ABSTRACT

ZHANG, JINGJING. Using Multilevel Modeling to Predict Doctoral Time-To-Degree. (Under the direction of Dr. Audrey J. Jaeger and Dr. Paul Umbach).

The American system of doctoral education is considered one of the best and attracts talent not only within the United States, but also from around the world. Despite its preeminent status, some facets of doctoral education need attention. Considering the median time-to-degree ranged from 5.7 years in physical and earth sciences to 7.1 years in humanities and arts in 2017 (NSF, 2017a), the elongated time-to-degree not only has increased cost per degree for doctoral granting institutions, especially public institutions that are already under severe financial constraints, but it has also decreased the productivity and value achieved per degree, as well as the return on the educational investment.

Analyzing data from 2002-2012 Survey of the Earned Doctorates, National Research Council, and Integrated Postsecondary Education Data System (IPEDS), my study constructed two hierarchical linear models (HLM), a two-level institution model and a three-level program model, to examine factors at the student level, departmental level, and institution level that affect doctoral time-to-degree. Cultural capital theory (Bourdieu, 1977), human capital theory (Becker, 1994), and the organizational impact model (Berger & Milem, 2000) are employed as the overarching theoretical framework guiding this study. HLM results detected that race/ethnicity, disability status, number of dependents under the age of five, parental education achievement, amount of tuition remission and types of financial support at student level, fields of study, program median GRE, program diversity ranking at departmental level, and type of institution and institution research activity at institution level consistently and significantly impact doctoral time-to-degree.
Using Multilevel Modeling to Predict Doctoral Time-To-Degree

by

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DEDICATION

This dissertation is dedicated to my parents, Zhonghua Jin and Weidong Zhang, for instilling the importance of education in my mind from an early age and for your unwavering support.

To my husband, Zhuo, for your understanding and appreciation of my doctoral journey and for believing in me when I had doubts about myself.

To Liam and Lucas, for teaching me persistence and resilience.
BIOGRAPHY

Jingjing “Kate” Zhang spent her childhood in Tianjin, China. She attended Tianjin Foreign Studies University where she received a Bachelor of Arts degree in English Culture and Literature. After graduating from college, she went to Virginia Polytechnic Institute and State University for her master’s degree in Education Leadership and Policy Analysis while working as a Graduate Hall Director. During her two years at Virginia Tech, her interest in higher education was strengthened by her coursework and daily interactions with undergraduate students and higher education practitioners.

Following her graduate studies, Kate went to North Carolina State University to further her education while working part-time as a Researcher and then Director of Research for the National Initiative for Leadership and Institutional Effectiveness (NILIE). After completing her coursework for a Doctorate of Philosophy in Educational Research and Policy Analysis, Kate started to work full-time as an Assistant Director in the Office of Strategic Planning and Assessment at UNC Eshelman School of Pharmacy. After four years at UNC – Chapel Hill, Kate moved to Duke University where she serves as an Associate Director of Assessment in the Division of Student Affairs.

Kate enjoys spending time traveling and exploring the world with her husband Zhuo and her sons, Liam and Lucas.
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CHAPTER ONE: INTRODUCTION

The need to focus on graduate education has never been more important than now in this unstable socioeconomic climate. Lifelong engagement in learning and research is crucial for adults to thrive in an internationally connected and dynamic world. Graduate education prepares students for successful futures, not only as scholars in academia, but also as leaders in an array of industries across the United States and the world. Graduate education also contributes to the advancement of many career sectors, particularly in science and engineering fields. In a society facing international competition daily, the need for a highly educated and well-trained workforce cannot be overestimated.

While graduate deans and faculty are paying more attention to the time it takes a student to earn a graduate degree (which is referred to as the time-to-degree in this study), it still has taken doctoral students longer to complete their respective degrees than ever before (National Science Foundation [NSF], 2017a). In 1978, the average time-to-degree for doctoral students was 6.3 years. More specifically, the time-to-degree for doctoral students by field was 5.9 years in physical science, 5.8 years in engineering, 5.9 years in life sciences, 6.8 years in education, and 6.2 years in social science (Hoffer & Welch, 2006). In 2016, the average time-to-degree for recipients of doctorates increased to 7.7 years with the breakdown of time-to-degree being 6.1 years in physical sciences, 6.5 years in engineering, 6.7 years in life sciences, 11.7 years in education, and 9.3 years in humanities and arts (NSF, 2018).

