty participants in the study agreed that students who struggled with the transition to independent research also struggled with the fear of failure, the ambiguity and frustrations associated with empirical research, and the self-confidence to persist through a series of challenges. Maher et al. (2004) also identified self-confidence as one of the key factors that affected a woman's ability to succeed in a doctoral program. The manner in which a student's unique personality processes and reacts to a challenging situation relates to their level of understanding of the nature of research, and while a faculty member has little impact over the former, they have opportunity to impact the latter.

Finally, Lovitts (2008) outlines the role that motivation plays in not only establishing what an individual student can and cannot accomplish in doctoral study, but in whether the student completes the degree. The degree to which an individual enjoys what they are doing is directly related to the interest, time and energy invested into completing the task. Motivation requires the doctoral student to focus simultaneously on both the current task and the end goal. Brien (1992, as cited in Bair and Haworth, 2004) clearly articulates the merger of motivational factors, stating that when a student believed in the promise of the doctorate as a path to one's career aspirations, then "it was more likely that [the] students would diligently continue in the doctoral program" (p. 507). The implication from Lovitts' (2008) research is that if the challenges and/or roadblocks an individual encounters during their doctoral program deflate the student's enthusiasm for the research or the discipline, then the transition to independent research takes longer and is more difficult, leading to departure or longer time to degree. Lovitts (2008) concludes that the unique qualities of the student—"the personal and social resources necessary for the conceptualization and completion of creative work (a dissertation)"—are critical to success in graduate school (p. 319). She recommends that the faculty who train graduate students change their approach to mentoring and advising to support and encourage students to employ the qualities within themselves that are most critical to success: their intelligence, their knowledge, their style of thinking, their personality, and their motivation (Lovitts, 2008).

Although the qualities of a student are uniquely owned and controlled internally by that individual, it is possible that the external efforts of the faculty, the graduate program and the institution impact the student. It is important to highlight that the literature supports a level of impact, but not control, on the qualities of the student. The university and its entities can never control the intelligence, personality, or motivation of any of its students. However, the ability of the institution to influence, and hopefully enhance, the individual qualities of its students is tightly coupled to the literature on doctoral degree completion and socio-demographic characteristics—the outer ring of the completion-attrition kaleidoscope.

The socio-demographic characteristics of doctoral students represent a set of factors that exist beyond the control and influence of the university. The institution cannot change the gender, age, race/ethnicity, citizenship or marital/parental status of its students, but the literature demonstrates that each of these factors has a significant impact on the relationships of doctoral students, their progress through the degree, and degree completion.

Gender as a factor on time to degree

In their study of 459 Ph.D. recipients from University of Illinois, Urbana-Champaign (UIUC), Berg and Ferber (1983) sought to define and examine measures of success for men and women in graduate school. Results were drawn from mailed surveys completed by students admitted to thirty-two sample departments during the years 1968-1975. They found that more women cited "ability to handle the work"—a characteristic that is thematically consistent with the personality traits described in Lovitts (2008)—as an important part of their choice of discipline (Berg & Ferber, 1983, p. 635). They suggest a link between the personality trait self-confidence and the choices women make when entering and persisting through graduate school. More women reported dependence on family support structures than men, and women did not indicate they had developed as many relationships for interaction with faculty of either gender. Students in their study were found to have more comfortable interactions with faculty of the same sex, which put female students seeking a mentor at a disadvantage in all of the studied fields due to the greater proportion of male faculty (Berg & Ferber, 1983). While the sample and research for this study are now more than 30 years old, the findings highlight that women have perceived disadvantages in doctoral programs for years.

Seagram et al. (1998) also sought to understand the extent to which the doctoral degree experiences of men and women differed and the resulting impact on time to degree. In their study of 154 graduates from York University, they argue that the university environment is 'chilly' toward women and that women graduate students have few appropriate role models (Seagram et al., 1998, p. 320). Their statistical analysis did not reveal significant effects for gender and time to degree, but did reveal a significant effect for discipline, a topic that will be covered in greater detail in a subsequent section. What their analysis did reveal was a significant difference in expected time to completion. Women thought that they would finish faster than they did. Alternatively stated, it took women longer to complete than they expected. Their findings for men indicated that expected time to degree and actual time to degree were in sync. Furthermore, survey respondents frequently cited gender as a factor they perceived impacted their time to degree, and of those, more were women than men. Overall, they found that women perceived higher levels of conflict with and lower levels of interest from their advisers and committee as evidenced by longer delays in receipt of feedback than those experienced by their male counterparts. Furthermore, they found that men were more satisfied overall than women with the doctoral student experience (Seagram et al., 1998).

Research by Maher et al. (2004) attempts to pinpoint specific factors, both positive and negative, that impact the degree progress of women. Of particular relevance for this study is their focus on factors that lead to considerably longer time to degree for women. Among the 160 survey respondents, all of whom were admitted to the Stanford School of Education between 1978-1989 and graduated with the doctorate no later than

1997, 37 percent were identified as late finishers because they took 6.75 years or more to complete the doctorate. Women represented 61 percent of the late finishers compared to 44 percent of the early finishers. The ages of early- and late-finishing women in the study sample were comparable, indicating that other factors influenced the rate of progress and degree completion. The survey instrument included 46 different factors, 18 which were thought to facilitate degree completion and 28 thought to constrain degree completion. Their analysis grouped the factors together and identified six thematic areas of impact on degree progress:

1. Commitment to timely degree completion;
2. Working relationships with faculty;
3. Funding opportunities;
4. Family issues;
5. Research experiences; and
6. Capability to make "the system" work for them (Maher et al., 2004).

These themes are not only consistent with the thematic constructs of the kaleidoscope model used to ground this study, but help demonstrate the interaction and dependency of the combination of individual, socio-demographic, and institutional factors on degree completion. Maher et al. (2004) found that late-finishing women reported greater impact of the constraining factors and fewer facilitating factors within these thematic areas than their early-finishing peers. In addition, the timing and number of factors encountered separately and in combination by a student had the greatest degree of impact on degree progress and completion. The overall implications and conclusions identified by Maher et al. (2004) are closely aligned with the goals of this study and perhaps just as well stated by them: "students, institutions, and society cannot afford the potential loss of talent that occurs when the doctoral process is severely hampered" (p. 403). I discuss the research of Maher et al. (2004) in greater detail at the end of this chapter.

Age as a factor on time to degree

One factor that cannot be influenced, not by the student, the program, or the institution, is age. While many people would like to be able to slow or even stop the clock, our age is unique to each of us and aging occurs for all of us at the same rate. In an overview of historic data on age and the doctorate, Pressey (1962) set a foundation for future time to degree research and argued that the rise in median age of doctoral recipients is an undesirable trend. He used as his case study the early academic and professional achievements of the presidents of several disciplinary societies. He observed that in 1958, the median age at the award of the doctorate for the 1,222 members of the American Psychological Association (APA) was 32.7 years, which was in sharp contrast to the 25.7 year median age of the last 25 APA presidents. Similar reviews of the American Economic Association, the American Sociological Society, and the Political Science Association revealed that 72 of the 75 most recent presidents had achieved the doctorate by a median age of 28.9 years. He argued that professional success is clearly associated with early completion of the doctorate due in large part to the fact that the sooner one embarks upon a professional career, the more time one has to build a successful portfolio. Pressey (1962) also argued that an individual's career is inherently shortened by taking longer to complete the degree, and their full potential may go unrealized. He suggested that our system of education needs modification. Students should reasonably expect to enroll from ages six to 26, at which point professional careers should begin. Although he did not address age as a factor which contributes to extended time to degree, Pressey (1962) made a passionate plea for earlier completion of doctoral degree requirements to satisfy the career goals of the needs of the nation.

Nettles and Millett's (2006) study of more than 14,000 students at 21 institutions addresses age as one of the many factors used to assess rate of progress and doctoral degree completion. They found age to be an advantage with regard to rate of progress in five disciplinary areas—education, engineering, humanities, and science and mathematics. However, being older did not equate to a greater likelihood of completing the degree in engineering fields. The findings from Nettles and Millett (2006) are in contrast to those of Abedi and Benkin (1987) and Tuckman et al. (1990), who respectively found no interaction between age and time to degree and that age did not affect time to degree. The findings from Nettles and Millett (2006) are more recent and based on a much larger sample, which indicates a possible shift in the impact of age on time to degree. In addition to their findings on age and time to degree, Nettles and Millett (2006) also found that across all fields, older students were less likely to receive financial support than their younger peers. They do not specify a reason for their finding, leaving one to wonder if the result is related to age, outside employment, or other factors. The well-known impact of inadequate financial support will be addressed in greater detail later in this chapter.

Race/Ethnicity as a factor on time to degree

Like gender, race/ethnicity is a variable included in many studies of doctoral program success, degree completion, and time to degree. Nettles (1990a) used ethnic background as the key variable in his study of the experiences, performance, and success of Black, Hispanic, and white students in doctoral programs. Using a sample of 953 survey responses from doctoral students at four institutions, Nettles (1990a) sought to understand how the demographic background, socio-economic status (SES), undergraduate preparation, transition to the doctoral program, and socialization within the doctoral program affected students from the three identified ethnic groups. Although the study does not specifically address time to degree, the findings set an important foundation for what we know about the experiences of traditionally underrepresented students in doctoral programs—which is a critical component of rate of progress within the doctoral program and the eventual outcome of doctoral study.

Nettles (1990a) notes that his study sample is not perfectly representative and that results should therefore be interpreted with caution, but he nevertheless observed that Black students who advanced to doctoral programs came from the poorest SES backgrounds and had to rely most heavily on their own financial resources due to the lower rate at which they received teaching and research assistantships. Hispanic students were also less likely than white students to receive assistantships despite the fact that many of the Hispanic students within the sample came from more academically selective undergraduate institutions. Both the Black and Hispanic students reported feelings of racial discrimination in their interactions with peers and faculty, yet both minority groups were more likely than their white peers to report satisfaction with the doctoral program. Furthermore, students from both minority groups were just as likely as their white peers to have identified with a mentor who provided adequate support (Nettles, 1990a). These findings form a clear parallel to the middle ring of the kaleidoscope and the theoretical model for this study. The interactions between ethnic background and both financial support and mentoring affected the satisfaction and doctoral student experience of the students in the Nettles (1990a) study.

Like Nettles (1990a), Ellis (2001) evaluates the interactions between race, socialization, and doctoral degree completion for Black and white students. Her study is based on the experiences of 42 doctoral degree recipients and 25 (then) enrolled students at a predominantly white research institution. Ellis (2001) found that race was a "salient factor" with regard to mentoring, program environment, and research and teaching—three of the six institutional factors found within the middle ring of the kaleidoscope and the theoretical model for this study. Her findings suggested that while mentoring and advising had the strongest impact on success in doctoral study for all groups in her sample, Black women had the most challenging relationships with their advisers. While having a mentor of the same race was required, she found that students looked for guidance and role models of the same race within their program faculty. Similar to Nettles (1990a), Ellis (2001) observed higher levels of satisfaction with the doctoral program among Black males who had graduated than among all other groups. All currently enrolled students in her sample were less satisfied with the doctoral program than their graduated peers. Ellis (2001) attributes their dissatisfaction to the fact that they are still engaged in the academic activities of the doctoral program, but it is an important distinction to note that the opinions of graduates were higher.

How the interactions between ethnicity and various institutional factors evolve into the outcomes of doctoral study is important for the study of extended time to degree. Nettles and Millett (2006) dedicated a substantial portion of their study to understanding the effect of group differences, including race, on degree completion and time to degree. Their findings raise some very large, very red flags. First, fewer than 50 percent of the Black students from every field within the study actually completed the degree by 2001 when they assessed the status of survey participants. The same held for Hispanic students in humanities and social science disciplines. Not only did Black and Hispanic students have lower completion rates, but among those who had completed, time to degree was longer than their international, white and Asian American peers. Overall, Nettles and Millett (2006) found that average time to degree for Black (6.26 years) and Hispanic (6.34 years) students was approximately a full year more than their international peers (5.32 years) (p. 135). Field-specific comparisons revealed that the two most underrepresented groups (Blacks and Hispanics), consistently had the longest time to degree. Nettles and Millett (2006) attribute the shorter and longer time to degree to a number of factors, but notably the presence of mentor and the type and level of financial support. For underrepresented minorities, having an assistantship and a mentor were both key components of a faster rate of progress, integration into the graduate program, and degree completion.

Citizenship as a factor on time to degree

Abedi and Benkin (1987) used citizenship as one of several demographic variables in their study of the differences in registered and elapsed time to degree. Using data on 4,255 doctoral degree recipients between 1976 and 1985 from University of California, Los Angeles (UCLA), they studied mean time to degree, not median time to degree as did this study. They determined that for their sample, citizenship was the sixth most important variable which could be used as a predictor of time to degree. However, although statistically significant, they found that including citizenship did not contribute to the predictive ability of their equation and their discussion ends there. That citizenship did not contribute significantly to time to degree and their decision to offer only minimal discussion suggests that the differences between domestic and international students are not critical factors. By comparison, Nettles and Millett (2006) found a number of differences between the doctoral experiences of domestic and international students. International students who responded to the questionnaire for their study exhibited faster progress toward the degree. Furthermore, faster rate of progress through the academic requirements translates into faster time to degree. They suggest that the process to obtain and retain a visa, with its requirement that students document the length of their degree program, places a level of pressure to complete on international graduate students that is not experienced by domestic students. Differences in the extracurricular activities of international students, typically lower than white students in the study sample, may result in fewer distractions and thus, faster time to degree. The reduced involvement in extracurricular activities may also correspond to the lower levels of satisfaction with the socialization experience among international students observed by Nettles and Millett (2006).

Marital/Parental Status as a factor on time to degree

As the age of doctoral students increases and as time to degree in doctoral programs gets longer, whether looking at mean or median time to degree, it should come as no surprise that many doctoral students have embarked upon non-academic relationships such as marriage or domestic partnerships, and parenting. While these external relationships have the potential to enhance one's personal satisfaction in ways that are beyond measure, they can also introduce certain challenges and complications into the doctoral career. For their part, Nettles and Millett (2006) found that being married appears to have positive effects on both degree completion and time to degree. They found that among the students in their sample, married students (without distinguishing by gender) had lower drop-out rates than their single peers, and depending on field, were more likely to complete the degree and/or finish faster. They suggest that married or partnered students may feel financial burden or pressure to complete the degree as quickly as possible. In addition, having a spouse or significant other provides a level of support and encouragement which motivates students to complete the degree. The same cannot be said for their findings with regard to children. As already noted in

Chapter One, Nettles and Millett (2006) found that “having children under the age of eighteen is the enemy of speedy time to degree” (p. 220). While the students in their sample reported similar socialization and research experiences, they were also more likely than their childless peers to stop-out. If they did persist, they took longer to complete the degree. Here Nettles and Millett (2006) suggest that parental responsibilities draw students away from participating in many of the socializing and research activities of the doctoral program, perhaps including serving as teaching or research assistants. In addition, the time and financial commitments of parenting, such as finding affordable, consistent, or convenient child care, are likely to require attention and accommodation by the graduate program and institution in order to help student parents.

Issues associated with child care are also found in other studies. Abedi and Benkin (1987) found a direct correlation between the increase in number of dependents and lengthening of time to degree. Like Nettles and Millett (2006), Abedi and Benkin (1987) suggest that while the potential support from a larger family is great, the time commitments and possible need to work outside of the graduate program to support the family are significant detractors from degree progress. Maher et al. (2004) found that more than 36 percent of the late-finishing women in their study felt that child care had a significant and negative impact on their degree progress. Comments from their survey respondents indicate that many of the late-finishing women gave birth to at least one child while trying to complete their degree requirements. Mason and Goulden (2002/2004) dedicate an entire study to the question ‘do babies matter’? In Part II of their study, Mason and Goulden (2004) used data from the National Science Foundation's Survey of Doctorate Recipients (SDR) and a survey of all ladder-rank faculty within the 10-campus University of California system. They point out that for typical individuals, the graduate student to assistant professor years coincide exactly with the most common and/or likely childbearing years for both men and women. They argue that this creates a collision course or 'baby gap' within academia. Their findings suggest that women are less likely than men to have as many children as they would like. Mason and Goulden (2004) suggest that one reason for the baby lag might be the inequitable division of parental responsibilities. According to their results, women aged 30-50 reported more than 100 hours of care giving and other responsibilities each week versus just over 85 for their male counterparts. Furthermore, work commitments took precedence over family time for many of the faculty. As one respondent indicated, "graduate students pick up the signal very early: devote time to family or community at your own risk" (Mason & Goulden, 2004, p. 7). It is doubtful that the picture painted of academic careers is highly attractive for students, particularly women, who wish to balance personal and professional success. Such dismal sentiments do not provide a rosy picture of support for graduate student parents or to encourage individual and program efforts to keep them on-track to complete the degree in a timely fashion.

Research on Institutional Factors and Time to Degree

The theoretical framework for this dissertation builds the case that all of the factors detailed in the previous sections have the potential to impact time to degree, and in particular, extended time to degree. However, the faculty, graduate programs, and institutions themselves have only moderate potential to influence the unique qualities of the student and zero potential to influence the socio-demographic characteristics of the student. Proverbially speaking, those factors exist within a sphere of influence beyond the control of the institution. The factors defined by the center ring of the kaleidoscope—the institutional factors—can be influenced and even controlled to a certain degree by the institution and thus represent a window of opportunity. The next six sections present what we know from existing literature about the interactions and impact of institutional factors—selection, mentoring, financial support, program environment, processes and procedures, and research mode of the field and discipline—on extended time to doctoral degree.

Selection as a factor on time to degree

Although it is not a major focus of the research for this dissertation, selection and “fit” during the admission process and early phase of the doctoral program have critical roles in the experiences of doctoral students. According to Lovitts and Nelson (2000), problems with the doctoral program begin when the individual is an applicant. Using data from a survey and telephone interviews conducted by Lovitts (2001), they found that 95 percent of students, both those who eventually complete and those who drop-out, were initially attracted to an institution without knowledge of the character, culture, and dynamics within their chosen program. Ideally, the admission and selection process is as much about the applicant choosing the program as it is about the program admitting them, yet it appears that the prospective students are making their choices without all of the information. Furthermore, Lovitts and Nelson (2000) argue that once admitted, if students are ill- or uninformed about factors such as the expectations of the program or the structure of the program, both academically and procedurally, they are less likely to feel welcomed and integrated into the program. A ‘left to one’s own devices’ approach casts a negative shadow and does little or nothing to promote a sense of ‘fit’ for the student. What is ‘fit’? Beyond the compatibility of personalities, common characteristics of ‘fit’ could include assistance planning one’s academic program, selecting advisers, getting involved with committees or research activities with peers and faculty. If we accept Lovitts and Nelson’s (2000) argument that ‘fit’ matters, then perhaps the argument is really that first impressions do matter. As stated by Lovitts and Nelson (2000), “a student who enters a department whose culture and structure facilitate academic and personal integration is more likely to complete the Ph.D. than a student whose departmental culture is hostile or laissez-faire” (p. 50).

The study sample used for the Lovitts and Nelson (2000) article was the same one collected and used by Lovitts for her own 1997 doctoral dissertation and her 2001 book *Leaving the Ivory Tower: The Causes and Consequences of Departure from Doctoral Study.* The sample was comprised of survey responses from 816 students, both completers and non-completers, from two institutions, as well as follow-up telephone interviews with selected students from each disciplinary area. In her 2001 book, Lovitts argues that to reduce attrition from doctoral programs, departments need to better inform new students of both the formal and informal requirements of the program. Formally, prospective and new students receive brochures, handbooks, and various printed materials about the program and institution. Informal information represents the ‘cheat sheet’ or ‘how-to’ notes that could easily fill an entire frequently asked questions (FAQ) bulletin, but are often ascertained only through interactions with program students and faculty (Lovitts, 2001). Orientations to the program for incoming doctoral students are one way to convey much of the necessary information, but Lovitts (2001) asserts that they must be high-quality, comprehensive orientations. Even after the orientations, the faculty must not assume that the new students know everything about how to ‘fit’ into the culture and climate of the graduate program.

Nettles and Millett (2006) took the notion of ‘fit’ and looked at how selection impacts completion. They suggest that for the student, attending the first-choice program has a strong positive effect on his or her interactions with faculty by virtue of the fact that the student wanted to be there, in that program, at that institution. Within their sample, 69 percent of the students were attending their first or only choice of doctoral program. They also found that for students in engineering, the sciences, and mathematics, attending the first-choice of institution had a small, yet significant, influence on degree completion (Nettles & Millett, 2006). While Nettles and Millett (2006) looked at the impact of selectivity on degree completion from the student perspective, Gardner (2009a) offers some insight from the faculty perspective. In her study, Gardner (2009a) interviewed 38 faculty members from seven doctoral programs at a single institution. The participating faculty represented the senior members of their respective departments, having served on the most dissertation committees and worked with the most students. The degree completion rates for the different disciplines ranged from 76.5 percent in Communication to 17.6 percent in Engineering (Gardner, 2009a). In her interviews with faculty from Psychology, a program with a 70.2 percent completion rate, one emerging theme was the link between selectivity and completion. The faculty credited the highly competitive nature of their field and additional institutional financial support with enabling them to make cream-of-the-crop admissions decisions. Gardner (2009a) quotes one faculty member's forceful assertion that admissions decisions impact degree outcomes and completion: "the single most important factor, bar none, factor of 10—if you do an experiment around a regression it would account for at least 90% of the variance—is admissions. Poor admissions decisions are unfixable" (p. 395). Gardner (2009a) suggests that the acknowledgement by several faculty members of the link between quality admissions decisions and degree completion may be a better reflection of the skills and abilities of the students than of the program.

Mentoring as a factor on time to degree

A mentor can fulfill many roles. He or she might be an adviser, a counselor, a guide, a tutor, or a teacher. A mentor is someone who influences the thinking and actions of another person. Sometimes an individual looks to a single mentor for guidance and other times, several people provide the necessary direction and assistance. In academia, the responsibilities of mentoring a student through a doctoral program are typically performed by the dissertation adviser. Members of the dissertation committee may also serve as mentors. Baird (1995) asserts that the faculty adviser is one of the most, if not the most, significant individuals in a doctoral student's career. In his overview chapter outlining the relationship between advisers and their graduate students, Baird (1995) identifies three major stages in the doctoral career: the beginning, the middle, and the dissertation phase. He also identifies the mentoring needs associated with each phase. During the first phase, approximately the first year of the doctoral program, new students need an adviser or mentor who can help acquaint and acclimate them to the other students and faculty, the culture of the program and the discipline, and the procedures of the program and the institution. The adviser's role is to keep the student from falling into a 'left to one's own devices' approach to graduate school as described by Lovitts and Nelson (2000).

The second of Baird's (1995) phases coincides with the competency building years in the doctoral program as evidenced by the completion of coursework and comprehensive examinations. It is during this phase that the doctoral program is fostering the student's intelligence and knowledge of the field. It is also, according to Baird (1995), when the student needs guidance from a mentor to identify their professional interests, to choose the area of research or even the specific topic necessary to reach that goal, and to select the members of a dissertation committee who will collectively help the student progress through the program and graduate. Ideally, by the time the doctoral student reaches the third stage they have been adequately mentored and socialized so that they possess the required methodological knowledge and understanding of the discipline to complete the dissertation. A crucial obligation of the adviser in the third stage is to help students understand the fact that the dissertation “is like no other writing they have done before or will do again” (Baird, 1995, p. 29). Students need a mentor to help them conceptualize the idea and method for their dissertation, to provide advice and guidance during the writing process, and most important, to provide encouragement and support during the lengthy period of writing a dissertation. Baird (1995) acknowledges that the obligations and expectations of mentors as he has outlined them require significant time, but he argues that the time is well spent when one considers that the faculty are training the scholars of the next generation.

The work of Bargar and Mayo-Chamberlain (1983), like Baird (1995), provides detailed steps for both the adviser and the advisee to establish and maintain a quality relationship. With regard to advisers, Bargar and Mayo-Chamberlain (1983) assert that they are in the best position to create an academically stimulating and positive environment for doctoral students. Advisers must demonstrate positive expressions of interest in a student, his/her work, and his/her overall well-being; they must practice open communication about developmental issues, both the student’s and the adviser’s; and they must create a developmental environment for the student through socialization activities (Bargar & Mayo-Chamberlain, 1983, p. 410). In addition to helping the student through the adjustment period at the beginning of graduate school and socializing them to the climate and culture of the program, the adviser has significant academic responsibilities. The adviser must challenge the student's intellectual creativity and help the student to think in new ways about the discipline. Bargar and Mayo-Chamberlain (1983) assert that the dissertation is itself a creative endeavor and process which will be aided by the development and stimulus coming from the adviser. They caution that the adviser not take over the student's research, but stress how important it is for the adviser to help the student see his or her dissertation in the context of the larger body of knowledge.

With regard to advisees, Bargar and Mayo-Chamberlain (1983) note that many students fail to see themselves as the 'shapers' of their academic environment and achievements. Students can change that perspective by taking charge of their half of the adviser-advisee relationship. Bargar and Mayo-Chamberlain (1983) encourage students to exercise care in selecting an adviser by trying to mesh the intellectual and interpersonal elements with one's academic goals. An academic 'marriage' of sorts, the adviser-advisee relationship requires openness, trust, and ongoing communication. Once an adviser has been selected, advisees should ask questions and essentially 'pick the brain' of their adviser. By doing so, the student learns and the adviser begins to discern their intellectual curiosity and creativity. In addition, Bargar and Mayo-Chamberlain (1983) urge students to consciously develop themselves, to expand their view of their own potential and think outside of the box, and to seek opportunities to integrate into the department and the discipline. The adviser is ideally present to help the student with each of those steps. Ultimately, the give-and-take between adviser and advisee should challenge the student and help the student to be innovative and creative in their thinking and research.

Understanding the intricacies of the adviser-advisee relationship is only half the battle. One must also understand what the literature tells us about how mentoring impacts degree progress and time to degree. In their study of doctoral student involvement in local and professional organizations, Gardner and Barnes (2007) conducted interviews with ten higher education students from five institutions. When asked about what influenced them to become involved in professional organizations, the students in their study credited their faculty mentors for either pointing them in that direction, or simply instructing them to join the organization. Once involved in one or more professional associations, the students reported that the networking opportunities expanded their connections with peers and established professionals who served as role models and mentors. The involved students in Gardner and Barnes' (2007) study understood their career goals, felt mentored by their faculty, and seemed satisfied with their doctoral experience. Although the study does not specifically address time to degree, it provides concrete evidence of the impact of faculty mentoring with regard to student socialization. Gardner and Barnes (2007) demonstrate the positive effects for students who receive faculty guidance and support to 'learn the ropes' of the professional associations and culture of their discipline. The students made the connection that their involvement and participation was an important part of their graduate student experience and a foundation for their future careers.

Golde (2000) also addresses the importance of socialization and integration into graduate school in her study of attrition from doctoral programs. Attrition being the opposite of completion—whether with timely completion or with extended time to degree—it is important to understand why students leave doctoral programs because the reasons for non-completion may be similar to the reasons for extended time to degree. Based on interviews she conducted with 68 former doctoral students, all of whom left their initial program without completing the degree, Golde (2000) presents case studies of three different student attrition experiences. Each of the three students reported that their decision to leave the doctoral program was the result of multiple factors. Among those factors, all three students experienced troubled or strained relationships with one or more of their advisers. Golde (2000) suggests in her findings that the attrition stories of these students confirm the importance of quality faculty mentoring to guide and socialize students, and the detrimental consequences of poor faculty mentoring. She argues that progress toward the degree is the result of quality time and interaction with faculty, and a student perception that the mentor is interested in their research ideas and professional goals. The students in Golde's (2000) study reported positive responses to their advisers when they sensed care and respect versus indifferent treatment or a 'cookie cutter' approach to advising and mentoring. The case studies demonstrate how important it is for students and faculty to build relationships where mentoring can occur and the student can flourish.

The literature described thus far focuses primarily on the one-to-one relationship between adviser and student. Burnett (1999) describes what he terms a 'Collaborative Cohort Model' (CCM) of advising doctoral students through the dissertation phase of graduate study as a new approach to mentoring, degree progress, and degree completion. Based on the pilot experiences of seven doctoral students at a metropolitan, Australian university, the CCM established a formal, faculty advised workgroup for the cohort of dissertation-stage students. The workgroup met twice per semester and every student presented a report—in person, via teleconference, or in written format—of their degree progress. Every student then received feedback about the work they had presented from the faculty adviser of the workgroup and their cohort peers. The workgroup provided a forum for the students to discuss their research in addition to meetings with their own dissertation adviser and committee members. According to Burnett (1999), the model was deemed very effective by the students. All of the students were satisfied or extremely satisfied with the pilot program. The faculty observed improved quality of the work produced by the students, students gained significant experience discussing, reviewing, and writing about their research, and most important for the context of this dissertation, students were more likely to finish their dissertations and graduate (Burnett, 1999). The CCM did not replace the adviser-advisee relationships, but it provided another forum for students to receive mentoring and critical feedback about their research.

Although the terminology of the literature presented in this dissertation tends toward the use of the 'adviser' almost interchangeably with the word 'mentor', a discussion article by Creighton, Creighton, and Parks (2010) draws some important distinctions. They define the terms and the roles as follows:

> An *advisor* is a person (not necessarily a faculty member) who is typically assigned to a department or program to meet with the student, to provide advice on degree plans and what courses to take, and address other academic issues or concerns. A *mentor*, on the other hand, is a person (a faculty member) whom the student seeks to emulate professionally and to work with and learn from during the research process (Creighton, Creighton, & Parks, 2010, p. 42).

Their discussion continues with the development of a conceptual model for helping faculty to better understand and develop the skills necessary to mentor effectively. Their 'PPE cycle' involves planning, practicing, and evaluating mentoring efforts (Creighton et al., 2010). Drawing from the literature, they suggest guidelines for the faculty in each of the three stages of the PPE cycle. With regard to planning, the authors suggest that mentors plan and account for frequency of contact with their doctoral students and a transparent system for monitoring academic progress. With regard to practicing, they suggest that mentors must seek opportunities to engage their doctoral students in scholarly activities early and often. They also suggest that the faculty must seek time to practice good mentoring and make mentoring an important part of their institutional responsibilities. With regard to evaluating effective mentoring, Creighton et al. (2010) suggest that faculty make regular use of a mentoring survey to assess how well their efforts are being received by their doctoral students. They suggest that the use of mentoring evaluations, like course evaluations, will enable the faculty to make improvements and adjustments to their mentoring plans and practices. The basis of much of their rationale for the PPE approach is drawn from data in the literature, in particular Nettles and Millett (2006), which repeatedly demonstrates that far more students who complete the doctoral degree report doing so with the help and guidance of a mentor. Creighton et al. (2010) stress that mentoring, like teaching, is a pedagogy which must be learned, practiced, and continually enhanced. They argue for university and departmental recognition of both the need for and accomplishments of effective mentors.

I have reserved the work of Nettles and Millett (2006) for the end of the discussion on the role of mentoring in doctoral degree programs because their work unites the literature in a meaningful way. They asked their survey respondents to indicate whether they had had a faculty member who was a mentor. They defined a mentor for their participants as “a faculty member to whom [you] turn for advice, to review a paper, or for general support and encouragement” (Nettles & Millett, 2006, p. 266). Like the research discussed above, they stress the importance of mentoring with regard to socialization and integration in the doctoral program and the profession, academic guidance, and professional development. Although mentoring is only one small piece of their much larger study, they found that mentored students had more positive feelings about the faculty and better interactions with faculty. In addition, having someone who served as a mentor, not just an academic adviser, was positively linked to both degree completion and faster time to degree, particularly in humanities and social science fields. For students, the umbrella of mentoring ought to be broad enough to help a student explore, yet narrow enough to stay focused within the discipline, and it should keep the student from feeling isolated (Nettles & Millett, 2006). With regard to institutions, Nettles and Millett (2006) argue that mentoring as an investment in the retention and success of the institution's students, with returns in the form of degrees awarded and satisfied alumni. Citing the fable of the rabbit, his dissertation on foxes and wolves, and his lion adviser, the moral of their story is that "[the] dissertation theme doesn't really matter—as long as you have the right dissertation adviser" (Nettles & Millett, 2006, p. 190).

Financial support as a factor on time to degree

The English language is full of quotations, proverbs and euphemisms about money. We are told that it cannot buy love or happiness, it is not everything, and it will not last forever. While all of those may be true, when it comes to financing a doctoral program, the difference between having money and not having money might also mean the difference between finishing or not, and for those who do finish, how quickly they do so. In their extensive study of trends in doctoral programs, degree completion, and time to degree, Bowen and Rudenstine (1992) begin their tenth chapter—Financial Support for Graduate Students—as follows:

> The availability of financial support is often assumed to be *the* most important factor in encouraging the timely completion of the PhD—and its absence is widely believed to cause protracted periods of time to be devoted to frustrating (and often ultimately unsuccessful) efforts to obtain a PhD (p. 177).

Using historical data to establish trends in graduate student support, and data from ten participating institutions, Bowen and Rudenstine (1992) briefly discuss types of financial support and then compare the impact of support on completion rates and time to degree. Common types of financial support include fellowships, research assistantships, and teaching assistantships. Students also pay for their doctoral programs by taking loans or using only their own resources. These students are referred to as self-supporting because they bear the full financial burden of the doctoral program. For those who receive financial support from the institution or an external benefactor, the types of support are likely to vary throughout the doctoral career. A student might have the same type of support for an entire year, or different support each term or within a single term.

The effect of financial support on the doctoral career is not surprising. Bowen and Rudenstine (1992) found that students who funded their own doctoral program had much higher rates of attrition, lower completion rates by as much as one-half, and had longer time to degree than their institutionally supported peers. Their finding is consistent with Abedi and Benkin (1987), who also found that self-supporting doctoral students took longer to complete the degree than their institutionally supported peers. Bowen and Rudenstine (1992) hypothesize that students with full institutional support were allowed to devote more time to their doctoral program compared to self-supporting students who were more likely to be part-time students and therefore able to dedicate only part-time effort to their academic work. They found that, generally speaking, the type of support had greater impact on time to degree. Median time to degree for self-supporting students was as much as a full year longer than institutionally supported students, and time to degree for students supported by teaching assistantships was longer than that of students supported by fellowships (Bowen & Rudenstine, 1992).

Ehrenberg and Mavros (1995) sought to further explain the effect of financial support on time to degree by conducting a more comprehensive analysis of data for one of the institutions participating in the Bowen and Rudenstine (1992) study. Using student-level data for doctoral students enrolled at Cornell University 1962-86, Ehrenberg and Mavros (1995) looked at the type of support for each of the first six years the students were enrolled and their eventual time to degree (or dropout). They limit their study to students enrolled in economics, English, physics, and mathematics. Their findings are significant, not only statistically, but with regard to how institutions administer financial support and degree times of doctoral students. First, they found that students with teaching assistantships in all four fields were less likely to complete their degrees. Students who were self-supporting (or who used loans or tuition waivers) were also less likely to complete their degrees in all fields except economics. Second, they conducted simulations to determine if the best financial support and degree times were reflecting the superior ability of the student recipients or of the support itself. The simulation model predicted that students receiving fellowship and research assistantship support have the highest likelihood of completing the degree. A second simulation model tested the likelihood of completion among students who received fellowships and research assistantships at least half the time compared to those who received them less than half the time. Again, the simulation model predicted higher completion rates for the well-supported students. In comparing the two simulation models used to predict completion rates in their sample, Ehrenberg and Mavros found very few differences between their statistical models and the actual data. Thus, Ehrenberg and Mavros (1995) concluded that their simulations confirm that the analysis is showing the effect of financial support, not of unobserved ability. They further note that although their findings are based on only four fields at one institution, the implication is that additional funds to provide fellowship and research assistantship support would lead to higher completion rates and shorter time to degree. One noteworthy limitation of their study is that they do not address the role of stipend support on completion rates or time to degree, but they suggest that it is likely the patterns and outcomes of higher levels of support would mirror those observed in the study (Ehrenberg and Mavros, 1995).

Like Bowen and Rudenstine (1992), Nettles and Millett (2006) dedicate an entire chapter of their book to the financing of doctoral education. To evaluate the ways in which doctoral students finance their education, Nettles and Millett (2006) looked at factors according to the types of financial support offered throughout the doctoral career, the personal resources of students, and other types of support. The sample for their study included several fields not represented in the Ehrenberg and Mavros (1995) study, so it is difficult to draw comparisons, however, some of the Nettles and Millett (2006) findings are quite different. They found that holding a teaching assistantship improved the likelihood of degree completion in education and humanities fields, as did research assistantships in science and math fields. Contrary to their predecessors, they only observed a significant impact of fellowships on the likelihood of degree completion for one field, education. Also unlike their predecessors, Nettles and Millett (2006) did not find financial support to be a significant predictor of faster time to degree, while the amount of debt assumed during the doctoral program was found to extend time to degree in the social sciences. They argue that financial support is a central component of graduate school for doctoral students. To quote them, “the type of financial support students are offered may be an indication of the quality and extent of their academic opportunities and may even predict the quality of their experiences” (Nettles & Millett, 2006, p. 74). Sixty-seven percent of the students in their sample were offered some form of financial support at the time of admission, but the authors argue that the offers for multi-year and long-term support that the students received after the initial recruitment and admission period were more important. Given the length of doctoral programs, the existence of viable means of support through fellowships, research assistantships, and teaching assistantships can advantage students on their quest to complete the degree.

Program environment, processes, and procedures as factors on time to degree

Research repeatedly confirms the importance of integration into the program environment and understanding of the expectations of graduate study as critical components of degree progress, completion, and time to degree (Ellis, 2001; Gardner, 2009a; Girves & Wemmerus, 1988; Golde, 2005). In their survey study of 486 students who enrolled in one of 42 graduate programs at a Midwest university in autumn 1977, Girves and Wemmerus (1988) sought to understand the factors that contributed to or detracted from degree progress. Their survey instrument included demographic and background questions, and questions about the program environment, financial support, and faculty relationships. They divided their sample into groups according to degree objective and field to account for disciplinary differences. For the purpose of this study, I report only their findings related to doctoral students. I discuss the literature on disciplinary differences in greater detail in the next section as it ties closely to research mode.

Girves and Wemmerus (1988) used Biglan's (1973a/1973b) disciplinary categories—hard/soft sciences, applied/basic research, and life/nonlife—to understand field differences in their sample. The use of such categories is found throughout the literature, for example, two of the major studies already discussed in this dissertation: Bowen and Rudenstine (1992) and Nettles and Millett (2006). When discussing program characteristics, processes, and procedures it makes sense. Physics programs are different from English programs which are different from Public Policy programs. The nature of the academic requirements, the method of teaching, and the construction of the dissertation itself varies by discipline. We should expect that those differences translate into effects on the degree progress of doctoral students. Girves and Wemmerus (1988) found exactly that. The doctoral students in their sample who were enrolled in programs with a life orientation (meaning their research focused on living organisms), had better degree progress. Students enrolled in programs with applied orientations were more likely to have lower grades—a possible impediment to degree progress, and enrollment in soft science programs was linked to lower levels of involvement in the doctoral program. They also found that involvement in one’s graduate program, perceptions of the faculty, and department characteristics were all related to degree progress, but that involvement had the greatest significance.

Girves and Wemmerus (1988) suggest that involvement is a function of financial support and satisfaction with faculty relationships, a factor which is also linked to degree progress (Girves & Wemmerus, 1988). Their study is a good example of why it is so challenging to tease apart the very interrelated factors associated with degree progress. They argue that the role of the adviser, the type of support and the characteristics of the department are the equivalent of a three-legged stool of involvement in the doctoral program. They suggest that the adviser represents the first leg. The adviser establishes the expectations and initiates the necessary introductions to the department and discipline. The more guidance and support the student receives from the adviser increases the likelihood of greater student involvement and academic success. The greater the student’s initiative, involvement, and academic success, the more likely the faculty are to work with and successfully mentor the student. The circular relationship is powerful enough that it can predict degree progress within their model.

The second of the three legs, financial support (in the form of teaching or research assistantships or fellowships), directly and physically ties the student to the department and, almost by default, encourages involvement. Doctoral students who hold assistantships must work closely with the faculty. Girves and Wemmerus (1988) suggest that the presence of these students in the department is more likely to increase their interactions and result in faster socialization and integration. The third of the three legs is represented by the characteristics of the department itself and directly impact degree progress. Here, Girves and Wemmerus (1988) suggest that the combination of disciplinary culture, the academic norms, and the expectations and values of the faculty are important for students to understand. How the faculty interact with the students to teach them about the activities valued by the faculty impacts the student's interest and commitment to the department, and ultimately, how they progress through the degree.

Understanding how mentoring, financial support, and departmental characteristics interact to impact degree progress is easily observed in the literature, but do students actually know how to navigate the process of doctoral education? Golde and Dore (2001) ask that exact question. Their study, *At Crossed Purposes: What the experiences of today's doctoral students reveal about doctoral education*, reports the results of survey responses from 4,114 students in 11 academic disciplines at 27 universities (Golde & Dore, 2001). All of the students selected for participation in the study had completed at least three years of their doctoral program. They found that doctoral students in their sample did not feel trained or prepared for the careers they sought and they did not know how to effectively navigate the doctoral program. I focus on the second of their major findings. Golde and Dore (2001) put forth the assumption that students who have completed at least three years of a doctoral program should have acquired the following skills:

1. Understand and be adept at negotiating the formal logistical requirements of their program;
2. Understand the mechanisms and overriding logic of the doctoral program;
3. Grasp the informal and tacit expectations (p. 34).

They report, however, being startled at the number of students in their sample who did not understand either the expectations of them as a student, or what they could expect of the doctoral program. Golde and Dore (2001) respond by outlining six components of doctoral programs—advising, financial support, annual reviews, coursework and examinations, teaching and grading, time to degree and graduation—where they felt the expectations of and for both students and faculty should be clear. Again, the study demonstrates the interconnected nature of the different institutional factors that impact degree progress and time.

With regard to advising, Golde and Dore's (2001) discussion closely mirrors the research already presented in this dissertation. They echo the importance of the mentoring relationship and the value of having multiple mentors. They also note that having a satisfactory (or better) relationship with the adviser was linked to amount and quality of time. More than 32 percent of students reported dissatisfaction with the amount and quality of time they received from their advisers and a similar number were unclear about how much time they could or should expect from their adviser. They found that the more criteria students used to select their advisers, whether before or after enrollment, was directly linked to the level of satisfaction. With regard to financial support, the authors did not explore the impact of different types of support, but rather whether students understood how they would be financially supported throughout the doctoral program. While more than 57 percent of students were clear about the specific commitments for financial support, almost 60 percent had some degree of uncertainty about the support for their dissertation research. Golde and Dore (2001) assert that it is important for students to understand what support they will have, when, and at what level. Not understanding can become a distraction and a source of frustration which draws the student's attention away from their academics.

With regard to annual reviews, the sample data indicated that it was not a widely used mechanism for providing feedback on degree progress. Golde and Dore (2001) suggest that an annual review is an ideal time for the student and adviser to discuss and set goals for degree progress. As evidence of the possible value of this method of communicating with doctoral students, they note that they observed a 90 percent review rate reported by students from one of the participating institutions where annual reviews were mandated by policy. With regard to coursework and examinations, the students reported confusion about how these early academic requirements prepared them for independent research. And while comprehensive examinations have been used for decades as a tool to evaluate a student's readiness to advance into the independent research phase of the doctoral program, the students in Golde and Dore's (2001) study felt they were arbitrary or unhelpful. The implication is that coursework and examinations must be relevant and up-to-date so that the students can readily understand the often subtle connections and nuances of the discipline. Furthermore, annual reviews provide a useful opportunity to reinforce for doctoral students the academic purpose of degree requirements and the student's own progress toward achieving them.

With regard to teaching and grading, approximately half the students in Golde and Dore's (2001) sample were expected to serve as teaching assistants. They found that while 63.8 percent of the students understood their obligations of a teaching assistantship, only 42 percent felt able to grade student assignments. They suggest that the written policies associated with teaching assistantships must but augmented by mentoring from faculty. Students learn the rules of fair grading from the faculty they work with.

Finally, with regard to time to degree and graduation criteria, the numbers are startling. Golde and Dore (2001) found that significantly fewer than half of the students in their sample, 30.9 percent, clearly understood how long it would take to complete the degree, and an equally pathetic 45.4 percent understood the requirements of completing the dissertation and graduating. That means that almost 70 percent and 55 percent, of students were confused about how long it would take to get a Ph.D. and what it would take to do it, respectively. The evidence clearly indicates a need for better communication of these very important program expectations and requirements so that students know what they are getting into as they progress through the doctoral program.

In a separate study published four years later, Golde (2005) evaluates the role of departments and disciplines on attrition from doctoral programs. To conduct the study, she used observations of time she spent in four departments and interviews with 58 students who had left those departments at a single Midwestern university. She then created case studies, outlined themes, looked for common themes across the departments, and finally categorized the themes. Early in her discussion of findings, Golde (2005) highlights one point that she asserts is crucial to understanding the effects of department on students: “how the life of a disciplinary practitioner is portrayed to those who are apprentices (graduate students) is quite different in different departments” (p. 680). Her point is consistent with the assertions from Girves and Wemmerus (1988) that there is significant variation between departments and disciplines. Again, those distinctions are covered in greater detail in the next section. Golde (2005) identified six themes, five of which represent mismatches between the student and the department or discipline, and a sixth which represents a disconnect between the student and the community within the department. For the purposes of this dissertation, I discuss two of Golde’s (2005) themes: poor fit of expectations between student and department, and structural isolation of student. The research is focused on the reasons why students depart from the doctoral program, but we know from other research that the reasons for departure are often similar to the reasons for longer time to degree, thus, the relevance for this study (Nettles & Millett, 2006).

First, inaccurate expectations about the nature of graduate school are, according to Golde (2005), a mismatch of information between the student and the department. When the department has not been transparent about its culture, its environment, and its expectations of students, the students are not in a position to fulfill their obligations. Conversely, when a student is not clear with the department about their academic and professional goals, and their questions about graduate school itself, the department cannot respond appropriately to address or meet the student's needs. The result of the mismatch of information is a lot of assumptions. The students assumed graduate school would follow one path, and the departments assumed that the students were informed. This ties back into the discussion of socialization and integration that evolves out of a quality mentoring experience, but it also highlights that it requires both student engagement and initiative and department socialization for successful doctoral completion.

The second theme, structural isolation of the student, relates to how welcomed the student feels into the community within the department. The departmental community is, for lack of a better description, the 'life' part of the graduate program. It is the opportunities for students and faculty to connect in a non-academic setting, for students to develop peer and cohort groups, and for the development of collegial relationships which provide academic support, but are not exclusively academic in nature. Golde (2005) indicates that being socially isolated from one's peers and faculty resulted, for the students in her study, in an absence of collegial, supportive, and academic relationships. In the case of the students in this study, that also resulted in departure from the graduate program. She suggests that to combat the isolation of the student from the departmental community, there must be intentional effort to provide social opportunities.

The themes associated with the role of the program environment, processes and procedures of the department are consistent. Students must feel integrated, they must understand what is expected of them and when, and they must have guidance and support through the challenging academic phases of the doctoral program. The absence of these factors leads to attrition, as demonstrated by Golde (2005). The existence of these factors can not only lead to degree completion, but faster time to degree as demonstrated by Girves and Wemmerus (1988).

Research mode of the field and discipline as factors on time to degree

In my discussion regarding the importance of program environment, processes, and procedures for doctoral students, I briefly introduced the topic of disciplinary differences as one of the contributing factors on degree progress and by extension, time to degree. In the context of program environment, processes, and procedures, the variations between disciplines translate into different programmatic culture and requirements which students need to understand to navigate the logistics of graduate school. In the context of research and the research mode of the field, the characteristics of disciplines themselves are, if nothing else, different and must be approached as such. Some disciplines depend on an experimental approach to new discoveries; others are grounded in non-experimental research. Disciplines require different cognitive approaches ranging from analytical to artistic; and even within areas that are often assumed to be similar—such as engineering or laboratory sciences—the techniques can be vastly different. Understanding the differences, and similarities, between the disciplines serves to not only help explain why indoctrination into the research mode of the field impacts degree progress for doctoral students, but it also helps inform the disciplinary comparisons of extended time to degree within this dissertation.

Biglan (1973a/1973b) dedicates two papers to the examination and explanation of the characteristics of disciplines and the relationships between them. In the first of his papers, Biglan (1973a) studied 36 academic areas at two institutions. He asked the faculty at both institutions, 162 and 54 of whom participated respectively, to make judgments about the similarities of academic areas. The faculty participants were asked to categorize the academic areas based on that individual's perceptions of the subject matter similarities. The faculty members were then asked to rate their categories by selecting one characteristic from each of the following traits: pure/applied, physical/non-physical, biological/non-biological, personally interesting/not interesting, traditional/nontraditional, and life science/non-life science (Biglan, 1973a, p. 196). The analysis identified three dimensions of academic programs which characterize the nature of the discipline: the degree to which a paradigm exists, the degree of concern with application, and concern with life systems (p. 202). Biglan (1973a) asserts that a paradigm exists when all members of a particular field subscribe or gravitate toward a particular organizing theory. Fields with fewer organizing theories have greater consensus and are considered more pure or paradigmatic, while fields on the opposite end of the spectrum are characterized by more varied content, theory, or method, and are considered idiosyncratic. For example, a physics program would be characterized as paradigmatic and a history program would not. The second dimension, degree of application, refers to whether the nature of the academic area was concerned with "application to practical problems" (Biglan, 1973a, p 202). In the context of this dimension, the spectrum distinguishes between applied fields such as education and non-applied fields such as history. The third dimension is perhaps the easiest to understand and interpret because it deals with the differences between living and inanimate objects. Those academic areas which focus on any sort of living organism, such as agriculture, are considered opposite of those programs that deal only with non-living objects, such as history.

The result of Biglan's (1973a) first paper is a framework with which to categorize and classify academic disciplines and to better understand their similarities and differences. In his second paper, Biglan (1973b) describes how the differences in academic subject areas affect the structure of the program and the relationships and interactions of students and faculty within the program. He evaluated the social connectedness and commitment to teaching/research of faculty according to his dimensional taxonomy of programs. Of particular importance for this dissertation, he found significant interactions between social connectedness and the number of dissertations sponsored by faculty. Specifically, the higher the social connectedness of the academic area, the higher the number of dissertations sponsored. Fields with a paradigm or unifying theory were found to have positive relationships between social connectedness and research leading to publication. Applied fields were characterized by greater reliance on peers for evaluation of work. Life system fields were noted for the greater use of supervision and advising of graduate students by multiple faculty mentors, rather than a single adviser. Biglan's (1973b) findings highlight important differences in the characteristics of disciplines. He asserts that any research on university faculty must account for organizational and disciplinary differences. For the purposes of this dissertation, I extend that assertion to the study of doctoral students. Without taking discipline into account, the study of extended time to degree would, as Biglan (1973b) argues, "mask different relationships in different areas" (p. 212). Alternatively, Biglan (1973b) suggests limiting research to the study of only a few academic areas. Since the goal of this research is to study extended time to degree broadly, that approach does not work. Thus, this dissertation accounts for disciplinary differences when evaluating the likelihood that institutional factors impact extended time to degree.

Becher (1981) provides another comparison of disciplines with a more narrow focus on the culture of academic fields and the mode of research. He conducted interviews with faculty in six different disciplines at four different institutions to compare and contrast the structural characteristics of the fields. I focus on a few of Becher's (1981) points regarding disciplinary distinctions. He argues that while the differences between disciplines can seem obvious, defining those differences is ambiguous. To quote Becher (1981), "it is unrealistic to expect that the essential ingredients of each discipline can be analysed and displayed as a tidy formula" (p. 113). He suggests that disciplines have identities and that those identities are subject to regional, temporal, and localized interpretations of the field. The focus of entomology might differ on the west and east coasts, physics today is not the same as physics a decade ago, and political science programs might subscribe to different ideological approaches. Becher (1981) asserts that the similarities and differences between the beliefs, values, and practices of fields will be more noticeable than the epistemological distinctions (p. 113).

Becher (1981) also addresses the different modes of research and publication observed by different disciplines. With regard to research, he observed differences in the degree of collaboration and team work in the different institutional and disciplinary settings. Furthermore, he notes that for those who aspire to join the research community—such as doctoral students—certain 'rituals' must be observed (p. 119). Junior researchers must secure the approval and topic acceptance from more senior academics to engage in the process. While the ritual may seem obvious and justified, the doctoral student or junior researcher needs guidance to become familiar with the process. With regard to publication, letters, journal articles, books, and student texts are all examples of prestigious and preferred methods of scholarly contribution, but the level of respect attributed to each varies widely by academic area. Within the publication approaches themselves, the methodology varies. For instance, the inclusion of a literature review and the scale of the review vary by discipline. He also notes that the use of technical language varies, with some disciplines placing a premium on complex descriptions while others value clear, non-technical discussion. Becher (1981) suggests that disciplinary training is critical early in one's career because in many fields, once an individual has chosen his or her specialty, it is difficult to change academic directions. His points are particularly salient for doctoral students. Previous discussion demonstrated the critical role of the adviser/mentor in the socialization of the student to the program environment as critical to success. Here we see how the introduction and exposure to the research mode of the field could be of equal importance.