Further, the increasing debt level has also caused significant financial burden for doctoral students. Education-related debt of doctorate recipients increased from an average of $18,777 in 2009 to $23,132 in 2017 with numbers ranging from $10,156 in mathematics and computer sciences to $40,709 in education (NSF, 2010; 2018). These increasing debt levels may explain
why student financial support (e.g., fellowships, grants, assistantships, and student loans) remained one of the six key factors that affects student outcomes, which ultimately determine whether a student will complete a PhD program (Council of Graduate Schools, 2010a). Moreover, while pursuing a PhD, doctoral students must find the means to cover the direct costs associated with completing the degree, as well as consider the forgone earnings and opportunity costs they were not able to obtain through work or other activities while they completed their degree. Given the increasing costs of higher education, it is likely that elongated time-to-degree serves not only as a barrier to the individuals pursuing the doctoral degree, but also to the doctoral granting institutions and greater society that have both made significant financial and intellectual investment in students.

Various studies have been conducted on the doctoral student population and their experiences, especially within the past 20 years (Blockett, Felder, Parrish III, & Collier, 2016; Johnson, Ward, & Gardner, 2017). Much of the current literature has concentrated on exploring how certain components, such as mentoring and supervision (Akerlind & McAlpine, 2015; Bogle, 2010; Bruce & Stoodley, 2011; Lee, 2008; Nakamura & Shernoff, 2009; Patton, 2009); financial support (Ampaw & Jaeger, 2011; Baird, 1997; Bowen & Rudenstine, 1992; Sowell, Alum, & Okahana, 2015; Tuckman, Coyle, & Bae, 1990); and graduate school socialization (Gardner, 2010b; Hermanowicz, 2015; Weidman, Twale, & Stein, 2001) impact students’ completion in doctoral education. While much has been studied on doctoral student experiences empirically, less is known about the predictors affecting doctoral time-to-degree, especially in relation to predictors affecting subpopulations of doctoral students (e.g., gender, racial/ethnic background, first-generation status). For example, national data collected by NSF (2018) suggested that African American and American Indian students took longer to complete a
doctorate than their Asian and White counterparts. In psychology and social sciences, on average, it takes an American Indian student 6.8 years and an African American student 6.7 years to obtain a doctoral degree, while it takes 6 years for a White student to complete the degree. In education, on average, African American students take half a year longer than Asian students (6.8 years versus 6 years) to obtain the doctorate (NSF, 2018). While explanations on the variances in time-to-degree based on race/ethnicity have been attributed to financial support and debt level (Kim & Otts, 2010), other factors contributing to the knowledge on the doctoral time-to-degree of various subpopulations remains largely unknown.

Expanding the research on time-to-degree beyond the undergraduate level has many challenges. The decentralization of doctoral education means that scholars and researchers must focus on specific institutions, departments, and/or academic disciplines (de Valero, 2001). As a result, much of the existing research (Perez, Robbins, Harris, & Montgomery, 2019; Ramirez, 2017; Williams, Brown Burnett, Carroll, & Harris, 2018) has been derived from exploratory qualitative studies with relatively small sample sizes. The findings, accordingly, are not representative of the larger doctoral student population. More complex studies attempting to examine the doctoral student population beyond the scope of particular institutions have been limited by outdated data sources (Bowen & Rudenstine, 1992; Ehrenberg & Mavros, 1995; Ehrenberg, Zuckerman, Groen, & Brucker, 2010). Due to the challenges of small sample size and limited access to large representative datasets, the ability to present a holistic picture of doctoral students and their education has been diminished.

Growing pressures for doctoral granting institutions have forced administrators to distribute various resources in more efficient ways (Lovitts & Nelson, 2000). For doctoral students, the financial constraints of higher education have forced them to reconsider the costs
associated with a lengthy time-to-degree, including explicit expenses and opportunity costs (Bair & Haworth, 2004; Bentley & Berger, 1998; Chang, 2011; Denecke & Slimowitz, 2004; de Valero, 2001). As a result, it is crucial for education researchers and policymakers to start examining ways to improve doctoral student retention and advancement (Main, 2018).

The Problem

Doctoral education is recognized as the highest level of study in the United States and around the world. The American system of doctoral education is considered one of the best and attracts talent not only within the borders of the United States, but also from around the world. Despite its preeminent status, some facets of doctoral education need attention. Considering the median time-to-degree ranged from 5.7 years in physical and earth sciences to 7.1 years in humanities and arts in 2017 (NSF, 2017a), the elongated time-to-degree not only has increased cost per degree for doctoral granting institutions, especially public institutions that are already under severe financial constraints, but it has also increased opportunity costs and explicit expenses for individuals pursuing the doctoral degree. As a result, such extended time taken to earn the degree bring forth a series of questions still unanswered, despite scholars’ and researchers’ previous attempts to study doctoral education.

Both faculty and graduate deans seeking financial support from federal and state governments, foundations, and private sectors need to better justify the elongated time-to-degree of their doctoral students (Lipschutz, 1993; Zhou & Okahana, 2019). Numerous studies have addressed these issues from different angles (Brannock, Litten, & Smith, 2000; Gardner & Holley, 2011; Lawson & Fuehrer, 2001; McAlpine & Emmioglu, 2015; McCallum, 2016; Tenenbaum, Crosby, & Gliner, 2001). Some previous research on doctoral students has focused on the effect of financial support on doctoral degree progress (Ampaw & Jaeger, 2011;
Ehrenberg & Mavros, 1995; Hoffer et al., 2006; Kim & Otts, 2010; Rapoport, 1998; Siegfried & Stock, 2001. For example, Ehrenberg and Mavros (1995) examined doctoral completion in the fields of economics, English, mathematics, and physics at Cornell University from the period of 1962 to 1986. They found that doctoral students with teaching assistantships or fellowships were less likely to complete degrees in all examined disciplines. Furthermore, doctoral students with loans, self-support, or tuition waivers were less likely to successfully obtain a Doctor of Philosophy (PhD). More specifically, Ehrenberg and Mavros (1995) predicted that out of 100 individuals in physics who received fellowship support, 78 would complete their degrees within six years while only 32 students who received teaching assistantships were predicted to graduate within six years. On the other hand, out of 100 individuals in mathematics who received research assistantships, all students were predicted to complete the program within six years, whereas only 25 students with other support (e.g., loans, self-support, or tuition waivers) would graduate within the same duration. In this particular study, controls for gender and academic capacities (as measured by GRE scores) were not related to degree completion. The study was comprehensive, but it overlooked the impact of race/ethnicity on completion and time-to-degree and only focused on one of the most elite institutions in the United States.

Another study examined how various factors, including financial aid and labor market conditions, affected doctoral students’ persistence during three stages of doctoral education: transition, development, and research (Ampaw & Jaeger, 2011). The data set was acquired from a state-supported institution between the academic years of 1994-1995 and 1998-1999. Using event history analysis, they compared the effects of various factors on persistence at three different stages in doctoral education. Ampaw and Jaeger (2011) found that gender did not affect doctoral degree completion once assistantships and fields of study were controlled. White
and minority students showed differences in degree completion during the development stage of their doctoral program. In addition, academic preparedness had no significant effect on degree completion beyond the transition stage. Lastly, students with research assistantships were more likely to complete all three stages of doctoral education in comparison to their counterparts with any other types of financial support. Ampaw and Jaeger (2011) pointed out that one of the main limitations to this study derived from the use of secondary data from a single institution, which had limited fields of study and limited generalizability to other types of institutions.

In a more recent study, Horta, Cattaneo, and Meoli (2018) investigated the effects of various types of PhD funding on scholars’ research performance both during the PhD program and beyond. Drawing a sample of 4095 PhDs in Portugal, Horta et al. (2018) found that doctoral students funded by PhD grants demonstrated stronger research productivity and visibility during and after the PhD than the ones who were self-funded. However, research productivity remained similar for research project grants recipients and those who did not receive research project grants. One of the limitations of this study was that the PhD sample used in the study was from Portugal, a country where the funding scheme differs from the United States. As a result, it is yet unclear whether similar conclusions can be drawn for doctoral recipients in the United States.