The dissertation is the primary research tool used in almost all doctoral programs to expose students to the research culture and to assess that individual's ability to conduct independent research. Stewart et al. (2005) suggest that the dissertation serves two major functions within the context of the doctoral program: first, it trains the Ph.D. student in the research mode of the field and second, the final product results in an original contribution to the body of research. Isaac et al. (1992) discuss the doctoral dissertation as not only a degree requirement and a contribution to scholarly work, but as a reflection of the academic culture of a discipline. They evaluated survey responses from 596 faculty to assess perceptions of the role and purpose of the doctoral dissertation. More than 50 percent of the faculty in their sample indicated that the purpose of the dissertation was either to demonstrate skills or to train in research skills (Isaac et al., 1992). The majority of faculty respondents also indicated that formulation of the dissertation topic should occur early in the doctoral career, and that the dissertation itself must reflect the independence and originality of the student. In addition, the authors emphasize that the nature of the discipline must be considered when discussing the expectations and requirements of the dissertation. Field of study introduces a layer of complexity with regard to the dissertation due to the variability of composition, style, and expected content of the research. However, despite the disciplinary contrasts, Isaac et al. (1992)

also observed strong support among their faculty respondents for maintaining the dissertation as a crucial piece of the doctoral student experience.

Any discussion of the dissertation must eventually lead to critical questions regarding how the process of research and writing impacts degree completion and time to degree. Although Isaac et al. (1992) did not specifically address time to degree, they did note that barriers to timely completion include financial support and difficulty defining the research topic. Both of these factors are thematically consistent with the work of Nettles and Millett (2006) which does address the role of research and research productivity on rate of progress and degree completion. Nettles and Millett (2006) begin their chapter on research productivity with a quotation from one of their survey respondents. In the quotation, the student was bemoaning the fact that the minimum standards and stakes for him/her to secure a tenure-track position had increased compared to the days when his/her faculty mentors were job hunting. The ‘stakes’ as described by that student do appear to be higher in some disciplines: students in the Nettles and Millett (2006) study reported greater need to document pre-doctoral research activity to improve their chances of finding an academic position.

The benefits of integration into the discipline and socialization with advisers and other faculty represent only one part of the process of learning and understanding the research mode of the field. We know that scholarship differs by field and that to succeed, doctoral students must master the mode of their field. Nettles and Millett (2006) found that students who engaged in and published or presented their research while in graduate school were as much as 3.9 times more likely to complete the Ph.D. (p. 173). It is not clear from their findings how the timing of engagement in research activities, e.g. pre-dissertation research, impacts the likelihood of completion. While they observed the greatest effect in the sciences and mathematics, their research showed research productivity was a positive predictor of degree completion in all fields. They concluded that having a mentor and engaging in research activities were critical factors that influenced degree completion. They also found that holding a research assistantship, which provided formal opportunity for the student to engage with a faculty mentor on a research project, provided a stable and supportive environment that positively impacted rate of progress, degree completion, and time to degree (Nettles & Millett, 2006).

Research on Lengthy, Untimely, or Elongated Time to Degree

Research repeatedly demonstrates the critical links between student-faculty interactions, mentoring, financial support, program environment, and degree completion (Gardner & Barnes, 2007; Lovitts, 2008; Nettles & Millett, 2006). In theory, when all of these pieces are working in coordination, a doctoral student progresses through the degree program and successfully graduates (Gardner, 2009a). The factors associated with degree completion and the amount of time it takes to complete the degree are individually and collectively the subject of an extensive body of literature, much of which has already been discussed. We know from the literature that longer time to degree makes it less attractive for students to pursue the doctorate, delays the short- and long-term earnings potential of students, and leads to societal costs in both unrealized financial gain and the intellectual talent pool (Maher et al., 2004; Rodwell & Neumann, 2008). Unfortunately, most of the literature addresses time to degree for cohorts or groups of students without differentiating between those who finish quickly, those who finish near the mean or median, and those who take longer—or even significantly longer—to complete the degree. Nettles and Millett (2006) make several references in their findings to factors that impacted either rate of progress or time to degree, but it is important to note that it was neither the goal nor the intention of their research to identify characteristics of extended time to degree. The fact that their research touches on this topic is invaluable, but it highlights the need for dedicated research. Studies by Maher et al. (2004) and Rodwell and Neumann (2008) begin to fill some of the gaps in the literature and refer, respectively, to constrained degree progress and untimely completion. I discuss each in turn to highlight the foundation for and necessity of additional research which specifically addresses extended time to degree.

In developing the survey instrument used for their study of women's degree progress, Maher et al. (2004) asked doctoral students and graduates to identify the factors which either facilitated or constrained their own degree progress. They received usable survey responses from 160 alumni, both men and women, of Stanford University's doctoral program in education. Responses were then categorized into one of three groups based on the length of time it took the respondent to complete the doctoral degree: early, average, or late finishers. The group divisions were time driven—less than 4.25 years, 4.50 to 6.50 years, and 6.75^{+} years—but the authors do not provide explanation for how they determined those cut-off points. For the purposes of their research, Maher et al. (2004) focused on the responses of the early- and late-finishing women in their sample. Among late-finishing women within their study, Maher et al. (2004) found that more women responded ‘no’ with regard to questions about whether they’d had help or support from staff, productive prior research experience, and prior relevant/useful coursework. Furthermore, women in the late-finishing group were more likely to be affected by not just one, but multiple constraining factors.

While Maher et al. (2004) focused on the factors associated with early- and late-finishing women in doctoral degree programs, it is important to note that they felt their findings were consistent with those observed in the literature for all doctoral students regardless of gender. Their findings also confirm what one might anecdotally expect, that early- and late-finishing doctoral students reported opposite patterns with regard to the numbers of facilitating and constraining factors they encountered during their doctoral careers. With respect to factors which might at some level be influenced or impacted by the institution, they found that late-finishing women did not know how to make the system work for them, had more trouble securing financial support and research experiences, and spent more time bouncing between faculty advisers and mentors trying to find a supportive path to degree progress. Maher et al. (2004) readily acknowledge that the external factors, such as a family death or divorce, impaired the student’s ability to progress, but that no institution can control for such factors. They suggest that helping students learn how to work within the academic system, providing adequate financial support, engaging the students in research and a review of their research to assess progress, and establishing student mentoring systems will aid all students, not just women, in their quest for a timely doctoral degree.

Rodwell and Neumann (2008) took a slightly different approach to their study of factors that predict timely, and therefore untimely, doctoral degree completion. They first identified two main types of characteristics, those of the candidate and those of the candidature. The candidate variables, as one might expect, include gender, age, and residency, but they have also included whether the doctoral student comes from an English or non-English speaking background. These variables are reasonably consistent with the individual and socio-demographic characteristics identified within the theoretical model for this dissertation. The variables used in this study are consistent with many of the institutional factors of this dissertation's theoretical model. Rodwell and Neumann (2008) include type of enrollment, discipline, and student supervision in their discussion of significant variables associated with candidacy. They hypothesize that gender, age, non-English speaking background, previous educational background, discipline, and type of enrollment will predict whether a candidate achieves timely degree completion (Rodwell & Neumann, 2008, p. 68). To test their hypothesis, the authors used data from Australia's Graduate Destination Survey for 347 graduates of two institutions during the years 2000-2005. After standardizing time to degree values for their sample to full-time equivalent (FTE), they found major differences between the times to degree of full- and part-time students. According to their methodology, the FTE standardized time to degree for part-time students was 3.25 years compared to 5.0 years for full-time students (Rodwell & Neumann, 2008). Part-time students from English-speaking backgrounds who were in life science, hard science, and social science disciplines were more likely to finish in fewer than 3.25 FTE years, while the same variables plus residency predicted timely degree completion among full-time students. They found that both completion rates and time to degree were subject to disciplinary differences, a finding that is consistent with Becher (1981) and Nettles and Millett (2006). Within their sample, Rodwell and Neumann (2008) observed faster time to degree, regardless of enrollment type, among students in life science disciplines, and comparatively slower completion rates for part-time students in language, humanities, and law disciplines. They assert that their findings confirm that students in science disciplines experience faster time to degree than their non-science peers. While their findings do substantiate those of studies ranging from Bowen and Rudenstine (1992) to Nettles and Millett (2006), one aspect of their methodology is inconsistent with the approach taken in this dissertation. The use of a standardized time to degree allows for comparison across enrollment types, but does not account for total time to degree and the years dedicated to doctoral study.

Synthesis and Summary of the Literature

The research that planted the first of many seeds for this dissertation was conducted by Yaritza Ferrer de Valero (2001). Based on the research from Dr. Ferrer de Valero's (2001) own doctoral dissertation, the article in *The Journal of Higher Education* begins "time to doctoral degree has increased consistently in American universities since

1967, in some fields by as much as two years" (p. 341). I have read that simple sentence thousands of times and always wondered, why? Why has time to degree increased? Did degree requirements change significantly? Are subsequent generations of people somehow less intelligent or less capable than their pre-1967 peers? Although I ask these questions here in a rhetorical sense, my questions of 'why' were not answered by the existing literature. Many consider the works of Bowen and Rudenstine (1992), Lovitts (2001), and Nettles and Millett (2006) the cornerstones of the doctoral degree completion and attrition picture, but as valuable as they are, none of these studies satisfied my intellectual curiosity or sufficiently answered my own 'why' questions. That is perhaps because my 'why' questions eventually evolved into questions of 'what' and became the foundation of this dissertation.

As I began to explore my dissertation topic, I sought to understand *what* makes time to degree longer for some students. My quest for understanding has been guided by the conceptual and theoretical framework presented in Chapter One, as well as the existing research presented in this chapter. We know from the research that individual factors and characteristics, socio-demographic factors, and institutional factors all impact time to degree. We know that some of those factors are unchangeable, others are subject to minimal or moderate influence, and others can be changed significantly or controlled by the institution and its representative. We know that disciplines are different and that what impacts time to degree in one field might be neutral or irrelevant in another.
Table 1, subsequent pages, summarizes and attributes the work of the key authors who

have influenced how I conceptualize and approach the study of time to degree. Knowing what impacts time to degree is only half the battle. We also need to know, as I have defined it for the purposes of this dissertation, what is extended time to degree? The extensive body of research described in Table 1 does not adequately identify or define the institutional characteristics which are more likely to impact or lead to extended time to degree, relative to the discipline, for the students in each field who take the longest to complete the degree and graduate. This dissertation seeks to fill part of that gap.

Table 1: Summary of Relevant Literature

Individual Characteristics:	
Abedi & Benkin (1987); Berg & Ferber (1983); Ellis (2001); Lovitts (2008); Maher, Ford, & Thompson (2004); Mason & Goulden (2004); Nettles (1990a); Nettles (1990b); Nettles & Millett (2006); Pressey (1962); Seagram, Gould, & Pyke (1998)	• The individual qualities of the student—intelligence, knowledge, thinking style, personality, and motivation—are unique to the individual but are subject to some degree of influence by the institution or the doctoral program. • The socio-demographic characteristics of the student—gender, age, race/ethnicity, citizenship, and parental status—are fixed factors which cannot be changed by the institution or the doctoral program. • Both individual qualities and socio-demographic characteristics play a significant role in the student's adaptation to the program environment, their perception of mentoring, and access to funding. • The interactions between the individual qualities and socio-demographic characteristics of the student—commonly referred to as the "life happens" reasons for departure from or longer enrollment in doctoral study—are factors beyond the control of the institution or the doctoral program, but need not be the source of delay or departure if adequate services and support are available. • ANTICIPATED OUTCOME: Individual characteristics cannot be controlled by the institution, but can have an increasing effect on time to degree.
Institutional/Program Characteristics: Selection:	
Gardner (2009a); Lovitts (2001); Lovitts & Nelson (2000); Nettles & Millett (2006)	• Prospective and new students need up-front information about the doctoral program including academic expectations, anticipated length of study, and program completion rates. • The steps taken by graduate programs to help acclimate new students and encourage 'fit' between the student and program are critical to a successful doctoral experience. • Successful selection is closely linked to mentoring due to the need for early connections between students and mentors.

	• ANTICIPATED OUTCOME: Selection has little or no increasing effect on extended time to degree.
Mentoring (Support and Training)	
Baird (1995); Bargar & Mayo-Chamberlain (1983); Burnett (1999); Creighton, Creighton, & Parks (2010); Gardner & Barnes (2007); Golde (2000); Nettles & Millett (2006)	• Mentors and advisers serve many roles: academic, professional, and personal to help the student navigate the doctoral program • The mentor/adviser sets the example and tone for the student of the culture and climate of the discipline. • How well the mentor and student adapt to each other's style, expectations, and needs impacts their collaborative relationship. • Mentoring follows several different formats—master-apprentice models, group advising models, and master-protégé models—the key is to find the right model for the student and the discipline. • ANTICIPATED OUTCOME: Mentoring factors can reduce time to degree.
Financial Support	
Abedi & Benkin (1987); Bowen & Rudenstine (1992); Ehrenberg & Mavros (1995); Nettles and Millett (2006)	• Financial support is critical to student success and degree progress, with students who have more support completing at higher and faster rates. • Type, length, and amount of support can make a difference in the degree progress and time to degree of a doctoral student. • New views of financial support include providing health benefits for students and their dependents. • Poor financial support or self-support distracts students from their academic goals and endeavors due to the need to find support elsewhere (usually outside of the institution). • ANTICIPATED OUTCOME: Financial support factors can reduce time to degree.
Program Environment, Processes, and Procedures	
Girves & Wemmerus (1988); Golde (2005); Golde & Dore (2001)	• Students who have clear sense of requirements are more likely to feel integrated and eventually succeed in the doctoral program. • Environment, culture, and climate are critical pieces of student integration that impact student comfort and engagement in the doctoral program. • Integration and understanding of the academic milestone requirements (e.g. coursework, exams, service, research, and the dissertation) of the program are vital for degree completion. • There are critical transition points—coursework to exams, exams to research, dissertation, and student to professional—where students can get derailed if departmental expectations are unclear. • ANTICIPATED OUTCOME: Program environment, processes and procedures have limited effect to reduce time to degree.

Research Mode of the Field and Discipline	
Becher (1981); Biglan (1973a/ 1973b); Isaac, Quinlan, & Walker (1992); Nettles & Millett (2006)	• Time to degree is longer for students in humanities and social sciences, and shorter for students in science and engineering fields. • Disciplinary differences must be observed in research and analysis of degree progress and time to degree. • To succeed as researchers, doctoral students need to be taught the research mode of their field. • The mentor is a critical part of disciplinary training and transition to independent research. • Exposure to research, early and often, aids degree completion. • ANTICIPATED OUTCOME: Factors associated with research mode of the field can reduce time to degree.
Existing research on long time to degree	
Maher, Ford, & Thompson (2004); Rodwell & Neumann (2008)	• Current research evaluates factors and issues that impact time to degree without defining what constitutes long time to degree. • The lack of a definition, relative to discipline, for extended time to degree means existing research does not specifically target which characteristics of institutions more likely to impact ETTD.

The next chapter outlines the research methodology for this dissertation, including the sources of data, the specific institutional characteristics to be evaluated, and the analytical and statistical approach. The chapter also demonstrates how the framework provided by the conceptual model and the attention to disciplinary differences reinforce the validity of this approach to the study of extended time to degree in doctoral programs.

CHAPTER THREE

Research Methodology

This chapter outlines the research methodology for this dissertation, the sources of data, the specific institutional characteristics to evaluated, and the analytical and statistical approach. This dissertation evaluates selected institutional and program characteristics that may contribute to, predict or have a higher probability of contributing to extended time to degree in doctoral programs. The primary research question is: What institutional characteristics impact extended time to degree in doctoral programs? As previously noted, to address the primary research question, the statistical analysis for this study is quantitative. Hierarchical linear modeling is the statistical method used to identify institutional factors that contribute to extended time to degree for the students who take the longest to complete the doctorate and graduate, relative to their disciplinary peers. The first section of this chapter describes the sources of data used for this study, as well as a rationale for the selection and use of those data. The sections that follow provide a justification for why Hierarchical linear modeling is an appropriate methodology to answer the research questions and explain the analytical approach. The final section summarizes the methodological approach and how the data sample was generated.

Data Sources and Rationale

The goal of this research is to identify institutional factors that impact extended time to degree for doctoral students in a broad sample of institutions. In order to achieve a representative sample on such a large scale, this dissertation draws from existing nationally collected data sources to analyze the institutional characteristics that contribute to extended time to doctoral degree across a broad sample of institutions and institution types. The primary data for the research are drawn from the Doctorate Records File (DRF) of the Survey of Earned Doctorates (SED). The SED is a nationally prepared, institutionally administered survey of all doctorate recipients in the United States. The SED is sponsored by six federal agencies: the National Science Foundation (NSF), the National Institutes of Health (NIH), the Department of Education (DOE), the Department of Agriculture (USDA), the National Endowment for the Humanities (NEH), and the National Aeronautical and Space Administration (NASA). The survey is conducted annually for all doctorate recipients between the period July 1 and June 30 of the following year, and the data are collected on behalf of these agencies by the National Opinion Research Center (NORC) at the University of Chicago. Graduating doctoral students typically complete the SED at the time that they submit the final copy of their dissertation to the institution, although there is variation in the approach taken by institutions in administering the survey. Completed surveys are then sent by those institutions to NORC where the results are compiled and analyzed. This study looks at data for the fiscal years 2004, 2005, and 2006 in order to coincide with the collection period for the supplemental data, described below. The dataset is substantial in size and contains student-level records for more than 130,000 doctoral recipients.

The survey is divided into three sections: Part A—Education, Part B—Postgraduation Plans, and Part C—Background information. The research for this dissertation analyzes the data available from Parts A and C. In Part A, SED respondents are asked to identify their graduate program, the title and disciplinary field of their dissertation, the primary and secondary types and level of financial support that they received during their doctoral student career, their outstanding debt from both undergraduate and graduate education, their education history, their enrollment pattern while in graduate school for the doctorate, and their enrollment pattern while pursuing any graduate school. The SED data provides the individual-level records which are necessary to determine the patterns of time to doctoral degree and the point of extended time to degree within each discipline. The information collected in Part A of the SED also provides data points which are used to address one of the six sections of the middle ring of the Ph.D. kaleidoscope: financial support. The individual-level financial support data provides a rich set of information from which to compare levels and types of support across a single discipline and to better understand the impact of that support on extended time to degree. The categorization by the doctorate recipient of his or her discipline serves as a proxy for research mode of the field.

In Part C, SED respondents are asked questions regarding their socio-demographic background. The demographic data about the doctorate degree recipients enabled this research to control and look for institutional effects based on gender, citizenship, race and ethnicity, marital status, child dependents, age, and highest educational attainment of parents. These data are consistent with the socio-demographic characteristics of students identified by the outer ring of the Ph.D. kaleidoscope. A list of the data fields available from the SED are provided in Table 2. While the aggregate results of the SED are published annually, the individual-level data are considered restricted data, but are available to researchers by special request. Analyses of the SED data must be reported in the aggregate or in such a manner that the published results cannot be used to identify individual students. Since the goal of this research is to identify and predict factors on a broad scale that contribute to extended time to degree, relative to discipline, the objective is not in conflict with the disclosure limitations.

Table 2: Data elements selected for use from the Survey of Earned Doctorates

SED Survey Question:	***SED Question:***
A.	Year Completed PhD
A2.	Name of the primary field of your dissertation research.
A5.	Which of the following were sources of financial support during graduate school?
A8.	When you receive your doctoral degree, how much money will you owe that is directly related to your undergraduate and graduate education?
A12.	In what month and year did you first enter any graduate school in any program or capacity?
A13.a.	How many years were you taking courses or preparing for exams for this doctoral degree (including a master's degree, if that was part of your doctoral program)?
A13.b.	How many years were you working on your dissertation after coursework and exams (non-course related preparation and research, writing and defense)?
A16.	Are you earning, or have you earned, an MD or a DDS?
C1.	Gender.
C2.	Marital status.
C3.	Number of dependents.
C4.	What is the highest educational attainment of your mother and father?
C6.	What is your date of birth?
C7.	What is your citizenship status?
C12.	What is your racial background?

The second source of data is the publicly available information from the National Research Council's (NRC) *A Data-based Assessment of Research-Doctorate Programs in the United States* (henceforth, the NRC study or the 2010 study) released in September 2010. The 2010 study is the third assessment of doctoral programs conducted by the NRC, previous studies were released in 1995 and 1982, but is the first to rely heavily on data provided by and collected about the participating institutions, programs, and faculty. The data collected by the NRC for the 2010 study covers over 5,000 Ph.D. programs in 62 fields at 212 institutions (Ostriker, Kuh, & Voytuk, 2010). For a field or discipline to be included in the NRC study, at least 500 Ph.D. degrees had to have been awarded in the five years prior to 2004-05, and at least 25 universities had to have programs in that field. The NRC also identified 14 emerging fields for which they collected data but did not produce rankings of programs. Since the research for this dissertation incorporates the use of the supplemental data, rather than the rankings calculated by the NRC, I am able to evaluate extended time to doctoral degree for the majority of fields and programs for which data were collected.

The doctoral programs and institutions that participated in the NRC study were asked to determine the most appropriate field for each program using a taxonomy provided by the NRC. Data were collected identically for all fields, and the taxonomy distinctions were used for grouping the programs during the NRC's own statistical analysis. For the purposes of this dissertation, the discipline and field information are drawn from the NRC data. Because the analysis in this dissertation draws only from the data collected by the NRC without incorporating any of the NRC's rankings of doctoral programs, the integrity of the data is maintained. Institutions participating in the 2010 study provided data to the NRC regarding the control of the institution, the numbers of students and faculty associated with each program, certain demographic characteristics about the students and faculty, and financial support provided to doctoral students. The programs also provided the NRC with information about the types of services and support available to doctoral students within the program, such as a new student orientation, instruction in writing or statistics, and whether annual evaluations were performed for all students. Participating institutions were asked to identify whether a program or service was offered only at the institution level, only at the program level, by both the institution and the program, or by neither the institution nor the program. In order to conduct their rankings of graduate programs, the NRC also sought direct information from faculty. The faculty were asked to rank-order the characteristics about graduate education that they felt were most important to their field. The faculty rankings of program characteristics are not publicly available at this time and are not used in the analysis for this dissertation. A list of the relevant data fields available from the NRC study are provided in Table 3. Because the data available from the NRC study represents a slightly smaller sample than that of the SED data, which includes all doctorate recipients, the use of NRC data reduced the scale and scope of this research to only those fields and programs included in the NRC data. The reduction in size of the data set did not negatively impact the validity or the significance of the analysis.

Table 3: Data elements selected for use from the NRC's *A Data-based Assessment*

NRC Column:	NRC Field Title:
C	Field
G	Control [Public/Private]
I	Program Size Quartile
T	Average Num. of Publications (2000-06) per Allocated Faculty, 2006
V	Percent of Faculty with Grants, 2006
X	Percent of First Year Students with Full Financial Support, Fall 2005
AA	Percent with Academic Plans
AC	Non-Asian Minority Faculty as a Percent of Total Core and New Domestic Faculty, 2006
AD	Female Faculty as a Percent of Total Core and New Faculty, 2006
AE	Non-Asian Minority Students as a Percent of Total Domestic Students, Fall 2005
AF	Female Students as a Percent of Total Students, Fall 2005
AG	International Students as a Percent of Total Students, Fall 2005
AJ	Average GRE Scores, 2004-2006
AO	Total Faculty, 2006
AT	Number of Students Enrolled, Fall 2005
AU	Average Annual First Year Enrollment, 2002-2006
AV	Percent of Students with Research Assistantships, Fall 2005
AW	Percent of Students with Teaching Assistantships, Fall 2005
BB	Orientation for New Graduate Students
BC	International Student Orientation
BH	Assistance / Training in Proposal Writing
BQ	Annual Review of All Enrolled Doctoral Students
BS	Travel Support to Attend Professional Meetings

The information available from the NRC study clearly identifies several factors associated with each ring of the completion kaleidoscope and the theoretical model. For instance, GRE scores serves as a proxy for selection—an area otherwise not represented in the data—and permits review of whether higher or lower GRE scores, when combined with other factors, predicts extended time to degree. Factors such as assistance/training in proposal writing respond to the need to assess whether student exposure to the research mode of the field can predict extended time to degree. Other factors from the NRC study, such as new student orientations, are used to assess the effect of the program environment, processes and procedures on extended time to degree. Travel support to attend professional meetings and percent of students in the program with teaching or research assistantships, combined with individual-level data from the SED makes it possible to further evaluate financial support for students. Finally, faculty and student demographics for each doctoral program are used to assess the availability of faculty and effect of mentoring on extended time to degree. It is important to note that the proxies for various institutional characteristics, such as selection and mentoring, represent good data, but may or may not demonstrate an effect on extended time to degree. Thus, the interpretation of the statistical analysis discussed in Chapter Five addresses the nature of the effect, negative or positive, of the proxy variables on extended time to degree.

Defining the Data Set

In order to access the SED data, I was granted a data license by the National Science Foundation and access to participate in the Data Enclave Project, henceforth the Enclave, of NSF and the National Opinion Research Center (NORC) at the University of Chicago. NORC compiles and maintains the SED data for NSF. Through the Enclave, I was granted access to the 2010 edition of the Doctorate Records File, representing an N=ALL, of the records for individuals who received a doctorate from a U.S. institution and completed the SED, 1963-2010. In total, the 2010 DRF contains 1,892,307 records.

To improve the quality of the analysis for this dissertation, the research is limited in several ways in order to define a sample with no missing analysis variables. First, the sample is limited to only those SED records from the fiscal years 2004, 2005, and 2006 because these years, as previously noted, correspond to the timing of the data collection for the NRC study. After applying a filter for the selected years, 131,124 records from the SED were identified. Those records were then mapped to program-level NRC data which had been limited to only those records with no missing values for the selected analysis variables. The NRC records included data for 4,700 graduate programs which were then further limited, as described below, to 4,191 program records in non-duplicated fields.

It is important to note here one limitation of the crosswalk developed by NSF to link data between the SED and NRC. The SED asks degree recipients to identify one or more disciplines associated with their doctoral program. SED has not created a catalog or taxonomy of the various degree programs offered by institutions, but instead uses these field designations. By doing so, the SED tracks the evolution of disciplines, not degree programs, new programs, name changes, etc., across U.S. institutions. While the design and approach are appropriate for the longevity of the SED, it differs from the survey design for the NRC, which is an actual and static listing of programs at a given point in time.

The crosswalk between the SED and NRC matches programs based on the academic field identified in each data set. For many programs, such as English, French, Physics, and Chemistry, this pairing of data at the program level can be done with relative ease. However, in instances where an institution offers more than one doctoral degree program within the same discipline, a single SED record can link to two or more NRC Fields, thereby creating duplicate or triplicate records. Unfortunately, it is impossible to identify which of the multiple programs in the NRC data should be associated with the SED record. For the purposes of this analysis, I have elected to reduce the introduction of error into the sample by removing instances of multiple programs within the same field at the same institution from the record set. After making the determination to eliminate the multiple field programs, the mapping between the 131,124 SED individual records and the 4,191 NRC program records further reduced the sample size to 43,722 records.

The next set of filters applied to the sample is perhaps the most critical. First, only those records for which NSF was able to calculate time to degree populated in the SED variable "Total elapsed time from graduate entry to Doctorate" were selected. The variable is calculated using data from the variables for the MONTH and YEAR of entry into graduate school, subtracted from MONTH and CALENDAR YEAR of degree award. The filter produced 39,276 records. However, because the goal of this research is to evaluate the effect of institutional factors on doctoral time to degree, specifically for those with extended time to doctoral degree, another filter was applied to select only those records where the variable "Year of graduate entry" equaled the value for the variable "First year at Doctoral institution." SED data does not include a variable for MONTH of entry at the Doctoral institution, which would be required to accurately calculate a value for total elapsed time from DOCTORAL entry to Doctorate. Thus, a filter was employed to limit the sample to only those SED records where the values for the fields doctoral entry and graduate entry were equal. The result reduced the sample to 38,208 records.

The sample data were then transformed to prepare certain variables for analysis and to identify additional records which could be eliminated due to missing values in the socio-demographic and individual variables. Data transformations for four variables require explanation.

AGE: the approximate age of the doctorate recipient at the time of degree award was calculated based on the SED data variables Birth Month, Birth Year, Month of Doctorate and Calendar Year of Doctorate. Because a value for date was not available when determining either birthdate or award of doctorate, exact age could not be determined. However, calculations were made using the 15th of the month as the date for both birth and degree award to account for variation in the length of each month as well as variation in the dates degrees are awarded within the month. Records for which approximate age could not be calculated were dropped from the sample.

DEPENDENTS: Since 2004, SED has recorded whether a survey respondent indicated no dependents or dependents in one of three age ranges: 0-5, 6-18, or 19^{+}. For the purposes of this research, any survey respondent who indicated one or more dependents in any of the three age ranges was coded in a dichotomous variable DEPENDENTS as “1” = having dependents, while those who indicated no dependents were coded as “2” in the dichotomous variable. Survey respondents who did not respond to the SED question were dropped from the sample.

CITIZEN: a dichotomous variable was generated in which all records for those who identified themselves as U.S. Citizens or Permanent Residents were coded as “1”, while all others who provided citizenship information were coded as “2.” Records for which citizenship could not be determined were dropped from the sample.

DEBT: the SED collects information from survey respondents regarding cumulative undergraduate and graduate debt from loans using monetary ranges. For instance, a survey respondent could have $10,001-$20,000 in undergraduate debt and $10,001-$20,000 in graduate debt. Since amount and level of debt incurred is not the focus of this research, rather the question relates to whether the degree candidate took loans, three dichotomous variables were created: UGDEBT, GDEBT, and DEBT. For both UGDEBT and GDEBT, if the survey respondent indicated any level of debt, a “1” value was recorded. If no debt was incurred, a “2” was recorded. Missing values were left as missing values. The DEBT variable was recorded as “1” if the respondent reported that they incurred debt at either the undergraduate or graduate level en route to the doctorate. Since it is the intention of the research to analyze the effect of incurred debt on extended time to degree, missing data at one level does not require complete elimination of the record if debt could be determined from the other level. If the SED respondent did not report incurred debt at either the undergraduate or graduate level, then the DEBT variable was recorded as “2.” If data were missing at both the undergraduate and graduate level, the record was dropped from the sample.

Records for other socio-demographic and individual variables which did not require extensive data transformation were similarly evaluated for missing values and dropped if appropriate. There were insufficient numbers of records from two of the NRC Fields to include them in the analysis without potential individual disclosure, so those records were removed as well. Ultimately, the data transformations and removal of records with missing values produced a sample with 18,545 records.

Two additional data transformations were then performed in order to finalize the data set. First, the data were aggregated by NRC Field to calculate the mean and standard deviation of time to degree, using the variable TTDGEPHD which represents time in the doctorate at the specified institution. Variables were then calculated for Mean^{+}1SD, Mean^{+}2SD, and Mean^{+}3SD. Using the previously stated definition of extended time to doctoral degree—elapsed time equal to or greater than one standard deviation beyond the mean—all records meeting that criteria were coded as “1” in a dichotomous variable labeled ETTD. All records for which time to degree did not exceed one standard deviation beyond the mean were coded as “2” for the ETTD variable. Finally, in order to address and control for skewing of the analysis by outliers, those records with particularly long extended time to degree—all records with elapsed time to degree equal to or greater than three standard deviations beyond the mean—were capped at a value equal to the mean plus three standard deviations (MEAN3SD). Time to degree was capped for 329 records, or 1.8% of the 18,545 records. The final values for time to degree, original or capped, were recorded in a new variable, simply TTD, which served as the dependent variable for all analyses. With that, the preparation of the data was determined to be complete. Chapter 4 provides detailed descriptive statistics, Chapter 5 details the statistical analysis, and Chapter 6 relates findings to extant research and makes recommendations for research and practice.

Justification

Previous research, such as the studies by Bowen and Rudenstine (1992) and Nettles and Millett (2006), have employed several different statistical approaches to study factors associated with doctoral degree attrition, completion, and time to degree. Bowen and Rudenstine (1992) used descriptive statistics to demonstrate the differences in completion rates and time to degree between students of different disciplines, gender, and other groups. Their approach is highly informative and provides critical background for future studies of time to degree, but it does not use more advanced statistical methods to identify or pinpoint factors, either individual or institutional, which impact those outcomes. Nettles and Millett (2006) extended their analysis beyond descriptive statistics to include analysis of variance, chi-squares, Hierarchical linear models and ordinary least-squares (OLS) regressions. They looked at the relationship between student background and graduate student experience through both linear and logistic regressions (Nettles & Millett, 2006). Similar techniques and statistical approaches have been employed by several of the other studies previously discussed in Chapter Two (Abedi & Benkin, 1987; Ferrer de Valero, 2001; Maher et al., 2004; Rodwell & Neumann, 2008). The methodological choices for these studies were carefully selected and served the purpose for which the respective studies intended them. The goal of this research is to address and expand what we know about the ongoing issue of extended time to degree using an accepted statistical approach, but a new data set.

The stated purpose of this research is to identify characteristics of institutions that contribute to or predict the phenomenon of extended time to degree for the graduates who take the longest to complete the Ph.D. degree, relative to their disciplinary peers. The data selected for this study and described in the previous section represents multi-level, or nested data. The data represent student-, program-, and institution-level variables. In order to determine if there are interactions between the different levels of data, and to identify the factors that influence extended time to degree, Hierarchical linear modeling has been selected as the statistical method for this dissertation. According to Raudenbush (1988), Hierarchical linear modeling is an appropriate method for the analysis of multilevel data because it "enable[s] researchers to formulate and test explicit statistical models for processes occurring within and between … units" (p. 86). He credits Lindley and Smith (1972), Novick, Jackson, Thayer, and Cole (1972), and Smith (1973), with conducting the work that eventually led to the theories and procedures that now permit researchers to analyze multilevel data. Raudenbush (1988) argues that as a tool to evaluate multilevel data, Hierarchical linear modeling resolves the possibility of issues associated with aggregation bias, and enhances the formulation and complexity of the research questions. Furthermore, the use of Hierarchical linear modeling permits more accurate estimation of the effects of the program- and institutional-level variables on extended time to degree (Kim, 2007).

In their study of the effects of resources, inequality, and privilege bias on achievement, Chiu and Khoo (2005) used data from the Organization for Economic Cooperation and Development's (OECD) Program for International Student Assessment (PISA). The PISA study assessed the knowledge and skill acquisition of 15-year-olds who were near completion of their compulsory education. The data allowed Chiu and Khoo (2005) to analyze data for a large sample of schools from a number of different countries. They found that OLS regressions underestimated the standard errors in their multilevel data, which led them to use Hierarchical linear modeling in order to accurately model the effects of school and country on student achievement (Chiu & Khoo, 2005). The authors used two Hierarchical linear models for their regressions. They found that approximately half of the differences in student achievement in mathematics, reading, and science (MRS) could be attributed to student-level characteristics, one quarter of the differences occurred among school-level factors, and the remaining differences were attributable to country-level differences (Chiu & Khoo, 2005). In addition, individual students with access to greater resources at all levels had higher achievement scores, as did all students, generally speaking, from wealthier countries. Conversely, students from countries where resources were not distributed equally or equitably had lower MRS achievement scores. The use of Hierarchical linear modeling techniques allowed Chiu and Khoo (2005) to look for correlations within and between levels of their data, and to observe where changes must be made to both optimize and distribute resources in order to increase student learning and achievement.

In her study of the effect of loans on degree achievement, Kim (2007) used data from the 1995-1996 and 2000-2001 versions of the Beginning Postsecondary Student (BPS) survey which was administered by the National Center for Education Statistics (NCES). The latter of the two surveys was a follow-up to the first and yielded a sample of approximately 10,300 responses. Within that data, Kim (2007) further narrowed the size of the sample to the 3,251 baccalaureate degree-seeking students who first enrolled in four-year colleges and universities, all of whom had also taken student loans to finance their undergraduate education. Kim (2007) then identified a combination of student- and institution-level variables with which to build her model of the effect of student loans on degree attainment. Kim's (2007) analysis made use of a binary or dichotomous outcome variable, degree completion, which lead her to use Hierarchical generalized linear modeling (HGLM) to evaluate the effects of her multilevel data. Kim's (2007) methodology provides insight for one of the possible challenges of analysis for this dissertation. The time to degree data from the SED when evaluated by discipline may produce a normal distribution, in which case the value determined for extended time to degree might be calculated as one or two standard deviations above the mean. However, if the time to degree data from the SED are not normally distributed, or if a skewed or split distribution is observed, then the dependent variable might be determined as a specific point and recorded in a dichotomous variable. In the case of Kim's (2007) study, the use of the HGLM model permitted her to evaluate the effect of loans on degree attainment for students from different income groups and different racial/ethnic groups. She was also able to evaluate how different student and institution variables impacted degree attainment between these groups. The statistical methodology from Kim's (2007) study guided the decision regarding the statistical approach for this dissertation and the analysis of extended time to degree.

A third example of the use of Hierarchical linear modeling to study multilevel factors associated with achievement and degree completion was conducted by Kim and Otts (2010). The authors used student-level data from the 2005 SED, the same primary source of data as used for this dissertation, and paired it with institution-level data from the Integrated Postsecondary Education Data System (IPEDS) hosted by NCES. With a sample of 21,683 U.S. citizens and permanent residents, Kim and Otts (2010) sought to test the effect of student loans on time to the doctorate degree. Due to the nested nature of the data where students exhibit similarities within a discipline across institutions, and within an institution regardless of discipline, Kim and Otts (2010) used Hierarchical linear modeling to estimate the effects of college variables on student outcome variables. The authors conducted their analysis within broad disciplinary fields, as defined by NSF, and looked first at the borrowing trends among students and then at the patterns of degree completion. Relevant for this study for more than just the statistical methodology, Kim and Otts (2010) found that "the type of financial support students receive in graduate school influences time to degree completion" (p. 22). Interestingly, they found that students with more than $50,000 in loan debt completed the doctorate faster than their non-borrowing peers in all fields except social sciences, where students with lesser loan amounts completed at times to degree comparable to their non-borrowing peers (Kim & Otts, 2010). Like the study for this dissertation, the analysis is limited to only those students who actually complete the doctorate, thus, they suggest additional research to determine the effect of loans on whether the student completes the degree at all, not just the timeliness of degree completion. Like both Chiu and Khoo (2005) and Kim (2007), Kim and Otts' (2010) study demonstrates how Hierarchical linear modeling is a useful statistical method to identify and predict the effect of multilevel factors on the dependent variable, in the case of this dissertation, extended time to degree.

Statistical Approach

For analysis purposes, the combined data from the SED and the NRC are categorized into factors, or levels, associated with each of the three rings of the kaleidoscope, as described in the theoretical model: student qualities, socio-demographic factors, and institutional factors. The broad categories are then further divided into the sub-categories identified by the middle and outer rings, respectively. Table 4 details the categorization of factors as used for the Hierarchical linear model analysis. The factors identified as Discipline & Institutional Factors, Socio-Demographic Factors, and Student Qualities & Time to Degree Factors serve as control factors and calculation variables to determine the students, relative to discipline, with extended time to degree. The factors in the remaining six sections served as continuous variables against which I conducted the Hierarchical analysis of extended time to degree.

Table 4: Categorization of Factors for Descriptive Statistics and Analysis

Factor Type:	Data Source:	Question:
Institutional Factors		
Discipline & Institutional Factors	NRC	Field
		Control [Public/Private]
		Program Size Quartile
	SED	Name of the primary field of your dissertation research.
Financial Support	NRC	Percent of Students with Research Assistantships, Fall 2005
		Percent of Students with Teaching Assistantships, Fall 2005
		Percent of First Year Students with Full Financial Support, Fall 2005
	SED	Primary source of financial support
		At the time of graduation, debt incurred related to undergraduate and graduate education
Support and Training	NRC	Assistance / Training in Proposal Writing
		Travel Support to Attend Professional Meetings
Processes & Procedures	NRC	Orientation for New Graduate Students
		International Student Orientation
		Annual Review of All Enrolled Doctoral Students
Program Environment	NRC	Non-Asian Minority Faculty as a Percent of Total Core and New Domestic Faculty, 2006
		Female Faculty as a Percent of Total Core and New Faculty, 2006
		Non-Asian Minority Students as a Percent of Total Domestic Students, Fall 2005
		Female Students as a Percent of Total Students, Fall 2005
		International Students as a Percent of Total Students, Fall 2005
		Total Faculty, 2006
		Number of Students Enrolled, Fall 2005
		Average Annual First Year Enrollment, 2002-2006

Factor Type:	Data Source:	Question:
Research	NRC	Percent with Academic Plans
		Average Num. of Publications (2000-06) per Allocated Faculty, 2006
		Percent of Faculty with Grants, 2006
Selection	Carnegie	Carnegie Classification
	NRC	Average GRE Scores, 2004-2006
Socio-Demographic Factors		
Age; Citizenship; Gender; Marital/Parental Status; Race/Ethnicity	SED	Gender
		Marital status
		Number of dependents
		Date of birth
		Citizenship status
		Racial background
Student Qualities & Time to Degree Factors		
Individual & Time to Degree Characteristics	SED	Year completed PhD
		Month and year first entered any graduate school in any program or capacity
		Years taking courses or preparing for exams for this doctoral degree (including a master's degree, if that was part of your doctoral program)
		Years working on your dissertation after coursework and exams (non-course related preparation and research, writing and defense)
		MD or DDS degree
		Highest educational attainment of mother/father

The SED and NRC data are appropriate data sets for the analysis in this dissertation for several reasons. First, a study of extended time to degree across a broad spectrum of institutions requires a comprehensive, or nearly comprehensive, data set. The value for extended time to degree is calculated as one standard deviation beyond the mean for each field, which ensures that the analysis of institutional characteristics is relative to discipline rather than generalized across the doctoral enterprise. One could attempt to collect the individual- and program-level data necessary to generate the required dataset, but the task would be wrought with methodological challenges and error-prone. Therefore, the use of existing, nationally collected data is a more effective choice. The SED is collected using an approved and reputable protocol by a consistently reputable organization (NORC). The annual collection of SED data also allows for replicability of the study. The raw data for the NRC study were collected using a methodology and protocol approved by the National Academies. The SED and NRC data fulfill the requirements for the individual- and program-level data, respectively, which are necessary in order to conduct Hierarchical analysis of the institutional factors associated with extended time to degree.

Second, the SED data provides valuable individual-level data. To elaborate, individual-level data are necessary in order to determine the point of extended time to degree, equal to one standard deviation beyond the mean, when survey respondents in a given field completed the Ph.D. relative to their disciplinary peers. The graduates in each discipline who have time to doctoral degree equal to or greater than one standard deviation beyond the field mean are identified for the remainder of the research as those who experienced extended time to degree. The SED data also contain detailed information about the actual financial support received by each Ph.D. recipient and that individual's socio-demographic characteristics. This study controlled for demographic characteristics in order to address whether institutional factors associated with extended time to degree impacted constituencies differently.

Third, the data from the 2010 NRC study provided the program-level data which was necessary to understand the institutional characteristics that impact extended time to degree, excluding financial support which was gathered from the SED data. The characteristics and conditions as defined for each program were the same for all students enrolled in that program. The variation in how those characteristics and factors impact students was observed through the interaction of individual and program characteristics and in the Hierarchical analysis of extended time to degree. In addition, Charlotte Kuh, Director of the 2010 NRC study, has indicated that the NRC is considering repeating the collection of program and institution data every two years. Although it is too early to know if that data collection will in fact occur, the possibility means that analysis similar to that used for this dissertation could be conducted on a bi-annual basis. Thus, a follow-up analysis conducted two years from now using updated data from both the SED and regarding institutional factors could identify changes in patterns and trends associated with extended time to degree. The prospect of repeatability of the study strengthens the significance of this study.

Protection of Confidentiality and NSF Disclosures

The National Science Foundation requires that researchers analyzing restricted-use SED data protect the confidentiality and anonymity of individual survey respondents. In order to maintain the integrity of the study and the restricted-use data, results are never reported in a manner that could identify the individual. Results reported have been subject to Disclosure Review by NSF and approved for public dissemination. Results are reported by field and always in the aggregate. Results regarding any demographic characteristics are reported at the field level, not at the program level where the information could be individually identifying. These measures are consistent with the goal of this dissertation to identify characteristics of institutions that impact extended time to degree at a broad level, not at the individual level. The use of NSF data does not imply NSF endorsement of the research methods or conclusions contained within this dissertation. Further, NSF does not endorse the non-NSF data utilized in this report, does not assume responsibility for the accuracy of the non-NSF data, and does not necessarily endorse the research methodology used in the report.

Summary

This chapter outlined the research methodology selected for this dissertation, the sources of data, the specific institutional characteristics to be evaluated, and the analytical and statistical approach. I argued that Hierarchical analysis is an appropriate statistical approach to identify which of the factors of the theoretical model—admissions, financial support, mentoring, research mode of the field, program environment, and processes and procedures—contribute to extended time to degree for the students who take the longest to complete the doctorate and graduate, relative to their disciplinary peers. I presented three examples of the use of Hierarchical linear modeling to study factors associated with attrition, outcomes, and completion of Ph.D. programs. The chapter presented the rationale for the use of existing data sets, and made a case for the use of both individual-level data from the Survey of Earned Doctorates and program-level data from the NRC's

A Data-Based Assessment of Research-Doctorate Programs in the United States. Finally, I addressed the commitment to the National Science Foundation to maintain confidentiality and student anonymity in the analysis and reporting of SED data.

CHAPTER FOUR

Descriptive Statistics

This chapter details the descriptive statistics derived from the data sample in order to understand as much as possible about the extended time to doctoral degree graduates. The descriptive statistics provided within this chapter do not represent all of the descriptive statistics which can be generated from the combined SED and NRC data, but rather a representative sample. The presentation of data moves from macro level statistics to micro level statistics.

Institutions and Extended Time to Degree

Over the course of the three years included in this analysis—2004, 2005, and 2006—a total of 200 distinct institutions are represented. As displayed in Table 5, the number of institutions represented in each of the three years varies, with an overall count of 200. The variation in the number of institutions represented reflects annual changes in the fields from which students graduated for a cumulative total of 200 institutions.

Table 5: Distribution of Institutions and Doctorate Recipients by Fiscal Year of Doctorate and Extended Time to Degree

FY of Doctorate	Institutions Represented	Doctorate Recipients	ETTD Doctorate Recipients	ETTD Doctorate Recipients as a Percent of Overall
2004	196	6,225	767	12.32%
2005	191	5,856	630	10.76%
2006	192	6,464	636	9.84%
OVERALL	200	18,545	2,033	10.96%

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Table 5 also details the number of doctorate recipients represented in the sample from each of the three years and of those, the number of extended time to doctoral degree graduates representing almost 11% of the total sample. The overall measures of extended time to doctoral degree are the aggregate of the field-level determinations of extended time to doctoral degree.

Field and Extended Time to Degree

Table 6 details the frequencies and descriptive statistics for each of the fields included within the dataset for analysis. In all, 58 different fields are represented. The N, Min, Max, Mean, and SD are calculated using standard statistical methods. Extended time to doctoral degree is the calculation, by field, of the Mean of elapsed time to doctoral degree plus one standard deviation. Capped TTD represents the Mean plus three standard deviations. As described in Chapter Three, records which equaled or exceed a value for elapsed time to degree greater than three standard deviations beyond the Mean were capped to prevent skewing of the analysis.

The next three columns in Table 6 detail the Ns of those graduates within each field who did NOT experience extended time to doctoral degree, those who did, and the percent of extended time to doctoral degree graduates, relative to the field. Overall, the Median value for %ETTD is 10.976% while the Mode is 11.11%. Theatre and Performance Studies had the fewest extended time to doctoral degree graduates with only 6.52%, while Nursing had the highest number with 19.35%.

Table 6: Characteristics of Elapsed Time to Doctoral Degree by Field

Field	N	Min	Max	Mean	SD	ETTD	Capped TTD	N Not ETTD	N ETTD	% ETTD
OVERALL	18,545	1.92	33.66	6.99	2.89	--	--	16,512	2,033	10.96%
Aerospace Engineering	248	3.25	14.14	6.39	1.92	8.31	12.15	228	20	8.06%
Agricultural and Resource Economics	97	3.25	18.19	7.47	3.41	10.88	17.70	84	13	13.40%
American Studies	99	4.41	21.59	9.54	3.57	13.11	20.25	89	10	10.10%
Animal Sciences	77	3.66	14.06	6.67	2.30	8.97	13.57	68	9	11.69%
Anthropology	634	3.75	22.66	9.68	3.60	13.28	20.48	574	60	9.46%
Applied Mathematics	207	2.75	13.63	5.81	1.87	7.68	11.42	190	17	8.21%
Astrophysics and Astronomy	114	3.75	10.66	6.13	1.18	7.31	9.67	102	12	10.53%
Biochemistry, Biophysics, and Structural Biology	823	2.00	10.23	5.98	1.32	7.30	9.94	722	101	12.27%
Biology/Integrated Biology/Integrated Biomedical Sciences	81	2.66	11.04	6.24	1.46	7.70	10.62	73	8	9.88%
Biomedical Engineering and Bioengineering	565	2.00	11.68	5.93	1.64	7.57	10.85	513	52	9.20%
Cell and Developmental Biology	307	3.34	10.00	6.24	1.21	7.45	9.87	271	36	11.73%
Chemical Engineering	1,028	1.92	10.52	5.47	1.27	6.74	9.28	949	79	7.68%
Chemistry	202	2.00	11.44	5.58	1.43	7.01	9.87	188	14	6.93%
Civil and	516	2.75	18.04	6.81	2.87	9.68	15.42	474	42	8.14%

Field	N	Min	Max	Mean	SD	ETTD	Capped TTD	N Not ETTD	N ETTD	% ETTD
Environmental Engineering										
Classics	75	4.66	18.22	8.61	3.16	11.77	18.09	62	13	17.33%
Communication	122	2.75	22.68	9.00	4.29	13.29	21.87	105	17	13.93%
Comparative Literature	196	4.66	17.55	8.72	2.80	11.52	17.12	167	29	14.80%
Computer Engineering	51	3.75	12.34	6.27	2.12	8.39	12.63	42	9	17.65%
Computer Sciences	1,162	2.58	13.88	6.65	2.14	8.79	13.07	1029	133	11.45%
Earth Sciences	99	4.17	14.83	7.04	2.24	9.28	13.76	88	11	11.11%
Ecology and Evolutionary Biology	277	2.91	15.34	6.94	2.15	9.09	13.39	250	27	9.75%
Electrical and Computer Engineering	1,612	2.00	14.01	6.38	2.15	8.53	12.83	1449	163	10.11%
English Language and Literature	120	2.66	21.47	8.77	3.59	12.36	19.54	107	13	10.83%
Entomology	80	2.91	14.32	6.85	2.37	9.22	13.96	70	10	12.50%
Food Science	51	2.58	24.04	7.80	4.69	12.49	21.87	47	4	7.84%
Forestry and Forest Sciences	31	2.92	16.77	6.76	2.74	9.50	14.98	28	3	9.68%
French and Francophone Language and Literature	111	4.25	16.87	8.36	2.66	11.02	16.34	94	17	15.32%
Genetics and Genomics	316	3.33	11.03	6.15	1.40	7.55	10.35	284	32	10.13%
Geography	133	3.00	17.11	7.88	2.87	10.75	16.49	116	17	12.78%
German Language and Literature	62	4.42	13.66	8.05	2.00	10.05	14.05	52	10	16.13%

Field	N	Min	Max	Mean	SD	ETTD	Capped TTD	N Not ETTD	N ETTD	% ETTD
History	73	3.25	17.17	8.70	3.21	11.91	18.33	61	12	16.44%
History of Art, Architecture and Archaeology	261	4.66	21.78	9.94	3.42	13.36	20.20	232	29	11.11%
Immunology and Infectious Disease	369	2.25	10.45	5.92	1.40	7.32	10.12	316	53	14.36%
Kinesiology	95	2.75	19.66	7.58	3.52	11.10	18.14	84	11	11.58%
Materials Science and Engineering	512	2.92	11.47	5.61	1.62	7.23	10.47	465	47	9.18%
Mathematics	68	2.75	12.31	6.12	2.02	8.14	12.18	57	11	16.18%
Mechanical Engineering	850	1.92	14.07	6.26	2.23	8.49	12.95	759	91	10.71%
Microbiology	497	2.25	11.48	6.07	1.40	7.47	10.27	456	41	8.25%
Music	362	3.59	20.73	8.49	3.69	12.18	19.56	316	46	12.71%
Neuroscience and Neurobiology	859	2.66	10.44	6.10	1.31	7.41	10.03	746	113	13.15%
Nursing	248	3.75	33.66	13.02	7.09	20.11	34.29	200	48	19.35%
Nutrition	168	2.00	18.40	6.44	3.01	9.45	15.47	155	13	7.74%
Oceanography, Atmospheric Sciences and Meteorology	116	3.92	12.88	6.92	1.90	8.82	12.62	101	15	12.93%
Operations Research, Systems Engineering and Industrial Engineering	201	2.00	20.54	7.06	3.53	10.59	17.65	185	16	7.96%

Field	**N**	**Min**	**Max**	**Mean**	**SD**	**ETTD**	**Capped TTD**	**N Not ETTD**	**N ETTD**	**% ETTD**
Pharmacology, Toxicology and Environmental Health	313	2.25	11.77	5.85	1.60	7.45	10.65	284	29	9.27%
Philosophy	436	1.92	20.42	8.28	3.18	11.46	17.82	398	38	8.72%
Physics	198	3.25	13.98	6.60	2.16	8.76	13.08	177	21	10.61%
Physiology	170	2.92	12.87	5.93	1.65	7.58	10.88	158	12	7.06%
Plant Sciences	166	2.25	17.69	7.13	2.94	10.07	15.95	150	16	9.64%
Political Science	740	2.75	17.30	8.07	2.91	10.98	16.80	634	106	14.32%
Psychology	771	2.09	13.68	6.84	2.14	8.98	13.26	663	108	14.01%
Public Affairs, Public Policy and Public Administration	84	3.75	29.89	10.71	6.28	16.99	29.55	72	12	14.29%
Public Health	216	2.25	20.02	8.11	3.71	11.82	19.24	187	29	13.43%
Religion	161	3.66	21.64	9.65	3.46	13.11	20.03	142	19	11.80%
Sociology	645	2.66	19.55	8.54	3.18	11.72	18.08	578	67	10.39%
Spanish and Portuguese Language and Literature	215	3.66	17.75	7.90	2.94	10.84	16.72	187	28	13.02%
Statistics and Probability	209	2.75	12.94	5.64	1.83	7.47	11.13	191	18	8.61%
Theatre and Performance Studies	46	3.92	24.65	9.10	3.92	13.02	20.86	43	3	6.52%

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Fields with more than 15% of their graduates experiencing extended time to doctoral degree are French and Francophone Language and Literature (15.32%), German Language and Literature (16.13%), Mathematics (16.18%), History (16.44%), Classics (17.33%), and Computer Engineering (17.65%). By comparison, fields with fewer than 8% of their graduates experiencing extended time to doctoral degree are Chemistry (6.93%), Physiology (7.06%), Chemical Engineering (7.68%), Nutrition (7.74%), Food Science (7.84%), and Operations Research, Systems Engineering and Industrial Engineering (7.96%). With the exception of Theatre and Performance Studies, which has the lowest %ETTD of all participating fields identified in this data sample, the other six fields with a particularly low %ETTD graduates are science and technology based disciplines. The longer time to degree for the Humanities and Social Science disciplines is consistent with observations from Denecke et al. (2009). Conversely, with the exception of Mathematics and Computer Engineering, which were initially surprising, four of the seven fields with the greatest percentage of extended time to doctoral degree graduates are from social science and Humanities disciplines.

The distinction here is that we are not looking at the Mean elapsed time to doctoral degree, but rather the %ETTD. If one looks at the fields with the lowest and highest Mean elapsed time to doctoral degree, then very traditional trends with regard to science vs. non-science disciplines are evident. In fact, the Mean, in years, is below six years for the ten fields with the fastest elapsed time to doctoral degree: Chemical Engineering (5.47 years), Chemistry (5.58 years), Materials Science and Engineering

(5.61 years), Statistics and Probability (5.64 years), Applied Mathematics (5.81 years), Pharmacology, Toxicology and Environmental Health (5.85 years), Immunology and Infectious Disease (5.92 years), Physiology (5.93 years), Biomedical Engineering and Bioengineering (5.93 years), and Biochemistry, Biophysics, and Structural Biology (5.98 years). All ten are science, technology and engineering disciplines. The ten fields with the longest, or slowest, Mean elapsed time to doctoral degree are, with the exception of Nursing which is struggling with both the highest %ETTD students and the longest time to degree, all social science and Humanities based disciplines: Comparative Literature (8.72 years), English Language and Literature (8.77 years), Communication (9 years), Theatre and Performance Studies (9.1 years), American Studies (9.54 years), Religion (9.65 years), Anthropology (9.68 years), History of Art, Architecture and Archaeology (9.94 years), Public Affairs, Public Policy and Public Administration (10.71 years), and Nursing (13.02 years).

Program Size Quartile and Extended Time to Degree

Table 7 notes statistics regarding the distribution of degree recipients by program size quartile and extended time to degree status. The percentages in parentheses represent the column distribution of graduates with and without extended time to degree, as well as overall, by program size quartile. The two columns labeled “% Size Quartile Not ETTD” and “% Size Quartile ETTD” represent the row distribution of graduates from each program size quartile by extended time to degree status.

Table 7: Distribution of Doctorate Recipients by Program Size Quartile and Extended Time to Degree

Program Size Quartile	Not ETTD		ETTD		Overall (% Overall)
	Count (% Not ETTD)	% Size Quartile Not ETTD	Count (% ETTD)	% Size Quartile ETTD	
Smallest Size Quartile	1,665 (10.08%)	85.78%	276 (13.58%)	14.22%	1,941 (10.47%)
2nd Quartile	2,645 (16.02%)	88.46%	345 (16.97%)	11.54%	2,990 (16.12%)
3rd Quartile	3,923 (23.76%)	89.08%	481 (23.66%)	10.92%	4,404 (23.75%)
Largest Size Quartile	8,279 (50.14%)	89.89%	931 (45.79%)	10.11%	9,210 (49.66%)
Overall	16,512	89.04%	2,033	10.96%	18,545

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Comparing the column percentages first, the proportion of graduates in each program size quartile is fairly consistent between those with and without extended time to doctoral degree. The proportion of degree recipients from 2nd Quartile sized programs are very similar for those with (16.97%) and without (16.02%) extended time to degree, varying by less than one percentage point. The proportion of degree recipients from 3rd Quartile sized programs are nearly identical for those with (23.66%) and without (23.76%) extended time to degree, varying by only one-tenth of a percentage point. The majority of degree recipients, those with and without extended time to degree, graduated from doctoral programs categorized as being in the largest program size quartile, and the fewest graduated from programs in the smallest size quartile. The relative consistency and apparent evenness in the distribution of degree recipients by program size quartile among those with and without extended time to degree allows us to reject any notion of disproportionate clustering of extended time to degree graduates in a particular program size quartile.

That said, analysis of the row percentages highlights an apparent link between smaller program size and extended time to degree. The smaller the program size quartile, the greater the proportion of graduates with extended time to degree. 14.22% of graduates from the smallest sized programs experienced extended time to degree compared to 10.11% of graduates from the largest program size quartile. The apparent link between smaller sized programs and extended time to degree will be explored further in the statistical analyses in Chapter Five.

Institutional Control, Carnegie Classification, and Extended Time to Degree

Turning to how the data compare by the type of institutional control—public vs. private—and by Carnegie Classification of the institution, public institutions awarded nearly twice as many of the doctorates within the sample, a ratio of almost exactly 2:1, public vs. private (see Table 8). A greater percentage of the degree recipients from public institutions, 11.6%, experienced extended time to doctoral degree compared to 9.8% of those at private schools.

Table 8: Distribution of Doctorate Recipients by Carnegie Classification, Institution Type, and Extended Time to Degree

	Public			Private			Overall (% by Carnegie Class)
2005 Carnegie Classification	**Not ETTD**	**ETTD**	**Overall**	**Not ETTD**	**ETTD**	**Overall**	
Research Universities (very high research activity)	9,531	1,185	10,716	5,181	534	5,715	16,431 (88.60%)
Research Universities (high research activity)	867	156	1,023	405	72	477	1,500 (8.09%)
Special Focus Institutions --Medical schools and medical centers	259	59	318	*small n*		72	390 (2.10%)
Doctoral/Research Universities	*small n*		15	93	18	111	126 (0.68%)
Institution Not Classified	*small n*		51	0	0	0	51 (0.28%)
Special Focus Institutions--Schools of Engineering	*small n*		22	0	0	0	22 (0.12%)
Baccalaureate Colleges--Arts & Sciences	0	0	0	*small n*		17	17 (0.09%)
Masters Colleges and Universities (larger programs)	*small n*		4	0	0	0	4 (0.02%)
Special Focus Institutions --Theological seminaries, Bible colleges, and other faith-related institution	0	0	0	*small n*		4	4 (0.02%)
Overall (% by Institution Type)	10,744 *(88.44%)*	1,405 *(11.56%)*	12,149 (65.51%)	5,768 *(90.18%)*	628 *(9.82%)*	6,396 (34.49%)	18,545 (100%)

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

The overwhelming majority of degree recipients, just over 96%, graduated from institutions categorized by the 2005 Carnegie Classification rubric as either Research Universities (very high activity) or Research Universities (high research activity). Less than 4% of the sample population graduated from institutions not categorized as a Research University by the 2005 Carnegie Classification. To comply with NSF confidentiality standards, Table 8 includes several cells which have been obscured due to small N's. NSF prohibits public disclosure of data where the cell size in a table is less than or equal to three, or where the small cell size could be mathematically derived from other data. In order to compensate for these very small N's, I have aggregated data for the smaller Carnegie Classifications in statistical analyses regarding institutional selectivity.

It is also helpful to consider institutional type differences for the mean elapsed time to doctoral degree. Table 9 details the overall mean elapsed times to degree for all fields within each Carnegie Classification, institution type, and extended time to doctoral degree distinction. There are a number of meaningful institutional type differences here. For instance, among the doctorate recipients in this sample, graduates from private institutions completed the degree 2.51% faster, overall, in 6.87 years vs. 7.05 years, than their counterparts at public institutions. Extended time to doctoral degree was 4.56% shorter, overall, at private institutions, although at institutions classified as Doctoral/Research Universities, the mean extended time to doctoral degree was better at public institutions, 9.33 years, than private institutions, 12.31, a difference of 31.85% in favor of the public universities.

Table 9: Mean Elapsed Time to Doctoral Degree (in years) by Carnegie Classification, Institution Type, and Extended Time to Degree

	Public			Private				% Difference in Mean Elapsed Time to Doctoral Degree between Public and Private Institutions		
Carnegie Classification	**Not ETTD**	**ETTD**	**Overall**	**Not ETTD**	**ETTD**	**Overall**	**Overall Mean**	**Not ETTD**	**ETTD**	**Overall**
Research Universities (very high research activity)	6.33	12.55	7.02	6.30	11.84	6.82	**6.95**	-0.48%	-5.67%	-2.86%
Research Universities (high research activity)	6.38	13.36	7.44	6.57	12.56	7.47	**7.45**	3.05%	-5.99%	0.45%
Special Focus Inst--Medical schools and medical centers	6.25	9.26	6.81	5.71	8.46	5.79	**6.62**	-8.63%	-8.67%	-15.01%
Doctoral/Research Universities	5.47	9.33	5.73	6.41	12.31	7.36	**7.17**	17.12%	31.85%	28.56%
Institution Not Classified	6.70	16.71	7.09	n/a	n/a	n/a	**7.09**	n/a	n/a	n/a
Special Focus Inst--Schools of engineering	5.74	13.58	6.09	n/a	n/a	n/a	**6.09**	n/a	n/a	n/a
Baccalaureate Colleges --Arts & Sciences	n/a	n/a	n/a	7.38	17.46	8.56	**8.56**	n/a	n/a	n/a
Masters Colleges and Universities (larger programs)	*small n*		11.16	n/a	n/a	n/a	**11.16**	n/a	n/a	n/a

Special Focus Inst--Theological seminaries, Bible colleges, and other faith-related institutions	n/a	n/a	n/a	*small n*		8.46	**8.46**	n/a	n/a	n/a
Overall Mean	6.33	12.51	7.05	6.32	11.94	6.87	**6.99**	-0.22%	-4.56%	-2.51%

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

At both public and private institutions, without regard to Carnegie classification, the mean of time to doctoral degree for graduates with extended time to degree is, overall, nearly twice that of their counterparts without extended time to degree. Among graduates from institutions categorized by the Carnegie classification Research Universities-very high research activity, the difference in mean elapsed time to degree for those graduates without extended time to doctoral degree at public and private institutions was almost negligible—less than one percent—at 6.33 and 6.30 years, respectively. However, when comparing extended time to doctoral degree graduates from the same very high research institutions, mean elapsed time to degree differs by almost 3/4 of a year, or 5.67% faster at private institutions. The trend is echoed at Research Universities-high research activity, where extended time to doctoral degree graduates from private institutions finish a full 8/10 of a year, or 5.99% faster, than their public institution peers.

Institution Type, Gender and Extended Time to Degree

The differences between institution types can also be examined in terms of the sex of the degree recipient. In the research sample, sex of the doctorate recipient is limited to only those degree candidates who indicated “female” or “male” in their SED response. As observed in Table 10, women received almost 40% of the doctorates among the sample as a whole, and had a lower proportion of extended time to doctoral degree recipients, only 10.61% overall compared to 11.19% of men. The distribution of female graduates at public and private institutions is consistent with the overall sample, 38.88% and 40.37% respectively. The percent of extended time to doctoral degree recipients is higher for both sexes at public institutions, more so for men where almost 12% of graduates experienced extended time to degree. Men at private institutions had the lowest rate of extended time to doctoral degree with only 9.7% graduating more than one standard deviation beyond the mean.

Table 10: Distribution of Doctorate Recipients by Sex, Institution Type, and Extended Time to Degree

	Public			Private			Overall
Sex of Doctorate Recipient	**Not ETTD**	**ETTD**	**Overall**	**Not ETTD**	**ETTD**	**Overall**	**(% of Sex)**
Female	4,207	517	4,724	2,324	258	2,582	7,306 (39.40%)
Male	6,537	888	7,425	3,444	370	3,814	11,239 (60.60%)
Overall (% of Institution Type)	10,744 *(88.4%)*	1,405 *(11.6%)*	12,149 (65.5%)	5,768 *(90.2%)*	628 *(9.8%)*	6,396 (34.5%)	18,545 (100.00%)

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Table 11: Mean Elapsed Time to Doctoral Degree (in years) by Sex, Institution Type, and Extended Time to Degree

	Public			Private				Percent Difference in Mean Elapsed Time to Doctoral Degree between Public and Private Institutions		
Sex of Doctorate Recipient	**Not ETTD**	**ETTD**	**Overall**	**Not ETTD**	**ETTD**	**Overall**	**Overall Mean**	**Not ETTD**	**ETTD**	**Overall**
Female	6.68	13.68	7.44	6.55	12.85	7.18	**7.35**	-1.94%	-6.11%	-3.58%
Male	6.11	11.83	6.80	6.17	11.31	6.66	**6.75**	0.86%	-4.40%	-1.94%
Overall Mean	6.33	12.51	7.05	6.32	11.94	6.87	**6.99**	-0.22%	-4.56%	-2.51%

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Not only did male doctorate recipients complete in greater numbers, but Table 11 suggests they completed faster, overall, than females. Mean elapsed time to doctoral degree is lower (faster) among male degree recipients at both public and private institutions, and among degree recipients with and without extended time to doctoral degree. At public institutions and within the sample as a whole, male graduates without extended time to doctoral degree finished just over 0.5 years sooner than their female counterparts, while those with extended time to doctoral degree completed the degree 1.85 years faster. The difference among graduates, by sex, who did not experience extended time to doctoral degree is smaller at private institutions where males finished only 0.38 years faster than females, and men with extended time to doctoral degree finished 1.54 years faster. The difference between public and private institutions appears to have a greater impact for females with extended time to doctoral degree. They completed 6.11% faster at private institutions. Conversely, males who did not experience extended time to doctoral degree completed slightly faster at public institutions where the Mean elapsed time to doctoral degree was 6.11 years vs. 6.17 years.

Age, Gender and Extended Time to Degree

A number of differences are observed in the approximate age of doctorate recipients both overall and by sex. Overall, the median age (in years) at the award of the doctorate is 30.25 years with an overall mean of 31.95 years (see Table 12). In order to prevent individual disclosure, rather than provide the overall min and max, Table 12 presents the lower quartile (25th percentile) of the age range, overall, which occurs at 28.33 years with an upper quartile (75th percentile) counterpart at 33.66 years.

Table 12: Characteristics of Approximate Age at Award of Doctorate, Overall and by Sex of Doctorate Recipient

	All Doctorate Recipients			Female Doctorate Recipients			Male Doctorate Recipients		
	Not ETTD	ETTD	Overall	Not ETTD	ETTD	Overall	Not ETTD	ETTD	Overall
N	16,512	2,033	18,545	6,531	775	7,306	9,981	1,258	11,239
Mean Age (Years)	31.11	38.78	31.95	31.59	40.51	32.54	30.8	37.71	31.57
Mode Age (Years)	28.75	36.5	28.75	28	34.83	28	28.08	36.5	28.08
Lower Quartile (Years)	28.17	33.42	28.33	28.25	33.92	28.42	28.08	33.17	28.33
Median Age (Years)	29.83	36.91	30.25	30	38.41	30.42	29.75	36.25	30.17
Upper Quartile (Years)	32.58	42.42	33.66	33	46	34.17	32.25	40.73	33.33

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Male doctorate recipients are younger than females, overall, across all categories except for mode age (in years) where the most frequent age for women without extended time to doctoral degree was 28 vs. 28.08, and for women with extended time to doctoral degree, 34.83 vs. 36.5 years. With regard to those with extended time to doctoral degree, the median age at award of doctorate for men was just over two years younger than women, and the mean age was nearly three years younger than women. The lower quartile (25th percentile) terminates within the range of the 33rd year for both men and women, but the upper quartile (75th percentile) begins at age 46 for women with extended time to doctoral degree compared to 40.73 for men with extended time to doctoral degree.

Gender, Marital Status and Extended Time to Degree

Patterns of degree completion differ for men and women by their marital status. The majority of all graduates within the sample reported themselves as married, 49.95% overall AND for both men and women, at the time their doctorate was awarded (see Table 13). Among women, 35% had never married vs. 40% of men, and 10% of women were living in a marriage-like relationship compared to only 7% of men. More women, 4.6%, were either divorced or separated compared to only 2.6% of men. When considering each marital status and sex in terms of extended time to degree, divorce produced the greatest proportion doctorate recipients who had extended time to degree for both sexes, 22.84% of women and 22.75% of men. These rates are more than double the 10.96% rate for extended time to doctoral, overall within the sample. The next highest rate of extended time to degree for any marital status among women is 12.36% for those who are married, and among men is 13.54%, also for those who are married.

Divorce resulted in not only the highest proportion of graduates with extended time to doctoral degree, but also aggregates to the longest mean elapsed time to degree for women, 16.12 years on average, while separation appears to have contributed the most to mean time among men at 13.77 years. It was previously established that men finished faster than women, overall, but when broken down by marital status (see Table 14), there are some distinctions worth noting. Married men with extended time to doctoral degree finished 12.29% faster, 11.98 years vs. 13.65 years, than women. Divorcees, as noted above, had particularly long time to degree with men finishing 20.71% faster than women. The difference between the sexes was the most pronounced for those who were widowed. Without knowing when each of these degree recipients lost their spouse it is irresponsible to draw conclusions with regard to the passing of a spouse on degree progress. However, the seemingly large difference in time to degree supports the notion that the introduction of a significant life event alters or delays progress toward the doctoral degree.

While the loss of a spouse seems to negatively impact time to degree, particularly for women, the absence of a spouse may affect faster time to degree. If time to degree by marital status is ranked, those who have never married, overall, had the shortest mean elapsed time to degree and completed the doctorate in 6.46 years, on average. That is slightly more than 0.5 years faster than the average for the sample as a whole. Living in a marriage-like relationship also appears to positively impact the length of doctoral study with an overall rate of 6.93 years.

Table 13: Distribution of Doctorate Recipients by Marital Status, Sex, and Extended Time to Degree

Marital Status of Doctorate Recipient	Female			Male			Overall (% of Marital)
	Not ETTD	ETTD	Overall	Not ETTD	ETTD	Overall	
Married	3,199	451	3,650	4,854	760	5,614	9,264 (49.95%)
Never Married	2,377	185	2,562	4,161	362	4,523	7,085 (38.20%)
Marriage-like relationship	682	57	739	735	66	801	1,540 (8.30%)
Divorced	223	66	289	197	58	255	544 (2.93%)
Separated	*small n*		48	*small n*		43	91 (0.49%)
Widowed	*small n*		18	*small n*		3	21 (0.11%)
Overall (% of Sex)	6,531 *(89.39%)*	775 *(10.61%)*	7,306 (39.40%)	9,981 *(88.81%)*	1,258 *(11.19%)*	11,239 (60.60%)	18,545 (100.00%)

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Table 14: Mean Elapsed Time to Doctoral Degree (in years) by Marital Status, Sex, and Extended Time to Degree

Marital Status of Doctorate Recipient	Female			Male			Overall Mean	% Difference in Elapsed Time to Doctoral Degree by Sex and Marital Status		
	Not ETTD	ETTD	Overall	Not ETTD	ETTD	Overall		Not ETTD	ETTD	Overall
Married	6.78	13.65	7.63	6.23	11.98	7.01	**7.25**	-8.05%	-12.29%	-8.09%
Never Married	6.32	11.79	6.72	5.92	10.82	6.32	**6.46**	-6.31%	-8.28%	-5.99%
Marriage-like relationship	6.60	13.09	7.10	6.33	11.70	6.77	**6.93**	-4.19%	-10.63%	-4.71%
Divorced	7.69	16.12	9.62	7.10	12.78	8.39	**9.04**	-7.72%	-20.71%	-12.75%
Separated	7.16	15.37	9.05	7.31	13.77	8.81	**8.94**	2.03%	-10.43%	-2.58%
Widowed	8.52	14.01	10.04	*small n*		8.30	**9.80**	-20.78%	-35.21%	-17.34%
Overall Mean	6.63	13.41	7.35	6.13	11.68	6.75	**6.99**	-7.53%	-12.91%	-8.13%

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Dependents, Parental Status and Extended Time to Degree

Regarding the role of dependents and parental status on extended time to doctoral degree, 3,948 doctorate recipients, or 21.29%, indicated that they had one or more child dependents (see Table 15). Of those, 20.67% experienced extended time to doctoral degree. Although there are more men in the sample than women, and a greater percentage of men have children (22.48%), a greater proportion of women with children experienced extended time to doctoral degree (21.11%). Almost 92% of those without dependents completed the degree without extended time to degree, and they did so with shorter times to degree for both men and women.

Overall, having dependents seems to be associated with longer time to degree, if not extended time to degree (see Table 16). Across the entire sample, those without dependents finished in 6.65 years on average, which was 19.34% faster than the 8.24 years, on average, for those with dependents. Females without dependents or extended time to degree finished more than one year, 14.79%, faster than their peers with children, 6.44 years vs. 7.56 years. Furthermore, women without dependents but with extended time to degree finished 2.26 years, or 15.29%, faster than their peers with children, completing in 12.53 years vs. 14.79 years. The differences in elapsed time to degree for men follow similar trends to those of women. Men with dependents, on average, took only six additional months to complete the degree, 6.02 years vs. 6.56 years, while men with extended time to degree but without dependents finished 1.35 years, or 10.86%, faster than their peers with dependents, 11.12 years vs. 12.47 years.

Table 15: Distribution of Doctorate Recipients by Sex, Parental (Dependents) Status, and Extended Time to Degree

Sex of Doctorate Recipient	Dependents			No Dependents			Overall (% of Sex)
	Not ETTD	ETTD	Overall	Not ETTD	ETTD	Overall	
Female	1,121	300	1,421	5,410	475	5,885	7,306 (39.40%)
Male	2,011	516	2,527	7,970	742	8,712	11,239 (60.60%)
Overall (% of Dependents)	3,132 *(79.33%)*	816 *(20.67%)*	3,948 (21.29%)	13,380 *(91.66%)*	1,217 *(8.34%)*	14,597 (78.71%)	18,545 (100.00%)

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Table 16: Mean Elapsed Time to Doctoral Degree (in years) by Sex, Parental (Dependents) Status, and Extended Time to Degree

Sex of Doctorate Recipient	Dependents			No Dependents			Overall Mean	Percent Difference in Elapsed Time to Doctoral Degree between those With and Without Dependents		
	Not ETTD	ETTD	Overall	Not ETTD	ETTD	Overall		Not ETTD	ETTD	Overall
Female	7.56	14.79	9.08	6.44	12.53	6.93	**7.35**	-14.79%	-15.29%	-23.70%
Male	6.56	12.47	7.77	6.02	11.12	6.46	**6.75**	-8.20%	-10.86%	-16.88%
Overall Mean	6.92	13.33	8.24	6.19	11.67	6.65	**6.99**	-10.50%	-12.43%	-19.34%

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Marital Status, Parental Status and Extended Time to Degree

The N's in the sample become too small to be meaningful if I attempt to look at sex, marital status, parental status and extended time to degree simultaneously, so Tables 17 and 18 exclude the variable for sex to evaluate the distribution and mean elapsed time to doctoral degree. More than 93% of graduates with dependents were either married or living in a marriage-like relationship. Consistent with the overall results, 92% of those with both dependents and extended time to degree were either married or living in a marriage-like relationship. Those who were separated and had dependents had the longest time to degree at 16.88 years on average, which is almost three years or 17.61% longer than their separated peers without dependents. Divorcees with dependents had the second longest time to degree on average at 15.36 years, although divorcees without children experienced the longest time to degree, on average, for both those with and without extended time to degree, 14.07 years and 7.25 years respectively. In addition, divorcees without dependents but with extended time to degree took 94.07% longer than their Not-ETTD peers. The difference is even more pronounced for degree recipients who had dependents and were separated, where it took 122% longer to complete the degree, 16.88 years on average vs. 7.59 years.

The doctorate recipients who never married and did not have dependents had the fastest time to degree, on average, among both those with (11.10 years) and without (6.07 years) extended time to degree despite being the category representing the largest population, 7,014 graduates, within this group of descriptive statistics.

Table 17: Distribution of Doctorate Recipients by Marital Status, Parental (Dependents) Status, and Extended Time to Degree

Marital Status of Doctorate Recipient	Dependents			No Dependents			Overall (% of Marital Status)
	Not ETTD	ETTD	Overall	Not ETTD	ETTD	Overall	
Married	2,866	733	3,599	5,187	478	5,665	9,264 (49.95%)
Never Married	64	7	71	6,474	540	7,014	7,085 (38.20%)
Marriage-like relationship	79	21	100	1,338	102	1,440	1,540 (8.30%)
Divorced	94	47	141	326	77	403	544 (2.93%)
Separated	23	5	28	47	16	63	91 (0.49%)
Widowed	6	3	9	8	4	12	21 (0.11%)
Overall (% of Parental Status)	3,132 *(79.33%)*	816 *(20.67%)*	3,948 (21.29%)	13,380 *(91.66%)*	1,217 *(8.34%)*	14,597 (78.71%)	18,545 (100.00%)

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Table 18: Mean Elapsed Time to Doctoral Degree (in years) by Marital Status, Parental (Dependents) Status, and Extended Time to Degree

	Dependents			No Dependents				Percent Difference in Elapsed Time to Doctoral Degree between those With and Without Dependents		
Marital Status of Doctorate Recipient	**Not ETTD**	**ETTD**	**Overall**	**Not ETTD**	**ETTD**	**Overall**	**Overall Mean**	**Not ETTD**	**ETTD**	**Overall**
Married	6.88	13.15	8.16	6.21	11.75	6.68	**7.25**	-9.70%	-10.63%	-18.12%
Never Married	6.42	14.48	7.21	6.07	11.10	6.45	**6.46**	-5.48%	-23.33%	-10.52%
Marriage-like relationship	7.05	13.62	8.43	6.43	12.08	6.83	**6.93**	-8.89%	-11.31%	-19.05%
Divorced	7.97	15.36	10.43	7.25	14.07	8.55	**9.04**	-8.98%	-8.44%	-18.01%
Separated	7.59	16.88	9.25	7.06	13.90	8.80	**8.94**	-7.07%	-17.61%	-4.93%
Widowed	10.04	12.97	11.02	7.15	12.33	8.88	**9.80**	-28.74%	-4.93%	-19.39%
Overall Mean	6.92	13.33	8.24	6.19	11.67	6.65	**6.99**	-10.50%	-12.43%	-19.34%

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Citizenship and Extended Time to Degree

The next four tables, Tables 19-22, incorporate the citizenship of the doctorate recipient into the analysis of trends in population distribution and mean elapsed time to doctoral degree. For the purposes of the statistical analysis which follows in Chapter Five, graduates are grouped into two categories representing U.S. citizens and Permanent Residents, compared to International doctorate recipients. As Table 19 indicates, 26.66% of the doctorate recipients from the study sample are International, split 26.4% female and 73.6% male. Because the distribution of sex by citizenship is skewed more toward males than females, we find that only 17.88% of the women in the research sample, overall, are international compared to 32.37% of the men.

The observed differences, which can be highlighted from Table 20, paint a picture that is consistent with much of what we already know about time to doctoral degree. Within this research sample, international males finish the fastest on average at 5.93 years, followed by international females at 6.22 years, followed by U.S. males at 7.14 years, and finally U.S. females at 7.60 years. Among International doctorate recipients, only 4.87% of males and 4.06% of females experienced extended time to degree. Furthermore, International males finished faster than their female peers by only incremental amounts of time. Specifically, 0.60 years for those with and 0.32 years for those without extended time to degree, both of which translate to relatively small percent differences, 5.25% and 5.19% respectively.

Table 19: Distribution of Doctorate Recipients by Citizenship, Sex, and Extended Time to Degree

Citizenship of Doctorate Recipient	Female: Not ETTD	Female: ETTD	Female: Overall	Male: Not ETTD	Male: ETTD	Male: Overall	Overall (% of Citizenship)
U.S. Citizens and Permanent Residents	5,278	722	6,000	6,520	1,081	7,601	13,601 (73.34%)
International Doctorate Recipients	1,253	53	1,306	3,461	177	3,638	4,944 (26.66%)
Overall (% of Sex)	6,531 *(89.39%)*	775 *(10.61%)*	7,306 (39.40%)	9,981 *(88.81%)*	1,258 *(11.19%)*	11,239 (60.60%)	18,545 (100.00%)

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Table 20: Mean Elapsed Time to Doctoral Degree (in years) by Citizenship, Sex, and Extended Time to Degree

Citizenship of Doctorate Recipient	Female: Not ETTD	Female: ETTD	Female: Overall	Male: Not ETTD	Male: ETTD	Male: Overall	Overall Mean	Percent Difference in Elapsed Time to Doctoral Degree between Sexes by Citizenship: Not ETTD	ETTD	Overall
U.S. Citizens and Permanent Residents	6.78	13.55	7.60	6.37	11.81	7.14	**7.34**	-6.09%	-12.82%	-5.96%
International Doctorate Recipients	6.00	11.43	6.22	5.68	10.83	5.93	**6.01**	-5.19%	-5.25%	-4.53%
Overall Mean	6.63	13.41	7.35	6.13	11.68	6.75	**6.99**	-7.53%	-12.91%	-8.13%

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Table 21: Distribution of Doctorate Recipients by Citizenship, Parental (Dependents) Status, and Extended Time to Degree

Citizenship of Doctorate Recipient	Dependents			No Dependents			Overall (% of Citizenship)
	Not ETTD	ETTD	Overall	Not ETTD	ETTD	Overall	
U.S. Citizens and Permanent Residents	2,239	730	2,969	9,559	1,073	10,632	13,601 (73.34%)
International Doctorate Recipients	893	86	979	3,821	144	3,965	4,944 (26.66%)
Overall (% of Dependents)	3,132 *(79.33%)*	816 *(20.67%)*	3,948 (21.29%)	13,380 *(91.66%)*	1,217 *(8.34%)*	14,597 (78.71%)	18,545 (100.00%)

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Table 22: Mean Elapsed Time to Doctoral Degree (in years) by Citizenship, Parental (Dependents) Status, and Extended Time to Degree

Citizenship of Doctorate Recipient	Dependents			No Dependents			Overall Mean	Percent Difference in Elapsed Time to Doctoral Degree between those With and Without Dependents		
	Not ETTD	ETTD	Overall	Not ETTD	ETTD	Overall		Not ETTD	ETTD	Overall
U.S. Citizens and Permanent Residents	7.25	13.58	8.81	6.39	11.78	6.93	**7.34**	-11.91%	-13.21%	-21.28%
International Doctorate Recipients	6.08	11.20	6.53	5.69	10.83	5.88	**6.01**	-6.27%	-3.31%	-9.88%
Overall Mean	6.92	13.33	8.24	6.19	11.67	6.65	**6.99**	-10.50%	-12.43%	-19.34%

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Among International doctorate recipients, 19.80% had dependents compared to 21.82% of U.S. citizens and permanent residents (see Table 21). However, of the Internationals with dependents, only 86 or 8.78%, experienced extended time to doctoral degree relative to their disciplinary peers. When you consider that number in the context of the entire population of International graduates, only 1.74% had both dependents and extended time to degree. In contrast, nearly a quarter of U.S. graduates with dependents, 24.59%, experienced extended time to degree relative to their disciplinary peers, and 5.37% of U.S. citizens and permanent residents, overall, had both dependents and extended time to degree. Whereas nearly a quarter of U.S. graduates with dependents had extended time to degree, just over 10% of those without dependents experienced the phenomenon. Even fewer International graduates without dependents, only 3.63%, had extended time to degree.

The differences in mean elapsed time to degree favor International graduates. International graduates who did not have extended time to degree finished in 5.69 years on average, which was 6.27% faster than their peers with dependents who still finished in 6.08 years on average (see Table 22). Among Internationals with extended time to degree, those without dependents finished in 10.83 years on average, which was only 3.31% faster than the 11.20 years it took their peers with dependents. By comparison, U.S. citizens and permanent residents without dependents or extended time to degree finished in a very respectable 6.39 years on average, which was 12.30% longer than their International peers without dependents but 11.91% faster than their domestic peers with dependents. Among domestic graduates with extended time to degree, those without dependents finished nearly two years, or 13.21% faster on average than those with dependents. The numeric trend certainly points toward effects of both citizenship and dependents on time to degree. The statistical analyses in Chapter Five will explore those questions more thoroughly.

Race/Ethnicity and Extended Time to Degree

Another way to assess differences and similarities within the sample population, and taking the distinctions by citizenship one step further, is to look at the distribution of doctorate recipients for U.S. citizens and permanent residents broken down by race/ethnicity. As Table 23 indicates, the vast majority of the doctorate recipients in the sample, 57.93%, self-identified their race/ethnicity as white. When the percentage is calculated among only those who are U.S. citizens or permanent residents, 78.99% of the doctorate recipients are white. I note here that due to instances of small N's, the data presented in Table 23 are not fully cross-tabbed. While the distinctions of extended time to degree by sex for this particular sample cannot be disclosed, it is still useful to observe the differences and similarities at the higher level.

A greater proportion of the domestic graduates, 694 or 5.10%, were of Hispanic origins compared to 469, or 3.45%, who were Black/African American. These two groups represent the largest of the racial/ethnic groups traditionally identified as underrepresented minorities. Graduates who identified as American Indian/Alaskan Native and Native Hawaiian/Other Pacific Islander each contribute less than 1% to the domestic population within the sample, 0.30% and 0.24% respectively. In total, graduates from the four racial/ethnic groups just discussed, those who are traditionally underrepresented minorities, comprise 9.09% of the domestic population within the sample. In fact, the number of underrepresented minorities, 1,236 in total, is less than the domestic graduates of Asian origin who comprise 9.34%, or 1,271 graduates from the domestic population.

While the numbers of underrepresented minorities in the sample population are small compared to their proportion in the U.S. population, the numbers and percentages of graduates with extended time to degree are higher than the overall sample. American Indian/Alaskan Natives were divided 54%-46% female-male, with 14.63% of the graduates experiencing extended time to degree relative to their disciplinary peers. Native Hawaiian/Other Pacific Islanders were similarly divided 53%-47% female-male, but with only 3 of the 32 graduates, or 9.38%, experiencing extended time to degree. Within the Black/African American population, females are the most well represented among any of the underrepresented minority groups at 55%, but as a whole, Black/African Americans had the highest rate of extended time to degree, 20.90%, of all of the underrepresented groups. Hispanics are divided about as close to 50%-50% as possible, 348 females and 346 males, but with an extended time to degree rate several percentage points above the overall sample at 15.13%.

It is possible that the numbers of underrepresented minority students could be slightly higher given the number of graduates who categorized themselves as “Two or

More Racial Backgrounds" and "Other." These two groups represent 2.58% of the domestic population within the sample, 11.11% of whom had extended time to degree.

Table 23: Distribution of Doctorate Recipients by Race/Ethnicity, Sex, and Extended Time to Degree

	Female	**Male**	**Not ETTD**	**ETTD**	**Overall (% of Race/Ethnicity)**
American Indian/Alaskan Native	22	19	35	6	41 (0.22%)
Asian	564	707	1076	195	1,271 (6.85%)
Native Hawaiian/Other Pacific Islander	17	15	29	3	32 (0.17%)
Black/African American	260	209	371	98	469 (2.53%)
Hispanic	348	346	589	105	694 (3.74%)
Cuban	*34*	*28*	*51*	*11*	*62 (0.33%)*
Mexican American/Chicano	*109*	*114*	*186*	*37*	*223 (1.20%)*
Other Hispanic	*131*	*150*	*237*	*44*	*281 (1.52%)*
Puerto Rican	*74*	*54*	*115*	*13*	*128 (0.69%)*
White	4,637	6,106	9386	1357	10,743 (57.93%)
Two or More Racial Backgrounds	116	124	218	22	240 (1.29%)
Other	36	75	94	17	111 (0.60%)
International	1,306	3,638	4714	230	4,944 (26.66%)
Overall (% of Sex or ETTD)	7,306 (39.40%)	11,239 (60.60%)	16,512 (89.04%)	2,033 (10.96%)	18,545 (100.00%)

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Table 24: Mean Elapsed Time to Doctoral Degree (in years) by Race/Ethnicity, Sex, and Extended Time to Degree

	Female	**Male**	**Not ETTD**	**ETTD**	**Overall Mean**
American Indian/Alaskan Native	9.02	7.28	7.28	13.67	8.21
Asian	6.95	6.99	6.29	10.73	6.97
Native Hawaiian/Other Pacific Islander	6.92	6.92	6.51	10.89	6.92
Black/African American	8.05	8.14	6.84	12.83	8.09
Hispanic	7.67	7.45	6.78	11.94	7.56
Cuban	8.54	7.68	6.95	13.70	8.15
Mexican American/Chicano	7.96	7.51	7.02	11.31	7.73
Other Hispanic	7.55	7.36	6.60	12.02	7.45
Puerto Rican	7.04	7.47	6.69	11.96	7.22
White	7.64	7.11	6.55	12.80	7.34
Two or More Racial Backgrounds	7.39	6.93	6.64	12.25	7.15
Other	7.66	7.26	6.60	11.77	7.39
International	6.22	5.93	5.77	10.97	6.01
Overall Mean	7.35	6.75	6.33	12.33	6.99

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Gender, Race/Ethnicity and Extended Time to Degree

Among domestic females, Native Hawaiians had the fastest time to degree on average at 6.92 years, followed by Asian Americans at 6.95 years on average (see Table 24). American Indian females had the longest time to degree on average at 9.02 years, which is basically an entire year more than the next closest group, Black/African Americans, who completed in 8.05 years on average. Among domestic males, Native Hawaiians again had the fastest time to degree of any racial/ethnic group, finishing in an average of 6.92 years, identical to their female counterparts. They were closely followed by men of Two or More Races at 6.93 years, and Asian Americans at 6.99 years, which was also nearly identical to—although slightly longer, than—their female peers. Black/African American men also took longer, on average, than their female counterparts and the longest among male domestic graduates at 8.14 years. Hispanic men took the next longest amount of time to finish, requiring an average of 7.45 years to finish. With the exception of the groups already identified (as well as those from the Hispanic sub-category "Puerto Rican" where men finished in an average of 7.47 years compared to 7.04 years for women), men from all other racial/ethnic groups finished faster than women.

When comparing the average extended time to degree by racial/ethnic group, Asian Americans and Native Hawaiians are again among the fastest at 10.73 years and 10.89 years respectively. Whites, Black/African Americans and American Indians had the longest average rates of extended time to degree at 12.80 years, 12.83 years and 13.67

years. Even among those who did not have extended time to degree, Black/African Americans and American Indians had the longest average time at 6.84 years and 7.28 years, respectively.

Time Spent on Coursework, the Dissertation and Extended Time to Degree

The amount of time required to complete the doctorate, with or without extended time to degree relative to the discipline, is the combination of years spent completing coursework and years preparing the dissertation. Table 25 details the average time spent completing these tasks by different socio-demographic characteristics of the doctorate recipients within the sample. To highlight a few points, International graduates without extended time to degree spent the least amount of time in coursework, averaging 2.99 years, while those with dependents spent the most time at 3.69 years. Women with extended time to degree spent the most time completing coursework, averaging 5.26 years, followed closely by those with dependents at 5.16 years. At the dissertation stage, International graduates without extended time to degree were the fastest researchers and writers completing in 2.78 years. Perhaps noteworthy is that while females without extended time to degree had the longest average number of years spent preparing the dissertation, 3.18 years, the time spent was less than half a year longer than their International peers.

Table 25: Characteristics of Time Spent Completing Coursework, Preparing Dissertation and Elapsed Time to Doctoral Degree by Socio-Demographics of Doctorate Recipients

Characteristic of Doctorate Recipient	Years Completing Coursework			Years Preparing Dissertation			Elapsed Time to Doctoral Degree		
	Not ETTD	ETTD	% Diff	Not ETTD	ETTD	% Diff	Not ETTD	ETTD	% Diff
Female	3.47	5.26	51.71%	3.18	5.01	57.46%	6.63	13.41	102.16%
Male	3.22	4.60	42.86%	2.99	4.92	64.86%	6.13	11.68	90.41%
Dependents	3.69	5.16	39.85%	3.08	4.86	57.95%	6.92	13.33	92.64%
No Dependents	3.23	4.65	43.83%	3.06	5.02	64.05%	6.19	11.67	88.49%
U.S. Citizens and Permanent Residents	3.45	4.98	44.27%	3.17	4.99	57.08%	6.55	12.51	90.86%
Internationals	2.99	3.88	29.76%	2.78	4.71	69.27%	5.77	10.97	90.21%
Overall	3.32	4.85	46.08%	3.06	4.96	62.09%	6.33	12.33	94.79%

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

The data in Table 25 tell an interesting story. For instance, the average number of years spent preparing the dissertation was nearly identical for those without extended time to degree that did (3.08 years) and did not (3.06 years) have dependents. Yet when you look at the averages for those who had extended time to degree, the graduates without dependents took longer to prepare the dissertation than those with dependents, 5.02 years vs. 4.86 years. Also noteworthy is that the average number of years preparing the dissertation for each of the socio-demographic characteristics identified in Table 25 is right at, or under, five years for all groups. An average of five years to complete the dissertation isn't that unthinkable, yet we know that those with extended time to degree had an individual elapsed time to degree that was at least one standard deviation beyond the mean for their discipline.

The differences among all socio-demographic groups between those with and without extended time to degree are more pronounced at the dissertation writing phase than at the coursework phase. At most, extended time to degree females took almost 52% longer at the coursework phase, while the difference between extended time to degree Internationals and their counterparts at the dissertation phase was a dramatic 69%. It is certainly worth evaluating which characteristics are influencing time to degree for International graduates who appear to be moving swiftly through their doctoral programs at much faster rates in both the coursework and dissertation stages than their domestic peers.

Sources of Financial Support and Extended Time to Degree

In addition to looking at how the different phases of the doctorate impact the length of the degree, the SED data allows us to look at the primary source of support identified by each graduate. From Table 26 we learn that the majority of graduates received a research assistantship (31.44%), followed by fellowship or scholarship (24.46%) as their primary source of support. Teaching assistantships (14.78%) and grants (13.01%) round out the top four, which collectively account for nearly 84% of the graduates within the sample. More women used loans, earnings from a spouse or partner, or traineeships to support their doctoral studies than men. Nearly three times as many men held research assistantships as women, not surprising as the research assistantship was the primary source of support for 38.40% of men. Only 4.6% of those with traineeships experienced extended time to degree, followed by 7.27% with research assistantships, 7.38% with fellowships or scholarships, and 8.99% of those with grants.

Conversely, a staggering 47.65% with employer reimbursement experienced extended time to degree, as did an equally staggering 41.75% who relied on their personal earnings to fund their doctoral education. The additional categories with the greatest proportion of extended time to degree graduates include: 32.14% who relied on personal savings, 18.44% who relied on their spouse or partner, and 18.17% who used loans. To put it into context, the top four categories of support account for nearly 70% of the sample, but only 48% of the extended time to degree graduates, while the five categories mentioned above served as the primary source of support for just under 13% of the overall sample, but accounted for 33% of the extended time to degree graduates.

Table 26: Distribution of Doctorate Recipients by Primary Source of Support, Sex, and Extended Time to Degree

	Sex of Doctorate Recipient		Extended Time To Degree Status		
Primary Source of Support	**Female**	**Male**	**Not ETTD**	**ETTD**	**Overall (% of Primary Source of Support)**
Fellowship, Scholarship	2045	2492	4202	335	4,537 (24.46%)
Grant	1118	1295	2196	217	2,413 (13.01%)
Teaching assistantship	1146	1595	2438	303	2,741 (14.78%)
Research assistantship	1515	4316	5407	424	5,831 (31.44%)
Other assistantship	42	45	73	14	87 (0.47%)
Traineeship	95	79	166	8	174 (0.94%)
Internship, clinical residency	15	13	25	3	28 (0.15%)
Loans (from any source)	353	280	518	115	633 (3.41%)
Personal savings	86	110	133	63	196 (1.06%)
Personal earnings during graduate school	251	276	307	220	527 (2.84%)
Spouse's, partner's, or family's earnings or savings	394	300	566	128	694 (3.74%)
Employer reimbursement/assistance	107	212	167	152	319 (1.72%)
Foreign (non-U.S.) support	48	132	157	23	180 (0.97%)
Other	3	3	3	3	6 (0.03%)
Unknown	88	91	154	25	179 (0.97%)
Overall (% of Sex or ETTD)	7,306 (39.40%)	11,239 (60.60%)	16,512 (89.04%)	2,033 (10.96%)	18,545 (100.00%)

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Table 27: Mean Elapsed Time to Doctoral Degree (in years) by Primary Source of Support, Sex, and Extended Time to Degree

	Sex of Doctorate Recipient		Extended Time To Degree Status		
Primary Source of Support	**Female**	**Male**	**Not ETTD**	**ETTD**	**Overall Mean**
Fellowship, Scholarship	6.95	6.49	6.29	11.83	6.70
Grant	6.30	6.28	5.95	9.69	6.29
Teaching assistantship	7.67	7.23	6.82	12.17	7.41
Research assistantship	6.22	6.11	5.78	10.71	6.14
Other assistantship	8.19	8.44	7.62	11.99	8.32
Traineeship	7.01	6.51	6.47	13.19	6.78
Internship, clinical residency	7.07	7.14	6.48	12.29	7.10
Loans (from any source)	9.25	8.57	7.85	13.87	8.95
Personal savings	11.69	9.60	8.52	14.74	10.52
Personal earnings during graduate school	11.80	11.11	8.70	15.25	11.44
Spouse's, partner's, or family's earnings or savings	8.98	8.23	7.37	14.31	8.65
Employer reimbursement/assistance	11.45	10.28	7.55	14.10	10.67
Foreign (non-U.S.) support	7.15	6.76	6.22	11.24	6.87
Other	14.58	5.47	5.47	14.58	10.03
Unknown	8.22	6.61	6.56	12.61	7.40
Overall Mean	7.35	6.75	6.33	12.33	6.99

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Table 27 gives meaning to the distribution of primary source of support by putting the data into the mean elapsed time to degree. Here we see the impact, on average, of each type of support on the number of years required to complete the degree. Across both sexes and those with and without extended time to degree, doctorate recipients who identified either research assistantships or grants as their primary source of support had the fastest average times to degree. At the opposite end of the spectrum, across all four categories, those who relied on either personal savings or personal earnings during graduate school had among the longest average times to degree relative to the category.

Tables 28-30 break down the mean elapsed time to doctoral degree for each of the top for primary sources of support—fellowships, grants, teaching assistantships and research assistantships—by sex, citizenship and parental status. Here the N's are large enough that the crosstabs can provide meaningful information for analysis. Table 28 presents data regarding the four major sources of support on time to degree for men and women. For both sexes, having either a research assistantship or grant resulted in average time to degree of less than six years for those who did not experience extended time to degree.

All four primary sources of support translate into average time to degree of less than six years for International graduates without extended time to degree (see Table 29). Even when considering the overall rates by primary source of support, meaning for those with and without extended time to degree combined, International graduates with either grants or research assistantships completed the doctorate, on average, in less than six years. Similarly, U.S. citizens and permanent residents receiving either grants or research assistantships obtained their doctorates in less than six years, on average. Among those with extended time to degree, men, women, Internationals, domestics, as well as those with and without dependents, had the longest average time to degree when their primary source of support was either a teaching assistantship or a fellowship.

Among those without dependents (see Table 30), research assistantships and grants are again associated with time to degree of less than six years for those who did not experience extended time to degree. And while these two forms of support are tied to the fastest average time to degree, those with dependents but without extended time to degree required just over six years to graduate. Those with dependents, fellowships and extended time to degree had the longest average time to degree, 12.82 years, of any of the groups presented in Tables 28-30. The percent difference in elapsed time to degree is the most pronounced between men and women with extended time to degree supported by fellowships. Here we observe a 12.05% difference in the average time to degree, with men finishing more than a year faster than women, 11.13 years vs. 12.66 years. When considering citizenship, the most pronounced difference is observed between graduates who were supported with teaching assistantships but did not have extended time to degree. Here we observe another difference of more than a year, with Internationals finishing 17.42% faster than U.S. citizens, 5.91 years vs. 7.16 years. And among those with and without dependents, parents with extended time to degree who were supported by grants completed 20.89% slower than their childless peers, 11.53 years vs. 9.12 years.

Table 28: Mean Elapsed Time to Doctoral Degree for the Four Largest Types of Primary Support by Sex and Extended Time to Degree

	Female			Male				Percent Difference in Elapsed Time to Doctoral Degree between Sexes		
Primary Source of Support	**Not ETTD**	**ETTD**	**Overall**	**Not ETTD**	**ETTD**	**Overall**	**Overall Mean**	**Not ETTD**	**ETTD**	**Overall**
Fellowship, Scholarship	6.49	12.66	6.95	6.12	11.13	6.49	**6.70**	-5.57%	-12.05%	-6.58%
Grant	5.99	10.22	6.30	5.93	9.36	6.28	**6.29**	-0.98%	-8.45%	-0.39%
Teaching assistantship	7.14	12.56	7.67	6.59	11.94	7.23	**7.41**	-7.79%	-4.95%	-5.80%
Research assistantship	5.96	10.87	6.22	5.72	10.67	6.11	**6.14**	-3.97%	-1.85%	-1.77%

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Table 29: Mean Elapsed Time to Doctoral Degree for the Four Largest Types of Primary Support by Citizenship and Extended Time to Degree

	U.S. Citizens and Permanent Residents			International Doctorate Recipients				Percent Difference in Elapsed Time to Doctoral Degree between U.S. Citizens/Permanent Residents and Internationals		
Primary Source of Support	**Not ETTD**	**ETTD**	**Overall**	**Not ETTD**	**ETTD**	**Overall**	**Overall Mean**	**Not ETTD**	**ETTD**	**Overall**
Fellowship, Scholarship	6.36	11.85	6.81	5.92	11.60	6.10	**6.70**	-6.84%	-2.10%	-10.40%
Grant	5.98	9.70	6.34	5.76	9.53	5.94	**6.29**	-3.67%	-1.80%	-6.30%
Teaching assistantship	7.16	12.32	7.79	5.91	11.40	6.32	**7.41**	-17.42%	-7.47%	-18.93%
Research assistantship	5.99	10.77	6.50	5.58	10.51	5.75	**6.14**	-6.79%	-2.45%	-11.52%

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Table 30: Mean Elapsed Time to Doctoral Degree for the Four Largest Types of Primary Support by Parental (Dependents) Status and Extended Time to Degree

	Dependents			No Dependents				Percent Difference in Elapsed Time to Doctoral Degree between those With and Without Dependents		
Primary Source of Support	**Not ETTD**	**ETTD**	**Overall**	**Not ETTD**	**ETTD**	**Overall**	**Overall Mean**	**Not ETTD**	**ETTD**	**Overall**
Fellowship, Scholarship	7.00	12.82	7.89	6.14	11.23	6.43	**6.70**	-12.27%	-12.37%	-18.53%
Grant	6.35	11.53	7.05	5.88	9.12	6.15	**6.29**	-7.40%	-20.89%	-12.75%
Teaching assistantship	7.25	12.76	8.33	6.73	11.81	7.17	**7.41**	-7.17%	-7.38%	-13.92%
Research assistantship	6.14	11.21	6.86	5.72	10.45	5.99	**6.14**	-6.88%	-6.78%	-12.63%

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Intersection of Field, Financial Support, and Extended Time to Degree

While the aggregated averages presented above are interesting and informative of the sample as a whole, the real purpose and function of this research is to understand the effect of factors, such as primary source of support, on extended time to degree relative to each field. Table 31 presents the mean elapsed time to degree for the four primary types of support for each of the fields included within this research study. The volume of information is overwhelming. While it is generally not advisable to compare time to degree across the broad range of fields because the approach doesn't take into account some of the distinct disciplinary differences which contribute to the length of doctoral study, there are some interesting highlights worth noting. To begin with, the graduates from Theatre and Performance Studies who were supported by research assistantships had the shortest average time to degree across all four primary types of support at 4.75 years. Interestingly, graduates of the same program who were supported by grants had the longest average time to degree at 15 years. Graduates from Nursing had some of the longest average times to degree for three of the four categories of support: fellowships, grants and teaching assistantships. Mathematics graduates with grants and research assistantships were among the fastest, on average, as were Chemistry graduates with fellowships and research assistantships, Chemical Engineering graduates with grants and teaching assistantships, and Applied Mathematics graduates with fellowships and grants.

Graduates from Food Science were among the fastest for fellowship recipients, but were right at the median of time to degree for teaching assistants and research assistants. Similarly, the graduates from Forestry and Forest Sciences programs were among the fastest to complete the degree while supported primarily by teaching assistantships, but like Food Science, were right at the median of time to degree for fellowships and research assistants. Graduates from Ecology and Evolutionary Biology graduated with time to degree, on average, that was equal to the median among those supported by fellowships and teaching assistantships; and Civil and Environmental Engineering graduates completed with time to degree that was, on average, right at the median for those supported by grants and research assistantships.