Many research studies on doctoral time-to-degree have also concentrated on student characteristics and the shortages of PhDs amongst underrepresented student groups in an array of academic disciplines (Gardner & Holley, 2011; Green & Kim, 2005; Griffin, Muniz, & Espinosa, 2012; Tierney, Campbell, & Sanchez, 2004; Woodrow Wilson National Fellowship Foundation, 2005). For example, using data from the Survey of Earned Doctorates (SED) from academic year 2004-2005, Hoffer et al. (2006) found that female students generally took longer than their male counterparts to complete their degrees. The median time-to-degree in 2005 in all fields of
study for women was 10.5 years, whereas it took men 9.4 years to complete. In terms of race/ethnicity, only 11.9% of all doctoral degrees were awarded to racial minority students in 2005. This is concerning because underrepresented minorities constitute 28% of the American population (NSF, 2009). Asians had the lowest average time-to-degree in 2005 at 8.8 years, followed by Hispanics (10.3 years), Whites (10.4 years), American Indians (12 years), and African Americans (12.7 years; Hoffer et al., 2006). Not only did it take racially underrepresented doctoral students longer to obtain their degree, but research suggested that African American, Hispanic, and American Indian doctoral students were more likely to have significantly higher debt than Asian and White students (Hoffer et al., 2006). As a result, from a human capital perspective, longer time-to-degree decreases the productivity and value achieved per degree, as well as the return on the educational investment. While shedding important light on this issue, most studies and reports on doctoral time-to-degree (Council of Graduate Schools, 2010b; NSF, 2017b) have largely been based on simple descriptive statistics and have examined a narrow set of predictors. Reports provided by Council of Graduate Schools and NSF have rarely discussed how student background information and types of financial resources could affect time-to-degree attainment. Additionally, they have often ignored the effects at the institutional level on student time-to-degree. Controls for socioeconomic status (SES), financial support, racial/ethnic, gender, and institution differences could more accurately assure the prediction of time-to-degree among doctoral students.

While some research on doctoral time-to-degree has been conducted over the past two decades, the majority of studies have focused on doctoral student experiences and their socialization process (Austin, Kruger, Gardner, & Mendoza, 2012; Brown & Watson, 2010; Felder, Stevenson, & Gasman, 2014; Gardner, 2008, 2010b; Gardner & Gopaul, 2012; Johnson
et al., 2017; Le & Gardner, 2010; Weidman et al., 2001). For instance, Gardner (2010b) explored how disciplinary context and culture influenced doctoral students’ socialization process at one institution by interviewing 60 doctoral students from six disciplines. She found that support from peers, faculty, and individuals outside of the department were crucial in facilitating a positive experience for doctoral students. In addition, self-direction became an emerging theme of the graduate socialization process. Ambiguity in graduate school guidelines, regulations, and expectations also shaped doctoral students’ experiences (Gardner, 2010b). Another qualitative study explored the experiences of Asian international doctoral students in STEM disciplines at a research-extensive institution (Le & Gardner, 2010). The study addressed how gender, nationality, age, academic disciplines, and marital status shaped students’ experiences. After interviewing nine international participants, Le and Gardner (2010) found that institutional context, support, family, and the academic department played a significant role in the daily lives of international doctoral students. Further, Asian international doctoral students in STEM fields were isolated from their American peers and faculty. They also faced a series of issues such as lack of funding, limited choice of advisor, and a lack of resources (Le & Gardner, 2010). In another study, Felder et al. (2014) interviewed 11 African American doctorate recipients in education to explore how race intersected with faculty-student interactions and the ways in which these interactions facilitated or hindered doctoral student socialization. The researchers found that race influenced doctoral student socialization through “student-faculty relationships, perception of faculty behavior, and the presence of faculty diversity” (Felder et al., 2014, p. 34).