Table 31: Mean Elapsed Time to Doctoral Degree (in years) by NRC Field for the Four Largest Types of Primary Support

NRC Field	Fellowship, Scholarship	Grant	Teaching assistantship	Research assistantship
Aerospace Engineering	5.78	5.74	5.90	6.47
Agricultural and Resource Economics	7.27	5.73	8.08	7.40
American Studies	8.30	9.64	8.98	17.33
Animal Sciences	6.11	6.00	8.02	6.64
Anthropology	8.82	9.14	9.21	8.66
Applied Mathematics	5.32	5.50	5.85	5.64
Astrophysics and Astronomy	5.89	5.97	6.79	6.08
Biochemistry, Biophysics, and Structural Biology	5.86	5.99	6.09	5.90
Biology/Integrated Biology/Integrated Biomedical Sciences	6.01	6.15	6.76	5.97
Biomedical Engineering and Bioengineering	5.92	5.88	6.53	5.67
Cell and Developmental Biology	6.08	6.42	6.35	6.17
Chemical Engineering	5.50	5.44	5.57	5.34
Chemistry	5.08	5.68	6.02	5.32

NRC Field	Fellowship, Scholarship	Grant	Teaching assistantship	Research assistantship
Civil and Environmental Engineering	6.51	6.59	6.43	6.18
Classics	7.39	6.63	8.71	n/a
Communication	8.89	8.00	8.26	8.11
Comparative Literature	8.20	7.98	8.44	11.50
Computer Engineering	7.84	n/a	6.71	5.75
Computer Sciences	6.31	6.83	6.86	6.43
Earth Sciences	6.23	6.65	7.26	7.19
Ecology and Evolutionary Biology	6.43	7.41	7.00	6.59
Electrical and Computer Engineering	6.03	6.40	6.90	6.10
English Language and Literature	8.08	8.39	8.06	5.37
Entomology	6.60	5.80	8.42	6.55
Food Science	5.32	5.66	7.23	6.28
Forestry and Forest Sciences	6.47	7.30	5.33	6.26
French and Francophone Language and Literature	7.27	8.61	8.59	n/a
Genetics and Genomics	6.01	6.12	7.48	5.93
Geography	7.18	7.06	7.74	8.02
German Language and Literature	7.63	8.04	8.13	n/a
History	8.31	7.57	8.19	12.83
History of Art, Architecture and Archaeology	8.70	8.04	9.69	11.00
Immunology and Infectious Disease	5.95	5.97	5.08	5.71
Kinesiology	8.12	8.67	6.21	6.99
Materials Science and Engineering	5.14	5.63	6.03	5.59
Mathematics	6.35	4.96	6.03	5.18
Mechanical Engineering	5.89	5.87	6.25	6.00
Microbiology	5.83	6.08	6.59	5.98
Music	7.46	9.82	7.97	6.08
Neuroscience and Neurobiology	5.90	6.20	6.58	6.05
Nursing	10.55	14.15	9.38	9.97

NRC Field	Fellowship, Scholarship	Grant	Teaching assistantship	Research assistantship
Nutrition	6.41	6.80	5.86	5.74
Oceanography, Atmospheric Sciences and Meteorology	7.11	6.59	8.33	6.64
Operations Research, Systems Engineering and Industrial Engineering	6.16	7.88	5.83	5.96
Pharmacology, Toxicology and Environmental Health	5.59	5.71	6.99	5.94
Philosophy	7.95	6.66	7.87	7.94
Physics	6.01	6.29	6.42	6.59
Physiology	5.94	5.88	6.34	5.46
Plant Sciences	6.23	7.30	7.38	6.56
Political Science	7.53	7.17	7.74	7.84
Psychology	6.48	5.71	6.83	6.41
Public Affairs, Public Policy and Public Administration	8.06	6.52	8.62	7.38
Public Health	6.94	5.95	8.31	7.01
Religion	8.99	9.07	8.34	n/a
Sociology	8.10	7.28	8.41	7.85
Spanish and Portuguese Language and Literature	6.68	8.52	7.73	n/a
Statistics and Probability	5.34	5.81	5.58	5.67
Theatre and Performance Studies	7.58	15.00	8.07	4.75
Overall Mean	6.70	6.29	7.41	6.14
Overall Median	6.45	6.59	7.12	6.26

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Throughout Table 31, there are a handful of instances where the cell value is listed as “n/a.” This is not intended to imply that the particular form of support is not applicable to the associated field, but rather that none of the graduates within the sample identified it as their primary source of support. For instance, research assistantships were not listed as the primary source of support in either Religion or Spanish and Portuguese Language and Literature.

Within each field, the variation in average time to degree by primary source of support covers a broad spectrum from very minimal to quite lengthy. For instance, the difference in average time to degree ranges from less than a quarter of a year for both Chemical Engineering and Biochemistry, Biophysics, and Structural Biology, to more than nine years in American Studies and more than ten years in Theatre and Performance Studies. The consistency of time to degree varies by less than one year for each of the four primary types of support in 27 of the participating fields. Although not a statistical analysis, the consistency suggests that the primary source of support does not influence time to degree as heavily in some fields as in others. Conversely, the irregularity across the remaining 31 fields suggests that in some fields, primary source of support is an important determinant of time to degree and perhaps extended time to degree. The analysis in Chapter Five will evaluate these questions in greater detail.

Education Level of the Graduate's Parents and Extended Time to Degree

Two additional factors which the data suggest affect the occurrence of extended time to degree relative to field are the education level of the graduate's father and mother. Based on the information provided in Table 32, the proportion of extended time to degree graduates was higher when the doctorate recipient indicated that either their mother or father had less than a high school diploma, a high school diploma, or some college. Specifically, 17% of graduates whose father had less than a high school diploma, followed by almost 14% whose father had a high school diploma and almost 12% whose father had some college education. The percentages differ, but the trend is the same with regard to mother's education level. 14% whose mother had less than a high school diploma experienced extended time to degree, followed by almost 14% whose mother had a high school diploma and 12% whose mother had some college. Fewer than 10% of those who identified that their mother had a bachelor's, master's or doctoral degree had extended time to degree. Similarly, fewer than 10% of those who identified that their father had either a bachelor's or a master's degree experienced extended time to degree. Having a parent with a professional degree translated to extended time to degree for 11% of the sample population.

In terms of the effect on length of time to degree, Table 33 certainly helps make the case for higher education. Among those with extended time to degree who identified that either their mother or father had less than a high school diploma or a high school diploma, the average time to degree exceeded 13 years. Those with a mother who holds a professional degree had the shortest average extended time to degree at 11.09 years followed by 11.16 years when the doctorate recipient's mother had a doctorate of her own. Average extended time to degree is shorter based on mother's education level than father's for five of the seven levels of education, excluding "Not applicable." Eighty-six graduates indicated that their father's education level was not applicable as did 54 graduates with respect to mother's education level.

Table 32: Distribution of Doctorate Recipients by Parent's Education Level and Extended Time to Degree

	Father's Education Level			Mother's Education Level		
	Not ETTD	**ETTD**	**Overall (% of Father's Ed)**	**Not ETTD**	**ETTD**	**Overall (% of Mother's Ed)**
Less than high school graduate	894	184	1,078 (5.81%)	1,182	196	1,378 (7.43%)
High/secondary school graduate	2,149	341	2,490 (13.43%)	3,050	485	3,535 (19.06%)
Some college	1,936	262	2,198 (11.85%)	2,682	368	3,050 (16.45%)
Bachelor's degree	4,493	458	4,951 (26.70%)	4,883	450	5,333 (28.76%)
Master's degree	3,131	311	3,442 (18.56%)	3,313	365	3,678 (19.83%)
Professional degree	1,605	202	1,807 (9.74%)	624	79	703 (3.79%)
Doctoral degree	2,232	261	2,493 (13.44%)	733	81	814 (4.39%)
Not applicable	72	14	86 (0.46%)	45	9	54 (0.29%)
Overall	16,512	2,033	18,545 (100.00%)	16,512	2,033	18,545 (100.00%)

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Table 33: Mean of Elapsed Time to Doctoral Degree by Parent's Education Level and Extended Time to Degree

	Father's Education Level			Mother's Education Level			Percent Difference in Elapsed Time to Doctoral Degree by Parent's Education Level		
	Not ETTD	ETTD	Overall	Not ETTD	ETTD	Overall	Not ETTD	ETTD	Overall
Less than high school graduate	6.60	13.40	7.76	6.34	13.23	7.32	-3.90%	-1.29%	-5.65%
High/secondary school graduate	6.41	13.29	7.35	6.41	13.13	7.33	0.08%	-1.21%	-0.22%
Some college	6.34	12.43	7.07	6.34	12.86	7.13	-0.08%	3.47%	0.80%
Bachelor's degree	6.13	12.01	6.67	6.23	11.81	6.71	1.74%	-1.67%	0.49%
Master's degree	6.30	11.74	6.79	6.36	11.46	6.86	0.98%	-2.34%	1.13%
Professional degree	6.59	12.05	7.20	6.38	11.09	6.91	-3.22%	-7.95%	-4.06%
Doctoral degree	6.39	11.78	6.95	6.39	11.16	6.86	0.01%	-5.24%	-1.28%
Not applicable	6.53	11.76	7.38	6.29	11.82	7.21	-3.65%	0.51%	-2.28%
Overall	6.33	12.33	6.99	6.33	12.33	6.99	n/a		

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Summary

This chapter detailed the descriptive statistics derived from the data sample in order to understand as much as possible about the phenomenon of extended time to doctoral degree in terms of frequencies and mean elapsed time to degree. The descriptive statistics provided within this chapter do not represent all of the descriptive statistics which can be generated from the combined SED and NRC data, but rather a representative sample. The analysis covered the distribution of N's and the mean elapsed time to degree, including extended time to degree, by field, gender, marital status, parental status, citizenship, race/ethnicity among U.S. citizens and permanent residents, time spent in coursework and preparing the dissertation, primary type of financial support, and education level of the doctorate recipient's parents.

Key observations include the apparent association between having dependents and longer time to degree. Black/African Americans had the highest rate of extended time to degree, and Black males had the longest time to degree among male domestic graduates, both of which suggest an association between race/ethnicity and time to degree. The field and type of primary support represent two of the many factors for which there may be an association with time to doctoral degree. Graduates with extended time to degree had the longest average time to degree when their primary source of support was a teaching assistantship or fellowship, and the difference in time to degree is the greatest between extended time to degree men and women who held fellowships. The descriptive statistics are consistent with previous findings regarding time to degree

(Nettles, 1990a; Nettles, 1990b; Nettles & Millett, 2006; Ehrenberg & Mavros, 1995). In addition, the descriptive statistics suggest several factors which will be evaluated more closely in the next chapter in order to assess the effect of key factors on extended time to degree.

CHAPTER FIVE

Statistical Analyses

In order to determine the institutional factors that contribute to time to doctoral degree, this chapter describes the statistical methods employed and the results of those tests. The chapter first describes the tests associated with model specification. The chapter then discusses the analysis and findings in three distinct sections which evaluate the institutional factors that affect time to degree across the entire sample, for those with and without extended time to doctoral degree, and at the level of the NRC Field. A summary at the end of this chapter highlights key findings which will be discussed in the context of recommendations in Chapter Six. The analyses were conducted within the Data Enclave of the National Science Foundation using IBM SPSS Statistics software.

Model Specification

In order to fit the model, I first tested the normality of the dependent variable, elapsed time to doctoral degree, for the entire sample. As noted in Table 34, the value of the test statistic, 0.167, was statistically significant at the level $p<0.001$, indicating that the data are not normally distributed, which was not unexpected. Time to degree data are based on human subjects who function in an uncontrolled environment with multiple and competing factors associated with the timing of each individual's degree completion.

Table 34: Test of Normality of Elapsed Time to Doctoral Degree

		Mean		Kolmogorov-Smirnov*		Skewness	
	df	Statistic	SE	Statistic	Sig.	Statistic	SE
Overall	18545	6.988	0.021	0.167	0.000	2.378	0.018

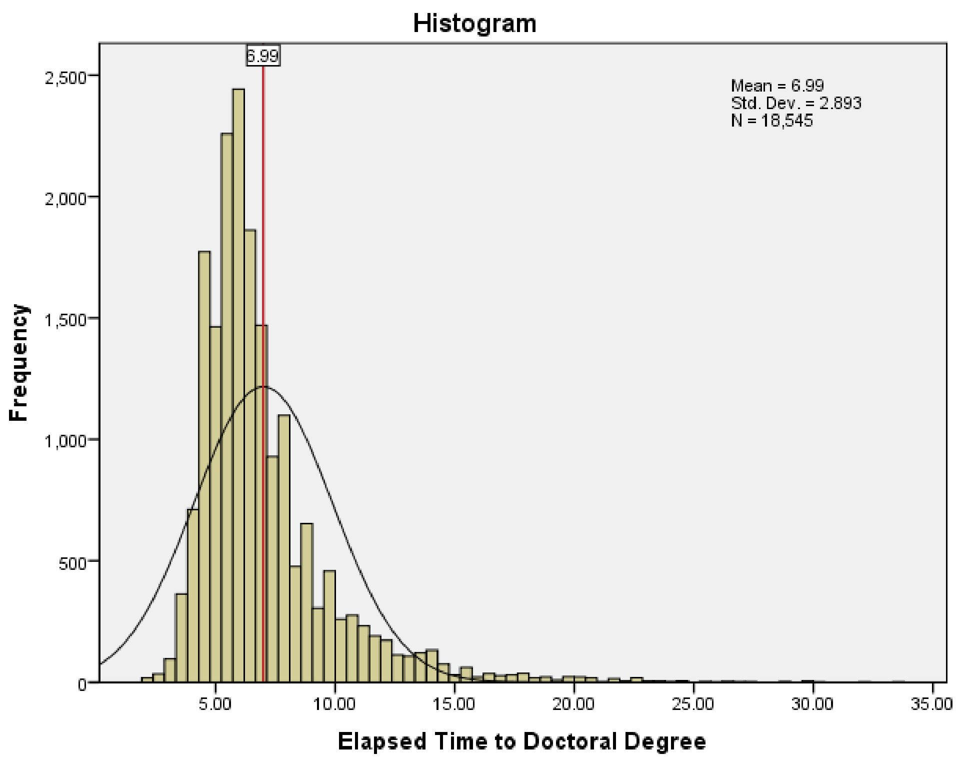
* Lilliefors Significance Correction

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

One of the central assumptions of Hierarchical linear models requires that data for the dependent variable be as close to normally distributed as possible. Therefore, I tested the normality of natural log, log, square, square root, and cubed transformations of the dependent variable for goodness of fit. In all instances, the value of the test statistic was identical, or nearly identical, to the original data with significance values of 0.000. Such results indicate that the original data are already so close to normally distributed that a transformation would not increase the stability of the data for analysis. In addition, the standard errors of the Mean and the Skewness are small, 0.021 and 0.018 respectively, which indicates greater stability of the data despite being non-symmetric around the mean.

The test of Skewness indicates that the data are positively skewed. The positive skew of the data indicates that there are greater numbers of graduates with time to degree below the sample Mean, which is exactly what is observed in Figure 3. The histogram of the dependent variable, elapsed time to doctoral degree, confirms that the value of the Mean, 6.99 years, is greater than the value of the Median, 6.25 years. To achieve symmetry around the mean for analytical purposes, the outliers to the right of the Mean could be dropped from the sample, which would help move the sample toward a more central tendency. However, given that the purpose of this research is to evaluate the effect of institutional factors on extended time to doctoral degree, relative to discipline, removing those outliers would be counterproductive. As described in Chapter Three, the value of the dependent variable for graduates with time to degree greater than three standard deviations beyond the Mean, by field, was capped to reduce the effect of outliers on the Mean. Excluding outlier records would have eliminated the target group, those with extended time to doctoral degree, from this research. Based on the conscious decision to include outliers and the small standard errors of the Mean and Skewness as reported in Table 34, the decision was made to proceed with the data sample.

Figure 3: Histogram of Elapsed Time to Doctoral Degree, Overall



Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

In addition to testing the entire sample, Table 35 details the results of normality tests by NRC Field. Like the overall sample, each field is non-normally distributed and each is positively skewed. Tests for all fields of the normality of natural log, log, square, square root, and cubed transformations of the dependent variable for goodness of fit produced test statistics that were identical, or nearly identical, to the original data with similar significance values. The results indicate that transforming the dependent variable to its natural log, log, square, square root, or cubed value would not produce a more robust or stable dependent variable. The standard errors of the Mean and Skewness tend to be greater at the field level than the entire sample, although the values, with a few exceptions, are still relatively small which indicates stability of the data despite being non-symmetric around the mean.

Table 35: Test of Normality of Elapsed Time to Doctoral Degree by NRC Field

		Mean		Shapiro-Wilk		Skewness	
NRC Field	**df**	**Statistic**	**SE**	**Statistic**	**Sig.**	**Statistic**	**SE**
Aerospace Engineering	248	6.386	0.122	0.864	0.000	1.702	0.155
Agricultural and Resource Economics	97	7.466	0.346	0.840	0.000	1.502	0.245
American Studies	99	9.543	0.359	0.880	0.000	1.477	0.243
Animal Sciences	77	6.670	0.262	0.823	0.000	1.735	0.274
Anthropology	634	9.681	0.143	0.890	0.000	1.446	0.097
Applied Mathematics	207	5.809	0.130	0.809	0.000	2.022	0.169
Astrophysics and Astronomy	114	6.131	0.111	0.925	0.000	1.214	0.226
Biochemistry, Biophysics, and Structural Biology	823	5.976	0.046	0.963	0.000	0.740	0.085
Biology/Integrated Biology/Integrated Biomedical Sciences	81	6.241	0.162	0.963	0.020	0.697	0.267

NRC Field	df	Mean		Shapiro-Wilk		Skewness	
		Statistic	SE	Statistic	Sig.	Statistic	SE
Biomedical Engineering and Bioengineering	565	5.932	0.069	0.890	0.000	1.420	0.103
Cell and Developmental Biology	307	6.242	0.069	0.948	0.000	0.857	0.139
Chemical Engineering	1,028	5.469	0.040	0.866	0.000	1.673	0.076
Chemistry	202	5.579	0.101	0.836	0.000	1.815	0.171
Civil and Environmental Engineering	516	6.807	0.126	0.810	0.000	2.013	0.108
Classics	75	8.613	0.365	0.886	0.000	1.113	0.277
Communication	122	9.001	0.389	0.869	0.000	1.331	0.219
Comparative Literature	196	8.725	0.200	0.920	0.000	1.035	0.174
Computer Engineering	51	6.266	0.298	0.840	0.000	1.286	0.333
Computer Sciences	1,162	6.651	0.063	0.882	0.000	1.436	0.072
Earth Sciences	99	7.044	0.225	0.863	0.000	1.492	0.243
Ecology and Evolutionary Biology	277	6.936	0.129	0.865	0.000	1.621	0.146
Electrical and Computer Engineering	1,612	6.377	0.053	0.855	0.000	1.648	0.061
English Language and Literature	120	8.767	0.328	0.849	0.000	1.601	0.221
Entomology	80	6.852	0.265	0.928	0.000	1.048	0.269
Food Science	51	7.803	0.657	0.707	0.000	2.383	0.333
Forestry and Forest Sciences	31	6.762	0.492	0.873	0.002	1.708	0.421
French and Francophone Language and Literature	111	8.361	0.253	0.931	0.000	1.005	0.229
Genetics and Genomics	316	6.154	0.079	0.938	0.000	1.042	0.137
Geography	133	7.879	0.249	0.893	0.000	1.315	0.210
German Language and Literature	62	8.051	0.254	0.958	0.034	0.613	0.304
History	73	8.703	0.375	0.918	0.000	0.863	0.281
History of Art, Architecture and Archaeology	261	9.942	0.212	0.886	0.000	1.398	0.151
Immunology and Infectious Disease	369	5.923	0.073	0.954	0.000	0.812	0.127
Kinesiology	95	7.578	0.361	0.839	0.000	1.607	0.247

NRC Field	df	Mean		Shapiro-Wilk		Skewness	
		Statistic	SE	Statistic	Sig.	Statistic	SE
Materials Science and Engineering	512	5.614	0.072	0.851	0.000	1.701	0.108
Mathematics	68	6.119	0.245	0.861	0.000	1.360	0.291
Mechanical Engineering	850	6.256	0.077	0.844	0.000	1.660	0.084
Microbiology	497	6.070	0.063	0.929	0.000	1.142	0.110
Music (except performance)	362	8.491	0.194	0.871	0.000	1.438	0.128
Neuroscience and Neurobiology	859	6.095	0.045	0.964	0.000	0.743	0.083
Nursing	248	13.021	0.450	0.911	0.000	0.739	0.155
Nutrition	168	6.440	0.233	0.758	0.000	2.343	0.187
Oceanography, Atmospheric Sciences and Meteorology	116	6.922	0.177	0.909	0.000	1.197	0.225
Operations Research, Systems Engineering and Industrial Engineering	201	7.055	0.249	0.784	0.000	2.046	0.172
Pharmacology, Toxicology and Environmental Health	313	5.849	0.090	0.861	0.000	1.618	0.138
Philosophy	436	8.285	0.152	0.829	0.000	1.882	0.117
Physics	198	6.600	0.154	0.833	0.000	1.708	0.173
Physiology	170	5.926	0.127	0.899	0.000	1.445	0.186
Plant Sciences	166	7.132	0.228	0.822	0.000	1.827	0.188
Political Science	740	8.075	0.107	0.905	0.000	1.190	0.090
Psychology	771	6.836	0.077	0.901	0.000	1.208	0.088
Public Affairs, Public Policy and Public Administration	84	10.714	0.685	0.803	0.000	1.694	0.263
Public Health	216	8.106	0.252	0.871	0.000	1.362	0.166
Religion	161	9.646	0.273	0.922	0.000	1.177	0.191
Sociology	645	8.539	0.125	0.903	0.000	1.292	0.096
Spanish and Portuguese Language and Literature	215	7.898	0.200	0.873	0.000	1.444	0.166
Statistics and Probability	209	5.640	0.126	0.792	0.000	2.100	0.168

NRC Field	df	Mean		Shapiro-Wilk		Skewness	
		Statistic	SE	Statistic	Sig.	Statistic	SE
Theatre and Performance Studies	46	9.105	0.578	0.870	0.000	1.682	0.350

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

For the purposes of visual observation, histograms of elapsed time to doctoral degree were generated for each NRC Field. Given that there are 58 fields, the histograms are included in Appendix A. Each histogram details the expected normal curve based on the Mean, which is represented by a red line. A blue dashed line is also included on each histogram to mark the value of one standard deviation beyond the mean, which represents the point established as extended time to doctoral degree for the purposes of this research.

Due to the number of factors which are used in the Hierarchical linear model, each factor group was tested for linear relationships and the presence of multicollinearity. Table 36 details the results of tests for each factor group. The Collinearity Statistics test the tolerance and Variance Inflation Factor (VIF) for each independent variable, represented by Equations 1 and 2.

Equation 1: Tolerance Value

$$\text{Tolerance} = 1 - R_i^2$$

Equation 2: Variance Inflation Factor (VIF)

$$\text{VIF} = \frac{1}{\text{Tolerance}}$$

The tolerance and VIF, which is the reciprocal of the tolerance, indicate the proportion of variance each independent variable share with the other independent variables in the model (O'Brien, 2007). For this data sample, the tolerance values for the factors at each level are very high and the corresponding VIF values are high, which indicates a low percent of variance is accounted for by other predictors. Only two factors, Total Students in Program and Average First-year Program Enrollment, have particularly low tolerance values, 0.156 and 0.191 respectively, which indicates that more of the variance in those factors is accounted for by other predictors. However, given that both values are above 0.10, they are not considered redundant and are not omitted from the analysis (O'Brien, 2007). The low eigenvalues and elevated Condition Index values between U.S. Citizen or Permanent Resident and Race/Ethnicity, between Education level of Father and Education level of Mother, and between Carnegie Classification and Average Program GRE scores indicate that there is collinearity between those variables. The strength of the tolerance values and the relevance of the variables to evaluate the effect on time to degree outweigh the risk that the factors are irrelevant. Therefore, the variables were not omitted from the analysis.

Table 36: Tests of Collinearity by Analysis Group

Analysis Group	**Analysis Factor**	**Collinearity Statistics**		**eigenvalue**	**Condition Index**
		Tolerance	**VIF**		
Socio-demographic Factors	Female	0.964	1.037	0.241	5.196
	Marital Status	0.933	1.072	0.100	8.078
	Dependents	0.841	1.189	0.069	9.708
	Approximate Age at Doctorate	0.868	1.151	0.052	11.200
	U.S. Citizen or Permanent Resident	0.484	2.066	0.021	17.556
	Race/Ethnicity	0.493	2.030	0.007	30.897

Analysis Group	**Analysis Factor**	**Collinearity Statistics**		**eigenvalue**	**Condition Index**
		Tolerance	**VIF**		
Individual & Time to Degree Factors	Years of doctoral coursework	0.991	1.009	0.247	4.676
	Years preparing dissertation	0.996	1.004	0.202	5.177
	Additional professional medical or dental degree	0.996	1.004	0.085	7.960
	Education level of Father	0.640	1.562	0.058	9.679
	Education level of Mother	0.641	1.560	0.003	39.827
Program Factors	Public Institution	0.999	1.001	0.101	5.318
	Program Size Quartile	0.999	1.001	0.038	8.734
Financial Support Factors	Primary Source of Support	0.934	1.071	0.697	2.555
	Incurred Educational Debt	0.983	1.017	0.384	3.440
	Percent First-year Students in Program with Full Support	0.925	1.081	0.263	4.162
	Percent of Students with Research Assistantships	0.910	1.099	0.082	7.452
	Percent of Students with Teaching Assistantships	0.925	1.081	0.024	13.731
Training Factors	Training in Proposal Writing	0.967	1.034	0.085	5.813
	Travel Support for Students	0.967	1.034	0.042	8.241
Process and Procedure Factors	New Graduate Student Orientation	0.958	1.044	0.080	6.929
	International Student Orientation	0.987	1.013	0.075	7.139
	Annual Review of Doctoral Students	0.970	1.031	0.026	12.217
Program Environment Factors	Underrepresented Minority Faculty in Program	0.710	1.409	1.291	2.178
	Female Faculty in Program	0.432	2.314	0.586	3.233
	Total Faculty in Program	0.514	1.947	0.396	3.930
	Underrepresented Minority Students in Program	0.723	1.383	0.267	4.791

Analysis Group	Analysis Factor	Collinearity Statistics		eigenvalue	Condition Index
		Tolerance	VIF		
	Female Students in Program	0.345	2.902	0.175	5.921
	International Students in Program	0.620	1.612	0.085	8.510
	Total Students in Program	0.156	6.397	0.046	11.520
	Average First-year Program Enrollment	0.191	5.245	0.031	13.955
Research Factors	Average Faculty Publications	0.797	1.255	0.658	2.196
	Percent Faculty with Grants	0.789	1.267	0.134	4.860
	Percent of Students with Academic Plans	0.980	1.020	0.036	9.348
Selectivity Factors	Carnegie Classification	0.995	1.005	0.301	2.993
	Average Program GRE Scores	0.995	1.005	0.005	22.407

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Hierarchical Linear Model

As discussed in Chapter Three, the Hierarchical linear model is a robust statistical test for evaluating the nested nature of individual doctoral graduates and field. For the purposes of this analysis, a random intercept model was selected to assess the effect of institutional factors on the individual outcome of elapsed time to doctoral degree. Porter (2005) indicates that the random intercept model is used extensively in higher education research because of the accuracy of the estimates of group-level variables on the dependent variable. The random intercept model is appropriate for this research because it allows for the socio-demographic and individual characteristics to explain the variation in the dependent variable, while the institutional factors explain variation in the intercept of elapsed time to doctoral degree. The notation for the Hierarchical linear model is provided in Equation 3:

Equation 3: Notation of the Random Intercept Model

$$\text{Level 1:} \quad Y_{ij} = \beta_{0j} + \beta_1(X_{ij}) + r_{ij}$$
$$\|$$
$$\text{Level 2:} \quad \beta_{0j} = \gamma_{00} + \gamma_{01}W_j + u_{0j}$$

The *i* subscripts indicate the individual graduates and the *j* subscripts indicate the different fields. The field-level variables, represented by the notation β_{0j} , are calculated for each field and the values are inserted into the student level model. The dependent and independent variables in this research are not grand-mean centered, which is not required when using a random intercept model. In this instance, subtracting the Mean would result in intercept values that do not translate into meaningful terms for discussion. By keeping the dependent variable in its uncentered form, the values of the intercept calculated for each Hierarchical linear model are interpreted in real terms.

The use of a Hierarchical linear model requires consideration of a few additional criteria. First, Porter (2005) suggests that the Hierarchical linear model, or multilevel model, is most effective when the sample has at least 30 groups and a minimum of ten individuals per group. With 58 fields represented, and between 31 and 1,612 individual records in each field—Forestry and Forest Sciences has the fewest while Electrical and Computer Engineering has the most—the data are more than adequate to conduct a multilevel analysis. In addition, the high numbers of groups within the second level reduces the standard errors and improves the accuracy of the model (Porter, 2005). Second, a test of the proportion of variance between fields, referred to as the Intraclass Correlation (ICC), is calculated from a multilevel model where no variables are specified at either the student or field level. The variances of the student (σ^2) and field (τ_{00}) levels are measured as noted in Equation 4 and as calculated for this research in Table 37.

Equation 4: Notation of the Null Model and the Intraclass Correlation Coefficient

Level 1: $Y_{ij} = \beta_{0j} + r_{ij} \quad == \sigma^2$

$\qquad\qquad\qquad ||$

Level 2: $\beta_{0j} = \gamma_{00} + u_{0j} \quad == \tau_{00}$

Combined: $Y_{ij} = \gamma_{00} + \mu_{0j} + \varepsilon_{ij}$

ICC: $\rho = \tau_{00}/(\tau_{00} + \sigma^2)$

Table 37: Results of the Null Model for Elapsed Time to Doctoral Degree

Fixed Effect	**Coefficient (t-statistic)**	**SE**	**Sig.**
Intercept	7.35 (37.06)	.198	.000
Random Effect	**Variance Component**	**SE**	**Sig.**
Residual	6.45 (σ^2)	.427	.000
NRC Field	2.24 (τ_{00})	.067	.000
ICC, $\rho = \tau_{00}/(\tau_{00} + \sigma^2)$			.26

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

According to Porter (2005), if the ICC is greater than 5%, then the use of a Hierarchical linear model is appropriate. The null model and the ICC for this research indicate that 26% of the variation in elapsed time to doctoral degree for the full sample is explained by field. Therefore, having satisfied the criteria for use of a Hierarchical linear model, the analysis continues with the presentation of data, detailed in Table 38, from the ICC and ten Hierarchical linear models. The coefficients in each model are calculated as fixed factors and covariates. Nominal and ordinal variables are considered factors and scale variables are considered covariates. The student-level model is tested in two phases, first testing only the socio-demographic characteristics of the individual graduate and then adding the individual characteristics. Subsequent analyses test the student-level model against each group of institutional factors. The final (or full) model tests the student-level characteristics against all of the institutional factors. Test statistics that are statistically significant note the level of significance and, given the sheer volume of data within the table, are shaded in light blue. The variance explained by the model at the student and field levels is measured as outlined by Equations 5 and 6.

Equation 5: Student-level Variance

$$\frac{\sigma^2_{\text{null model}} - \sigma^2_{\text{test model}}}{\sigma^2_{\text{null model}}}$$

Equation 6: Field-level Variance

$$\frac{\tau_{\text{null model}} - \tau_{\text{test model}}}{\tau_{\text{null model}}}$$

Following Table 38 is a discussion of findings and observations of the tests conducted on the entire sample. Tables 39 and 40 present the Hierarchical linear models calculated for those with and those without extended time to doctoral degree, respectively.

Table 38: Hierarchical Linear Model for Elapsed Time to Doctoral Degree, Overall

	ICC	Socio-demographic	Student	Discipline	Financial Support	Training	Process	Environment	Research	Selection	Full Model
Intercept	7.354** (37.06)	-3.623** (-21.27)	-3.912** (-13.63)	-3.905** (-13.55)	-3.305** (-10.37)	-3.893** (-13.52)	-3.803** (-13.18)	-3.861** (-12.95)	-3.612** (-12.03)	-3.135** (-6.99)	-2.453** (-4.86)
Variance components											
Residual	6.4543**	3.9803**	2.9714**	2.9705**	2.8933**	2.9715**	2.9694**	2.9695**	2.9708**	2.9657**	2.8847**
NRC Field	2.2397**	0.4197**	0.3912**	0.3929**	0.3732**	0.3920**	0.3931**	0.4118**	0.3590**	0.3435**	0.3458**
ICC	0.258										
Student-level: % var. exp.		0.383	0.540	0.540	0.552	0.540	0.540	0.540	0.540	0.541	0.553
NRC Field-level: % var. exp.		0.813	0.825	0.825	0.833	0.825	0.824	0.816	0.840	0.847	0.846
Student-level (N=18,545)											
Socio-Demographic Factors											
Female		0.0783* (2.37)	0.0337 (1.169)	0.0319 (1.107)	0.0427 (1.495)	0.0345 (1.196)	0.0351 (1.217)	0.0373 (1.286)	0.0337 (1.169)	0.0322 (1.116)	0.0463 (1.617)
Marital Status	*F-value*	** (8.790)	* (3.908)	* (3.962)	** (4.551)	* (3.913)	* (3.960)	* (3.895)	* (3.939)	* (3.852)	** (4.505)
Married		0.0556 (0.619)	0.0007 (0.009)	0.0010 (0.013)	-0.0051 (-0.065)	0.0011 (0.014)	0.0025 (0.032)	0.0013 (0.017)	0.0022 (0.028)	0.0103 (0.131)	0.0004 (0.005)
Never married		0.2821* (3.079)	0.1277 (1.590)	0.1290 (1.606)	0.1334^{+} (1.679)	0.1281 (1.595)	0.1308 (1.629)	0.1277 (1.590)	0.1304 (1.624)	0.1365^{+} (1.701)	0.1374^{+} (1.730)
Marriage-like relationship		0.1395 (1.377)	0.0003 (0.003)	0.0012 (0.013)	0.0219 (0.250)	0.0001 (0.001)	0.0043 (0.049)	0.0005 (0.006)	0.0058 (0.065)	0.0145 (0.164)	0.0277 (0.317)
Widowed		0.2019 (0.454)	-0.0890 (-0.232)	-0.0935 (-0.243)	-0.1258 (-0.332)	-0.0853 (-0.222)	-0.0957 (-0.249)	-0.0823 (-0.214)	-0.0870 (-0.226)	-0.1005 (-0.262)	-0.1528 (-0.403)

	ICC	Socio-demographic	Student	Discipline	Financial Support	Training	Process	Environment	Research	Selection	Full Model
Separated		0.2609 (1.151)	0.1676 (0.854)	0.1682 (0.857)	0.2193 (1.131)	0.1673 (0.852)	0.1666 (0.849)	0.1811 (0.923)	0.1684 (0.858)	0.1769 (0.902)	0.2295 (1.185)
Divorced		0^{a}	0^{a}	0^{a}	0^{a}	0^{a}	0^{a}	0^{a}	0^{a}	0^{a}	0^{a}
Dependents		0.2210** (5.302)	0.1753** (4.817)	0.1735** (4.768)	0.1579** (4.379)	0.1743** (4.788)	0.1737** (4.776)	0.1721** (4.728)	0.1732** (4.759)	0.1745** (4.799)	0.1549** (4.296)
Approx. Age		0.3095** (98.386)	0.2275** (74.547)	0.2272** (74.223)	0.2112** (67.267)	0.2275** (74.516)	0.2274** (74.537)	0.2270** (74.143)	0.2266** (73.909)	0.2260** (73.534)	0.2103** (66.594)
US or Perm Res		0.7346** (3.821)	0.3744* (2.216)	0.3744* (2.216)	0.3143^{+} (1.879)	0.3763* (2.227)	0.3744* (2.217)	0.3763* (2.226)	0.3797* (2.247)	0.3707* (2.196)	0.3135^{+} (1.874)
Race/Ethnicity	*F-value*	(1.591)	* (3.311)	* (3.289)	** (4.366)	* (3.293)	* (3.310)	* (2.966)	* (3.233)	* (3.238)	** (3.898)
Amer Ind/AK Native		-0.1088 (-0.298)	0.2610 (0.823)	0.2683 (0.846)	0.3840 (1.227)	0.2584 (0.815)	0.2659 (0.839)	0.2670 (0.842)	0.2474 (0.780)	0.2491 (0.786)	0.3987 (1.275)
Asian		0.1736 (0.877)	0.2139 (1.232)	0.2164 (1.246)	0.2604 (1.518)	0.2129 (1.226)	0.2172 (1.251)	0.2170 (1.250)	0.2134 (1.229)	0.2265 (1.306)	0.2718 (1.586)
Native HI/Pac Island		0.0818 (0.204)	-0.1215 (-0.349)	-0.1202 (-0.345)	-0.0453 (-0.132)	-0.1212 (-0.348)	-0.1151 (-0.331)	-0.1357 (-0.390)	-0.1165 (-0.335)	-0.1285 (-0.370)	-0.0398 (-0.116)
Black/African Amer		0.2437 (1.154)	0.4445* (2.399)	0.4441* (2.397)	0.5496* (3.000)	0.4442* (2.397)	0.4460* (2.408)	0.4293* (2.313)	0.4366* (2.356)	0.4278* (2.310)	0.5339* (2.911)
Hispanic		-0.0301 (-0.147)	0.0603 (0.336)	0.0652 (0.363)	0.1459 (0.822)	0.0611 (0.340)	0.0627 (0.349)	0.0668 (0.372)	0.0594 (0.331)	0.0553 (0.308)	0.1601 (0.902)
White		0.0449 (0.236)	0.1023 (0.612)	0.1035 (0.619)	0.1468 (0.889)	0.1024 (0.612)	0.1052 (0.630)	0.1085 (0.649)	0.0998 (0.597)	0.1041 (0.623)	0.1599 (0.969)
Two or more races		-0.0622 (-0.271)	0.0491 (0.245)	0.0515 (0.257)	0.0676 (0.341)	0.0475 (0.237)	0.0462 (0.230)	0.0560 (0.280)	0.0477 (0.238)	0.0388 (0.194)	0.0642 (0.325)

	ICC	Socio-demographic	Student	Discipline	Financial Support	Training	Process	Environment	Research	Selection	Full Model
Other/Unknown		0[a]	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]
Individual Characteristics & Time to Degree Factors											
Yrs. coursework			0.2949** (38.089)	0.2946** (37.910)	0.2702** (34.786)	0.2947** (38.061)	0.2938** (37.938)	0.2938** (37.899)	0.2929** (37.714)	0.2913** (37.466)	0.2676** (34.328)
Yrs. dissertation			0.5921** (69.906)	0.5936** (69.268)	0.5977** (70.913)	0.5923** (69.914)	0.5920** (69.915)	0.5929** (69.736)	0.5937** (69.859)	0.5976** (70.007)	0.5991** (70.134)
Add'l prof degree			-0.0161 (-0.199)	-0.0205 (-0.252)	0.0242 (0.302)	-0.0154 (-0.190)	-0.0216 (-0.267)	-0.0136 (-0.167)	-0.0129 (-0.159)	-0.0122 (-0.151)	0.0194 (0.243)
Ed level Father	*F-value*		+ (1.725)	+ (1.748)	+ (1.845)	+ (1.734)	(1.719)	+ (1.730)	+ (1.817)	+ (1.981)	+ (1.910)
Less than HS			-0.3636 (-1.459)	-0.3647 (-1.463)	-0.3532 (-1.436)	-0.3633 (-1.458)	-0.3611 (-1.449)	-0.3625 (-1.455)	-0.3677 (-1.475)	-0.3678 (-1.477)	-0.3580 (-1.457)
HS graduate			-0.2947 (-1.201)	-0.2961 (-1.207)	-0.2938 (-1.213)	-0.2948 (-1.201)	-0.2927 (-1.193)	-0.2953 (-1.203)	-0.3010 (-1.227)	-0.2998 (-1.223)	-0.3004 (-1.241)
Some college			-0.3314 (-1.349)	-0.3320 (-1.351)	-0.3125 (-1.289)	-0.3302 (-1.344)	-0.3270 (-1.331)	-0.3321 (-1.352)	-0.3356 (-1.366)	-0.3355 (-1.367)	-0.3169 (-1.308)
Bachelor's			-0.2326 (-0.952)	-0.2326 (-0.952)	-0.2187 (-0.907)	-0.2316 (-0.948)	-0.2292 (-0.938)	-0.2335 (-0.956)	-0.2361 (-0.966)	-0.2306 (-0.945)	-0.2215 (-0.919)
Master's			-0.2555 (-1.043)	-0.2560 (-1.046)	-0.2355 (-0.974)	-0.2543 (-1.039)	-0.2536 (-1.036)	-0.2546 (-1.040)	-0.2571 (-1.050)	-0.2519 (-1.030)	-0.2405 (-0.996)
Prof degree			-0.1708 (-0.693)	-0.1703 (-0.691)	-0.1502 (-0.617)	-0.1694 (-0.688)	-0.1675 (-0.680)	-0.1699 (-0.689)	-0.1702 (-0.691)	-0.1609 (-0.653)	-0.1524 (-0.627)
Doctorate			-0.2234 (-0.909)	-0.2237 (-0.910)	-0.2031 (-0.837)	-0.2222 (-0.904)	-0.2211 (-0.899)	-0.2231 (-0.908)	-0.2214 (-0.901)	-0.2168 (-0.883)	-0.2077 (-0.856)
n/a			0[a]	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]

	ICC	Socio-demographic	Student	Discipline	Financial Support	Training	Process	Environment	Research	Selection	Full Model
Ed level Mother	*F-value*		$^{+}$ (1.818)	$^{+}$ (1.797)	$^{+}$ (1.799)	$^{+}$ (1.814)	$^{+}$ (1.767)	$^{+}$ (1.883)	$^{+}$ (1.870)	$^{+}$ (1.895)	$^{+}$ (1.788)
Less than HS			0.4714 (1.530)	0.4659 (1.512)	0.5618^{+} (1.846)	0.4741 (1.539)	0.4618 (1.499)	0.4771 (1.548)	0.4844 (1.572)	0.4992 (1.621)	0.5592^{+} (1.839)
HS graduate			0.6066* (1.981)	0.6007^{+} (1.961)	0.6780* (2.241)	0.6089* (1.988)	0.5946^{+} (1.942)	0.6156* (2.010)	0.6203* (2.026)	0.6332* (2.069)	0.6709* (2.219)
Some college			0.6460* (2.106)	0.6389* (2.083)	0.7111* (2.347)	0.6481* (2.113)	0.6337* (2.067)	0.6546* (2.134)	0.6597* (2.151)	0.6740* (2.200)	0.7044* (2.327)
Bachelor's			0.5879^{+} (1.920)	0.5838^{+} (1.906)	0.6531* (2.159)	0.5902^{+} (1.927)	0.5761^{+} (1.881)	0.5963^{+} (1.947)	0.6018* (1.965)	0.6200* (2.026)	0.6502* (2.151)
Master's			0.6079* (1.981)	0.6036* (1.967)	0.6757* (2.229)	0.6104* (1.989)	0.5974^{+} (1.947)	0.6176* (2.012)	0.6236* (2.032)	0.6418* (2.093)	0.6735* (2.223)
Prof degree			0.5093 (1.631)	0.5017 (1.606)	0.5733^{+} (1.858)	0.5120 (1.639)	0.4992 (1.599)	0.5155^{+} (1.650)	0.5211^{+} (1.668)	0.5370^{+} (1.721)	0.5626^{+} (1.825)
Doctorate			0.6219* (1.996)	0.6188* (1.986)	0.6914* (2.247)	0.6242* (2.004)	0.6123* (1.966)	0.6304* (2.023)	0.6393* (2.052)	0.6642* (2.134)	0.6953* (2.260)
n/a			0^{a}	0^{a}	0^{a}	0^{a}	0^{a}	0^{a}	0^{a}	0^{a}	0^{a}

	ICC	Socio-demographic	Student	Discipline	Financial Support	Training	Process	Environment	Research	Selection	Full Model
NRC Field-level (N=58)											
Discipline & Institutional Factors											
Public Institution				-0.0115 (-0.407)							-0.1009* (-3.161)
Size Quartile	*F-value*			* (3.128)							(1.765)
Smallest Quartile				0.1183* (2.618)							0.0625 (1.193)
2nd Quartile				0.0182 (0.478)							-0.0236 (-0.536)
3rd Quartile				-0.0270 (-0.831)							-0.0433 (-1.179)
Largest Quartile				0[a]							0[a]
Financial Support											
Primary Support	*F-value*				** (33.720)						** (33.113)
Fellowship, scholarship					-0.3094* (-2.319)						-0.2965* (-2.222)
Grant					-0.2139 (-1.566)						-0.1968 (-1.441)
TA					-0.0930 (-0.688)						-0.0766 (-0.567)
RA					-0.1779 (-1.336)						-0.1574 (-1.182)

	ICC	Socio-demographic	Student	Discipline	Financial Support	Training	Process	Environment	Research	Selection	Full Model
Other assistantship					0.3043 (1.339)						0.3199 (1.408)
Traineeship					-0.1183 (-0.639)						-0.0630 (-0.340)
Internship/residency					0.1426 (0.390)						0.1906 (0.521)
Loans					0.0819 (0.548)						0.0820 (0.548)
Personal savings					0.3245[+] (1.792)						0.3394[+] (1.875)
Personal earnings					1.1940[**] (7.821)						1.2056[**] (7.899)
Spouse/family earnings					-0.0632 (-0.431)						-0.0388 (-0.264)
Employer assistance					1.1908[**] (7.230)						1.1953[**] (7.261)
Foreign (non-US)					-0.2746 (-1.485)						-0.2487 (-1.345)
Other					0.5738 (0.578)						0.5302 (0.534)
Unknown					0[a]						0[a]
Educational Debt					-0.121[**] (-4.392)						-0.122[**] (-4.413)
% 1st-Yr Full $$					0.0450 (0.729)						0.0487 (0.738)

	ICC	Socio-demographic	Student	Discipline	Financial Support	Training	Process	Environment	Research	Selection	Full Model
% Students RA					0.0797 (1.268)						0.0834 (1.250)
% Students TA					0.1106 (1.401)						0.0677 (0.809)
Support and Training											
Proposal Writing						-0.0291 (-1.062)					-0.0110 (-0.387)
Travel Support						-0.0109 (-0.364)					0.0273 (0.869)
Processes & Procedures											
New Orientation							-0.0908^{*} (-2.624)				-0.1011^{*} (-2.846)
Int'l Orientation							0.0041 (0.147)				0.0051 (0.180)
Annual Review							-0.0618^{*} (-2.320)				-0.0496^{+} (-1.796)
Program Environment											
URM Faculty								0.7587^{*} (3.252)			0.6183^{*} (2.655)
Female Faculty								-0.1852 (-1.229)			-0.2035 (-1.351)
Total Faculty								-0.0010^{+} (-1.912)			-0.0003 (-0.635)
URM Students								-0.1327 (-0.922)			-0.2440^{+} (-1.687)

	ICC	Socio-demographic	Student	Discipline	Financial Support	Training	Process	Environment	Research	Selection	Full Model
Female Students								-0.0517 (-0.358)			-0.0647 (-0.451)
Int'l Students								0.0657 (0.750)			0.0741 (0.817)
Total Students								0.0004 (0.999)			0.0003 (0.802)
Av 1st-Yr Enroll								-0.0009 (-0.525)			-0.0010 (-0.560)
Research											
Av Fac Pubs									-0.0054 (-0.844)		-0.0041 (-0.621)
% Faculty Grants									-0.2705* (-2.792)		-0.1276 (-1.206)
% Acad Plans									-0.1611 (-1.621)		-0.0768 (-0.757)
Selection											
Carnegie Classification	*F-value*									** (3.489)	** (4.470)
Research Univ (very high)										0.3889 (1.586)	0.4711^{+} (1.921)
Research Univ (high)										0.4102 (1.644)	0.4376^{+} (1.753)
Doctoral/Research										0.0001 (0.000)	-0.1013 (-0.341)
Masters										2.3509* (2.611)	2.7586* (3.091)

	ICC	Socio-demographic	Student	Discipline	Financial Support	Training	Process	Environment	Research	Selection	Full Model
Baccalaureate										-1.0660^{*} (-2.174)	-1.0536^{*} (-2.152)
Theological										-0.0268 (-0.030)	0.0200 (0.022)
Medical										0.2665 (1.028)	0.4081 (1.578)
Engineering										0.0783 (0.177)	0.3007 (0.684)
Not Classified										0^{a}	0^{a}
Av GRE Scores										$-.0017^{**}$ (-4.743)	$-.0014^{*}$ (-3.382)

Note: F- and t-statistics in parentheses; $p<.001^{**}$, $p<.05^{*}$, $p<.10^{+}$

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Factors that impact time to degree: Student-level factors

The results of the Hierarchical tests of elapsed time to degree for the entire dataset generate interesting and consistent results across the various analyses. Within the first model, where only socio-demographic characteristics of the graduates are included, the female factor is statistically significant for the first and only time. According to the multilevel test, being female minimally increases elapsed time to doctoral degree. Although not a statistically significant factor in any of the other models, it is noteworthy that in the full sample model, being female always increases time to degree. The analysis that occurs later in this chapter indicates that the effect of being female varies by field, with both increasing and decreasing impacts on time to doctoral degree. However, in the context of the analysis of the full sample, the increase in time to degree among women suggests a need for intervention on the part of institutions, programs, and doctoral education. When considering the doctoral enterprise as a whole, we need to better understand what it is about being female that is interacting with time to degree so that we can design or redesign services, or even redesign degrees, to be more equitable for both sexes. We need to evaluate the services available to and needs of female students.

The F-value for the marital status factor is statistically significant across all models, but the depth of its significance lies within the detail of each marital status. Being married, when testing the full dataset, is not significant in any model and minimally increases time to degree with the exception of the financial support model, where it is a reducing factor on time to degree. Having never married is statistically significant and increases time to degree, as indicated, in the socio-demographic (0.28 years), financial support (0.13 years), selection (0.14 years) and full models (0.14 years), with the largest effect occurring in the first of those models.

Consistent with Nettles and Millett (2006), having dependents has a statistically significant effect on and increases elapsed time to doctoral degree in every model of the full dataset. This research tested the dependents factor as a binary variable, Yes/No, rather than a scale measure of the actual number of dependents. As noted in Chapter Four, average time to degree (overall) for women with child dependents was 9.08 years. That was more than a year longer than their male counterparts with dependents (7.77 years), and more than two years longer than their male (6.46 years) and female (6.93) peers without children. Future analysis could certainly examine dependents as a scale variable to determine the effect of each additional child on elapsed time to doctoral degree. Within the context of this research, the finding suggests that institutions and doctoral programs, which cannot control or influence whether a doctoral student has children, instead consider the services offered to support graduate student parents as they pursue their graduate degree.

Another factor that reveals a statistically significant effect across all models for the full sample is age. Unlike the dependents variable, age is included as a scale variable and is calculated as the graduate's approximate age at the award of the doctorate. Based on the results when the student-level model is complete (all of the socio-demographic and individual characteristics are included), each additional year of age adds approximately

0.22 years to the elapsed time to degree of the doctorate recipient. Given that aging is inevitable and uncontrollable, other alternatives must be considered, including whether age is correlated with other factors such as dependents, level or type of financial support, or working full time. If we are able to diagnose what it might be about age that is interacting with time to degree, then institutions and doctoral programs will be able to address and evaluate whether appropriate balances of academic and individual support networks are in place to get the student through the doctoral program in a timely fashion.

Finally, when evaluated in the context of the Hierarchical linear models against the entire dataset, the race/ethnicity factor indicates a statistically significant effect. Among the categories of race/ethnicity, only Black/African American indicates a level of significance and an increase in elapsed time to degree across all models that include all student-level factors. The effect on time to degree is more pronounced than any other race/ethnicity, impacting time to degree by as much as 0.55 years in the financial support model and 0.53 years in the full model. This finding supports Nettles and Millett (2006), who found that Black/African American graduates had the longest time to degree. Before making any inferences about the meaning of this finding, it is important to evaluate the effects observed in the next two analyses where the Hierarchical linear models are calculated for those with and without extended time to doctoral degree.

The first two variables in the set of individual characteristics, years completing coursework and years preparing the dissertation, are two of the most influential factors across all of the Hierarchical linear models. Both factors are statistically significant with

$p<0.001$ in each analysis. As scale variables, we can interpret the results in the context of their effect on elapsed time to degree. Each additional year completing coursework adds approximately 0.29 years to the degree, and each additional year spent preparing the dissertation adds approximately 0.59-0.60 years. In the context of the goal of this research to identify institutional factors that contribute to time to degree, these two outcomes are important findings. The significance of these two major periods in the doctoral career, length of time spent completing coursework and writing the dissertation, on time to doctoral degree, has implications for reforms to doctoral education. Institutions and doctoral programs need to evaluate coursework requirements and the mechanisms established to help students complete their courses within certain time constraints. Similarly, institutions and programs need to assess the requirements and definitions of timely research associated with the preparation of the dissertation. As with the findings regarding race/ethnicity, because these tests include all graduates, those with and without extended time to doctoral degree, the subsequent tests are necessary to understand how pervasive the effects of coursework and dissertation writing time are on time to degree.

Having an additional professional, medical or dental degree does not appear to have a statistically significant effect on time to degree. Within some of the models the factor slightly increases time to degree, while in others it slightly reduces it. Overall, it does not appear to be a dominant factor for the analysis of the complete dataset. Education level of the graduate’s parents, however, does highlight some interesting findings. The F-values for father’s education level are statistically significant at the

p<0.10 level, but none of the categories within the variable demonstrate statistical significance. All of the coefficients and test statistics are negative, which suggests that father's education level reduces time to doctoral degree. Similarly, the F-values for mother's education level indicate statistically significant effects across all models at the p<0.10 level. In addition, the majority of categorical factors have significant increasing effects on elapsed time to degree, thus, suggesting that mother's education level increases time to doctoral degree. The significance of both fathers and mothers on time to degree suggests a strong relationship between the role of parents and academic achievement. In sum, the results of the Hierarchical linear models suggest that socio-demographic factors, and individual characteristics and time to degree factors affect elapsed time to doctoral degree.

Factors that impact time to degree: Field-level factors

With regard to discipline and institutional factors, public institutions have a slightly decreasing effect on elapsed time to doctoral degree, but it is only significant in the context of the full model. Conversely, the F-value for size quartile indicates a significant effect when the model only includes student-level and discipline factors, but is not significant in the context of the full model. The smallest quartile has an increasing and statistically significant effect in the discipline model, but no significance in the full model. While the third size quartile is not significant in either the discipline or full models, it does appear to have a decreasing effect on the intercept of the dependent variable. Discipline and institution factors minimally affect elapsed time to doctoral degree. However, when you consider institutional control and program size quartile in the context of other field-level factors, these variables do not predict much of the 26% variation in elapsed time to doctoral degree suggested by the null model.

Much has been written on the importance and impact of financial support on time to doctoral degree. Abedi and Benkin (1987), Bowen and Rudenstine (1992), Ehrenberg and Mavros (1995), and Nettles and Millett (2006) have all explored various angles on the importance of financial support to the doctoral student. The results of the Hierarchical linear models conducted on the full sample for this study are consistent with previous findings. The F-value for the primary source of support variable indicates statistically significant effects in both the financial support and full models. Having a fellowship or scholarship is also statistically significant and decreases elapsed time to degree. In addition, although not significant against the full dataset, having a grant, a teaching assistantship, a research assistantship, a traineeship—all institutionally provided forms of support—decrease elapsed time to degree. Using one's personal savings, personal earnings, or employer reimbursement/assistance as the primary source of support during the doctoral program all demonstrate statistically significant increases in elapsed time to degree, by as much as 1.21 years for personal earnings in the context of the full model. These findings confirm the work of Nettles and Millet (2006) and Ehrenberg and Mavros (1995) that having a fellowship is a key component of degree completion.

Contrary to my pre-analysis conceptions, incurring education debt, which I expected would increase time to degree, in fact indicates a significant effect to decrease time to degree. The effect may be because taking on student loans facilitated time and resources available to the person and motivation to complete the degree. To fully understand the effects of loans on student completion we might compare those who completed to those who did not. Likewise, research might compare different kinds of loans and completion outcomes. What the findings suggest here is that loans seemed to act as a facilitator of faster time to degree for those who completed. Future research needs to tease out how this tool is used, by whom, and in which cases it works to facilitate completion and in which situations it does not.

The final two variables in the financial support model, percent of students with research assistantships and percent of students with teaching assistantships, do not indicate statistically significant effects on time to degree, but are informative nonetheless. As scale variables, these data tell us that as the percentage of students within the doctoral program who are supported by research or teaching assistantships increases, time to degree slightly decreases. The effect is more pronounced for research assistantships where a percentage increase results in 0.18 and 0.16 year decreases in time to degree for the financial and full models, respectively. The effect for teaching assistantships indicates that for each percentage increase in TA appointments, time to degree decreases by 0.09 and 0.08 years for the financial and full models, respectively. Without the strength of a significant effect, it may be difficult to argue for changes to the proportion of students in a program supported by TA or RA positions. In sum, financial support factors as outlined in the Hierarchical linear models of the complete dataset affect elapsed time to doctoral degree.

The support and training factors, in the context of the full dataset, do not have a significant impact on time to degree. Although both training in proposal writing and travel support for students minimally decrease elapsed time to degree in the group model, in the full model only training in proposal writing appears to decrease time to degree. These factors have a much different outcome in subsequent models. In sum, for the overall sample, support and training factors do not appear to affect elapsed time to doctoral degree.

The variables for new graduate student orientation and annual reviews of all doctoral students both have decreasing and significant effects on elapsed time to doctoral degree. The measure of the effects may be small, only as much as -0.10 years, but the findings are consistent with Girves and Wemmerus (1988), Golde (2005), Golde and Dore (2001) that a clear sense of requirements, environment, and culture of the program increase the likelihood that a student will engage and succeed in the doctoral program. In addition, the work of Lovitts and Nelson (2000) suggests that the steps taken by graduate programs to help acclimate new students and encourage ‘fit’ between the student and program are critical to a successful doctoral experience. As anticipated, the effects of these two variables on time to degree are not huge, but they are effects nonetheless. International student orientation, in the analyses of the entire dataset, is not a significant or impactful factor, but process and procedure factors do affect elapsed time to doctoral degree.

The program environment factors are all scale variables, which makes it possible to interpret the effect of an increase in each variable on the intercept of the dependent variable, elapsed time to doctoral degree. However, the meaning behind the results of the statistical tests is more difficult to interpret. The percent of underrepresented minority faculty (0.76 and 0.62 years), total faculty (-0.001), and percent underrepresented minority students (-0.24) are all factors that have a statistically significant effect on time to degree for the full dataset in both models, the environment model, and the full model, respectively. I suspect that there may be a confounding effect with regard to the variable for underrepresented minority faculty. In the program environment model and the full model using the overall dataset, underrepresented minority faculty have a statistically significant increasing effect on time to degree. Although the data have not yet been presented, when the analysis is conducted for only those graduates with extended time to doctoral degree, the analysis indicates that an increase in the percentage of underrepresented minority faculty has a decreasing effect on time to degree. While it is difficult to understand and fully interpret the direction of the effect, the purpose of this part of the analysis is simply to identify that there is an effect.

Although not statistically significant in the context of the analysis of the overall sample, an increase in the percent of female faculty within the program has a decreasing effect on time to degree in both the program environment and full model analyses.

Although it will be discussed in greater detail later in this chapter, increases in the percent of female faculty within the program had a significant increasing effect on time to degree in only three fields: French and Francophone Language and Literature, Philosophy, and Political Science. Similarly, an increase in the percentage of underrepresented minority students has a decreasing effect on time to degree in both the program environment and full model analyses, significantly so for the full model. In the field analyses, an increase in the percentage of underrepresented minority students had a significant increasing effect on time to degree in only two fields: Applied Mathematics and Psychology. These findings indicate that time to degree for the overall sample is affected by program environment factors.

To succeed as a researcher, doctoral students must be taught the research mode of their field, be exposed to research early and often, and engage with someone who can mentor them into and through the transition to independent research (Isaac, Quinlan, & Walker, 1992; Nettles & Millett, 2006). When evaluated for the full dataset, which includes those with and without extended time to doctoral degree, all three of the research environment factors indicate effects that decrease time to degree. Only percent of faculty in the program with grants indicates decreasing statistical significance in the model of student-level and research factors, and none of the variables are statistically significant in the full model. The inference, however, is that environments with more productive faculty with regard to publications and grant support, and the more focused the students themselves are on academic careers, the more time to degree in those programs is reduced. Although the effect is not huge, elapsed time to degree for the full sample is affected by factors of the research environment in the graduate program.

The variables used as proxies for selectivity of the institution, Carnegie classification and average program GRE score, both indicate statistically significant effects on elapsed time to degree. The F-value for Carnegie classification indicates a significant effect at the $p<0.001$ level with interesting outcomes at the category level. In the full model, both very high and high Research Universities are statistically significant, but indicate an increase in time to degree of 0.47 and 0.44 years, respectively. Completing the doctorate at a Masters institution is associated with effects that are significant in both the selectivity and full models for the complete dataset, with increases in time to degree of more than 2.35 years! Conversely, doctorates completed at Baccalaureate institutions are associated with significant effects that decrease time to degree by just over one year. The findings suggest that composition and resources of an institution, as categorized by the Carnegie classification, have important implications for doctoral programs. At Baccalaureate institutions, where the number of doctoral programs is likely very small—perhaps only one or two programs—the resources and faculty dedicated to that program may be much more concentrated. The rather large increase in time to degree for those completing at a Masters-focused institution suggests that the university resources, number of programs, and/or number of faculty may not be sufficient to simultaneously support doctoral, masters and undergraduate programs.

A relatively minor effect, an increase in the average GRE scores for the program is significantly associated with a very slight decrease in elapsed time to degree. The finding suggests that increases in the selectivity of the program and the academic skill of those who are admitted lend themselves toward faster degree completion. The finding is troublesome for the diversity of the program given Nettles and Millett's (2006) finding that underrepresented minorities tend to have lower GRE scores. Although this research study did not have access to the actual GRE scores of the individual graduates, only the aggregated average score for each doctoral program, it warrants further investigation and consideration of options to encourage a diverse academic environment. In the context of this research and for the complete dataset, the data here are consistent with prior research that selectivity factors affect elapsed time to doctoral degree (Gardner, 2009a; Lovitts & Nelson, 2000; Nettles & Millett, 2006).

Factors that impact time to degree: The full Hierarchical linear model

When all of the student-level and field-level variables are considered for the full dataset which includes those with and without extended time to degree in the same sample, not all of the variable groupings measure or result in significant effects on elapsed time to degree. The main levels of every socio-demographic variable except the indicator for female are statistically significant, as are the main levels of every individual characteristic except having an additional professional degree. Among the student-level variables, the *t*-statistic for years preparing the dissertation is the largest contributing factor, followed by approximate age and years spent completing coursework. Considered as groups, the factors associated with discipline and institutional characteristics contribute significantly to the model with regard to type of institution, where the effect of being a public institution decreased time to degree by barely 0.10 years across the analysis of all fields. Variables from the financial support, process and procedure, program environment and selectivity groups all add significant effects, but neither the support and training factors nor the research variables made significant contributions to explaining the variation in elapsed time to degree. In fact, 84.6% of the variance that can be explained by field-level factors is accounted for by the full model. Thus, one can conclude that the model successfully identified factors that affect elapsed time to doctoral degree. However, given that the objective of this research is to identify the institutional factors that contribute to extended time to doctoral degree, the next section reexamines the same series of Hierarchical linear models using only the subjects with extended time to doctoral degree.

Graduates with Extended Time to Doctoral Degree

For the purposes of this research, extended time to doctoral degree has been defined as time to degree greater than or equal to the value of one standard deviation beyond the Mean relative to NRC Field. In order to correct for possible effects from true outliers, time to degree was capped at a value equal to three standard deviations beyond the Mean. The values for extended time to degree and capped time to degree for each NRC Field are listed in Chapter Four, Table 6. In addition, in some NRC Fields it appears there is a spike in the number of graduates when viewing the histograms found in

Appendix A, when in fact, the spike represents the capped time to degree for those graduates. The purpose of the Hierarchical linear models described in Table 39 is to address part of the primary research objective for this dissertation: to identify which institutional factors have an effect on extended time to doctoral degree. The models follow the same approach as those constructed to evaluate the full dataset.

Table 39: Hierarchical Linear Model for Elapsed Time to Doctoral Degree, Graduates With Extended Time to Doctoral Degree

	ICC	Socio-demographic	Student	Discipline	Financial Support	Training	Process	Environment	Research	Selection	Full Model
Intercept	13.182** (26.755)	5.4815** (10.622)	5.0230** (6.465)	5.1068** (6.534)	5.2904** (6.030)	5.1654** (6.622)	5.0629** (6.480)	5.3348** (6.579)	4.7785** (5.932)	4.4559* (2.855)	4.9031* (2.872)
Variance components											
Residual	3.8503**	2.8428**	2.7338**	2.7247**	2.6985**	2.7262**	2.7369**	2.7071**	2.7107**	2.7189**	2.6331**
NRC Field	13.834**	8.1681**	8.1225**	8.1679**	8.0292**	8.1768**	8.1171**	8.7976**	7.7529**	8.3388**	8.4484**
ICC	0.782										
Student-level: % var. exp.		0.262	0.290	0.292	0.299	0.292	0.289	0.297	0.296	0.294	0.316
NRC Field-level: % var. exp.		0.410	0.413	0.410	0.420	0.409	0.413	0.364	0.440	0.397	0.389
Student-level (N=18,545)											
Socio-Demographic Factors											
Female		-0.1796* (-2.013)	-0.1607^{+} (-1.807)	-0.1651^{+} (-1.856)	-0.1479^{+} (-1.655)	-0.1564^{+} (-1.760)	-0.1574^{+} (-1.767)	-0.1362 (-1.530)	-0.1612^{+} (-1.820)	-0.1541^{+} (-1.734)	-0.1189 (-1.331)
Marital Status	*F-value*	$^{+}$ (2.066)	(1.569)	-1.702	(1.843)	(1.599)	(1.558)	(1.832)	(1.378)	(1.595)	$^{+}$ (1.947)
Married		-0.1526 (-0.925)	-0.0934 (-0.570)	-0.1072 (-0.655)	-0.1458 (-0.886)	-0.0763 (-0.466)	-0.0974 (-0.594)	-0.0656 (-0.402)	-0.1035 (-0.635)	-0.1077 (-0.659)	-0.1294 (-0.791)
Never married		0.0122 (0.069)	0.0208 (0.118)	0.0111 (0.063)	-0.0074 (-0.042)	0.0360 (0.204)	0.0164 (0.093)	0.0499 (0.284)	0.0109 (0.062)	0.0072 (0.041)	0.0107 (0.061)
Marriage-like relationship		-0.0600 (-0.272)	-0.0872 (-0.397)	-0.1072 (-0.489)	-0.1400 (-0.639)	-0.0690 (-0.315)	-0.0928 (-0.421)	-0.0871 (-0.398)	-0.0939 (-0.430)	-0.1013 (-0.460)	-0.1550 (-0.709)

	ICC	Socio-demographic	Student	Discipline	Financial Support	Training	Process	Environment	Research	Selection	Full Model
Widowed		-1.5203* (-2.292)	-1.4486* (-2.215)	-1.5203* (-2.324)	-1.5307* (-2.353)	-1.4445* (-2.212)	-1.4482* (-2.213)	-1.4952* (-2.297)	-1.3158* (-2.019)	-1.4482* (-2.220)	-1.4942* (-2.313)
Separated		0.5119 (1.261)	0.4245 (1.058)	0.4201 (1.049)	0.4043 (1.009)	0.4624 (1.154)	0.4153 (1.034)	0.5403 (1.350)	0.3983 (0.997)	0.4246 (1.061)	0.4746 (1.192)
Divorced		0^{a}	0^{a}	0^{a}	0^{a}	0^{a}	0^{a}	0^{a}	0^{a}	0^{a}	0^{a}
Dependents		0.2384* (2.547)	0.2274* (2.439)	0.2193* (2.352)	0.1803^{+} (1.930)	0.2184* (2.343)	0.2262* (2.424)	0.2353* (2.527)	0.2381* (2.560)	0.2262* (2.424)	0.1842* (1.979)
Approx. Age		0.1823** (25.970)	0.1820** (24.749)	0.1825** (24.765)	0.1732** (22.923)	0.1816** (24.705)	0.1823** (24.751)	0.1820** (24.762)	0.1823** (24.850)	0.1812** (24.626)	0.1727** (22.879)
US or Perm Res		0.1612 (0.375)	0.2500 (0.567)	0.2623 (0.596)	0.1547 (0.349)	0.2615 (0.594)	0.2507 (0.568)	0.1716 (0.390)	0.2384 (0.542)	0.2795 (0.635)	0.1658 (0.376)
Race/Ethnicity	*F-value*	(1.379)	(0.585)	(0.595)	(0.619)	(0.616)	(0.590)	(0.795)	(0.710)	(0.775)	(1.135)
Amer Ind/AK Native		-0.5989 (-0.736)	-0.3137 (-0.387)	-0.2869 (-0.354)	-0.1094 (-0.135)	-0.3679 (-0.454)	-0.3109 (-0.383)	-0.1815 (-0.225)	-0.2952 (-0.365)	-0.3457 (-0.427)	-0.0767 (-0.095)
Asian		0.2589 (0.599)	0.1471 (0.333)	0.1524 (0.346)	0.1385 (0.314)	0.1321 (0.300)	0.1448 (0.328)	0.2225 (0.505)	0.1693 (0.385)	0.1248 (0.283)	0.1523 (0.347)
Native HI/Pac Island		0.7422 (0.681)	0.6237 (0.567)	0.6629 (0.603)	0.8923 (0.811)	0.5137 (0.467)	0.6289 (0.571)	0.8046 (0.732)	0.6371 (0.581)	0.5824 (0.530)	0.9432 (0.861)
Black/African Amer		0.1357 (0.302)	0.1138 (0.248)	0.0967 (0.211)	0.1016 (0.222)	0.1191 (0.260)	0.1138 (0.248)	0.1557 (0.340)	0.1304 (0.285)	0.0778 (0.170)	0.0900 (0.198)
Hispanic		0.0063 (0.014)	0.0035 (0.008)	0.0082 (0.018)	0.0095 (0.021)	0.0025 (0.005)	0.0025 (0.005)	0.0307 (0.067)	-0.0149 (-0.033)	-0.0249 (-0.055)	-0.0408 (-0.090)
White		0.3964 (0.952)	0.2633 (0.618)	0.2644 (0.621)	0.2670 (0.627)	0.2637 (0.620)	0.2635 (0.618)	0.3490 (0.820)	0.2899 (0.683)	0.2584 (0.608)	0.3183 (0.752)

	ICC	Socio-demographic	Student	Discipline	Financial Support	Training	Process	Environment	Research	Selection	Full Model
Two or more races		0.2504 (0.453)	0.1229 (0.221)	0.0951 (0.171)	0.0509 (0.092)	0.1089 (0.196)	0.1232 (0.221)	0.2153 (0.388)	0.1839 (0.332)	-0.0838 (-0.149)	-0.1229 (-0.220)
Other/Unknown		0^a	0^a	0^a	0a	0^a	0^a	0^a	0^a	0^a	0^a
Individual Characteristics & Time to Degree Factors											
Yrs. coursework			0.0211 (1.546)	0.0212 (1.556)	0.0106 (0.765)	0.0213 (1.564)	0.0211 (1.547)	0.0200 (1.469)	0.0227^{+} (1.665)	0.0222 (1.627)	0.0127 (0.919)
Yrs. dissertation			0.1086^{**} (7.409)	0.1054^{**} (7.070)	0.1156^{**} (7.766)	0.1092^{**} (7.454)	0.1087^{**} (7.406)	0.1108^{**} (7.520)	0.0980^{**} (6.616)	0.1088^{**} (7.340)	0.1057^{**} (6.949)
Add'l prof degree			0.2748 (1.420)	0.2804 (1.450)	0.3006 (1.545)	0.3000 (1.551)	0.2695 (1.390)	0.2921 (1.512)	0.2725 (1.413)	0.2909 (1.505)	0.3476^{+} (1.793)
Ed level Father	*F-value*		(0.817)	(0.799)	(0.852)	(0.808)	(0.821)	(0.776)	(0.801)	(0.879)	(0.844)
Less than HS			0.1929 (0.253)	0.2174 (0.285)	0.1492 (0.196)	0.2544 (0.333)	0.1874 (0.245)	0.1355 (0.178)	0.1772 (0.233)	0.2542 (0.334)	0.2097 (0.277)
HS graduate			0.5012 (0.662)	0.5137 (0.679)	0.4657 (0.617)	0.5519 (0.730)	0.4939 (0.652)	0.4257 (0.564)	0.4934 (0.654)	0.5645 (0.748)	0.5003 (0.667)
Some college			0.3979 (0.524)	0.3987 (0.525)	0.3523 (0.465)	0.4589 (0.605)	0.3931 (0.517)	0.3383 (0.447)	0.3824 (0.505)	0.4698 (0.620)	0.4093 (0.544)
Bachelor's			0.4907 (0.648)	0.5081 (0.671)	0.4749 (0.629)	0.5527 (0.730)	0.4852 (0.640)	0.4134 (0.547)	0.4837 (0.641)	0.5699 (0.754)	0.5493 (0.731)
Master's			0.5106 (0.672)	0.5059 (0.666)	0.4700 (0.620)	0.5661 (0.746)	0.5061 (0.665)	0.4583 (0.605)	0.5013 (0.662)	0.5652 (0.745)	0.5209 (0.692)
Prof degree			0.5772 (0.755)	0.5855 (0.766)	0.5357 (0.703)	0.6389 (0.837)	0.5729 (0.749)	0.5032 (0.660)	0.5645 (0.742)	0.6559 (0.860)	0.5974 (0.789)
Doctorate			0.6144 (0.806)	0.6243 (0.819)	0.5767 (0.758)	0.6716 (0.882)	0.6121 (0.802)	0.5565 (0.733)	0.5822 (0.767)	0.6906 (0.908)	0.6263 (0.829)

	ICC	Socio-demographic	Student	Discipline	Financial Support	Training	Process	Environment	Research	Selection	Full Model
n/a			0[a]	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]
Ed level Mother	*F-value*		(0.893)	(0.798)	(1.045)	(0.864)	(0.866)	(0.817)	(0.864)	(0.899)	(0.794)
Less than HS			-0.5452 (-0.575)	-0.6155 (-0.649)	-0.3296 (-0.349)	-0.6507 (-0.686)	-0.5326 (-0.561)	-0.3265 (-0.345)	-0.5602 (-0.593)	-0.6090 (-0.643)	-0.3872 (-0.411)
HS graduate			-0.6399 (-0.679)	-0.6957 (-0.738)	-0.4625 (-0.492)	-0.7298 (-0.775)	-0.6209 (-0.658)	-0.4142 (-0.440)	-0.6321 (-0.673)	-0.7401 (-0.787)	-0.5004 (-0.535)
Some college			-0.5450 (-0.575)	-0.6031 (-0.636)	-0.3665 (-0.388)	-0.6388 (-0.674)	-0.5305 (-0.559)	-0.3064 (-0.324)	-0.5396 (-0.571)	-0.6357 (-0.672)	-0.4032 (-0.428)
Bachelor's			-0.7170 (-0.757)	-0.7558 (-0.798)	-0.5654 (-0.599)	-0.8108 (-0.857)	-0.6997 (-0.738)	-0.4743 (-0.501)	-0.7169 (-0.759)	-0.7967 (-0.842)	-0.5825 (-0.619)
Master's			-0.7656 (-0.808)	-0.8040 (-0.848)	-0.6124 (-0.648)	-0.8493 (-0.897)	-0.7487 (-0.789)	-0.5130 (-0.542)	-0.7651 (-0.810)	-0.8439 (-0.891)	-0.6049 (-0.642)
Prof degree			-0.9798 (-1.013)	-1.0065 (-1.041)	-0.7910 (-0.820)	-1.0665 (-1.104)	-0.9599 (-0.992)	-0.7530 (-0.779)	-0.9626 (-0.999)	-1.0583 (-1.097)	-0.7769 (-0.808)
Doctorate			-0.8220 (-0.852)	-0.9003 (-0.933)	-0.7071 (-0.735)	-0.9067 (-0.940)	-0.8053 (-0.834)	-0.5784 (-0.600)	-0.7996 (-0.831)	-0.9217 (-0.957)	-0.7186 (-0.749)
n/a			0[a]	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]

	ICC	Socio-demographic	Student	Discipline	Financial Support	Training	Process	Environment	Research	Selection	Full Model
NRC Field-level (N=58)											
Discipline & Institutional Factors											
Public Institution				-0.1656^{+} (-1.922)							-0.1014 (-1.011)
Size Quartile	*F-value*			(2.017)							(1.731)
Smallest Quartile				0.0258 (0.214)							0.0255 (0.173)
2nd Quartile				0.2569* (2.313)							0.2607^{+} (1.965)
3rd Quartile				0.1245 (1.277)							0.1446 (1.269)
Largest Quartile				0[a]							0[a]
Financial Support											
Primary Support	*F-value*				* (2.020)						* (2.097)
Fellowship, scholarship					0.2041 (0.554)						0.1689 (0.461)
Grant					0.1021 (0.270)						0.1288 (0.343)
TA					-0.0599 (-0.163)						-0.0428 (-0.116)
RA					0.1308 (0.356)						0.1365 (0.373)

	ICC	Socio-demographic	Student	Discipline	Financial Support	Training	Process	Environment	Research	Selection	Full Model
Other assistantship					-0.3250 (-0.565)						-0.3767 (-0.652)
Traineeship					0.2541 (0.368)						0.2611 (0.380)
Internship/residency					0.5237 (0.490)						0.5317 (0.501)
Loans					0.2096 (0.532)						0.2302 (0.588)
Personal savings					0.1186 (0.287)						0.1033 (0.251)
Personal earnings					0.5798 (1.550)						0.6104 (1.640)
Spouse/family earnings					0.1700 (0.440)						0.1659 (0.432)
Employer assistance					0.6604^{+} (1.724)						0.6615^{+} (1.737)
Foreign (non-US)					-0.3470 (-0.681)						-0.3031 (-0.597)
Other					-0.3471 (-0.204)						-0.4913 (-0.290)
Unknown					0^{a}						0^{a}
Educational Debt					-0.2464* (-2.945)						-0.2250* (-2.703)
% 1st-Yr Full $$					0.0741 (0.462)						-0.0124 (-0.072)

	ICC	Socio-demographic	Student	Discipline	Financial Support	Training	Process	Environment	Research	Selection	Full Model
% Students RA					-0.0254 (-0.130)						0.0639 (0.311)
% Students TA					-0.1173 (-0.501)						-0.0726 (-0.295)
Support and Training											
Proposal Writing						-0.2027* (-2.535)					-0.1975* (-2.347)
Travel Support						-0.0276 (-0.318)					-0.0146 (-0.162)
Processes & Procedures											
New Orientation							-0.0570 (-0.579)				0.0132 (0.130)
Int'l Orientation							-0.0532 (-0.646)				0.0183 (0.219)
Annual Review							0.0013 (0.016)				-0.0039 (-0.046)
Program Environment											
URM Faculty								-0.5713 (-0.970)			-0.6480 (-1.084)
Female Faculty								-1.0334* (-2.288)			-0.7910+ (-1.731)
Total Faculty								-0.0037* (-2.302)			-0.0017 (-1.025)
URM Students								0.9810* (2.566)			0.9177* (2.367)

	ICC	Socio-demographic	Student	Discipline	Financial Support	Training	Process	Environment	Research	Selection	Full Model
Female Students								-0.4524 (-1.031)			-0.4848 (-1.099)
Int'l Students								0.0138 (0.054)			-0.1141 (-0.433)
Total Students								0.0013 (1.182)			0.0005 (0.459)
Av 1st-Yr Enroll								-0.0050 (-1.131)			-0.0026 (-0.561)
Research											
Av Fac Pubs									0.0970^{**} (4.537)		0.0992^{**} (4.460)
% Faculty Grants									-0.3517 (-1.271)		-0.3673 (-1.211)
% Acad Plans									0.2361 (0.816)		0.3961 (1.321)
Selection											
Carnegie Classification	*F-value*									* (2.328)	* (2.381)
Research Univ (very high)										-0.2955 (-0.249)	-0.3829 (-0.320)
Research Univ (high)										-0.0258 (-0.022)	-0.1933 (-0.160)
Doctoral/Research										-0.7864 (-0.625)	-0.9744 (-0.768)
Masters										4.2980^{*} (2.018)	4.9927^{*} (2.340)

	ICC	Socio-demographic	Student	Discipline	Financial Support	Training	Process	Environment	Research	Selection	Full Model
Baccalaureate										0.5369 (0.317)	0.4673 (0.275)
Theological										n/a	n/a
Medical										-0.5948 (-0.492)	-0.5824 (-0.477)
Engineering										1.5111 (0.740)	1.6154 (0.793)
Not Classified										0^a	0^a
Av GRE Scores										0.0013 (1.285)	0.0013 (1.137)

Note: F- and t-statistics in parentheses; $p<.001^{**}$, $p<.05^{*}$, $p<.10^{+}$

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Factors that impact extended time to doctoral degree: Student-level factors

The first key finding from this analysis of extended time to degree graduates is that the intercept of the null model for those with extended time to degree, henceforth the ETTD model, is nearly double that of the null model for the entire dataset, henceforth the Sample model. The ICC calculation for the null ETTD model indicates that as much as 78% of the variance in elapsed time to degree for those with extended time to degree may be explained by field level variables—discipline and institutional characteristics, financial support factors, support and training factors, processes and procedures, program environment, research, and selection—compared to only 26% in the Sample model. The intercept and the variance components of the Hierarchical ETTD models are statistically significant, and the percent of variance that can be explained at the student level is fairly consistent.

Within the socio-demographic characteristics, being female decreases time to degree across all of the Hierarchical linear models and is a significant effect in all with the exception of the program environment and full models. The effect of being female in the ETTD model is the complete opposite of the Sample model where being female was significant only one time, when socio-demographic characteristics were the only factors included in the analysis. The finding suggests that among graduates with extended time to degree, females may have a slight advantage over their male counterparts based on their gender.

Unlike the Sample model, the overall measure for marital status is not a highly significant factor on elapsed time to degree in the ETTD model, appearing in only the first and last Hierarchical linear models, while dependents and age remain highly significant factors across all models. Although not significant, being married or being in a marriage-like relationship both appear to decrease time to doctoral degree across all iterations of the ETTD model, which suggests that having the support of a partner helps doctoral students who are struggling with time to degree.

Race/ethnicity was not a significant factor for those with extended time to degree. Although not statistically significant, it is noteworthy that the coefficients for Black/African Americans were lower than those of Native Hawaiians/Pacific Islanders and Asian Americans in the ETTD model, which is the reverse of the trend observed in the Sample model. In addition, the coefficients for American Indian/Alaska Natives and Hispanics in the ETTD model actually indicate decreasing non-significant effects on time to degree. Further research is needed to understand what factors seem to result in more equitable outcomes among those with extended time tot degree by race.

Among the individual characteristics and time to degree factors for the ETTD model, years preparing the dissertation is the most dominant and significant factor across all variations of the Hierarchical linear models. Having an additional professional, medical or dental degree is minimally significant in only the full model, and neither father’s or mother’s education level is significant at any point. However, unlike the Sample model where many of the coefficients for father’s education level indicated non-significant decreases in time to degree and those for mother's education level indicated significant increases in time to degree, the direction of those influences has changed in the ETTD model. This observation suggests that mothers are a greater influence on degree completion for those with extended time to doctoral degree.

In sum, the results of the full ETTD model suggest that elapsed time to degree, which is also extended time to doctoral degree, is affected by a number of socio-demographic and individual characteristics.

Factors that impact extended time to doctoral degree: Field-level factors

Institution type has a significant decreasing effect in the Hierarchical linear model of discipline and institutional characteristics, but despite having a nearly identical coefficient to the Sample model, it is not a significant factor in the full ETTD model. Second quartile program size has an increasing and significant effect in the group and full Hierarchical ETTD models. Recall from the descriptive statistics in Chapter Four, graduates with and without extended time to degree were distributed in relatively equal proportion across each program size quartile, and the majority of graduates came from the largest program size quartile. The smallest program size quartile had the least number of graduates, but the highest percentage of extended time to degree graduates, followed by 2^{nd} quartile graduates. Considering both the descriptive statistics and the results of the Hierarchical ETTD model, the findings suggest that something about small-medium, or 2^{nd} quartile sized doctoral programs is not optimally sized for students who are experiencing extended time to doctoral degree.

The financial support model indicates that the overall measure for primary source of support is significant, but only the category variable for employer reimbursement/assistance measures a statistically significant effect. The effect increases time to degree, consistent with the Sample model, which suggests that while employer reimbursement/assistance programs are well intentioned, the effect of maintaining outside employment, likely full-time, while pursuing the doctoral degree increases time to degree and contributes to extended time to degree. The academic and professional pursuits appear to be at odds with one another. Also consistent with the Sample model, in the ETTD model, incurring educational debt is associated with a decrease in time to degree. The other factors associated with the financial support model do not exhibit or produce statistically significant effects on time to degree. Although not statistically significant, the increasing effect of a fellowship or scholarship (0.17 years) on time to degree in the ETTD model supports the findings in Chapter Four. Graduates with extended time to degree had the longest average time to degree when their primary source of support was a fellowship. This suggests that for students who are taking longer to complete the doctoral degree, relative to their disciplinary peers, continued use of a fellowship as the primary source of support does not advantage the student. Instead, the statistical analysis suggests that financial support categorized as "other assistantship," although not statistically significant, would help decrease extended time to degree by 0.38 years. The decreasing effect of the other assistantship is more than double the increasing effect of the fellowship or scholarship on extended time to degree.

An important finding for the graduates with extended time to degree is the significance and importance of training in proposal writing on time to degree. Assistance with proposal writing was significant at the level $p<0.05$, and decreased time to doctoral degree. The size of the effect is small, only approximately -0.20 to the level of the intercept, but it suggests that training opportunities help doctoral students to achieve their research objectives and graduate. Given that training graduate students is the general objective of doctoral education, a finding that supports more extensive efforts to do so can only enhance the educational environment. Unlike the Sample model, none of the factors in the process and procedures Hierarchical linear model are found to be significant. That is disappointing as practitioners involved in trying to improve graduate education have created programs to review the degree progress of doctoral students as a mechanism to monitor satisfactory academic progress. Here the coefficient is negative for the annual review variable and indicates a very small effect on time to degree (-0.004 years). Given the non-significance and very small impact of annual reviews, new graduate student orientation and international student orientation, one cannot say that process and procedure variables have an impact on extended time to degree.

Program environment factors have important and significant impacts on extended time to degree graduates. First, all of the coefficients associated with faculty are negative, suggesting that the faculty are key players in reducing time to degree for extended time to degree graduates. Unlike the Sample model, the ETTD model indicates that each increase in the percent of female faculty in the program can reduce time to degree by approximately 0.80 years. This finding suggests that while all faculty are evidently important to extended time to degree graduates, female faculty play a critical role in helping this group of students complete their degree requirements and graduate. The percentages of female and international students in the program and the average first-year enrollment are environmental factors that are found to decrease time to degree, although not significant in the ETTD model. Interestingly, where the percent of underrepresented minority faculty increased time to degree and the percent of underrepresented minority students decreased time to degree in the Sample model, the opposite trends are observed in the ETTD model. It appears that in the ETTD model, an increase in the percent of underrepresented minority students in the program is associated with an increase in time to degree. Further discussion of this finding is provided after the presentation of the third set of Hierarchical linear models.

With regard to factors associated with the research mode of the field, average number of faculty publications has a slightly increasing but highly significant effect (0.097 and 0.099 years in the research and full models, respectively) on time to degree. The high level of significance of average faculty publications in both the research and full models strengthens the importance of this finding. Further, it raises a flag that extended time to degree doctoral students may not benefit as much as other students from faculty engagement in other research activities. As a scale variable, the average faculty publications factor suggests that the more active the faculty are in research activities, the more students with extended time to degree experience increases in their time to degree.

The average number of publications represents only one of the faculty-driven variables in the research model. For the ETTD model, the percent of faculty with grants does not prove to be significant, but the coefficient is negative in the research and full models, -0.35 years and -0.37 years respectively. As a scale variable, each increase in the percent of faculty grants associated with a graduate program results in a decrease of time to degree. This finding suggests that extended time to degree students may benefit from the funding and support opportunities that are typically associated with faculty engagement in proposal and grant activities. The combination of these two factors suggests that a research environment where faculty are actively engaged in research affects extended time to doctoral degree.

In support of the previous findings, the coefficients for Carnegie classification categories very high university, high research university, and doctoral/research institution are all negative and suggest decreasing, although not significant, effects on extended time to degree. Despite being non-significant, the intensive and doctoral focused nature of these three institution types supports the notion that a robust research environment can provide the training and support required for doctoral students to complete the degree. By way of comparison, the significance of the variable for Masters institution, and in particular the severity of the effect identified by the coefficient—4.99 years in the full ETTD model and 2.75 years in the Sample model—further supports the findings from the Sample model. At Masters-focused institutions, the availability of institutional resources may not be sufficient to simultaneously support doctoral, masters and undergraduate programs, and respond to the needs of students with extended time to doctoral degree.

Factors that impact extended time to doctoral degree: Findings

The stated purpose of this research is to evaluate selected institutional and program characteristics that may contribute to extended time to degree in doctoral programs. The Hierarchical ETTD model suggests that both student-level and field-level factors affect extended time to doctoral degree. Student-level factors of which institutions and programs need to be mindful include the marital status of the individual, whether he or she has dependents, the passage of time and the effects of age and years spent preparing the dissertation on increasing time to doctoral degree, and whether the individual has an additional professional, medical or dental degree. These factors, which are predominantly beyond the control of the institution, represent the “life happens” reasons identified by Abedi and Benkin (1987), Berg and Ferber (1983), Lovitts (2008), Mason and Goulden (2004), and Nettles and Millett (2006). A recent study by Spaulding and Rockinson-Szapkiw (2012) found that intervening life experiences and dissertation challenges strained the academic and persistence efforts of doctoral students. Yet, these factors need not be the source of delay in completing the doctoral degree if adequate services and support are made available to doctoral students.

Institutions and programs can exercise some direct control and influence on field level factors that impact extended time to doctoral degree. In the full ETTD model, 39% of the variance at the field level is explained, which suggests that although factors that affect extended time to doctoral degree were identified, additional factors not identified by this research are likely contributors to extended time to degree. That being said, this research still identified key factors such as the size of the program, the primary source of support, educational debt, training in proposal writing, and the faculty in the context of the program and research environments. Specific recommendations are provided after the third set of Hierarchical linear models has been presented in order to incorporate the full context of study findings.

Graduates without Extended Time to Doctoral Degree

One must assume that even students who do not experience the phenomenon of extended time to doctoral degree are affected by student- and field-level factors. Given that these students are finding ways to successfully complete the degree requirements and graduate in a timeframe more centrally associated with the Mean for their respective discipline, it is important to consider factors essential to their success as well as those with extended time to doctoral degree. Thus, for comparative purposes and to help identify institutional characteristics which are helping or hindering those graduates who do not have extended time to doctoral degree, relative to their disciplinary peers, the set of Hierarchical linear models are generated one more time. The tests are run against the graduates from the sample population who did not experience extended time to doctoral degree. Henceforth, this set of models, in Table 40, will be referred to as the Not-ETTD model.

Table 40: Hierarchical Linear Model for Elapsed Time to Doctoral Degree, Graduates Without Extended Time to Doctoral Degree

	ICC	Socio-demographic	Student	Discipline	Financial Support	Training	Process	Environment	Research	Selection	Full Model
Intercept	6.5987** (43.280)	1.3470** (8.412)	0.1235 (0.554)	0.1212 (0.541)	0.3459 (1.411)	0.1243 (0.556)	0.2231 (0.995)	0.0473 (0.206)	0.3174 (1.370)	1.1240* (3.404)	1.3378** (3.606)
Variance components											
Residual	2.3110**	1.9189**	1.3227**	1.3218**	1.3094**	1.3227**	1.3209**	1.3220**	1.3225**	1.3207**	1.3050**
NRC Field	1.3300**	0.6152**	0.4035**	0.4057**	0.3908**	0.4045**	0.4067**	0.3872**	0.3791**	0.3495**	0.3222**
ICC	0.365										
Student-level: % var. exp.		0.170	0.428	0.428	0.433	0.428	0.428	0.428	0.428	0.429	0.435
NRC Field-level: % var. exp.		0.537	0.697	0.695	0.706	0.696	0.694	0.709	0.715	0.737	0.758
Student-level (N=18,545)											
Socio-Demographic Factors											
Female		0.0808* (3.329)	0.0242 (1.187)	0.0237 (1.162)	0.0309 (1.522)	0.0247 (1.210)	0.0249 (1.221)	0.0229 (1.120)	0.0242 (1.189)	0.0227 (1.116)	0.0292 (1.432)
Marital Status	*F-value*	** (4.665)	(1.300)	(1.335)	(1.491)	(1.304)	(1.341)	(1.282)	(1.313)	(1.253)	(1.480)
Married		0.0917 (1.297)	-0.0102 (-0.171)	-0.0088 (-0.148)	0.0060 (0.100)	-0.0101 (-0.170)	-0.0083 (-0.140)	-0.0127 (-0.213)	-0.0090 (-0.151)	-0.0009 (-0.016)	0.0117 (0.197)
Never married		0.1964* (2.736)	0.0365 (0.603)	0.0389 (0.643)	0.0589 (0.975)	0.0364 (0.602)	0.0396 (0.655)	0.0325 (0.537)	0.0384 (0.634)	0.0454 (0.750)	0.0641 (1.062)
Marriage-like relationship		0.1306+ (1.668)	-0.0085 (-0.129)	-0.0060 (-0.091)	0.0198 (0.301)	-0.0087 (-0.132)	-0.0051 (-0.078)	-0.0137 (-0.208)	-0.0046 (-0.070)	0.0037 (0.056)	0.0246 (0.375)

	ICC	Socio-demographic	Student	Discipline	Financial Support	Training	Process	Environment	Research	Selection	Full Model
Widowed		0.5693 (1.510)	0.3079 (0.983)	0.3055 (0.975)	0.3125 (1.001)	0.3130 (0.999)	0.3024 (0.965)	0.3187 (1.017)	0.3067 (0.979)	0.2993 (0.956)	0.3000 (0.962)
Separated		-0.0935 (-0.521)	-0.0824 (-0.552)	-0.0807 (-0.540)	-0.0342 (-0.230)	-0.0826 (-0.552)	-0.0811 (-0.543)	-0.0900 (-0.602)	-0.0821 (-0.550)	-0.0726 (-0.486)	-0.0398 (-0.268)
Divorced		0^{a}	0^{a}	0^{a}	0^{a}	0^{a}	0^{a}	0^{a}	0^{a}	0^{a}	0^{a}
Dependents		0.0695* (2.199)	0.0613* (2.314)	0.0616* (2.324)	0.0611* (2.308)	0.0608* (2.295)	0.0599* (2.260)	0.0622* (2.345)	0.0602* (2.274)	0.0593* (2.240)	0.0602* (2.274)
Approx. Age		0.1491** (53.822)	0.1018** (41.425)	0.1014** (41.175)	0.0964** (38.381)	0.1018** (41.413)	0.1017** (41.404)	0.1019** (41.352)	0.1012** (41.026)	0.1009** (40.784)	0.0960** (38.044)
US or Perm Res		0.4080* (2.815)	0.0849 (0.696)	0.0797 (0.654)	0.0562 (0.462)	0.0860 (0.705)	0.0852 (0.698)	0.0800 (0.655)	0.0889 (0.729)	0.0805 (0.660)	0.0460 (0.378)
Race/Ethnicity	*F-value*	(1.154)	(2.318)*	(2.321)*	(3.219)*	(2.295)*	(2.296)*	(2.317)*	(2.262)*	(2.360)*	(3.151)*
Amer Ind/AK Native		0.2172 (0.790)	0.4226^{+} (1.844)	0.4200^{+} (1.834)	0.4611* (2.021)	0.4194^{+} (1.831)	0.4280^{+} (1.869)	0.4328^{+} (1.889)	0.4154^{+} (1.813)	0.4118^{+} (1.798)	0.4662* (2.046)
Asian		0.1172 (0.784)	0.2247^{+} (1.789)	0.2269^{+} (1.807)	0.2432^{+} (1.944)	0.2239^{+} (1.783)	0.2284^{+} (1.820)	0.2251^{+} (1.793)	0.2239^{+} (1.783)	0.2352^{+} (1.874)	0.2539* (2.032)
Native HI/Pac Island		0.1117 (0.379)	-0.0008 (-0.003)	0.0081 (0.033)	0.0257 (0.105)	0.0004 (0.002)	0.0112 (0.045)	0.0017 (0.007)	0.0050 (0.021)	-0.0032 (-0.013)	0.0540 (0.221)
Black/African Amer		0.0815 (0.508)	0.3140* (2.326)	0.3180* (2.357)	0.3722* (2.765)	0.3128* (2.318)	0.3142* (2.330)	0.3181* (2.353)	0.3078* (2.281)	0.3082* (2.285)	0.3748* (2.782)
Hispanic		0.0272 (0.176)	0.1622 (1.249)	0.1672 (1.287)	0.1927 (1.489)	0.1626 (1.252)	0.1645 (1.267)	0.1704 (1.312)	0.1614 (1.243)	0.1607 (1.238)	0.2060 (1.593)
White		0.0052 (0.036)	0.1391 (1.151)	0.1419 (1.174)	0.1497 (1.243)	0.1387 (1.148)	0.1422 (1.177)	0.1418 (1.173)	0.1372 (1.135)	0.1407 (1.165)	0.1583 (1.316)

	ICC	Socio-demographic	Student	Discipline	Financial Support	Training	Process	Environment	Research	Selection	Full Model
Two or more races		0.0764 (0.446)	0.1749 (1.218)	0.1784 (1.243)	0.1786 (1.249)	0.1745 (1.216)	0.1723 (1.201)	0.1850 (1.289)	0.1728 (1.204)	0.1726 (1.203)	0.1859 (1.302)
Other/Unknown		0^{a}	0^{a}	0^{a}	0^{a}	0^{a}	0^{a}	0^{a}	0^{a}	0^{a}	0^{a}
Individual Characteristics & Time to Degree Factors											
Yrs. coursework			0.2730^{**} (42.745)	0.2715^{**} (42.347)	0.2637^{**} (41.000)	0.2727^{**} (42.690)	0.2717^{**} (42.538)	0.2726^{**} (42.662)	0.2718^{**} (42.464)	0.2703^{**} (42.145)	0.2607^{**} (40.397)
Yrs. dissertation			0.5798^{**} (77.395)	0.5818^{**} (76.703)	0.5808^{**} (77.143)	0.5799^{**} (77.402)	0.5800^{**} (77.463)	0.5789^{**} (76.997)	0.5814^{**} (77.385)	0.5845^{**} (77.195)	0.5815^{**} (76.160)
Add'l prof degree			-0.1616^{*} (-2.701)	-0.1619^{*} (-2.707)	-0.1427^{*} (-2.395)	-0.1609^{*} (-2.689)	-0.1637^{*} (-2.738)	-0.1576^{*} (-2.634)	-0.1599^{*} (-2.672)	-0.1667^{*} (-2.786)	-0.1475^{*} (-2.476)
Ed level Father	*F-value*		(1.359)	(1.422)	$^{+}$ (1.970)	(1.379)	(1.371)	(1.318)	(1.434)	(1.593)	* (2.069)
Less than HS			-0.0971 (-0.550)	-0.0889 (-0.504)	-0.0874 (-0.497)	-0.0986 (-0.559)	-0.0911 (-0.516)	-0.0967 (-0.548)	-0.1003 (-0.569)	-0.1061 (-0.602)	-0.0894 (-0.510)
HS graduate			-0.1561 (-0.899)	-0.1506 (-0.868)	-0.1551 (-0.898)	-0.1581 (-0.911)	-0.1507 (-0.869)	-0.1563 (-0.901)	-0.1603 (-0.924)	-0.1645 (-0.949)	-0.1583 (-0.917)
Some college			-0.1217 (-0.701)	-0.1151 (-0.663)	-0.1156 (-0.669)	-0.1232 (-0.709)	-0.1134 (-0.654)	-0.1218 (-0.702)	-0.1251 (-0.720)	-0.1312 (-0.756)	-0.1169 (-0.677)
Bachelor's			-0.0821 (-0.476)	-0.0746 (-0.432)	-0.0678 (-0.394)	-0.0834 (-0.483)	-0.0750 (-0.434)	-0.0832 (-0.482)	-0.0848 (-0.491)	-0.0865 (-0.502)	-0.0674 (-0.393)
Master's			-0.0898 (-0.519)	-0.0824 (-0.477)	-0.0707 (-0.411)	-0.0909 (-0.526)	-0.0846 (-0.489)	-0.0918 (-0.531)	-0.0914 (-0.528)	-0.0923 (-0.534)	-0.0725 (-0.422)
Prof degree			-0.0357 (-0.205)	-0.0272 (-0.156)	-0.0079 (-0.046)	-0.0368 (-0.211)	-0.0293 (-0.169)	-0.0383 (-0.220)	-0.0361 (-0.207)	-0.0337 (-0.194)	-0.0074 (-0.043)
Doctorate			-0.0895 (-0.515)	-0.0833 (-0.480)	-0.0633 (-0.366)	-0.0905 (-0.521)	-0.0838 (-0.483)	-0.0936 (-0.539)	-0.0885 (-0.510)	-0.0895 (-0.516)	-0.0656 (-0.380)

	ICC	Socio-demographic	Student	Discipline	Financial Support	Training	Process	Environment	Research	Selection	Full Model
n/a			0^a	0^a	0^a	0^a	0^a	0^a	0^a	0^a	0^a
Ed level Mother	*F-value*		(1.419)	(1.425)	(1.303)	(1.407)	(1.360)	(1.434)	(1.451)	(1.517)	(1.334)
Less than HS			0.3665^{+} (1.680)	0.3670^{+} (1.683)	0.3738^{+} (1.720)	0.3676^{+} (1.685)	0.3553 (1.630)	0.3695^{+} (1.694)	0.3716^{+} (1.703)	0.3791^{+} (1.739)	0.3693^{+} (1.701)
HS graduate			0.4073^{+} (1.878)	0.4076^{+} (1.880)	0.4065^{+} (1.882)	0.4087^{+} (1.885)	0.3928^{+} (1.812)	0.4101^{+} (1.891)	0.4128^{+} (1.904)	0.4193^{+} (1.935)	0.3976^{+} (1.842)
Some college			0.4522^{*} (2.083)	0.4523^{*} (2.084)	0.4455^{*} (2.060)	0.4529^{*} (2.086)	0.4379^{*} (2.019)	0.4547^{*} (2.095)	0.4576^{*} (2.108)	0.4645^{*} (2.142)	0.4371^{*} (2.023)
Bachelor's			0.4305^{*} (1.987)	0.4323^{*} (1.995)	0.4297^{*} (1.991)	0.4313^{*} (1.990)	0.4161^{+} (1.921)	0.4321^{*} (1.993)	0.4363^{*} (2.013)	0.4466^{*} (2.062)	0.4234^{+} (1.962)
Master's			0.4387^{*} (2.020)	0.4406^{*} (2.029)	0.4394^{*} (2.031)	0.4395^{*} (2.023)	0.4255^{+} (1.960)	0.4409^{*} (2.029)	0.4454^{*} (2.051)	0.4569^{*} (2.105)	0.4349^{*} (2.011)
Prof degree			0.3530 (1.597)	0.3546 (1.604)	0.3531 (1.603)	0.3545 (1.603)	0.3404 (1.541)	0.3532 (1.598)	0.3579 (1.619)	0.3659^{+} (1.656)	0.3431 (1.559)
Doctorate			0.4356^{*} (1.976)	0.4391^{*} (1.992)	0.4411^{*} (2.009)	0.4366^{*} (1.981)	0.4236^{+} (1.922)	0.4368^{*} (1.981)	0.4432^{*} (2.011)	0.4561^{*} (2.071)	0.4400^{*} (2.005)
n/a			0^a	0^a	0^a	0^a	0^a	0^a	0^a	0^a	0^a

	ICC	Socio-demographic	Student	Discipline	Financial Support	Training	Process	Environment	Research	Selection	Full Model
NRC Field-level (N=58)											
Discipline & Institutional Factors											
Public Institution				0.0355^{+} (1.773)							-0.0261 (-1.152)
Size Quartile	*F-value*			* (3.769)							* (2.769)
Smallest Quartile				0.0352 (1.082)							0.0058 (0.154)
2nd Quartile				-0.0422 (-1.566)							-0.0588^{+} (-1.875)
3rd Quartile				-0.0592* (-2.576)							-0.0580* (-2.221)
Largest Quartile				0[a]							0[a]
Financial Support											
Primary Support	*F-value*				** (12.338)						** (11.579)
Fellowship, scholarship					-0.1847^{+} (-1.916)						-0.1709^{+} (-1.774)
Grant					-0.0913 (-0.926)						-0.0807 (-0.819)
TA					-0.0081 (-0.082)						-0.0027 (-0.028)
RA					-0.0839 (-0.872)						-0.0746 (-0.776)

	ICC	Socio-demographic	Student	Discipline	Financial Support	Training	Process	Environment	Research	Selection	Full Model
Other assistantship					0.5119* (3.075)						0.5109* (3.070)
Traineeship					0.1532 (1.170)						0.1808 (1.380)
Internship/residency					0.1464 (0.557)						0.1729 (0.658)
Loans					0.1159 (1.064)						0.1083 (0.994)
Personal savings					0.2937* (2.103)						0.3048* (2.183)
Personal earnings					0.5482** (4.697)						0.5459** (4.679)
Spouse/family earnings					0.0322 (0.301)						0.0419 (0.392)
Employer assistance					0.2283^{+} (1.730)						0.2159 (1.636)
Foreign (non-US)					-0.1944 (-1.455)						-0.1779 (-1.333)
Other					0.7391 (0.904)						0.7637 (0.935)
Unknown					0^{a}						0^{a}
Educational Debt					0.0378^{+} (1.910)						0.0385^{+} (1.949)
% 1st-Yr Full $$					-0.0229 (-0.509)						0.0041 (0.085)

	ICC	Socio-demographic	Student	Discipline	Financial Support	Training	Process	Environment	Research	Selection	Full Model
% Students RA					0.0594 (1.324)						0.0318 (0.669)
% Students TA					-0.0354 (-0.623)						-0.0729 (-1.212)
Support and Training											
Proposal Writing						-0.0237 (-1.220)					-0.0052 (-0.257)
Travel Support						0.0152 (0.716)					0.0522* (2.314)
Processes & Procedures											
New Orientation							-0.0772* (-3.135)				-.0954** (-3.743)
Int'l Orientation							-0.0025 (-0.124)				-0.0075 (-0.368)
Annual Review							-0.0603* (-3.203)				-0.0572* (-2.906)
Program Environment											
URM Faculty								0.4725* (2.765)			0.4093* (2.382)
Female Faculty								0.0002 (0.002)			-0.0148 (-0.136)
Total Faculty								-0.0005 (-1.488)			-0.0005 (-1.197)
URM Students								-0.2735* (-2.636)			-0.3376* (-3.212)

	ICC	Socio-demographic	Student	Discipline	Financial Support	Training	Process	Environment	Research	Selection	Full Model
Female Students								0.1431 (1.389)			0.1231 (1.192)
Int'l Students								0.0333 (0.534)			0.0511 (0.783)
Total Students								0.0005^{+} (1.731)			0.0005 (1.599)
Av 1st-Yr Enroll								0.0000 (0.028)			-0.0007 (-0.500)
Research											
Av Fac Pubs									-0.0044 (-0.929)		-0.0037 (-0.754)
% Faculty Grants									-0.1627* (-2.264)		-0.1166 (-1.496)
% Acad Plans									-0.1077 (-1.513)		-0.0362 (-0.495)
Selection											
Carnegie Classification	*F-value*									* (2.215)	* (3.055)
Research Univ (very high)										-0.1142 (-0.682)	-0.0479 (-0.284)
Research Univ (high)										-0.1279 (-0.750)	-0.0772 (-0.448)
Doctoral/Research										-0.2314 (-1.133)	-0.3270 (-1.569)
Masters										0.2772 (0.404)	0.4338 (0.633)

	ICC	Socio-demographic	Student	Discipline	Financial Support	Training	Process	Environment	Research	Selection	Full Model
Baccalaureate										-1.283** (-3.712)	-1.327** (-3.811)
Theological										0.2375 (0.391)	0.0841 (0.139)
Medical										-0.0712 (-0.400)	0.0259 (0.145)
Engineering										-0.1666 (-0.551)	-0.0479 (-0.158)
Not Classified										0[a]	0[a]
Av GRE Scores										-.0013** (-4.891)	-.0011** (-3.811)

Note: F- and t-statistics in parentheses; $p<.001^{**}$, $p<.05^{*}$, $p<.10^{+}$

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Factors that impact time to degree in the Non-ETTD model: Student-level factors

The first key finding from the analysis of Not-ETTD graduates, with respect to discipline, is that the intercept of the null model for the Not-ETTD model is, not surprisingly, less than that of the Sample model. However, unlike the intercept for every test in both the sample and ETTD models, the intercept is only statistically significant for the null model, the socio-demographic model, the selectivity model, and the full Not-ETTD model. The ICC calculation indicates that as much as 36.5% of the variance in elapsed time to degree for those without extended time to degree may be explained by field level variables, which exceeds the minimum 5% threshold suggested by Porter (2005), but explains only half of the 78.2% variation of the ETTD model. The lower ICC of the Not-ETTD model compared to the ETTD model suggests that extended time to degree students are more affected by field and institutional factors than their peers. The variance components of the Hierarchical Not-ETTD models are statistically significant, and the percent of variance that can be explained at the student level is fairly consistent once all of the student-level factors are included.

Within the socio-demographic characteristics, the full model suggests that only dependents, age and race/ethnicity are statistically significant and increasing factors. The increasing effect of dependents is not as great in the Not-ETTD model—ranging from 0.0593 years to 0.0695 years—as it is in the ETTD model—ranging from 0.1803 years to 0.2384 years. The finding regarding dependents, which was also a significant factor across all iterations of the ETTD model, suggests that changes are necessary in the administration of doctoral programs and the support for doctoral students. Institutions and doctoral programs must consider the support mechanisms that are, or are not, in place to aid doctoral student parents.

Although race is not found to be a statistically significant factor in the ETTD model, it is a statistically significant factor in the Not-ETTD Hierarchical linear models. Consistent with Nettles (1990a) and Ellis (2001), the effect of race/ethnicity was significant at the $p<0.05$ level for Black/African American students, who had increased time to degree. American Indian/Alaska Natives and Asian Americans also experience significant increasing effects on time to degree. Being American Indian/Alaska Native added the most time, at 0.47 years followed by 0.37 years for Black/African American students. While in the ETTD model race/ethnicity factors were not significant, the findings from the Not-ETTD model suggest that race/ethnicity is a contributing factor that affects time to doctoral degree. In academic terms, 0.37-0.47 years is roughly equivalent to one quarter or semester of time. Institutions need to examine why Black/African American students who have early or average time to degree take longer to complete the degree than white students.

Among the individual characteristics and time to degree factors for the Not-ETTD model, years preparing the dissertation is the most dominant and significant factor across all variations of the Hierarchical linear models followed closely by years completing coursework. Having an additional professional, medical or dental degree is a significantly decreasing factor across all of the Hierarchical linear models. The findings regarding years spent on coursework and the dissertation, the latter of which is significant at the $p<0.001$ level across every Hierarchical linear model calculated for this research, suggests that one of the most important things institutions and doctoral programs can do to help reduce time to degree is to look carefully at coursework requirements and time spent preparing the dissertation to improve efficiency and effectiveness. Some students in every discipline will still take longer to finish than others. That is to be expected because the process of research is an inexact science—no one can predict exactly how long it will take for any project or study to converge. However, being mindful that every subject in this study completed the doctorate, the findings suggest that institutions and programs must do more to support student research and writing to reduce the amount of time spent preparing the dissertation.

The results of this research are empirically consistent with previous findings that understanding of the academic milestone requirements, a clear sense of requirements including the time associated with each, and adequate mentorship through the transition points in the doctoral program are critical indicators of degree completion (Girves & Wemmerus, 1988; Golde, 2005; Golde & Dore, 2001). In sum, the results of the Sample model, the ETTD model, and the Not-ETTD model all suggest that elapsed time to degree is affected by a number of socio-demographic and individual characteristics.

Factors that impact time to degree in the Non-ETTD model: Field-level factors

Similar to the ETTD model, in the Not-ETTD model, institution type is a minimally significant decreasing effect in the Hierarchical linear model of group factors, but it is not a significant factor in the full model. Second and third quartile programs, which represent medium to medium-large sized programs, have significant decreasing effects in the Not-ETTD model. This suggests that although second quartile sized programs are not optimally sized to help extended time to degree students, moderate enrollment may be the program size to target for faculty seeking to establish an environment that helps decrease time to doctoral degree.

The financial support model indicates that the overall measure for primary source of support is significant, and that having a fellowship or scholarship has a significant decreasing effect on time to degree. Recall that the fellowship metric was not significant or decreasing in the ETTD model. In that model, it exhibited a non-significant and increasing effect on time to degree. In the Not-ETTD model, the fellowship variable reduces time to degree, which suggests that institutions and graduate programs evaluate their financial support models. In the Not-ETTD model, having a grant, teaching assistantship or research assistantship had minimally, non-significant decreasing effects on time to degree. This indicates that while these forms of financial support are not hindering the time to degree of doctoral students, they are not the optimal type of financial support. Other assistantships, and using personal savings or earnings all produce significant increasing effects on time to degree, by as much as 0.55 years for doctoral students with outside employment. In the context of the Not-ETTD model, taking on educational debt has a minimally significant, increasing effect on time to degree. Extant research has already confirmed that the type, length and amount of support helps students complete at higher and faster rates, while poor support or self-support distracts students from focusing on their academic pursuits (Abedi & Benkin, 1987; Bowen & Rudenstine, 1992; Ehrenberg & Mavros, 1995; Nettles and Millett, 2006). The combination of these factors and the findings from this research suggests that institutions and graduate programs evaluate their financial support models to keep doctoral students from having to rely on personal sources of income or take on educational loans in order to support themselves throughout their doctoral program.

With regard to factors associated with the support and training, and the processes and procedures of the doctoral program, three of the five factors have significant effects on time to degree in the Not-ETTD model. The existence and availability of travel support for students has a slight increasing effect, but suggests that opportunities were made available to the doctoral student to participate and engage in individual or disciplinary research activities of their field. New graduate student orientation and annual reviews of all doctoral students both had significant decreasing effects on time to degree. This finding returns once again to the notion that a clear sense of degree requirements and mentoring throughout the doctoral program are critical factors for degree completion (Girves & Wemmerus, 1988; Golde, 2005; Golde & Dore, 2001).

The program environment factors in the Not-ETTD model have important and significant impacts on time to degree. The percent of underrepresented minority faculty and the percent of underrepresented minority students are both statistically significant at the $p<0.05$ level, with increasing and decreasing effects, respectively. Consistent with the

Sample model, each percent increase in underrepresented minority faculty appears to have a slight increasing effect, 0.41 years, on time to degree, and each percent increase in underrepresented minority students a slight decreasing effect of 0.34 years. Surprisingly, none of the factors from the research environment group produced significant results in the Not-ETTD model. Instead, the results—all of which were non-significant, minimally decreasing effects—suggest that a research environment defined by faculty publications, faculty grants, and students with academic career plans does not negatively impact time to degree for students with early or average time to degree, relative to discipline. This was an unusual finding because previous research has found that students who engage in and publish or present their research while in graduate school are more likely to complete the Ph.D. (Nettles & Millett, 2006). The findings, perhaps, suggest instead that among students with early or average time to degree, the composition of the research environment—as defined by faculty publications, faculty grants, and students with academic career plans—is meeting their needs, neither increasing nor decreasing time to degree. Future research might examine whether student participation as co-authors on faculty publications, support from or involvement in research associated with faculty grants, or higher numbers of students with academic career plans influences time to degree. These factors might offer better indications of engagement in the research environment and the effect on early or average time to degree.

In support of the suggestion that engagement in the research environment can help to reduce time to degree, within the Not-ETTD model, the coefficients for Carnegie classification categories very high research university, high research university, and doctoral/research institution are all non-significant and negative. These are institutions with a central mission focused on research, generally speaking. Like the ETTD model, despite being non-significant, the intensive and doctoral focused nature of these three institution types supports the notion that a robust research environment can provide the training and support required by doctoral students. One of the more surprising findings within the research is that time to degree for earned doctorates from Baccalaureate institutions is reduced by 1.33 years. The outcome, like the Sample model, suggests that the likely smaller number of doctoral programs, the availability of institutional resources, and/or the number of faculty dedicated to doctoral programs at Baccalaureate institutions creates an environment that is conducive to early or average time to degree, relative to discipline. A specific analysis examining factors such as the number of doctoral programs, the student-faculty ratios, or the allocation of institutional resources to the doctoral program(s) would be needed to address the validity of those questions.

Last but not least, for each increase in the average GRE scores for the doctoral program, time to degree in the Not-ETTD model experienced a highly significant, minimally decreasing effect. This suggests that the higher the academic caliber—as measured by GRE score—of the students in a doctoral program, the better the outcomes for time to degree. As noted in Gardner (2009a), Lovitts (2001), and Nettles and Millett (2006), successful selection and ‘fit’ between the student and the program are critical to a successful doctoral experience and degree completion.

In sum, the results of the Not-ETTD models, testing each group of variables against elapsed time to degree for those graduates who did not experience extended time to degree relative to their disciplinary peers, suggest that time to degree is affected by a number of student and field level factors.

Analysis of Variance Models by NRC Field

The primary goal of this research was to identify institutional factors that have an effect on extended time to doctoral degree. The preceding tests and discussion directly address that objective. The Hierarchical linear models were used because they accommodated the nested data of student- and field-level factors, and the model permitted the intercept of the dependent variable, elapsed time to degree, to differ for each field while the effects of the institution factors were considered equally across fields (Porter, 2005). While the descriptive statistics found in Chapter Four provided information regarding the Mean time to degree and the point of extended time to degree for each Field, they did not identify factors that contributed, positively or negatively, to time to degree. Furthermore, the Hierarchical linear models conducted for this research mask the factors that either increase or decrease time to degree in each NRC Field. Therefore, further analyses were necessary in order to reveal and understand which of the institutional factors identified for this study affect time to degree for each discipline. Analysis of Variance (ANOVA) tests were selected as an appropriate statistical method to evaluate which factors impact time to degree in each NRC Field. The ANOVA models follow the same approach as those constructed to evaluate the Sample models, the ETTD models, and the Not-ETTD models. Tables 41-47 present the full model for each NRC Field. Rather than listing the coefficients for each model, which might encourage comparisons between groups and is not the desired objective of this research, only the level of significance is listed. If the direction of the effect is negative and thereby decreases time to degree, then a minus (-) sign precedes the symbol for the level of significance and the font is red.

In addition, the R Square, F-value, and student-level N for each field are provided. The R Square indicates the fit of the model and the percent of variance in the dependent variable explained by the independent variables. The F-value represents the ratio of the variation between and within groups. Larger F-values indicate that a greater level of difference between groups, which in the case of this research indicates greater differences between doctoral programs within a given NRC Field. At the bottom of each table there is a count of the statistically significant factors for each program. The count is intended to serve as a guide regarding the extent to which time to degree is significantly impacted, positively or negatively, for each NRC Field.

Table 41: Significance of Factors by NRC Field, Aerospace Engineering-Biology

	Aerospace Engineering	Agricultural and Resource Economics	American Studies	Animal Sciences	Anthropology	Applied Mathematics	Astrophysics and Astronomy	Biochemistry, Biophysics, and Structural Biology	Biology/ Integrated Biology/ Integrated Biomedical Sciences
Measures of Fit									
R Square	0.671	0.701	0.674	0.772	0.657	0.736	0.762	0.545	0.748
F-value	11.62^{**}	4.13^{**}	4.20^{**}	3.57^{**}	31.52^{**}	13.38^{**}	7.42^{**}	25.45^{**}	3.46^{**}
Student-level N =	*241*	*91*	*97*	*74*	*629*	*203*	*113*	*802*	*78*
Socio-Demographic Factors									
Female			-*				-*		
Marital Status						-+			
Dependents		-+	-+						
Approx. Age	**	**	*	**	**	**	*	**	*
US or Perm Res									
Race/Ethnicity						-*			
Student Qualities & Time to Degree Factors									
Yrs. coursework	*				**	**	*	**	*
Yrs. dissertation	**	*	**	+	**	**	**	**	**
Add'l prof degree							-+		
Ed level Father								*	
Ed level Mother	+				+				
Discipline & Institutional Factors									
Public Institution	+								
Size Quartile								-*	
Financial Support									
Primary Support			*		*	**		*	
Educational Debt									
% 1st-Yr Full $$	+								
% Students RA	+				*				
% Students TA				+	+				
Support and Training									
Proposal Writing		-+		*	*			-*	
Travel Support	*			-*	-*			-*	

	Aerospace Engineering	Agricultural and Resource Economics	American Studies	Animal Sciences	Anthropology	Applied Mathematics	Astrophysics and Astronomy	Biochemistry, Biophysics, and Structural Biology	Biology/ Integrated Biology/ Integrated Biomedical Sciences
Processes & Procedures									
New Orientation	-*	*			-*			*	
Int'l Orientation	-+	-*		-*					
Annual Review				*				*	
Program Environment									
URM Faculty	-*					-*			
Female Faculty	-*			-*					
Total Faculty				-+					
URM Students						+			
Female Students	-*			*					
Int'l Students									
Total Students	*							*	
Av 1st-Yr Enroll	-*						-+		
Research									
Av Fac Pubs									
% Faculty Grants				-*					
% Acad Plans	-+	-*		-*	-*				
Selection									
Carnegie		-*							
Av GRE Scores									
Count of Statistically Significant Institutional Factors									
	16	8	5	12	11	8	6	11	3
Note: $p<001^{**}$, $p<05^{*}$, $p<10^{+}$									

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Table 42: Significance of Factors by NRC Field, Biomedical Engineering-Comparative Literature

	Biomedical Engineering and Bioengineering	Cell and Developmental Biology	Chemical Engineering	Chemistry	Civil and Environmental Engineering	Classics	Communication	Comparative Literature
Measures of Fit								
R Square	0.630	0.531	0.541	0.578	0.659	0.928	0.608	0.763
F-value	24.790**	8.432**	31.943**	6.087**	25.493**	15.966**	3.682**	13.798**
Student-level N =	*560*	*304*	*1,011*	*196*	*510*	*74*	*118*	*190*
Socio-Demographic Factors								
Female								
Marital Status		*		-*	*	-*		
Dependents	*				-+	*		
Approx. Age	**	**	**	**	**	**	**	**
US or Perm Res	-*	-+			-**		-+	
Race/Ethnicity			-*					-*
Student Qualities & Time to Degree Factors								
Yrs. coursework	**		**	*	**	*	+	**
Yrs. dissertation	**	**	**	**	**	**	*	**
Add'l prof degree	*			+	-*			
Ed level Father								
Ed level Mother			*				-*	
Discipline & Institutional Factors								
Public Institution								
Size Quartile		-+						
Financial Support								
Primary Support		-+		*	*			*
Educational Debt	-+				*			
% 1st-Yr Full $$	+							
% Students RA			*					
% Students TA	-*							
Support and Training								
Proposal Writing						*		
Travel Support								
Processes & Procedures								
New Orientation								
Int'l Orientation		*						
Annual Review					*			

	Biomedical Engineering and Bioengineering	Cell and Developmental Biology	Chemical Engineering	Chemistry	Civil and Environmental Engineering	Classics	Communication	Comparative Literature
Program Environment								
URM Faculty			+	+	*			+
Female Faculty	-*							
Total Faculty	-*					-+		
URM Students						-+		
Female Students								
Int'l Students							*	
Total Students	+		**					+
Av 1st-Yr Enroll			-**					
Research								
Av Fac Pubs							-+	
% Faculty Grants				*			+	
% Acad Plans								
Selection								
Carnegie					-+			-*
Av GRE Scores								
Count of Statistically Significant Institutional Factors								
	12	7	9	8	12	8	8	8
Note: $p<001^{**}$, $p<05^{*}$, $p<10^{+}$								

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Table 43: Significance of Factors by NRC Field, Computer Engineering-Forestry

	Computer Engineering	Computer Sciences	Earth Sciences	Ecology and Evolutionary Biology	Electrical and Computer Engineering	English Language and Literature	Entomology	Food Science	Forestry and Forest Sciences
Measures of Fit									
R Square	0.890	0.622	0.737	0.568	0.606	0.743	0.641	0.889	n/a
F-value	6.60**	50.332**	4.955**	8.838**	66.518**	6.351**	2.087*	3.647*	n/a
Student-level N=	*49*	*1,138*	*97*	*270*	*1,590*	*115*	*76*	*48*	*29*
Socio-Demographic Factors									
Female		*			*				
Marital Status		-*			*		+		
Dependents			-+						
Approx. Age		**	**	**	**	**		*	
US or Perm Res					-**				
Race/Ethnicity		-*	-+						
Student Qualities & Time to Degree Factors									
Yrs. coursework		**		**	**	*		*	
Yrs. dissertation	*	**	**	**	**	**	*		
Add'l prof degree									
Ed level Father		*			*				
Ed level Mother			-*						
Discipline & Institutional Factors									
Public Institution									
Size Quartile									
Financial Support									
Primary Support					**		+	+	
Educational Debt		+							
% 1st-Yr Full $$					*				
% Students RA									
% Students TA	-*					-*			
Support and Training									
Proposal Writing									
Travel Support	*				-*				
Processes & Procedures									
New Orientation			+		*	-+			
Int'l Orientation									
Annual Review									

	Computer Engineering	Computer Sciences	Earth Sciences	Ecology and Evolutionary Biology	Electrical and Computer Engineering	English Language and Literature	Entomology	Food Science	Forestry and Forest Sciences
Program Environment									
URM Faculty					-*				
Female Faculty									
Total Faculty									
URM Students					-+				
Female Students		-*	+						
Int'l Students	*								
Total Students		*							
Av 1st-Yr Enroll		-*							
Research									
Av Fac Pubs	-+				-*				
% Faculty Grants						+			
% Acad Plans					+				
Selection									
Carnegie		-*			-*				
Av GRE Scores	-+								
Count of Statistically Significant Institutional Factors									
	6	12	7	3	16	6	3	3	n/a
Note: p<001**, p<05*, p<10^{+}									

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Table 44: Significance of Factors by NRC Field, French-Kinesiology

	French and Francophone Language and Literature	Genetics and Genomics	Geography	German Language and Literature	History	History of Art, Architecture and Archaeology	Immunology and Infectious Disease	Kinesiology
Measures of Fit								
R Square	0.835	0.630	0.737	0.870	0.790	0.746	0.543	0.791
F-value	10.299**	12.811**	7.384**	5.456**	3.969**	18.237**	10.745**	5.785**
Student-level N =	*106*	*307*	*131*	*60*	*72*	*252*	*361*	*91*
Socio-Demographic Factors								
Female								-*
Marital Status								
Dependents						-*		
Approx. Age		**	**	*	+	**	**	**
US or Perm Res	-*							-*
Race/Ethnicity	+							
Student Qualities & Time to Degree Factors								
Yrs. coursework	*	*	*	+		*	**	
Yrs. dissertation	**	**	**	**	**	**	**	*
Add'l prof degree							-*	
Ed level Father		*						
Ed level Mother								-*
Discipline & Institutional Factors								
Public Institution	-*		-+					
Size Quartile	-*							-+
Financial Support								
Primary Support		*				+		
Educational Debt								*
% 1st-Yr Full $$								
% Students RA								
% Students TA						*	*	
Support and Training								
Proposal Writing								
Travel Support			+				-*	
Processes & Procedures								
New Orientation			*				**	
Int'l Orientation						*		
Annual Review								

	French and Francophone Language and Literature	Genetics and Genomics	Geography	German Language and Literature	History	History of Art, Architecture and Archaeology	Immunology and Infectious Disease	Kinesiology
Program Environment								
URM Faculty								
Female Faculty	+							
Total Faculty								
URM Students	-*							
Female Students	*							
Int'l Students			-*					
Total Students	*							
Av 1st-Yr Enroll								
Research								
Av Fac Pubs	-*							
% Faculty Grants	+						-*	
% Acad Plans	-*							
Selection								
Carnegie							*	
Av GRE Scores	*							
Count of Statistically Significant Institutional Factors								
	14	5	7	3	2	7	9	7
Note: p<001**, p<05*, p<10^{+}								

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Table 45: Significance of Factors by NRC Field, Materials Science-Nutrition

	Materials Science and Engineering	Mathematics	Mechanical Engineering	Microbiology	Music (except performance)	Neuroscience and Neurobiology	Nursing	Nutrition
Measures of Fit								
R Square	0.627	0.897	0.611	0.468	0.680	0.528	0.505	0.786
F-value	21.716^{**}	7.228^{**}	34.762^{**}	11.043^{**}	19.316^{**}	25.229^{**}	5.861^{**}	12.555^{**}
Student-level N =	*502*	*64*	*834*	*488*	*353*	*849*	*243*	*159*
Socio-Demographic Factors								
Female				+				
Marital Status	*						+	*
Dependents					-+		-*	
Approx. Age	**	*	**	**	**	**	**	**
US or Perm Res			-*				-*	
Race/Ethnicity								
Student Qualities & Time to Degree Factors								
Yrs. coursework	**	*	**	**	**	**		*
Yrs. dissertation	**	*	**	**	**	**	*	**
Add'l prof degree	*					-*		
Ed level Father								
Ed level Mother								
Discipline & Institutional Factors								
Public Institution					*			*
Size Quartile	-*							
Financial Support								
Primary Support	**		**				+	
Educational Debt							*	*
% 1st-Yr Full $$			-*					
% Students RA		-+	*					
% Students TA	-+							
Support and Training								
Proposal Writing			-*		-+			
Travel Support			*					
Processes & Procedures								
New Orientation				+				
Int'l Orientation			+				-+	
Annual Review						*		

	Materials Science and Engineering	Mathematics	Mechanical Engineering	Microbiology	Music (except performance)	Neuroscience and Neurobiology	Nursing	Nutrition
Program Environment								
URM Faculty		+				+		
Female Faculty								
Total Faculty						+	+	+
URM Students								
Female Students								
Int'l Students						*		
Total Students	+				*			
Av 1st-Yr Enroll					-*	*	-*	
Research								
Av Fac Pubs								
% Faculty Grants			-+					
% Acad Plans				-*	-+			
Selection								
Carnegie								
Av GRE Scores								
Count of Statistically Significant Institutional Factors								
	9	5	11	6	9	9	10	7
*Note: p<001**, p<05*, p<10+*								

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Table 46: Significance of Factors by NRC Field, Oceanography-Political Science

	Oceanography, Atmospheric Sciences and Meteorology	Operations Research, Systems Engineering and Industrial Engineering	Pharmacology, Toxicology and Environmental Health	Philosophy	Physics	Physiology	Plant Sciences	Political Science
Measures of Fit								
R Square	0.582	0.616	0.582	0.709	0.722	0.617	0.654	0.713
F-value	3.068**	7.046**	10.384**	27.453**	11.482**	5.762**	6.745**	49.584**
Student-level N =	*112*	*194*	*305*	*430*	*195*	*165*	*160*	*733*
Socio-Demographic Factors								
Female								
Marital Status			+					
Dependents				-+	+			
Approx. Age	**	**	**	**	**	*	**	**
US or Perm Res	-+		-*					
Race/Ethnicity						-*		-+
Student Qualities & Time to Degree Factors								
Yrs. coursework	*	*	**	**	+	**	**	**
Yrs. dissertation	**	*	**	**	**	**		**
Add'l prof degree					*			
Ed level Father								
Ed level Mother								
Discipline & Institutional Factors								
Public Institution								
Size Quartile	*							
Financial Support								
Primary Support		+		*	*			*
Educational Debt		+	-+					
% 1st-Yr Full $$				*				
% Students RA			-*		+			
% Students TA	-*				*			
Support and Training								
Proposal Writing					+			
Travel Support							-+	
Processes & Procedures								
New Orientation								
Int'l Orientation								
Annual Review							*	

	Oceanography, Atmospheric Sciences and Meteorology	Operations Research, Systems Engineering and Industrial Engineering	Pharmacology, Toxicology and Environmental Health	Philosophy	Physics	Physiology	Plant Sciences	Political Science
Program Environment								
URM Faculty						+	+	
Female Faculty		-*		+				+
Total Faculty					-+			
URM Students								
Female Students			*				*	
Int'l Students							*	
Total Students				*			-+	
Av 1st-Yr Enroll							*	
Research								
Av Fac Pubs					-+			
% Faculty Grants							-*	
% Acad Plans								
Selection								
Carnegie								
Av GRE Scores					*			
Count of Statistically Significant Institutional Factors								
	6	6	8	8	12	5	10	6
Note: $p<001^{**}$, $p<05^{*}$, $p<10^{+}$								

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Table 47: Significance of Factors by NRC Field, Psychology-Theatre

	Psychology	Public Affairs, Public Policy and Public Administration	Public Health	Religion	Sociology	Spanish and Portuguese Language and Literature	Statistics and Probability	Theatre and Performance Studies
Measures of Fit								
R Square	0.681	0.796	0.649	0.780	0.604	0.702	0.677	0.922
F-value	42.064**	5.100**	9.041**	12.023**	25.370**	11.399**	9.793**	5.479*
Student-level N =	*746*	*83*	*212*	*158*	*635*	*210*	*204*	*44*
Socio-Demographic Factors								
Female			-+					
Marital Status								
Dependents					-*	+	+	
Approx. Age	**	*	**	**	**	**	**	*
US or Perm Res			-*			-*	-+	
Race/Ethnicity					-*			
Student Qualities & Time to Degree Factors								
Yrs. coursework	**			**	**	*	**	
Yrs. dissertation	**		*	**	**	**	**	
Add'l prof degree				*		-+		
Ed level Father								
Ed level Mother								
Discipline & Institutional Factors								
Public Institution			+	+				
Size Quartile	*		-+					
Financial Support								
Primary Support	+		*	+				
Educational Debt	-*	*	+			*		
% 1st-Yr Full $$								
% Students RA				-*				
% Students TA	+			+				
Support and Training								
Proposal Writing			+					
Travel Support		-+			-*			
Processes & Procedures								
New Orientation							*	
Int'l Orientation		-*					-+	
Annual Review		-*	*	+				

	Psychology	Public Affairs, Public Policy and Public Administration	Public Health	Religion	Sociology	Spanish and Portuguese Language and Literature	Statistics and Probability	Theatre and Performance Studies
Program Environment								
URM Faculty	*				*			
Female Faculty								
Total Faculty				*				
URM Students	+							
Female Students		-*	*					
Int'l Students		-*		*		-+		
Total Students		*			**			
Av 1st-Yr Enroll					-*			
Research								
Av Fac Pubs	-+	-+						
% Faculty Grants		*						
% Acad Plans		+						
Selection								
Carnegie		+						
Av GRE Scores				-*				
Count of Statistically Significant Institutional Factors								
	10	12	11	12	9	8	7	1
Note: p<001**, p<05*, p<10^{+}								

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Factors that impact time to degree by field: Observations

The analysis from the Sample, ETTD, and Not-ETTD Hierarchical linear models already confirms that student and field level factors affect time to degree in doctoral programs. The ANOVA tests provide a sense of how each NRC Field is affected by the various socio-demographic, individual, and institutional factors, which opens the possibilities for evaluation and comparison by programs within each discipline. The number of effects attributed to each field ranges from 1-16. The value of the Mean, Median, and Mode for the count of significant effects attributed to each field is eight factors. The fields with the greatest numbers of factors include: Aerospace Engineering, Electrical and Computer Engineering, French and Francophone Language and Literature, Animal Sciences, Biomedical Engineering and Bioengineering, Civil and Environmental Engineering, Computer Sciences, Physics, Public Affairs, Public Policy and Public Administration, and Religion. The fields with the least number of factors include: American Studies, Genetics and Genomics, Mathematics, Physiology, Biology/ Integrated Biology/ Integrated Biomedical Sciences, Ecology and Evolutionary Biology, Entomology, Food Science, German Language and Literature, History, and Theatre and Performance Studies. The number of independent variables exceeded the number of subjects for Forestry, so an ANOVA test was not generated for that field.

The ANOVA tests provide a rich and intriguing array of information. Consider, for example, Aerospace Engineering and Electrical and Computer Engineering. Sixteen different factors produce significant effects on time to degree for these two NRC Fields, the most out of all other fields. For Aerospace Engineering, seven of those factors—new graduate student orientation, international student orientation, percent underrepresented minority faculty, percent female faculty, percent female students, average first-year enrollment, and percent of students with academic plans—have a decreasing effect on time to degree. In addition, five of the factors exhibit significance at the $p<0.05$ level, which is a strong indicator of the impact on time to degree. The nine factors that have an increasing effect on time to degree—approximate age, years completing coursework, years preparing the dissertation, education level of the mother, percent of first-year students with full support, percent of students with research assistantships, travel support for students, and total number of students enrolled in the program—present quite an array of variables to consider. For instance, the significant increasing effect of total number of students in the program suggests an area for future research regarding optimal size of Aerospace Engineering programs to enhance timely degree completion. Comparatively, the decreasing effects of both new graduate student and international student orientations suggest that Aerospace Engineering programs are doing something that is positively impacting the remainder of the doctoral career.

In Electrical and Computer Engineering programs, six of the 16 significant factors—U.S. citizen or Permanent Resident, travel support for students, percent underrepresented minority faculty, percent underrepresented minority students, average faculty publications, and Carnegie classification—exhibited decreasing effects on time to doctoral degree. The decreasing effects on time to degree that result from increases in underrepresented minority faculty and underrepresented minority students in Electrical and Computer Engineering programs suggests an area for future research. Mean times to degree for engineering fields in this study are already among the lowest within the sample, ranging from 5.47 years in Chemical Engineering to 7.06 years in Operations Research, Systems Engineering and Industrial Engineering. Therefore, future research needs to evaluate the effects of underrepresented minority faculty and underrepresented minority students, both of which are defined by the NRC data as including only non-Asian minorities, to decrease time to degree. Where travel support for doctoral students was an increasing effect for Aerospace Engineering, it decreases time to degree for Electrical and Computer Engineering. Being female and marital status both increase time to degree for Electrical and Computer Engineering, which suggests changes to the number, level, or type of personal support mechanisms may be necessary.

French and Francophone Language and Literature had 14 factors that produced statistically significant effects. Rather than analyze each factor for French as with Aerospace Engineering and Electrical and Computer Engineering, I draw attention to the finding that percent female faculty has an increasing effect on time to degree in this particular field. Biglan (1973b) described the effect of different disciplinary structures, such as science and non-science disciplines, on the relationships and interactions of students and faculty within an academic program, which would include the role and impact of female faculty. The data for this study encompasses 58 different fields, of which 38, or 65.5%, are considered science, technology, engineering or mathematics

(STEM) disciplines. All of the fields where an increase in the percent female faculty had a significant decreasing effect on time to degree occurred in STEM disciplines, three of them engineering focused: Aerospace Engineering, Animal Sciences, Biomedical Engineering and Bioengineering, and Operations Research, Systems Engineering and Industrial Engineering. Further studies might analyze the interactions between female faculty, doctoral students, and time to degree for these 58 fields, or using another data source, in order to understand the exact relationship between female faculty and time to degree relative to field. In addition, further Field specific analyses of the institutional factors identified in this study must consider the differences of academic culture, as suggested by Biglan (1973b) and Becher (1981).

Another way to present the ANOVA test results, given the large number of fields, is to calculate the instances of significant decreasing and increasing effects as a percent of the total number of programs. Table 48 presents those data and a descriptive view of the ANOVA tests.

Table 48: Significant Effects of ANOVA Tests by NRC Field

Independent Variables:	% of Fields where Factor Effect = a Statistically Significant Decrease in TTD	% of Fields where Factor Effect = a Statistically Significant Increase in TTD
Socio-Demographic Factors		
Female	7%	5%
Marital Status	7%	14%
Dependents	16%	9%
Approximate Age at Doctorate	0%	95%
U.S. Citizen or Permanent Resident	25%	0%
Race/Ethnicity	14%	2%

Independent Variables:	% of Fields where Factor Effect = a Statistically Significant Decrease in TTD	% of Fields where Factor Effect = a Statistically Significant Increase in TTD
Student Qualities & Time to Degree Factors		
Years of doctoral coursework	0%	77%
Years preparing dissertation	0%	93%
Additional professional medical or dental degree	9%	9%
Education level of Father	0%	7%
Education level of Mother	5%	5%
Discipline & Institutional Characteristics		
Public Institution	4%	9%
Program Size Quartile	11%	4%
Financial Support		
Primary Source of Support	2%	39%
Incurred Educational Debt	5%	16%
Percent First-year Students in Program with Full Support	2%	7%
Percent of Students with Research Assistantships	5%	9%
Percent of Students with Teaching Assistantships	9%	12%
Support and Training		
Training in Proposal Writing	9%	7%
Travel Support for Students	14%	7%
Processes & Procedures		
New Graduate Student Orientation	5%	14%
International Student Orientation	11%	5%
Annual Review of Doctoral Students	2%	12%
Program Environment		
Underrepresented Minority Faculty in Program	5%	18%
Female Faculty in Program	7%	5%
Total Faculty in Program	7%	7%
Underrepresented Minority Students in Program	5%	4%
Female Students in Program	5%	11%
International Students in Program	5%	9%

Independent Variables:	% of Fields where Factor Effect = a Statistically Significant Decrease in TTD	% of Fields where Factor Effect = a Statistically Significant Increase in TTD
Total Students in Program	2%	21%
Average First-year Program Enrollment	12%	4%
Research		
Average Faculty Publications	12%	0%
Percent Faculty with Grants	7%	9%
Percent of Students with Academic Plans	12%	4%
Selection		
Carnegie Classification	9%	4%
Average Program GRE Scores	4%	4%

Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Consistent with the Hierarchical linear models, the ANOVA tests of NRC Field indicate that approximate age at the award of the doctorate is a statistically significant, increasing effect for 95% of the fields. The high percentage of a significant, increasing effect of age on time to degree in the ANOVA tests is consistent with the results of every Hierarchical linear model calculated for this research. Increases in age, meaning the older the doctoral student gets before completing the degree, results in significant, increasing effects on time to degree at the $p<0.001$ level across every Hierarchical linear model. Age is perhaps the most inevitable of the “life happens” factors discussed by Abedi and Benkin (1987), Berg and Ferber (1983), Lovitts (2008), Nettles and Millett (2006), and Spaulding and Rockinson-Szapkiw (2012), which suggests a need for reforms in doctoral education to reduce both time to degree and the approximate age at completion for greater numbers of students. Similar to the findings regarding approximate age at the award of the doctorate, years preparing the dissertation and years completing coursework are not far behind, exhibiting increasing effects in 93% and 77% of fields, respectively. It is important to note that the count of significant factors presented in Tables 41-47, and the percentages reported in Table 48, reflect only the direction of statistically significant effects computed for each NRC Field in isolation, and do not account for the direction or influence exhibited by non-significant effects.

The primary source of support variable significantly increased time to degree for 39% of NRC Fields, as did the total number of students enrolled in the program by 21%. Incurring educational debt significantly increased time to degree for graduates in 16% of the NRC Fields. Being a U.S. Citizen or Permanent Resident significantly decreased time to degree in 25% of fields, the vast majority of which are science, technology, engineering or mathematics (STEM) fields. While having dependents was a statistically increasing factor across all of the Hierarchical linear models, it was a significant increasing effect in only 9% of the ANOVA tests and a significantly decreasing effect in 16%. Because the Hierarchical linear models are a more robust test than the ANOVA, I am more inclined to trust the results of the former that having dependents, as Nettles and Millett (2006) suggest, detracts significantly from time to doctoral degree. I am further inclined, in light of the findings from Chapter Four that women with dependents take a year longer than men with dependents and two years longer than those without dependents, to advocate for future research on how having dependents impacts men and women with respect to time to degree.

Overall, the ANOVA tests of each NRC Field reveal an array of findings. When considered field by field, the effects of student and field level variables have varying degrees of impact on elapsed time to doctoral degree. The bottom line, however, is that there is evidence that both student and field level factors impact time to degree in doctoral programs.

Summary

In sum, the study of time to doctoral degree is neither simple nor straightforward. In order to unpack the complexities of time to degree and understand the vast array of socio-demographic, individual, institutional, disciplinary, cultural, environmental and just plain “other” factors, this research relied on a guided theoretical framework. Researchers know that many factors—individual, departmental and institutional—have been associated with longer time to degree (Isaac et al., 1992; Lovitts 2008; Nettles & Millett, 2006), and progress toward degree completion (Girves & Wemmerus, 1988; Maher et al., 2004; Rodwell & Neumann, 2008). Individual student qualities and socio-demographic factors influence doctoral retention, attrition, and time to degree (Abedi & Benkin, 1987; Golde, 2000; Lovitts, 2001; Seagram et al., 1998). Student financial support, faculty and mentoring relationships, peer interaction, socialization, program culture and environment, and the research and writing of the dissertation influence time to doctoral degree (Gardner 2008; Gardner, 2009a; Girves & Wemmerus, 1988; Isaac et al., 1992; Nettles & Millett, 2006). The research for this study employed Hierarchical linear models to test nested student and field data against targeted independent variables in each of nine categories: socio-demographic factors, student qualities and time to degree factors, discipline and institution factors, financial support factors, support and training factors, process and procedure factors, program environment factors, research environment factors, and selectivity factors. In addition, the research employed analysis of variance tests to evaluate the effects of the same set of targeted independent variables for each of the NRC Fields included in the study. Observations regarding each test have been discussed throughout this chapter, as have some of the findings. The next chapter offers a more comprehensive analysis and discussion of the findings in the context of this study and recent literature.

Finally, although the framework for this research was not constructed using a feminist theory lens or orientation, I am intrigued by the findings from the Hierarchical ETTD model that can be attributed to women. Being female had a decreasing effect on extended time to degree that was statistically significant across all but two of the ETTD models. Mother's education level had decreasing, although non-significant, effect on extended time to degree across every Hierarchical ETTD model. And increases in the percent of female faculty in a doctoral program had a statistically significant, decreasing effect on extended time to degree in both the program environment model (-1.03 years) and the full ETTD model (-0.79 years). The findings suggest a need for future research that differentiates between genders when analyzing the effects of individual and field factors on time to degree and extended time to degree.

CHAPTER SIX

Discussion

The purpose and stated goal of this research was to identify select institutional and program characteristics that impact extended time to degree, relative to disciplinary field, in doctoral programs. The study is predicated on two notions: first, that only 50% of those who enroll in doctoral programs actually complete the degree (Bowen & Rudenstine, 1992), a finding that was supported and confirmed as recently as 2011 by Ampaw and Jaeger. Second, that among those who do finish, while an increasing trend in time to degree observed by Tuckman et al. (1990) more than two decades ago and affirmed more recently by Ferrer de Valero (2001) appears to have stabilized (NSF, 2011; NSF, 2012), relatively little research has focused on identifying factors and reform strategies to reduce time to degree for those who take the longest to complete the doctorate, relative to their disciplinary peers. This dissertation sought to fill that gap in the literature.

The theoretical framework for this study was constructed using a three-ringed kaleidoscope model. The three rings represent the different constructs and factors which have the potential to impact degree progress, the rate of progress, and time to degree of doctoral candidates. The center of the kaleidoscope represents the individual qualities of the doctoral student, the outer ring represents the socio-demographic characteristics of the student, and the center ring represents institutional and program factors. This study focused on the institutional and program factors inside the center ring and the impact of those factors, either increasing or decreasing, on extended time to doctoral degree.

The data for the study were drawn from the Doctorate Records File (DRF) of the Survey of Earned Doctorates (SED) under a license agreement with the National Science Foundation, and the publicly available information from the National Research Council's (NRC) *A Data-based Assessment of Research-Doctorate Programs in the United States.* SED records from three years—2004, 2005 and 2006—were selected to correspond and synchronize with the data collection years for the program-level data of the NRC study. After transforming the data and removing records with missing values, the sample included 18,545 student records representing 58 different fields. For the purposes of this research, extended time to doctoral degree was defined as completion equal to or greater than one standard deviation beyond the Mean, relative to the discipline. By defining extended time to degree as one standard deviation beyond the Mean, the research allows for variation in the distribution of completers within each field. Thus, it is possible to identify fields where greater numbers of students complete with or without extended time to doctoral degree based on a standardized definition of the point of extended time to degree.

Key findings from the descriptive analysis include apparent associations between dependents, race/ethnicity, primary source of support and gender with regard to time to degree. Graduates with child dependents had longer time to degree. Black/African Americans had the highest rate of extended time to degree, and Black males had the longest time to degree among male domestic graduates. Graduates with extended time to degree had the longest average time to degree when their primary source of support was a teaching assistantship or fellowship. The observed difference in time to degree between men and women was greatest for those who had both extended time to degree and were primarily supported by a fellowship or scholarship.

The Hierarchical ETTD model suggests that both student-level and field-level factors affect extended time to doctoral degree. Marital status, dependents, approximate age at the award of the doctorate, years spent preparing the dissertation, and an additional professional, medical or dental degree are individual factors that impact extended time to doctoral degree. Size of doctoral program, primary source of support, educational debt, training in proposal writing, the percent of female faculty in the program, and the average number of faculty publications represent institutional and program factors with significant impacts on extended time to degree.

Because graduates with extended time to degree do not exist in isolation within the academic environment, Hierarchical linear models of the full sample and of those graduates without extended time to doctoral degree provide equally meaningful information. Some factors did not impact every field, nor did they impact those with and without extended time to degree equally. However, certain factors—approximate age at award of doctorate, having dependents, years preparing the dissertation, primary source of support, educational debt, percent underrepresented minority students, and Carnegie classification—impacted time to degree across all three Hierarchical linear models and thereby warrant discussion.

Approximate age at the award of the doctorate and dependents impacted time to degree in every Hierarchical linear model. Holley and Caldwell (2012) recently found that relationships between doctoral students and their mentors, which ultimately impact time to degree, were influenced by two of the same demographic traits: age and family relationships (to use their terminology). Gardner (2009b), Jairam and Kahl (2012), and West, Gokalp, Peña, Fischer, and Gupton (2011) reported similar findings regarding dependents and families. Jairam and Kahl (2012) found important relationships between family and a doctoral candidate's progress toward degree completion, and Gardner (2009b) found that graduate students believed dependents factored heavily into the attrition decisions of their peers. West et al. (2011) found that 31% of their participants indicated that balancing family responsibilities detracted from their academic pursuits. Bolstered by the consistency of the findings in the context of the literature, this study confirms that age and dependents impact time to doctoral degree, including extended time to doctoral degree.

Although race/ethnicity was not a significant factor across all three Hierarchical linear models, the findings warrant discussion in light of recent research on doctoral completion and time to degree. In this study, race/ethnicity affects time to degree in the Hierarchical Sample and Not-ETTD models, with significance at the $p<0.05$ level for American Indian/Alaska Natives, Asian Americans and Black/African Americans, the last of these confirming the apparent association that was observed in the descriptive statistics. The effect and findings on race/ethnicity appear to support the findings of Kniola, Chang and Olsen (2012). Kniola et al. (2012) found that minority students face a different set of conditions and constraints when pursuing their doctorates, not the least of which includes faculty relationships and access to research resources. Similarly, Kim and Otts (2010) found that Black students received fewer research assistantships and were disadvantaged with regard to both the research experience and the effect on their time to degree. In this study, race/ethnicity was not a significant factor in the Hierarchical ETTD model. The finding suggests that future research explore whether the presence of a race/ethnicity effect on those with early or average time to degree, but not those with extended time to degree, reflects late attrition or completion of underrepresented minority students from doctoral programs. While the findings in this study do not provide evidence of a race/ethnicity effect on extended time to degree, they are otherwise consistent with recent research and confirm that among early and average completers, race/ethnicity impacts time to doctoral degree (Kim & Otts, 2010; Kniola et al., 2012).

The number of years spent preparing the dissertation affects time to degree for all doctoral students. Recent literature has not focused specifically on the effect of years preparing the dissertation on time to degree or extended time to degree, but a vast body of work exists with relevant findings. Both Barnes and Randall (2012) and Benton (2010) found that students were not satisfied with the level and depth of information provided by their graduate program with regard to degree requirements, expectations, or time to degree. In addition, students wanted greater and earlier access to realistic information about degree requirements and faculty expectations regarding average time to degree for the doctoral program (Barnes & Randall, 2012; Benton, 2010). Similarly, Gardner (2010) found that doctoral students struggled with ambiguity and a lack of understanding regarding the phase they were at within their graduate program, particularly the research and writing of the dissertation. Cohen (2011) suggests that the best approach to solving the problem of ambiguity described by Gardner (2010) is for doctoral students to choose a topic early and to develop a solid and achievable plan to complete the dissertation. To that end, West et al. (2011) found that peer dissertation groups and a Doctoral Student Center aimed at helping students with their writing challenges impacted the sense of success and, ultimately, degree completion. Spaulding and Rockinson-Szapkiw (2012) found that "delays and challenges associated with the successful completion of the dissertation presented some of the greatest obstacles participants needed to overcome" (p. 207). The findings from this quantitative study complement those of past qualitative studies and point to the activities associated with the preparation of the dissertation as a critical point for reform in reducing time to degree and extended time to degree in doctoral programs.

The primary source of support and the presence of educational debt are two financial support factors that affect time to degree for all doctoral students, with or without extended time to degree. These findings are consistent not only with previous research as noted throughout this dissertation, but also with recent findings from Kim and

Otts (2010). Kim and Otts (2010) found that the type of support a doctoral student receives impacts time to degree, noting that effects on time to degree are associated with both assistantship and fellowship support. In addition, Kim and Otts (2010) found that students in biological sciences, engineering, physical sciences, and education disciplines who incurred more than $50,000 in educational debt had faster time to degree. The research in this study found that fellowships had a significant decreasing effect on time to degree for those with early or average time to degree, but increased time to degree for those with extended time to degree. Incurring educational debt was also a significant effect in this research for students with and without extended time to degree. The similarity of findings support the results of this research that primary source of support and educational debt impact time to degree and extended time to degree.

The results of the three sets of Hierarchical linear models and the NRC Field-level ANOVA tests indicate that diversity in the academic environment—across both faculty and students with regard to gender, race/ethnicity, and citizenship—impacts time to degree. In addition, the results of the ETTD model suggest that the role of the faculty in creating an optimal research environment impacts time to degree. Jairam and Kahl (2012) suggest that the level of professional and subject-matter feedback and advice faculty provide is critical to supporting doctoral students toward degree completion. Similarly, Veal, Bull and Miller (2012) found that the effect of the relationships and interactions between students and faculty is enduring on student learning and professional development, and that diversity of the environment for those interactions is critical. The findings from this study complement extant research by identifying the relationships between diverse students, diverse faculty, the research environment, and extended time to doctoral degree.

Recommendations

Based on the findings of this research, which are grounded in and reinforced by extant literature on time to degree, I put forth five recommendations:

Develop Programs to Support Timely (Dissertation) Writing

Approximate age at the award of the doctorate, years preparing the dissertation, and training in proposal writing affect extended time to doctoral degree. Institutions cannot impact the age of doctoral students, nor is it appropriate to discriminate in the selection of applicants based on age. Institutions can affect both training in proposal writing and years spent preparing the dissertation. Recognizing that training in proposal writing was a significant decreasing factor for extended time to degree graduates, I recommend that serious consideration be given to enhancing doctoral writing programs with foci on proposal writing, grant writing, dissertation writing, and publication practices relative to the discipline. In line with a suggestion from Cohen (2011) and in close collaboration with the faculty, enhanced writing programs—whether institutionally provided or departmentally based—can help doctoral students identify a dissertation topic and begin to write about their area of study as early as possible.

Writing is a process, but it is also a measurable product. However the student and faculty define the writing milestones of the dissertation—5 pages, one section, two chapters—the goals and steps need to be specifically outlined in writing through an individual development or research plan. Furthermore, adoption of a “just-in-time” orientation or training strategy as suggested by Di Pierro (2012) may help to transition doctoral students more readily into and through the different phases of the graduate program. A “just-in-time” approach breaks extra-curricular subject matter into smaller, more targeted sessions that provide students with specific coaching at a precise phase of the doctoral program (Di Pierro, 2012). Because “just-in-time” training concentrates on only a few issues with each session, students learn about topics that are relevant and matter to them at that time, which limits information overload and encourages student success. If institutions enhanced doctoral writing programs through the addition of “just-in-time” or similar training sessions, such opportunities could presumably be integrated into students’ individual development or research plans which has the added benefit of increased clarity for the student with regard to academic milestones and progress (Barnes & Randall, 2012; Benton, 2010; Gardner, 2010). Therefore, enhanced doctoral writing programs and/or the inclusion of such training on individual development or research plans would represent active intervention(s) on the part of institutions and doctoral programs to reduce time to degree and extended time to degree.

Conduct Additional Research on Diversity and Extended Time to Degree

Inclusivity and diversity of students and faculty in the academic setting are critical to creating an optimal environment for research and other scholarly pursuits (Brazziel & Brazziel, 1987; Ehrenberg & Mavros, 1995; Ellis, 2001; Kim & Otts, 2010; Kniola et al., 2012; Mason & Goulden, 2002; Nettles, 1990a; Nettles, 1990b; Nettles & Millett, 2006). Institutions cannot impact the race/ethnicity of doctoral students, nor is it appropriate to discriminate in the selection of applicants based on socio-demographic characteristics. Institutions can take steps to support and enhance diversity in the program environment. Several of the findings from this study suggest a need for additional research to inform interventions aimed at supporting diversity in the program environment.

This study found a significant increasing effect of race/ethnicity on time to degree for American Indian/Alaskan Natives, Asian Americans, and Black/African Americans with early or average time to degree, but significant effects were not observed among any race/ethnicity groups for those with extended time to degree. In addition, this study found that each increase in the percentage of underrepresented minority students in the program environment resulted in a significant increasing effect of 0.918 years on extended time to degree. The combination of effects for those with extended time to degree is not immediately indicative of a problem. The former could mean that a student's race/ethnicity does not positively or negatively impact extended time to degree. The latter is troubling because it suggests that greater numbers of underrepresented minority students detract from timely degree progress for those with extended time to degree. Considered together, the findings suggest the existence of a more complex problem with regard to underrepresented minority students and extended time to degree. Recognizing that race/ethnicity had a statistically significant increasing effect on time to degree for those with early or average time to degree, but not those with extended time to degree, and that increases in the student diversity of the program environment increased extended time to degree, I recommend serious consideration be given to additional research on the factors associated with attrition, degree completion and extended time to degree for underrepresented minority students.

Develop Programs for Graduate Student Parents

Students from virtually every stage of adult life enroll in graduate programs. Many of them are or will become parents during the course of their doctoral degree. Institutions cannot impact the parental status or family planning decisions of doctoral students, nor is it appropriate to discriminate in the selection of applicants based on current or potential parental status. Institutions can affect the culture and climate of support experienced by doctoral student parents. Recognizing that dependents affect the academic pursuits of men, women, domestic and international doctoral students alike, and that having dependents was a statistically significant increasing effect on time to degree across every Hierarchical linear model in this study, I recommend that serious consideration be given to three possible interventions: inclusion of dependents as a topic in advising discussions, institutional maternity/paternity policies, and institutional dependent care policies.

Individuals with children complete the doctoral degree every year, and as the descriptive statistics in this study demonstrate, they do so with and without extended time to degree. Mason and Ekman (2007) found that pregnancy and child-rearing during graduate school delayed degree completion for women and impacted women’s academic careers. Furthermore, female graduate students with children feared they would be denied academic and professional opportunities by faculty who perceived that as mothers, the women would be less likely to succeed (Mason & Ekman, 2007). Having children does not need to be the cause of attrition (Gardner, 2010) or the reason behind longer time to degree (Nettles & Millett, 2006). This study's finding of a statistically significant, increasing effect of dependents on time to degree suggests a need for a shift in the academic climate away from the "no children allowed" atmosphere described by Mason and Ekman (2007, p. 15) toward a culture where consideration of dependents is part of the mentoring and advising dialogue. This is not to suggest that the amount of time for each milestone be extended, necessarily. Rather, if a student—male or female—is expecting or is already a parent, the advisor and advisee might discuss if adjustments need to be made to the individual development plan, research plan, or dissertation writing plan. Integration of dependents into the advising dialogue represents an active intervention on the part of institutions and faculty to shift the culture, to raise the cognizance by students and faculty regarding the impact of dependents on time to degree, and to preserve the integrity of academic plans designed to help reduce time to degree and extended time to degree.

As noted by Mason and Ekman (2007), the years of graduate school often coincide with the years when many individuals begin and raise families. The research for this study does not delineate whether the statistically significant increasing effect of dependents on time to degree is associated with the number or ages of the dependents, the time attributed to parenting, the costs associated with child-rearing, or some other set of factors. Future research is needed to explore the nature and sources of the effect of dependents on time to degree. In the interim, I present a set of policy-driven interventions designed to support timely degree completion for doctoral student parents: maternity/paternity and dependent care policies.

Many institutions have established maternity/paternity and/or dependent care policies for graduate students. The specific objectives of maternity/paternity policies are uniquely defined by each institution and reflect the range of services and/or options afforded to a new graduate student parent. For instance, a maternity/paternity policy may specify whether the leave of absence is paid or unpaid, the permitted length of leave, and the effect of leave on academic requirements including the time to degree clock. The absence of a maternity/paternity policy suggests that multiple stakeholders—graduate students, the faculty, graduate programs and the institution—are left without guidance regarding equitable accommodation of the student. The scale, cost to the institution, and impact of graduate student maternity/paternity leave understandably depend on how the policy is defined, as well as the implementation and use of the policy by graduate students. A clearly defined maternity/paternity policy aimed at supporting the continued academic progress of doctoral students represents an active intervention on the part of institutions to support and accommodate the time needs of new graduate student parents, and ideally helps to reduce time to degree and extended time to degree.

While a clearly defined maternity/paternity policy addresses the time needs of new graduate student parents, a dependent care program or policy responds to the strain of childcare expenses on graduate student resources. The cost of dependent care varies widely. If the financial strain of dependent care limits the financial resources of a graduate student, then time and attention may be diverted away from the student's academic pursuits, which negatively impacts time to degree. A program that offers a nominal grant, subsidy, or reimbursement to defray a portion of dependent care costs demonstrates support for graduate student parents. The scale, cost to the institution, and impact of a dependent care program for graduate students depends on how the policy is defined, the level and type of support offered, and effectiveness of the implementation and use of the program by graduate students. A clearly defined dependent care policy aimed at reducing the financial constraints of doctoral student parents represents an active intervention on the part of institutions to support and accommodate the financial needs of new graduate student parents, and ideally helps to reduce time to degree and extended time to degree.

Reorganize Doctoral Student Financial Support Mechanisms

Funding graduate students is expensive. The level and type of financial support graduate students receive impacts not only the livelihood of the student during his or her doctoral career, but also time to degree. Institutions, graduate programs, and faculty can affect the levels and types of financial support distributed to graduate students. Fellowships are perhaps one of the most expensive forms of support for the institution because the student typically receives tuition, fees and a stipend, but does not have a requisite assistantship responsibility. This study found that fellowship support had a significant decreasing effect on time to degree for those with early or average time to degree, and a slight non-significant, increasing effect on those with extended time to degree. Teaching and research assistantships are used by many institutions and doctoral programs to balance the training and support needs of the student with the instructional and research needs of the institution, program and faculty. This study found that teaching and research assistantships had decreasing, non-significant effects on those with early or average time to degree, while other assistantship types had greater decreasing, non-significant effect on those with extended time to degree. Recognizing this study's significant findings regarding financial support and time to degree, paired with the findings on the negative effect of years preparing the dissertation on time to degree, I recommend that serious consideration be given to reorganizing financial support so that students receive greater support and funding during the dissertation writing phase of the doctoral program. In addition, I recommend that institutions, graduate programs and faculty utilize the previously recommended writing programs to encourage more doctoral students to apply for extramural fellowships, scholarships and grants. Extramural awards from prestigious organizations offer a range of funding to support doctoral students from full tuition and fees to the expenses associated with conducting research. Efforts to prioritize financial support for doctoral students during the dissertation writing phase and to increase efforts to support extramural fellowship applications represent active interventions on the part of institutions and doctoral programs to maximize financial support for doctoral students to reduce time to degree and extended time to degree.

Establish Program-level Review of Time to Degree

One of the central tenets of this research was the importance and distinction of field in the analysis. Mean time to degree across all disciplines is 6.99 years according to this research, but that number is not meaningful in a field where average time to degree differs. The study incorporated Hierarchical linear models to analyze student data nested within fields, which allowed the intercept for each field to function independently. The results of the Hierarchical linear models helped to define the effects of institutional and program factors on time to degree, but did not produce field-specific results. In order to achieve field-specific results, analysis of variance tests based on the full Hierarchical linear model were conducted for 57 of the 58 fields—recall that the number of subjects in Forestry was too small for the ANOVA test to converge. Whether using the results of the tests conducted for this study or performing a completely independent analysis, I strongly recommend that graduate programs seek opportunities to measure the effectiveness of their academic, financial, programmatic, and support programs in the context of the discipline. In addition, I recommend that institutions work with campus institutional researchers and graduate program faculty to generate reports of time to degree and other academic metrics for review on an annual basis. Although not intended to be as comprehensive as a full program review, which typically occurs every 5-10 years, an annual review of student progress will give the institution and program a framework within which to identify problems and seek opportunities to keep students from falling into the traps of extended time to doctoral degree.

Summary

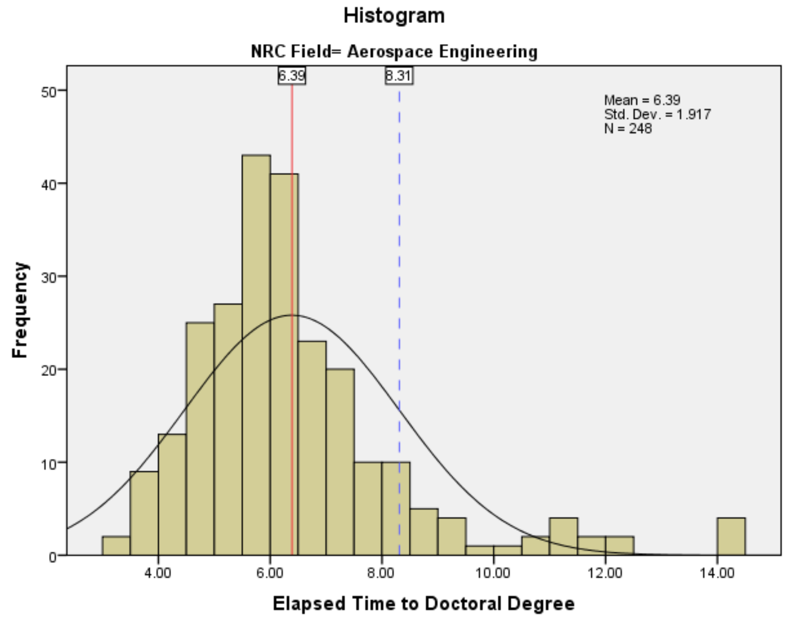
This dissertation has taken a long time. The road it has travelled has been wrought with many of the same challenges identified by this very research. But it is done and the experience of preparing it has been invaluable. It started because I wanted to understand why “time to doctoral degree has increased consistently in American universities since 1967, in some fields by as much as two years” (Ferrer de Valero, 2001, p. 341). Understanding the factors that impact time to doctoral degree is complex. Financial support, program and research environments, and training all impact time to degree. Socio-demographic and individual characteristics impact time to degree. Unlike previous research, this study evaluated the institutional factors that affect time to degree for not only a sample of the population, but for those graduates within the population who had extended time to degree relative to their disciplinary peers.

The recommendations outlined in this dissertation, which are based on the study findings, are aimed at improving the culture and climate of doctoral education for all graduate students. More specifically, these recommendations seek to support current and future students who may be headed toward extended time to doctoral degree by outlining institutional intervention strategies aimed at reducing the time required to complete the doctoral degree. The proposed interventions, if adopted by institutions and doctoral programs, will not reduce time to degree or eliminate extended time to degree for all students, but careful attention to the institutional and program factors addressed in this dissertation could decrease time to degree and improve the overall experience for many doctoral students.

[1] The use of NSF data does not imply NSF endorsement of either the research methods or the conclusions contained in this report.

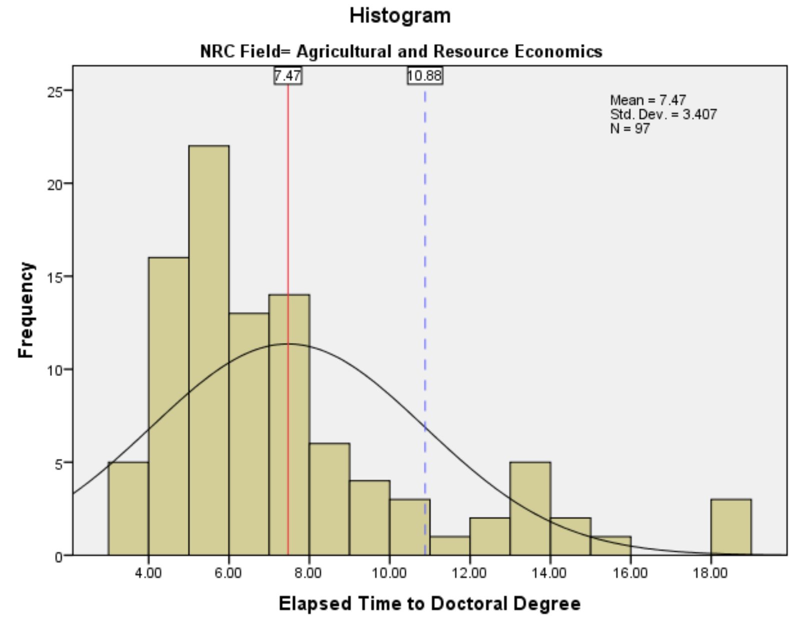
APPENDIX A

Figure 4: Histogram of Elapsed Time to Doctoral Degree for Aerospace Engineering



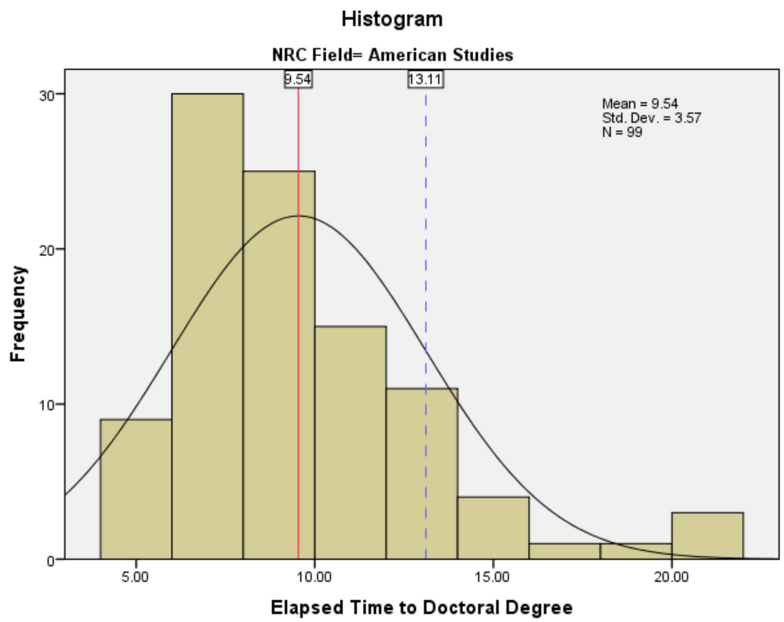
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 5: Histogram of Elapsed Time to Doctoral Degree for Agricultural and Resource Economics



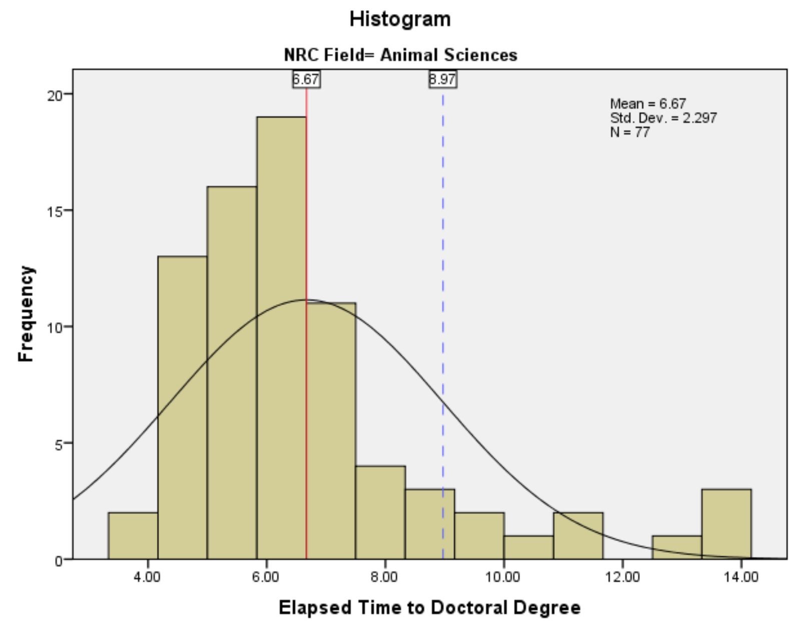
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 6: Histogram of Elapsed Time to Doctoral Degree for American Studies



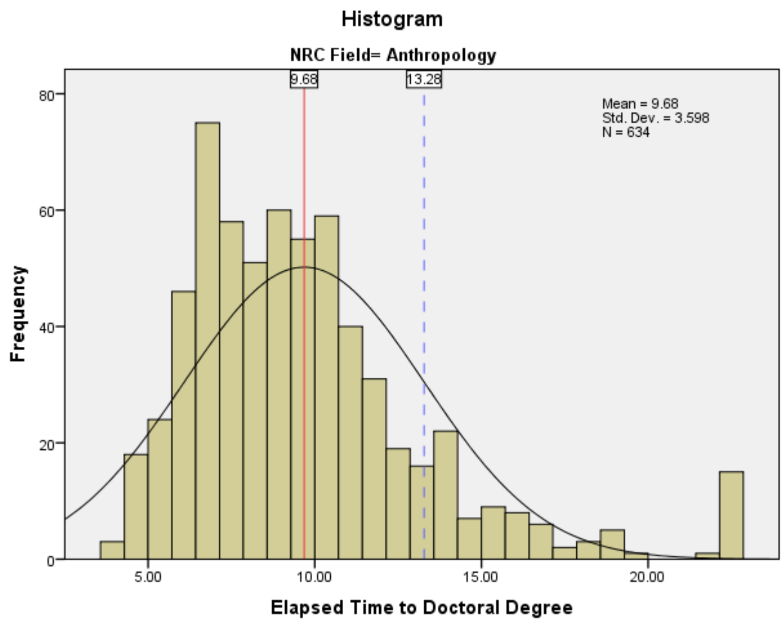
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 7: Histogram of Elapsed Time to Doctoral Degree for Animal Sciences



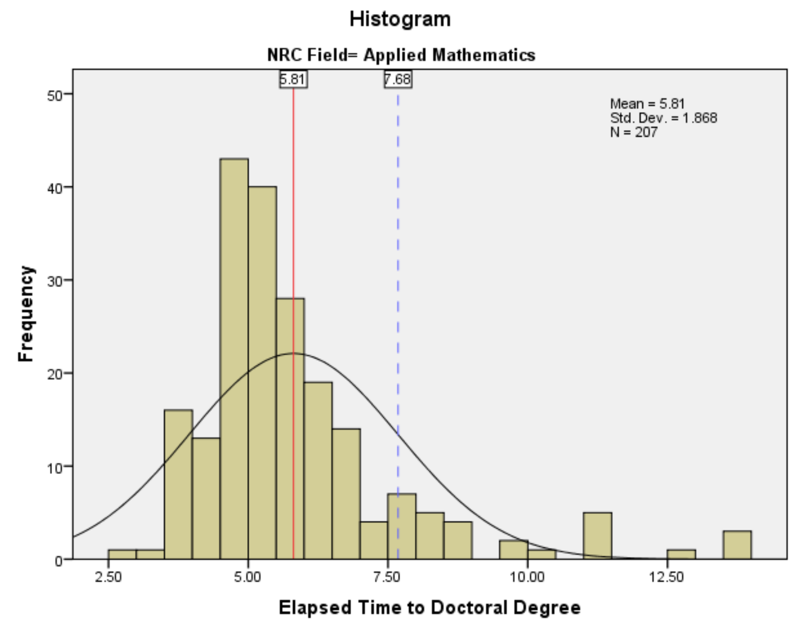
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 8: Histogram of Elapsed Time to Doctoral Degree for Anthropology



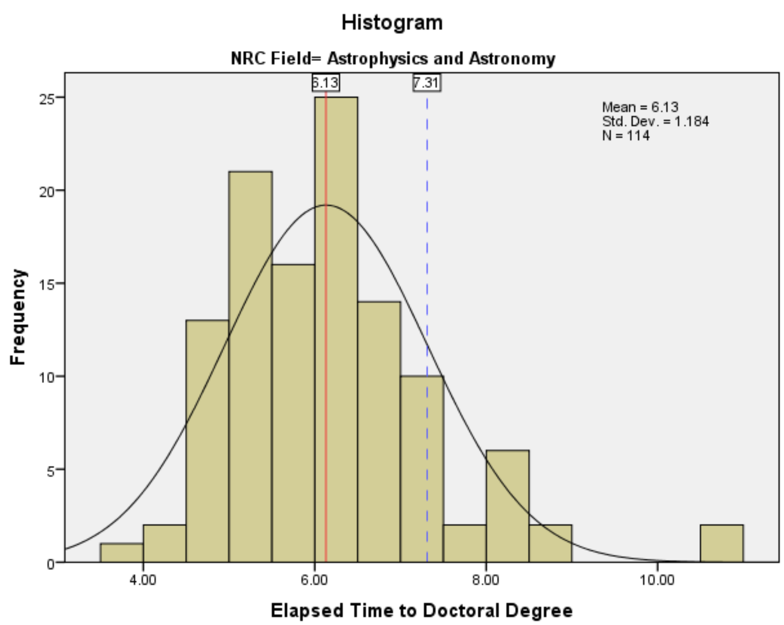
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 9: Histogram of Elapsed Time to Doctoral Degree for Applied Mathematics



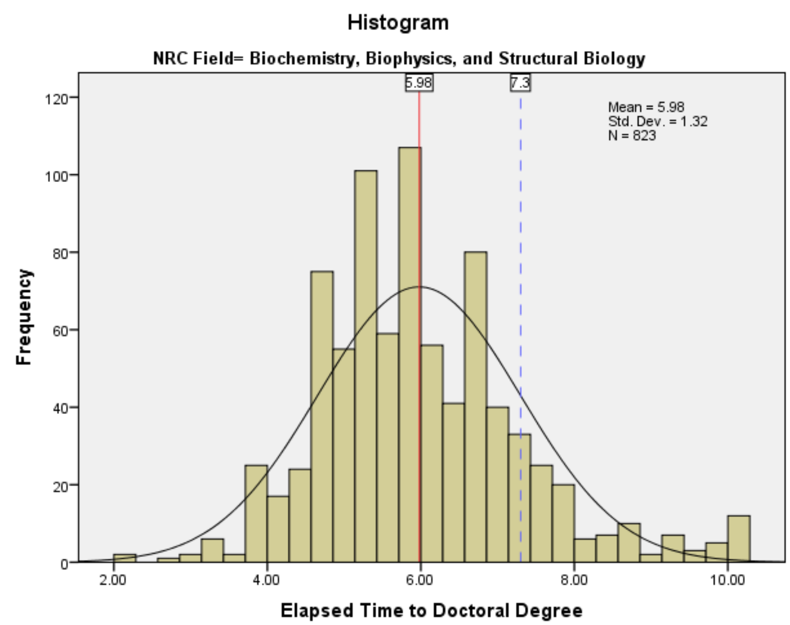
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 10: Histogram of Elapsed Time to Doctoral Degree for Astrophysics and Astronomy



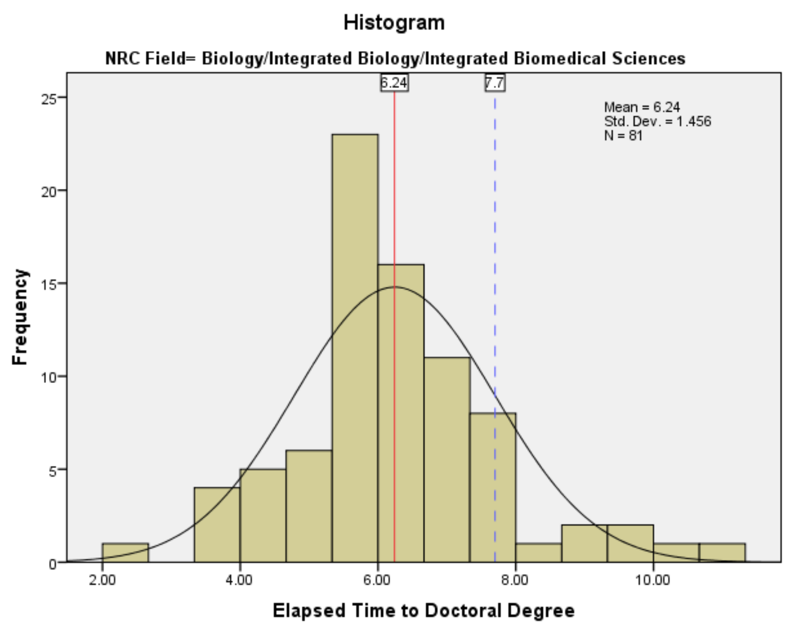
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 11: Histogram of Elapsed Time to Doctoral Degree for Biochemistry, Biophysics, and Structural Biology



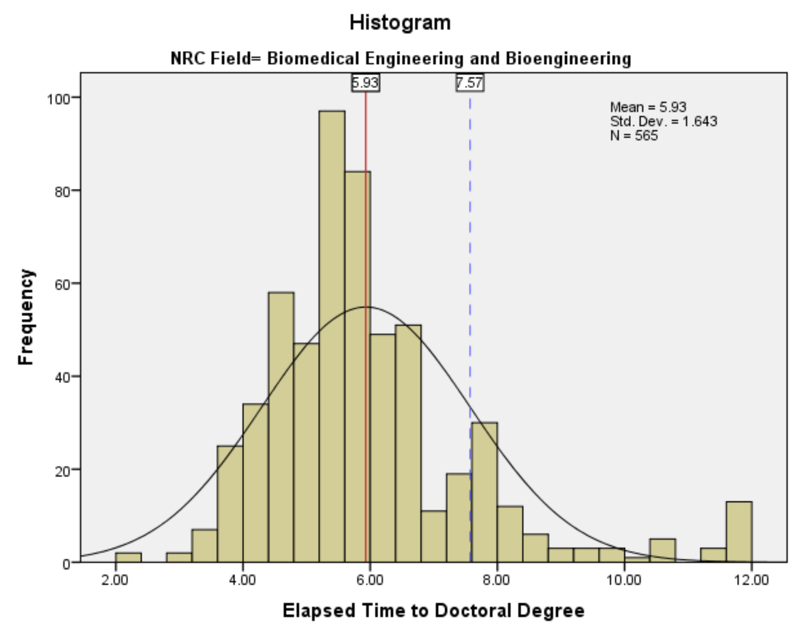
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 12: Histogram of Elapsed Time to Doctoral Degree for Biology/Integrated Biology/Integrated Biomedical Sciences



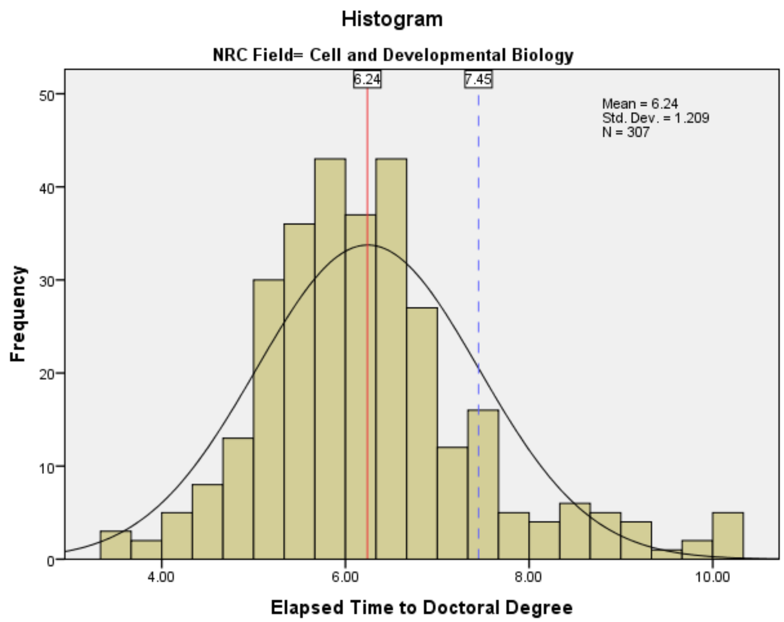
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 13: Histogram of Elapsed Time to Doctoral Degree for Biomedical Engineering and Bioengineering



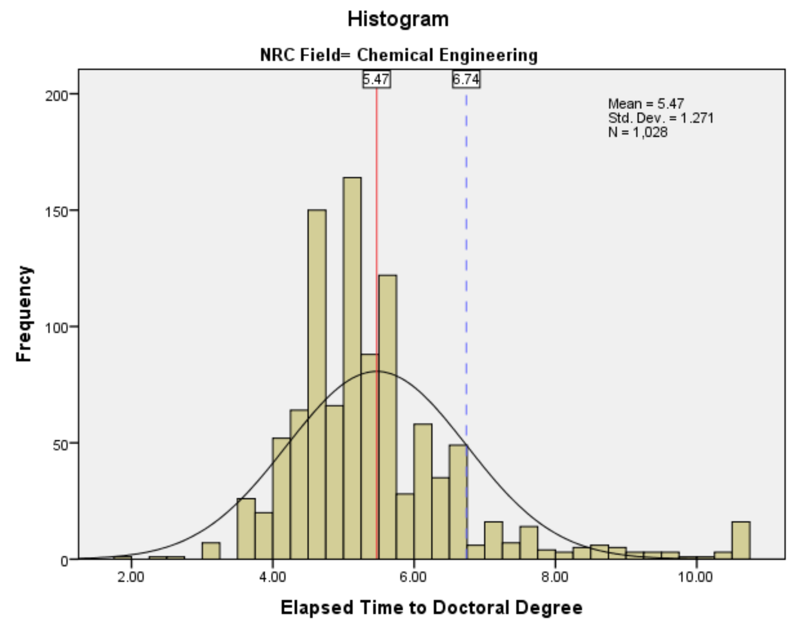
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 14: Histogram of Elapsed Time to Doctoral Degree for Cell and Developmental Biology



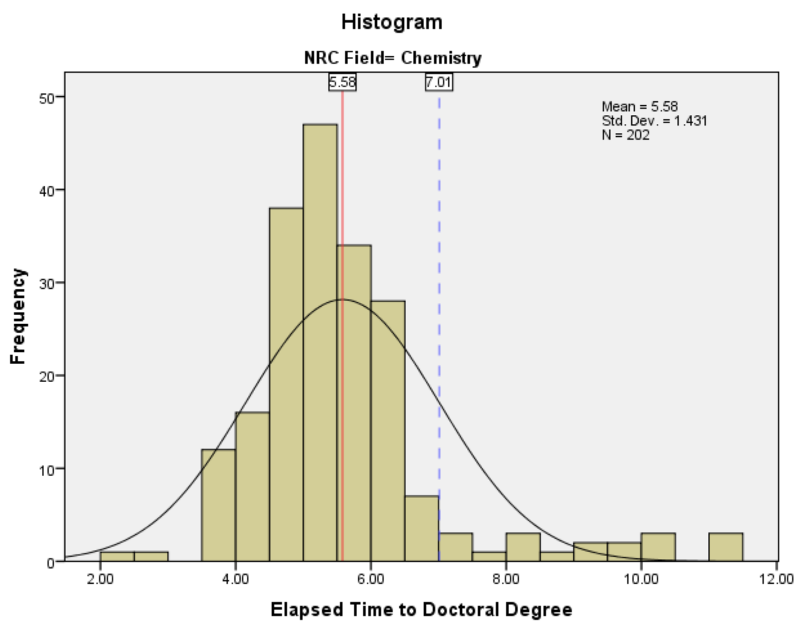
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 15: Histogram of Elapsed Time to Doctoral Degree for Chemical Engineering



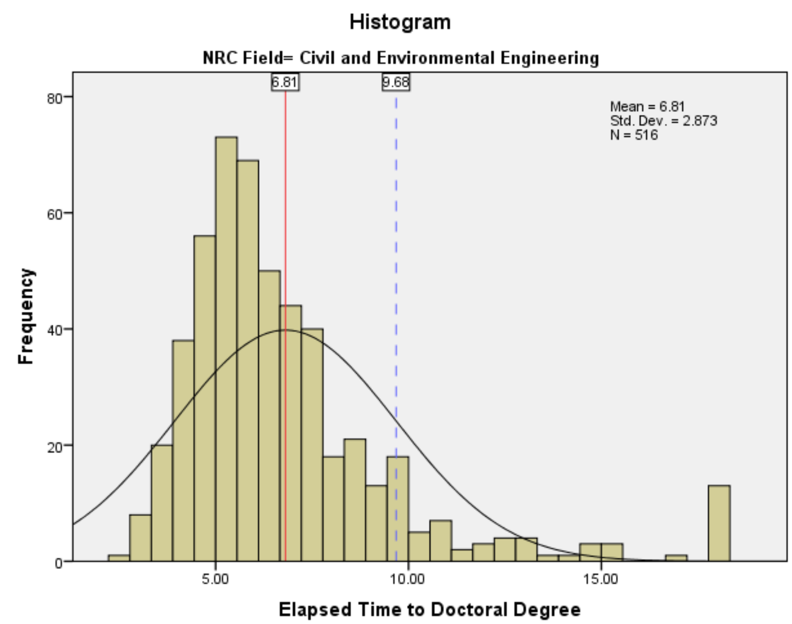
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 16: Histogram of Elapsed Time to Doctoral Degree for Chemistry



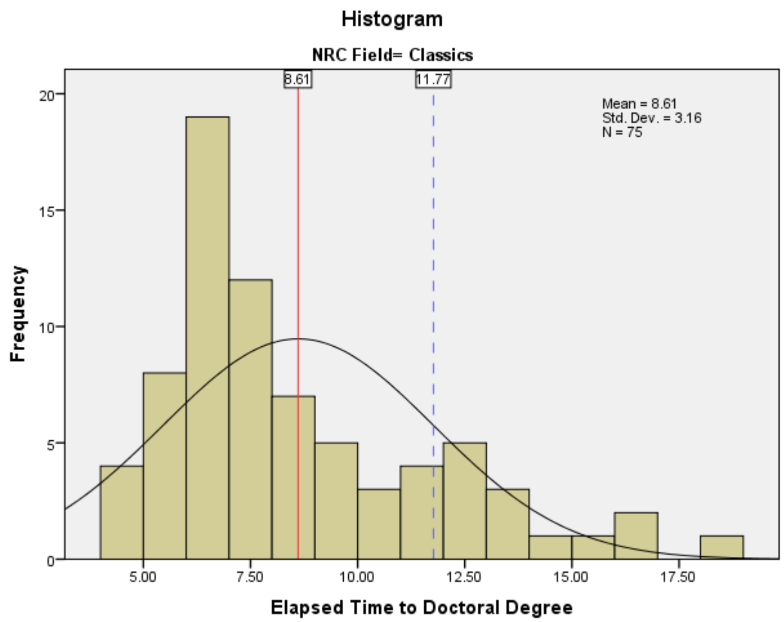
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 17: Histogram of Elapsed Time to Doctoral Degree for Civil and Environmental Engineering



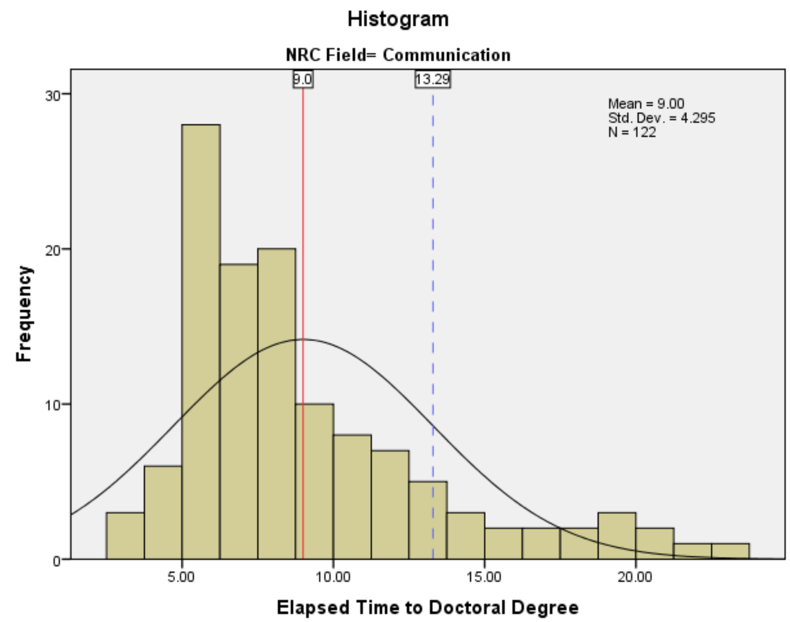
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 18: Histogram of Elapsed Time to Doctoral Degree for Classics



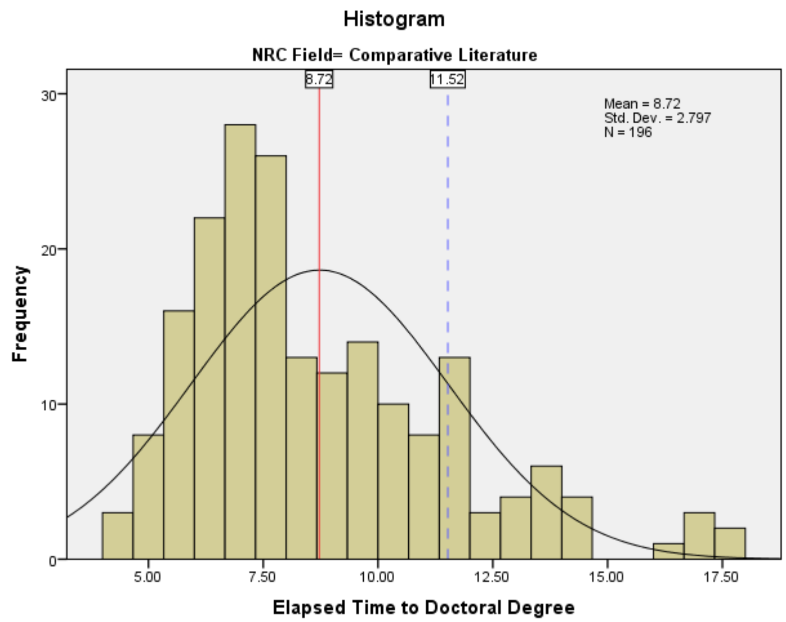
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 19: Histogram of Elapsed Time to Doctoral Degree for Communication



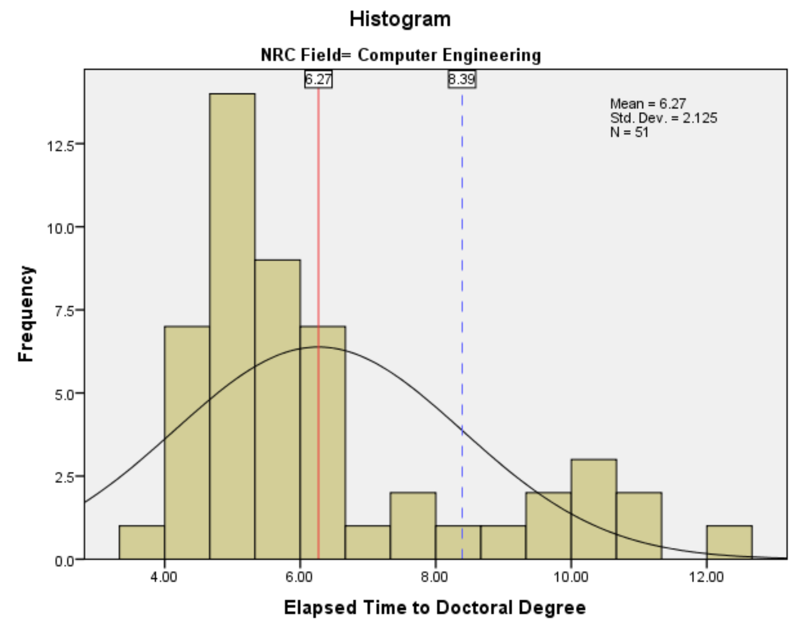
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 20: Histogram of Elapsed Time to Doctoral Degree for Comparative Literature



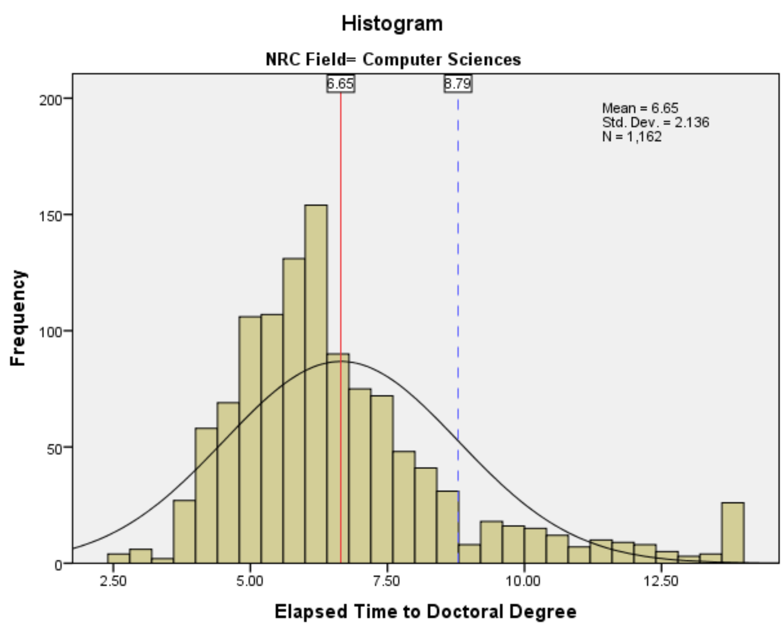
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 21: Histogram of Elapsed Time to Doctoral Degree for Computer Engineering



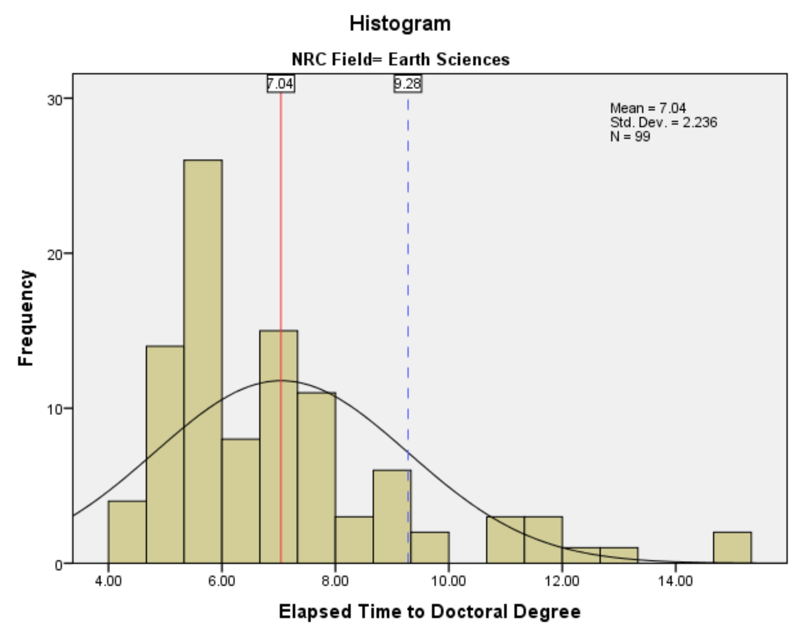
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 22: Histogram of Elapsed Time to Doctoral Degree for Computer Sciences



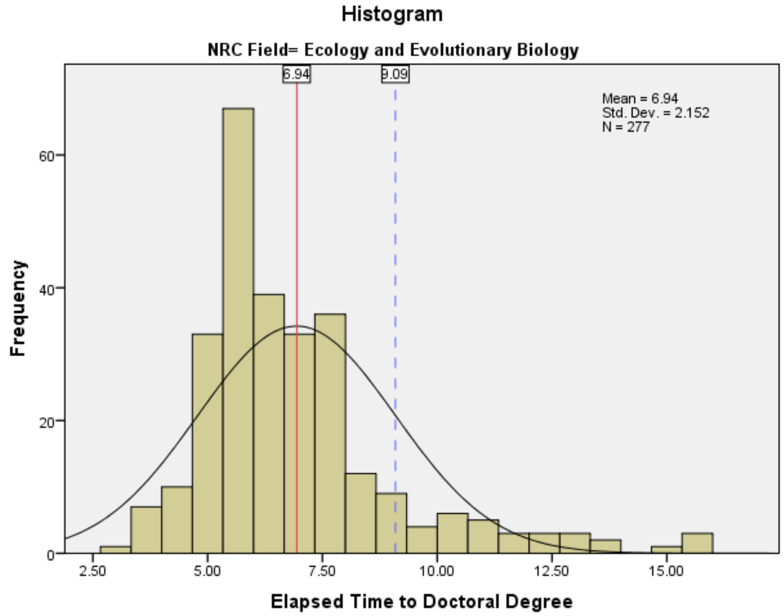
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 23: Histogram of Elapsed Time to Doctoral Degree for Earth Sciences



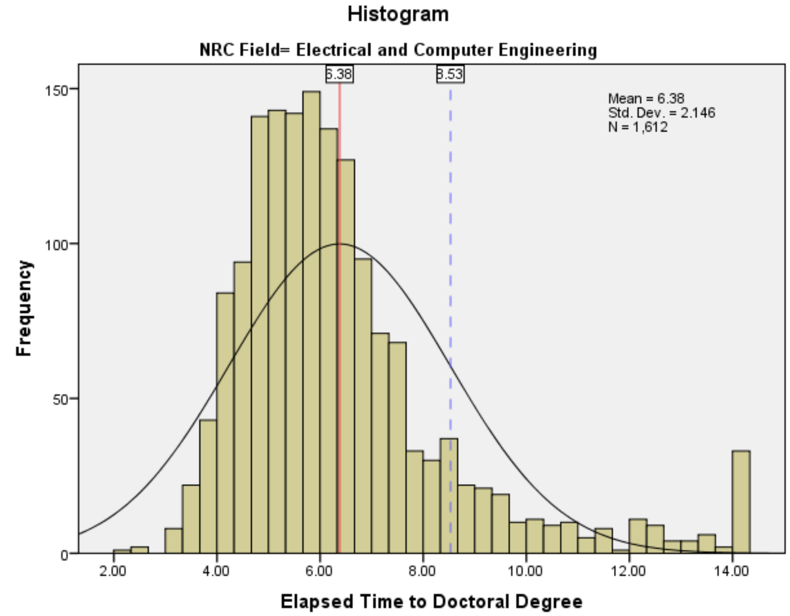
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 24: Histogram of Elapsed Time to Doctoral Degree for Ecology and Evolutionary Biology



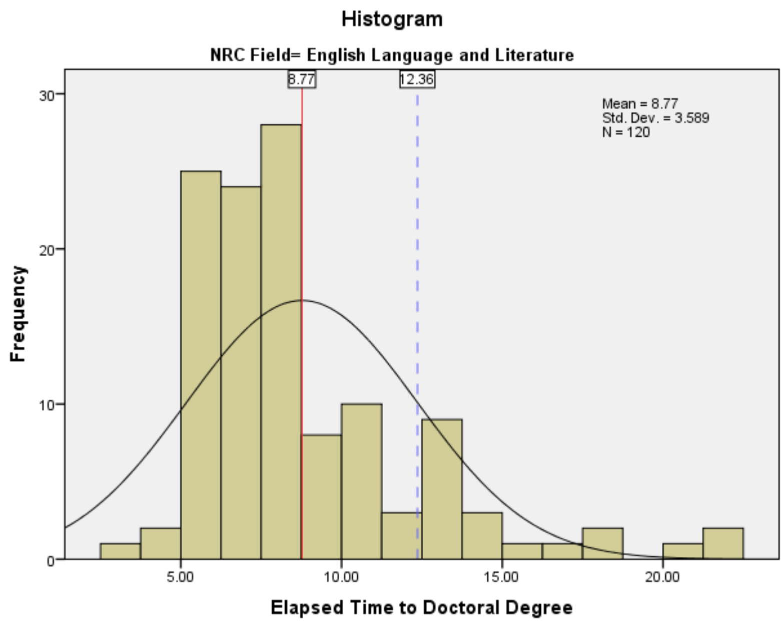
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 25: Histogram of Elapsed Time to Doctoral Degree for Electrical and Computer Engineering



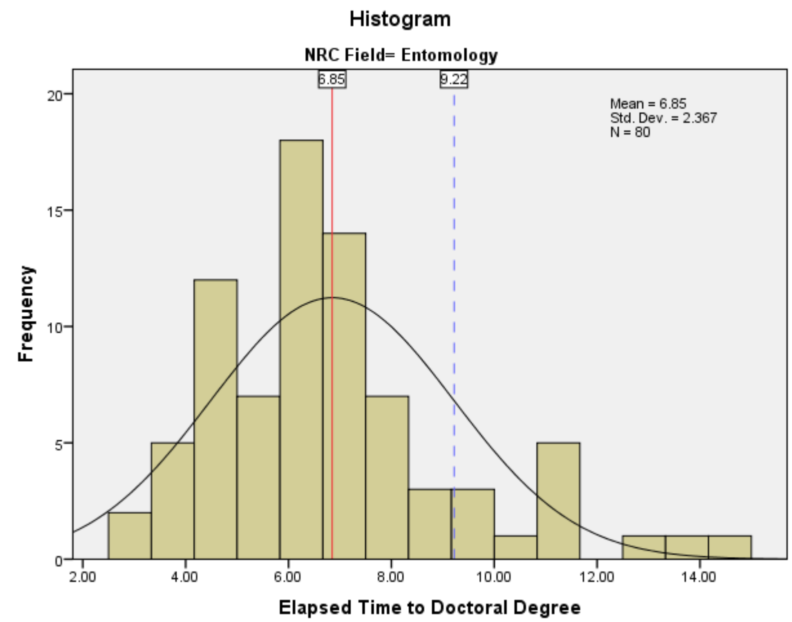
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 26: Histogram of Elapsed Time to Doctoral Degree for English Language and Literature



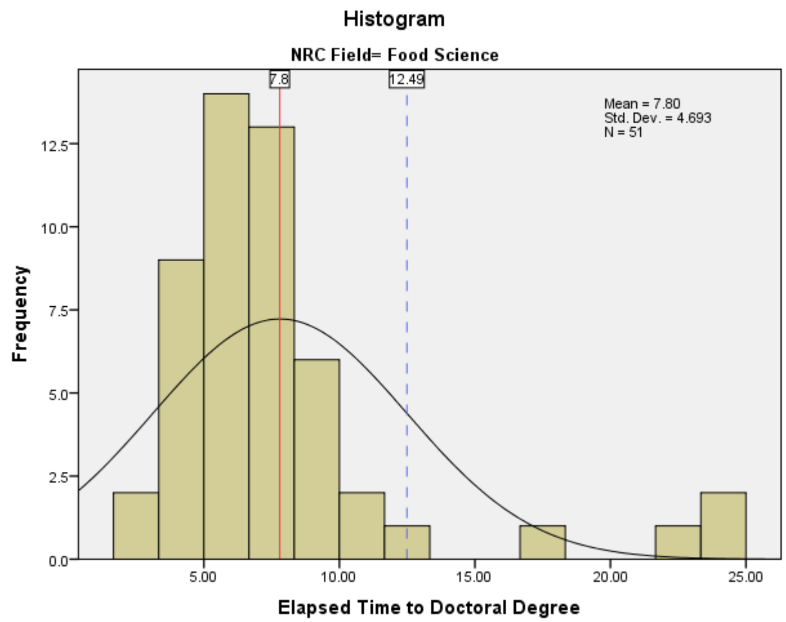
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 27: Histogram of Elapsed Time to Doctoral Degree for Entomology



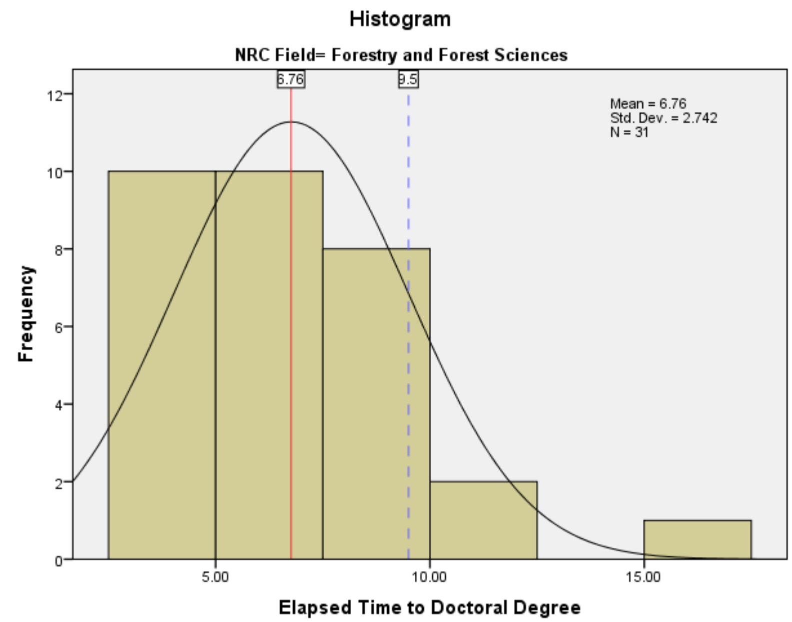
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 28: Histogram of Elapsed Time to Doctoral Degree for Food Science



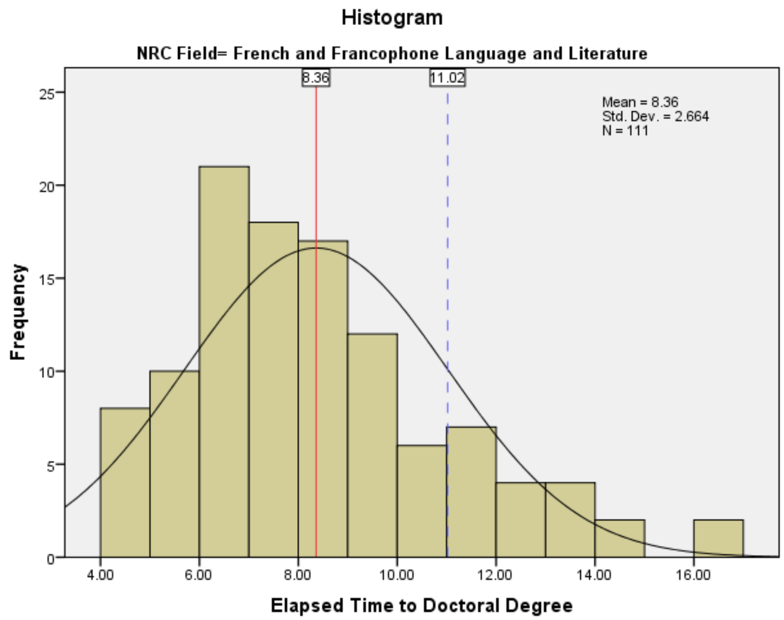
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 29: Histogram of Elapsed Time to Doctoral Degree for Forestry and Forest Sciences



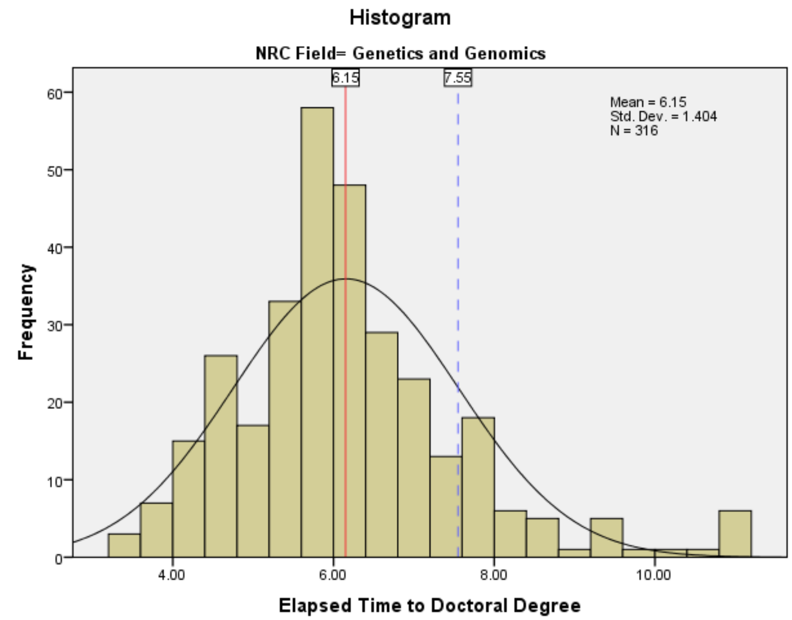
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 30: Histogram of Elapsed Time to Doctoral Degree for French and Francophone Language and Literature



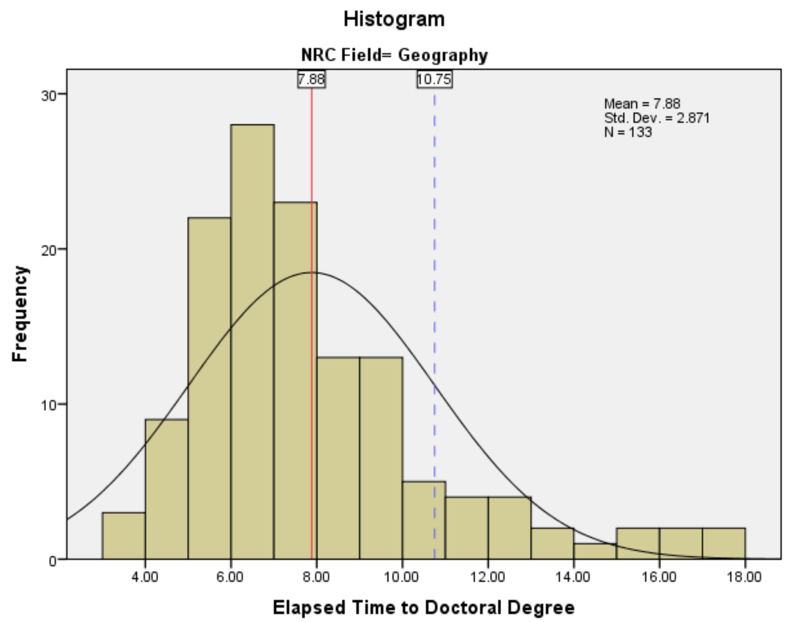
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 31: Histogram of Elapsed Time to Doctoral Degree for Genetics and Genomics



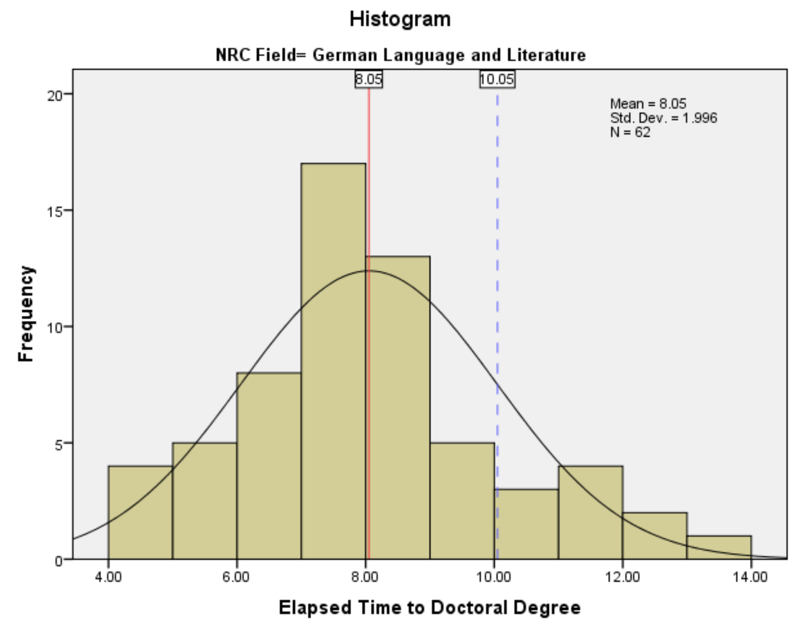
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 32: Histogram of Elapsed Time to Doctoral Degree for Geography



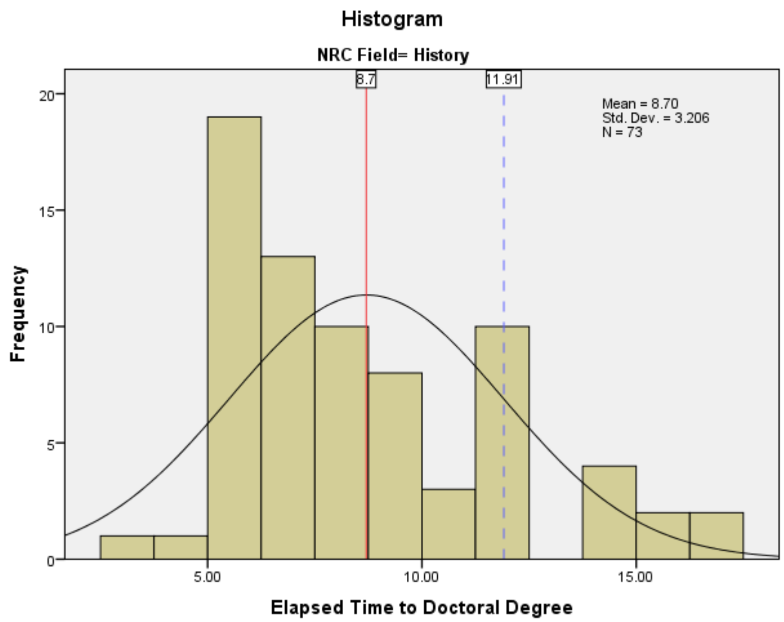
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 33: Histogram of Elapsed Time to Doctoral Degree for German Language and Literature



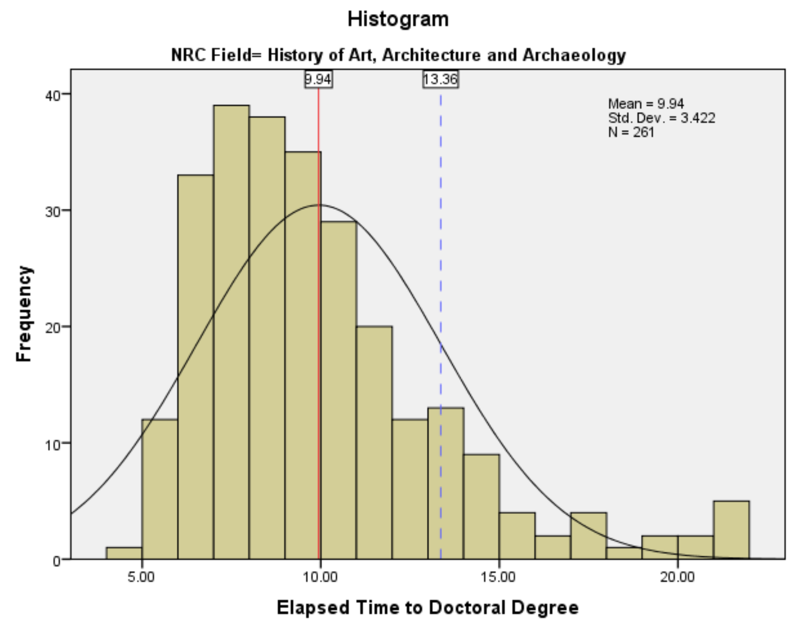
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 34: Histogram of Elapsed Time to Doctoral Degree for History



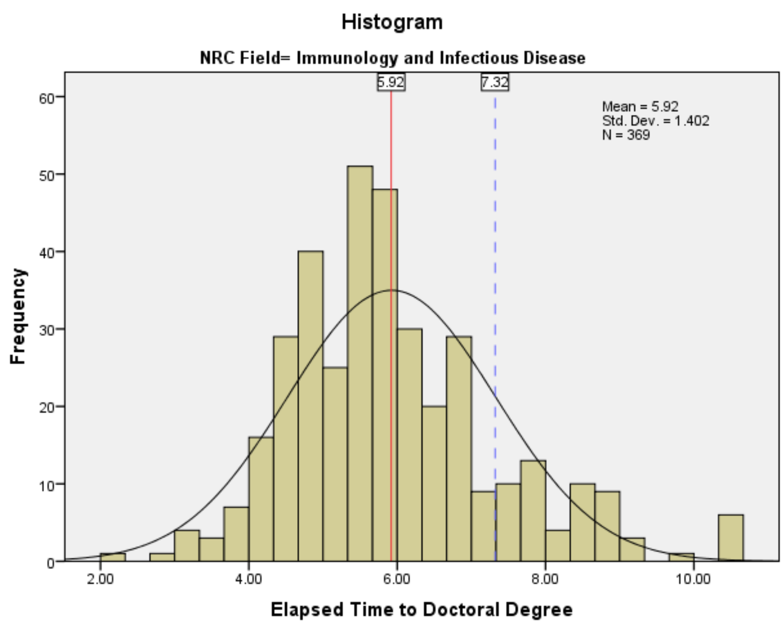
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 35: Histogram of Elapsed Time to Doctoral Degree for History of Art, Architecture and Archaeology



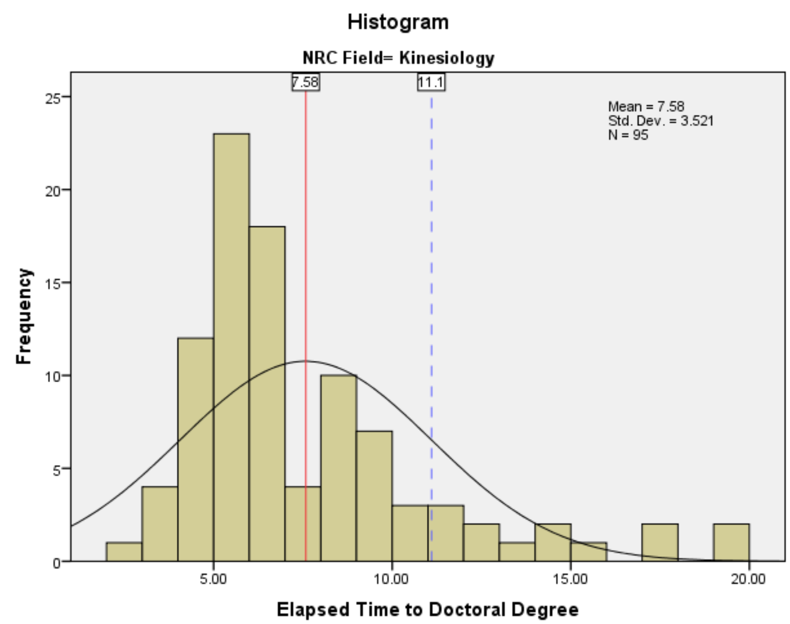
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 36: Histogram of Elapsed Time to Doctoral Degree for Immunology and Infectious Disease



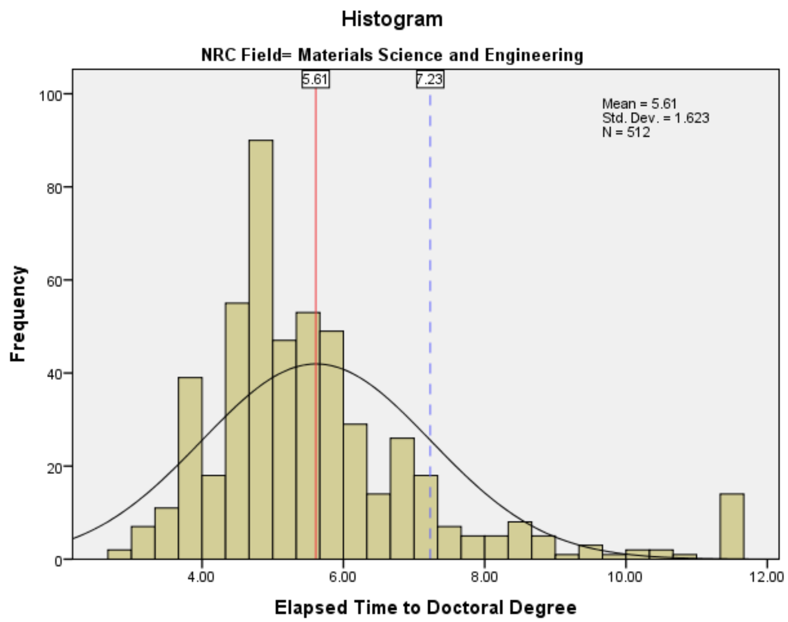
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 37: Histogram of Elapsed Time to Doctoral Degree for Kinesiology



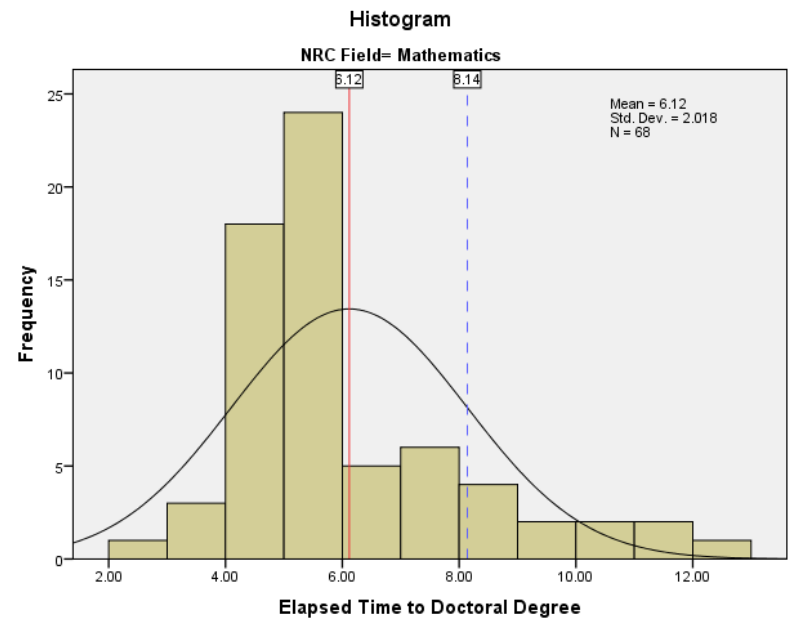
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 38: Histogram of Elapsed Time to Doctoral Degree for Materials Science and Engineering



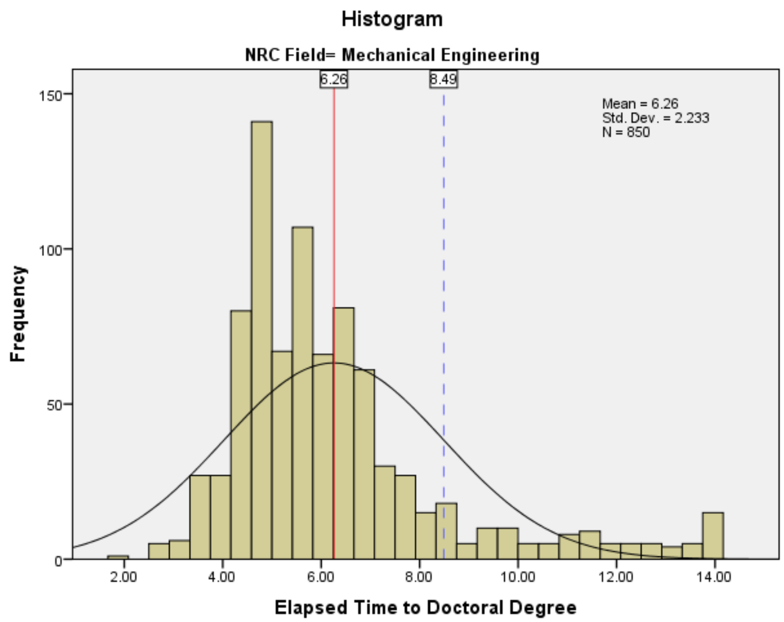
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 39: Histogram of Elapsed Time to Doctoral Degree for Mathematics



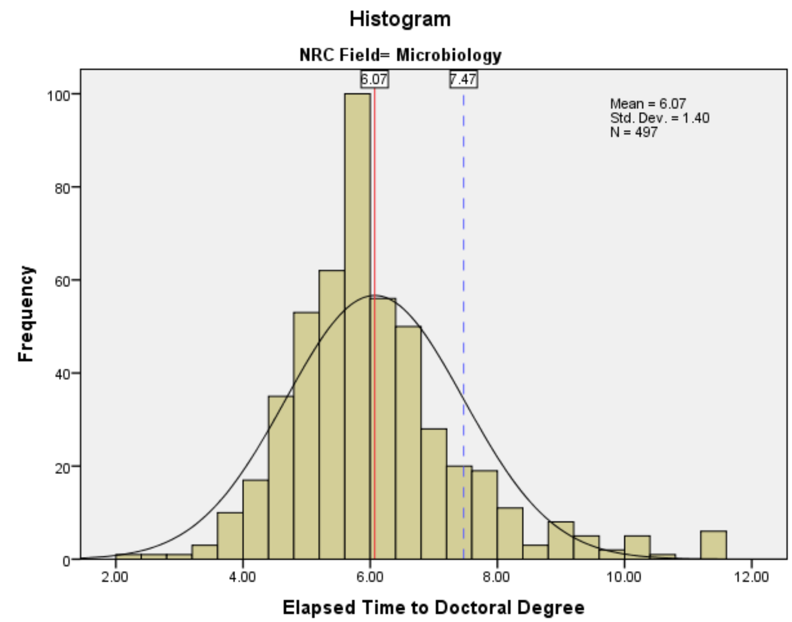
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 40: Histogram of Elapsed Time to Doctoral Degree for Mechanical Engineering



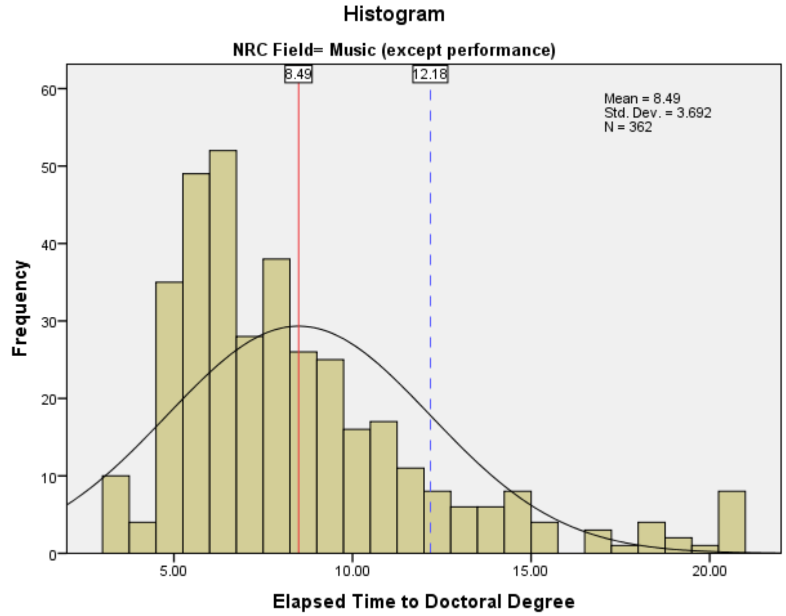
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 41: Histogram of Elapsed Time to Doctoral Degree for Microbiology



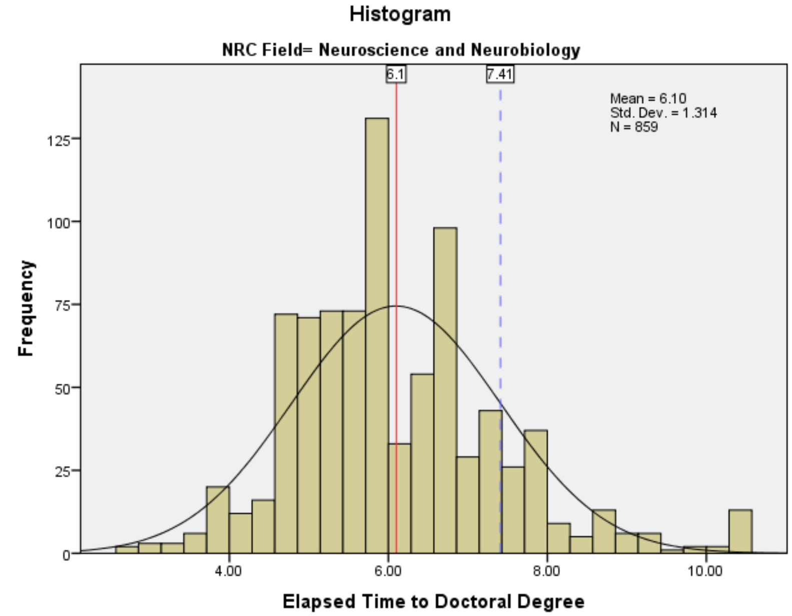
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 42: Histogram of Elapsed Time to Doctoral Degree for Music (except performance)



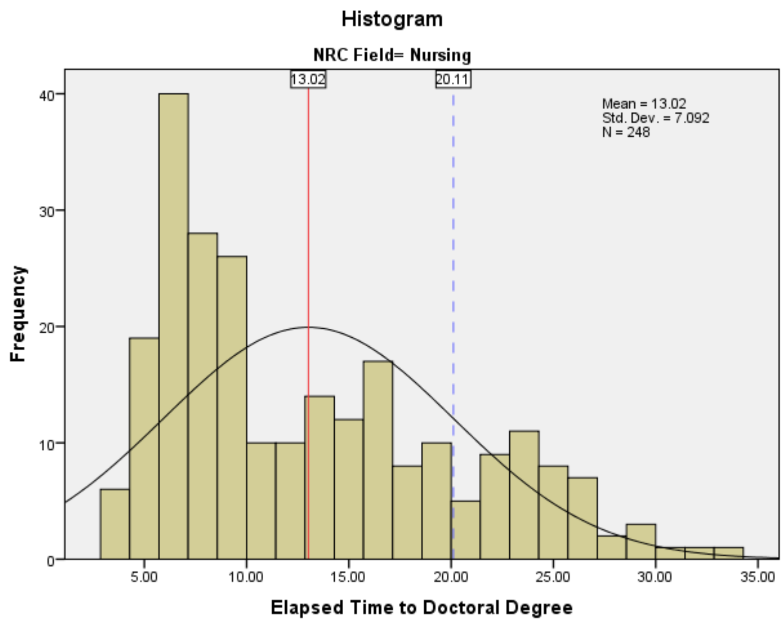
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 43: Histogram of Elapsed Time to Doctoral Degree for Neuroscience and Neurobiology



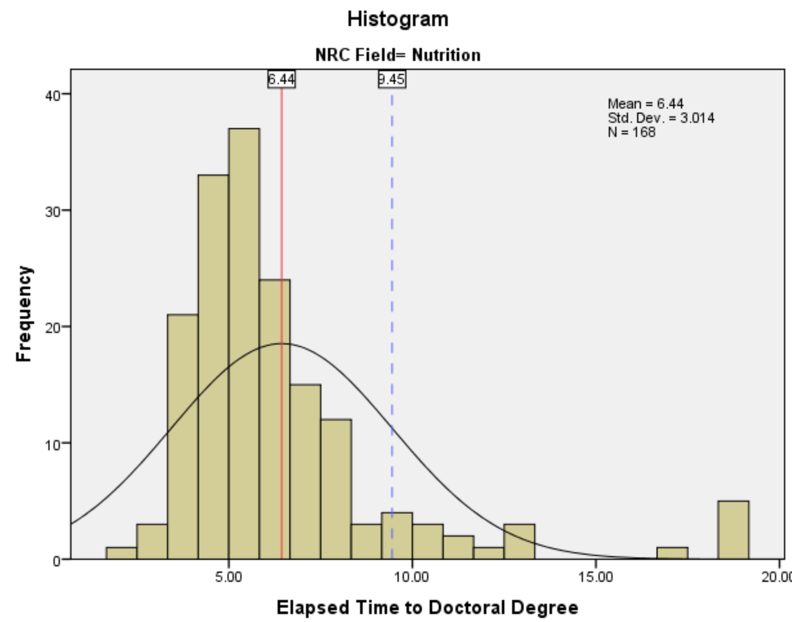
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 44: Histogram of Elapsed Time to Doctoral Degree for Nursing



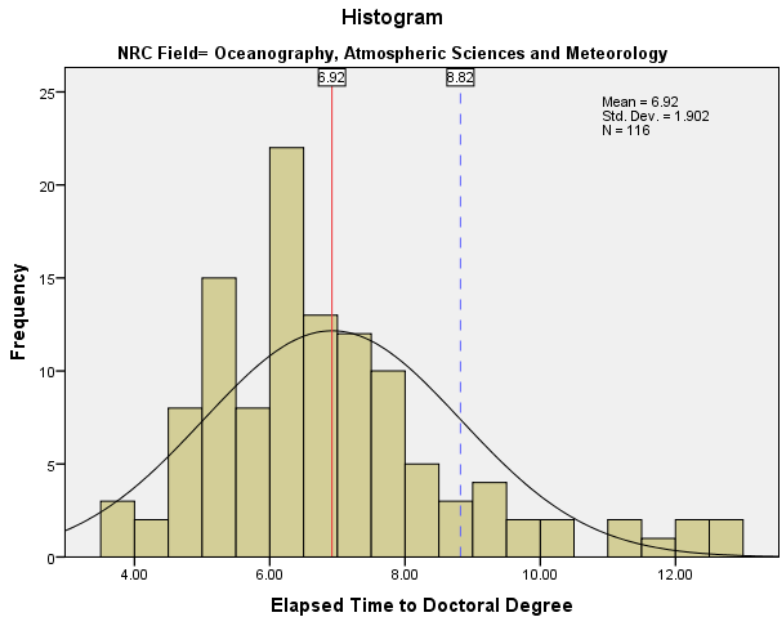
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 45: Histogram of Elapsed Time to Doctoral Degree for Nutrition



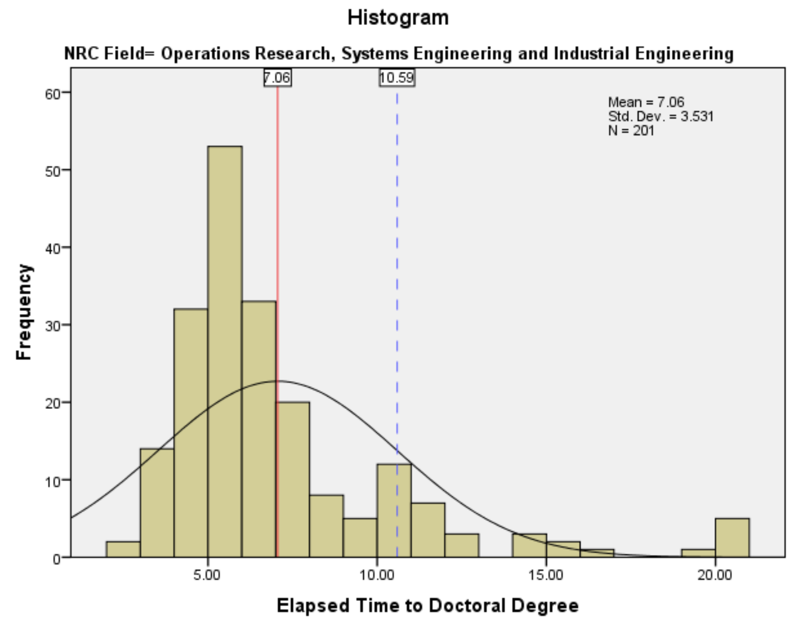
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 46: Histogram of Elapsed Time to Doctoral Degree for Oceanography, Atmospheric Sciences and Meteorology



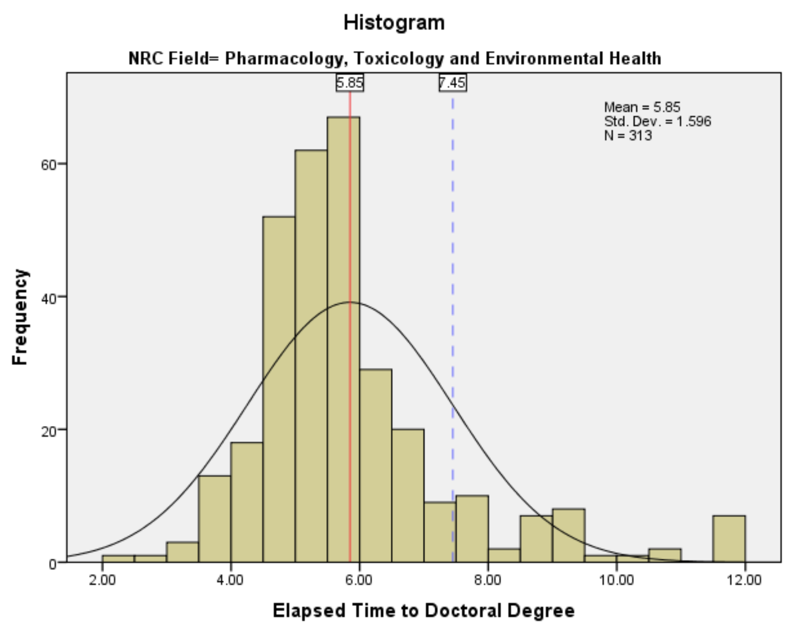
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 47: Histogram of Elapsed Time to Doctoral Degree for Operations Research, Systems Engineering and Industrial Engineering



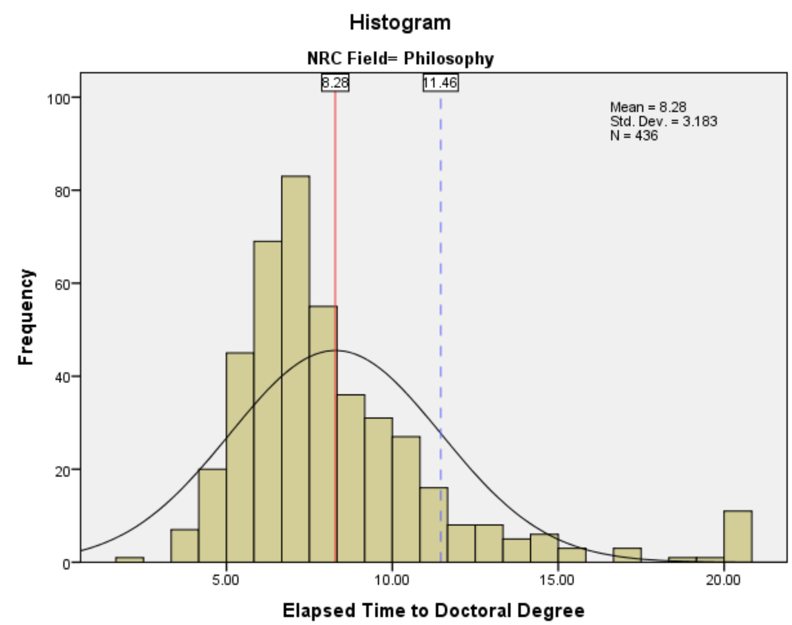
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 48: Histogram of Elapsed Time to Doctoral Degree for Pharmacology, Toxicology and Environmental Health



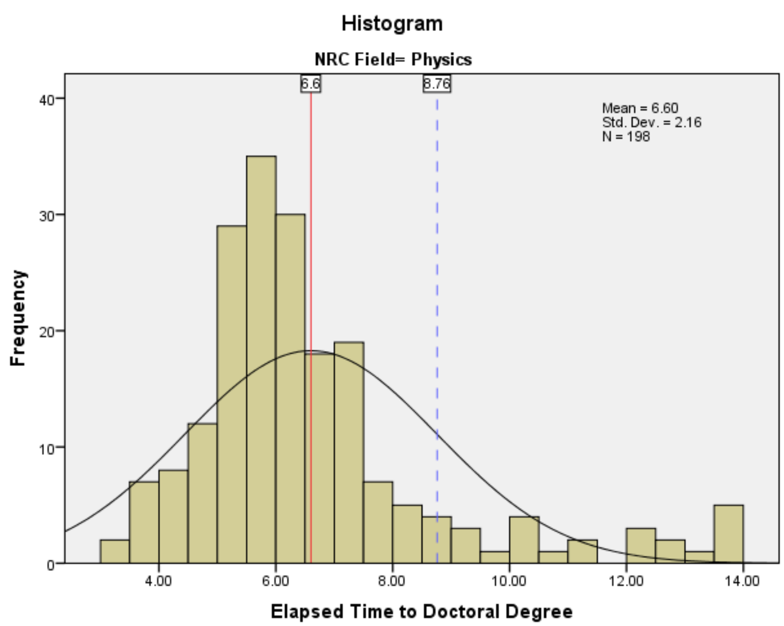
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 49: Histogram of Elapsed Time to Doctoral Degree for Philosophy



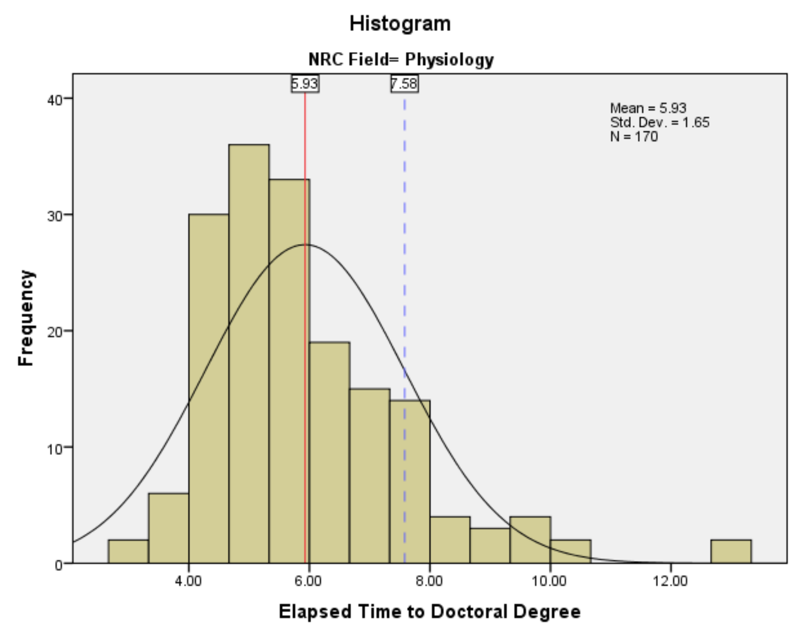
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 50: Histogram of Elapsed Time to Doctoral Degree for Physics



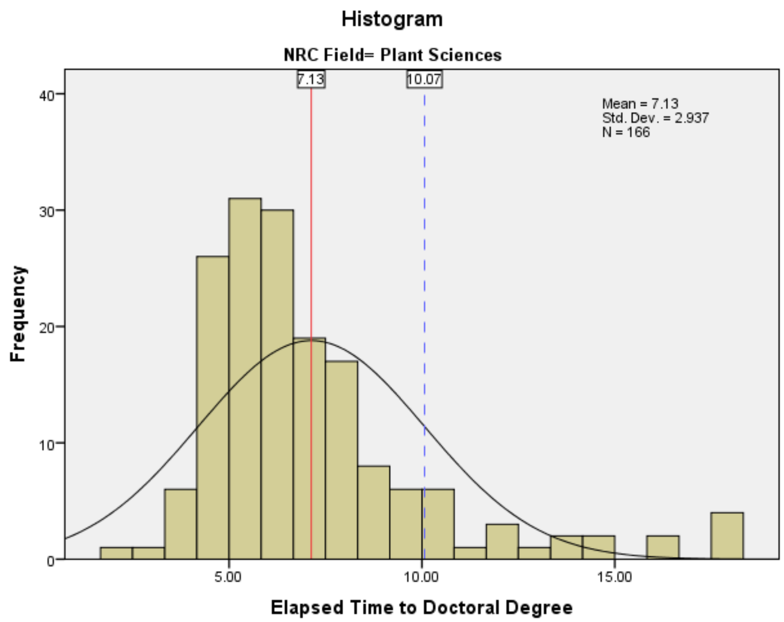
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 51: Histogram of Elapsed Time to Doctoral Degree for Physiology



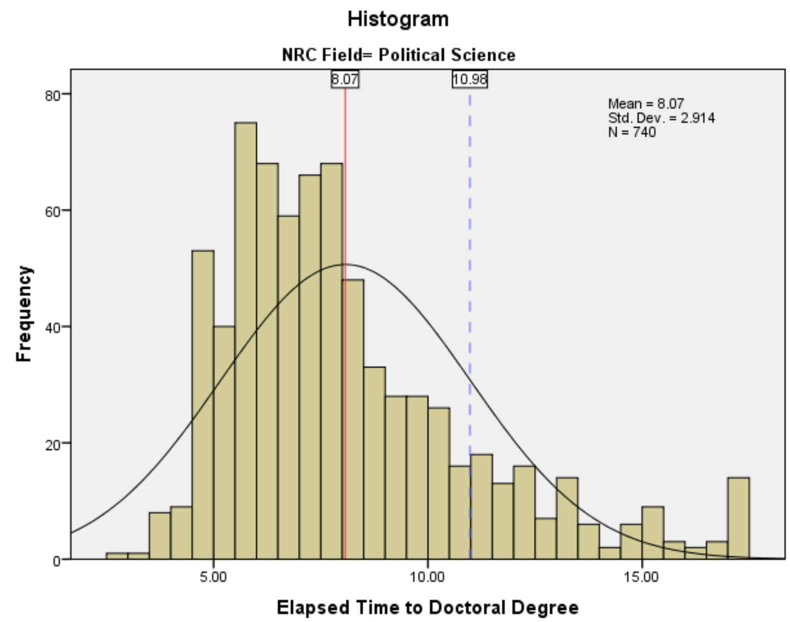
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 52: Histogram of Elapsed Time to Degree for Plant Sciences



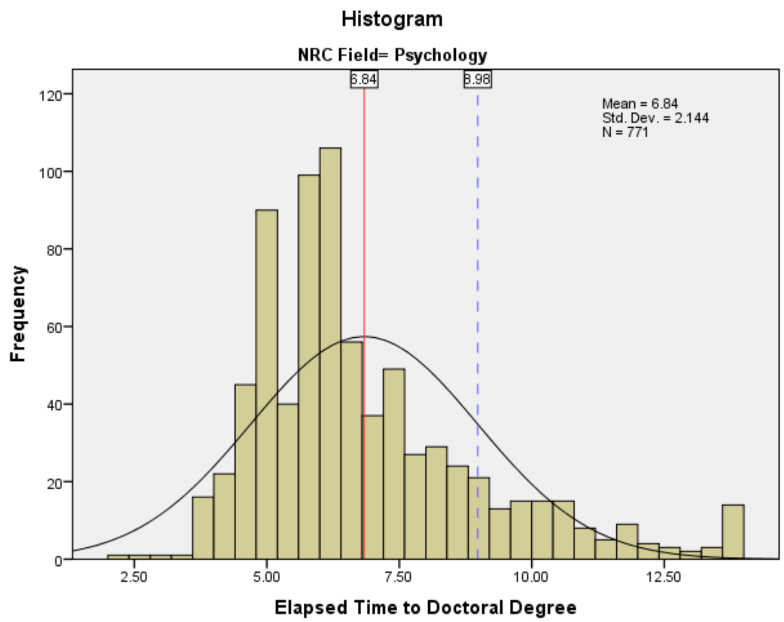
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 53: Histogram of Elapsed Time to Doctoral Degree for Political Science



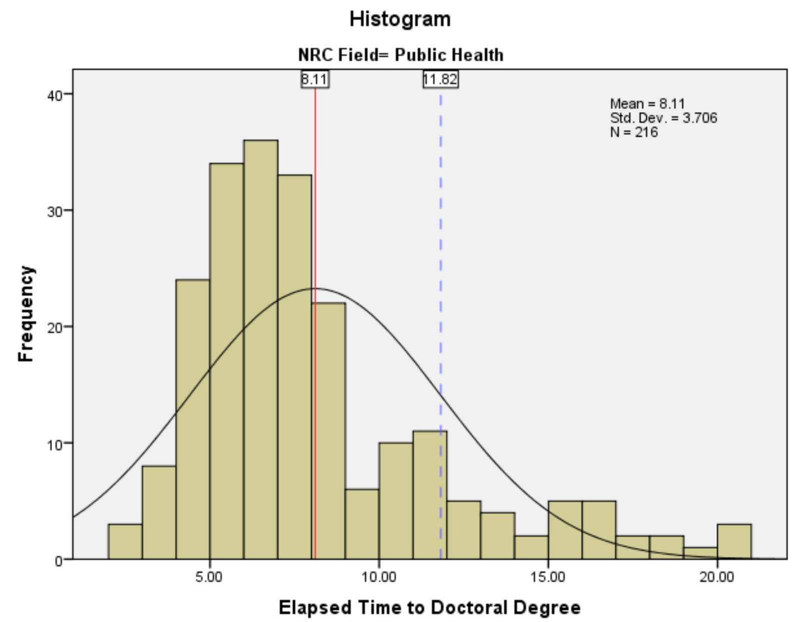
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 54: Histogram of Elapsed Time to Doctoral Degree for Psychology



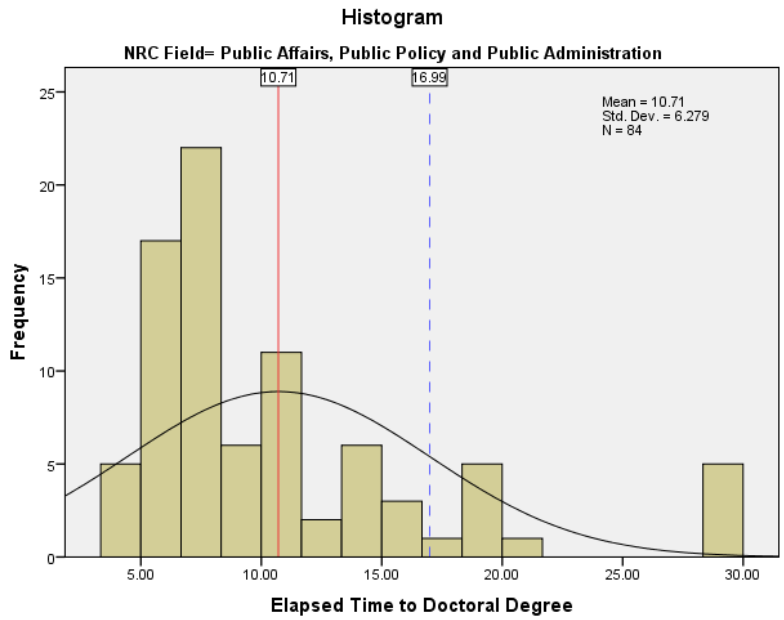
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 55: Histogram of Elapsed Time to Doctoral Degree for Public Health



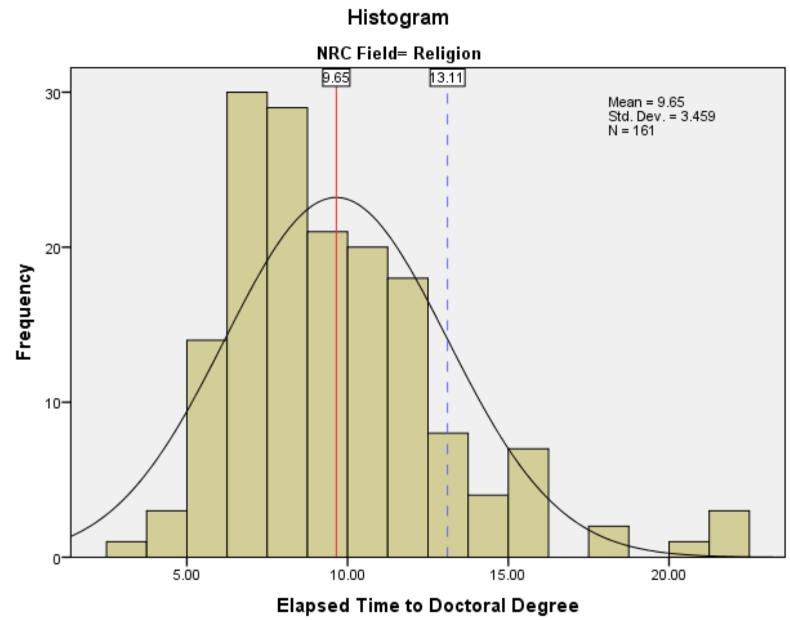
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 56: Histogram of Elapsed Time to Doctoral Degree for Public Affairs, Public Policy and Public Administration



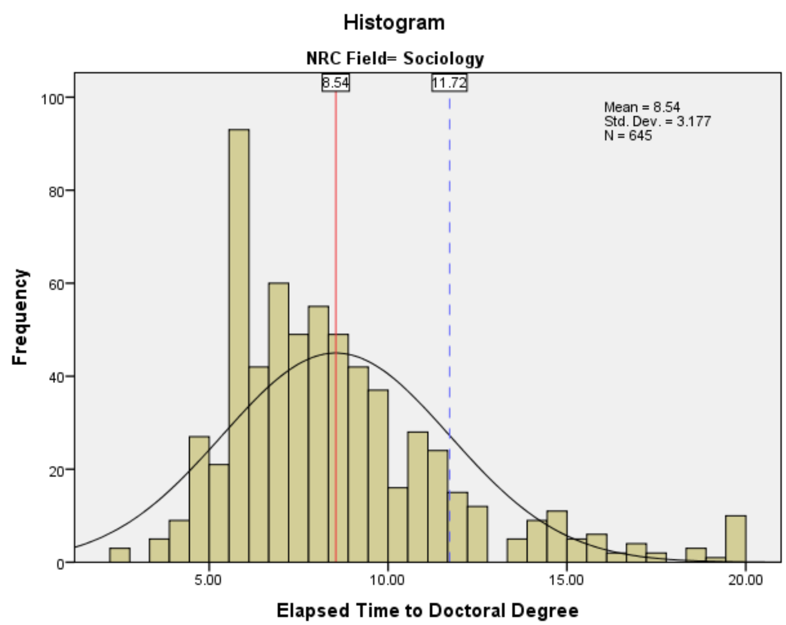
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 57: Histogram of Elapsed Time to Doctoral Degree for Religion



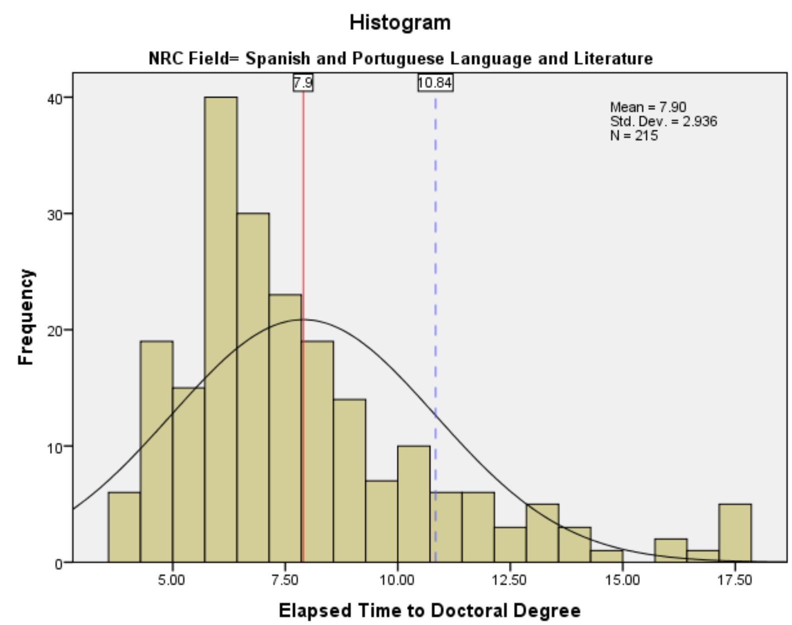
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 58: Histogram of Elapsed Time to Doctoral Degree for Sociology



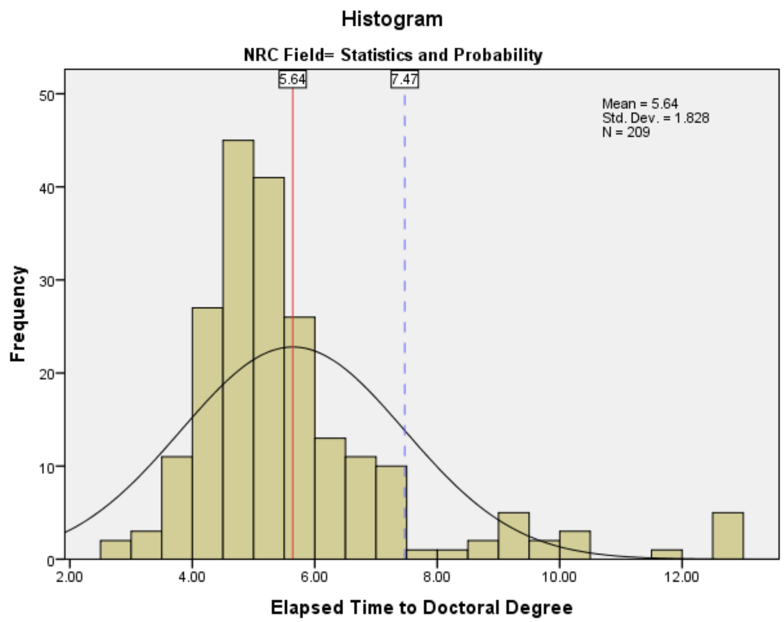
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 59: Histogram of Elapsed Time to Doctoral Degree for Spanish and Portuguese Language and Literature



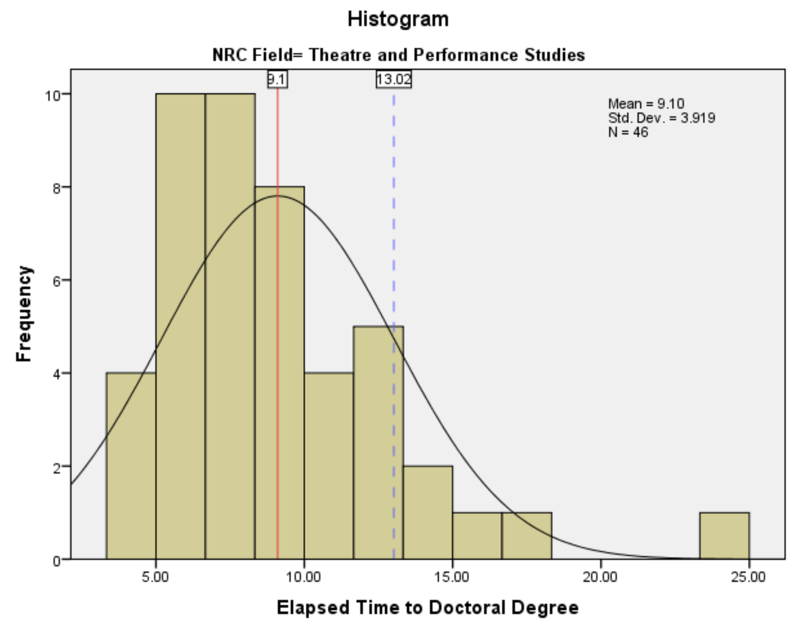
Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 60: Histogram of Elapsed Time to Doctoral Degree for Statistics and Probability



Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

Figure 61: Histogram of Elapsed Time to Doctoral Degree for Theatre and Performance Studies



Sources: NSF Survey of Earned Doctorates[1] and NRC Assessment of Research Doctorates in the U.S.

APPENDIX B

Helen Schurke Frasier
[redacted]
September 9, 2013

Debra W. Stewart, President
Council of Graduate Schools
One Dupont Circle NW, Suite 230
Washington, DC 20036

Dear Dr. Stewart:

I request your permission, on behalf of the Council of Graduate Schools, to reprint *The Ph.D. Completion-Attrition Kaleidoscope* from your publication:

Council of Graduate Schools (CGS). (2004). *Ph.D. completion and attrition: Policy, numbers, leadership and next steps.* Canada: Author. P. 12.

I have enclosed a copy of the material for your convenience.

This material will be reprinted in my dissertation, entitled *An Analysis of Institutional Characteristics that Contribute to Extended Time to Doctoral Degree*, which I anticipate will be published in December, 2013.

Sincerely,

Helen Schurke Frasier

Helen Schurke Frasier
University of Maryland, College Park
Higher Education, Student Affairs, and International Education Policy

---

Permission to reprint the above-reference material granted by:

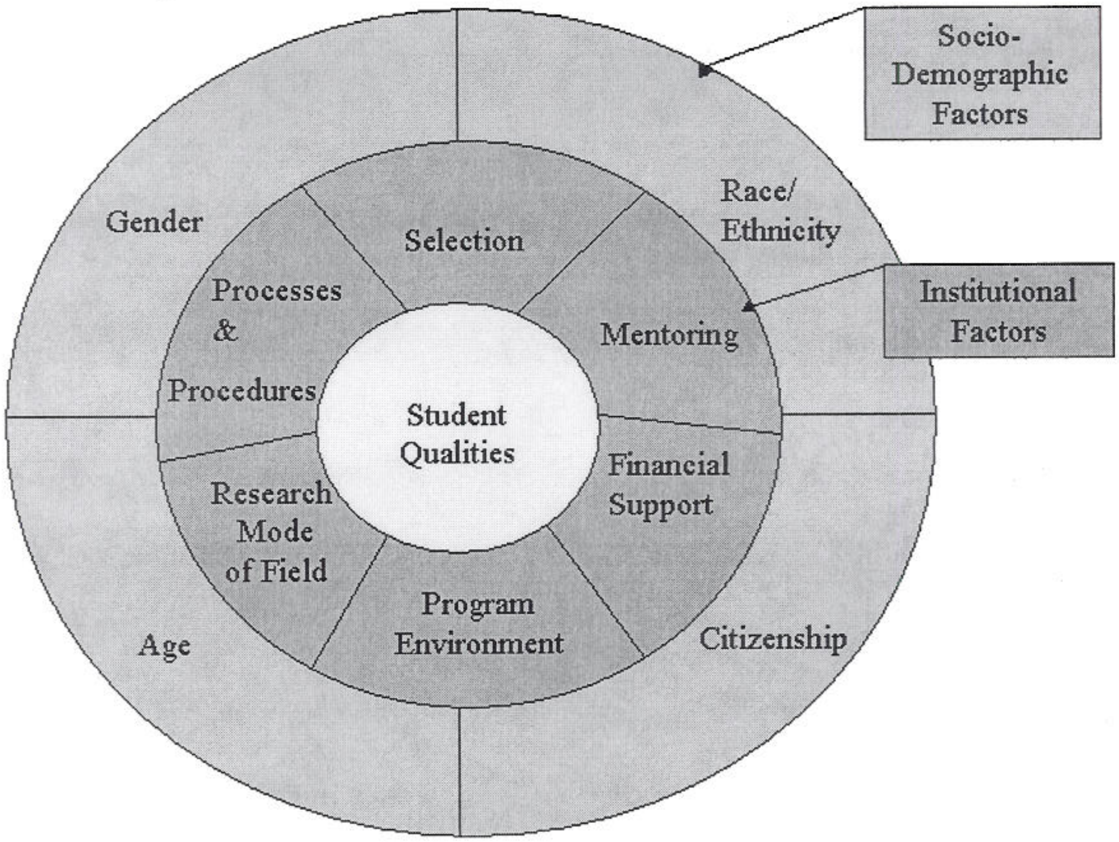
Name / Title: Keith T. Peresonov, CPA, MBA

Conditions: Associate VP, Finance & Operations
Approved as requested

Signature:

Copyright Authorization Request – Frasier, Helen Schurke

The Ph.D. Completion-Attrition Kaleidoscope



Council of Graduate Schools (CGS). (2004). *Ph.D. completion and attrition: Policy, numbers, leadership and next steps.* Canada: Author. P. 12.

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