Although comprehensive, the nature of qualitative inquiries prevents researchers from examining cross-level interrelationships among doctoral students’ personal characteristics,
disciplinary context, and institutional factors and how those factors may have affected doctoral time-to-degree. Hence, an analysis of differences based on demographic characteristics such as gender, race, age, enrollment status, and educational background, as well as program context and institutional characteristics, is needed to better understand the doctoral student population and time-to-degree issues (Felder et al., 2014; Gopaul, 2016). More specifically, most of the current studies have been largely based on exploratory, qualitative frameworks making them unable to address cross-level interrelationships amongst multiple factors that may be associated with doctoral time-to-degree.

While the attention on doctoral education has mainly been on completion and less on time-to-degree, the concepts are not mutually exclusive, as time-to-degree is negatively associated with degree completion; therefore, factors that impact completion are likely to be important predictors of time-to-degree as well. As a result, this study is informed by scholarly work on persistence and degree attainment. To contribute to the conversation on factors affecting time-to-degree of doctoral students, this study examines the effect of student characteristics, departmental context, and institutional characteristics on time-to-degree. This study particularly focuses on disparities on time-to-degree based on gender, race, and parental educational background (i.e., first-generation students).

**Purpose Statement**

Beyond the research conducted on persistence, limited studies have focused on doctoral time-to-degree, particularly on underrepresented population, such as female in STEM disciplines, racial/ethnic minority students, and first-generation students; thus, little is known about time-to-degree. The available literature on doctoral student time-to-degree has burgeoned since the 1990s (Ames, Berman, & Casteel, 2018; Bowen & Rudenstin, 1992; Geven, Skopek, &
Triventi, 2017; Gittings, Bergman, Shuck, & Rose, 2018; Golde, 1998; Horta et al., 2018; Lovitts, 2001; Nelson, 2018; Nerad & Cerny, 1993; Perrucci & Hu, 1995; Schroeder & Mynatt, 1993; Weidman et al., 2001; Zhou & Okahana, 2019), but studies based upon quantitative data have been slow to emerge. Within the limited research on doctoral time-to-degree, rarely has literature examined factors beyond the student level, nor have researchers focused on underrepresented doctoral subpopulations. Few studies have examined how potentially critical facets of student background, fields of study, and departmental and institutional components may interact to influence time-to-degree (Abedi & Benkin, 1987; Zhou & Okahana, 2019). Further, more research is needed to examine if institutional factors play a role in promoting or inhibiting doctoral degree attainment (Ampaw & Jaeger, 2011). Hence, a study that examines and incorporates these various factors is necessary to fully understand doctoral time-to-degree.

The purpose of this study was to present two models that predict time-to-degree among doctoral students based on individual characteristics, doctoral program components, and institutional affiliations. More specifically, this study used multilevel modeling to examine how doctoral students’ personal backgrounds (i.e., gender, race/ethnicity, citizenship, disability status, marital status, parental education background); amount of tuition remission and types of financial support; department and program components (i.e., academic discipline, program ranking, research activity ranking, diversity ranking, median program GRE); and institutional contexts (i.e., institution type, Carnegie Classification, degree of urbanization) function individually, and interact collectively, to affect doctoral time-to-degree. The study also highlights factors that may contribute to differences in time-to-degree of several subpopulations (e.g., female, racial/ethnic minorities, and first-generation students).
Scope

I used multilevel modeling to examine factors associated with doctoral time-to-degree at the student, program, and institutional levels. The multilevel modeling approach has several advantages over a conventional statistical analysis. This approach offers more reliable estimates in the case of unbalanced, nested data structure and considers the effects of students nested within programs, and programs nested within institutions (Raudenbush & Bryk, 2002). In addition, multilevel modeling allows the researcher to draw conclusions about correlations between the dependent variables, especially the extent to which correlations depend on the student level and on the program level (Snijders & Bosker, 2000).

Three primary data sources were used for the purpose of this study. First, student-level (level one) data is drawn from the 2002-2012 Survey of the Earned Doctorates, a large, nationally representative data set sponsored by the NSF. The SED includes data on characteristics of new doctoral recipients from all accredited institutions in the United States. The graduate school at each institution, as well as a data collection contractor, work closely to ensure all new doctorate recipients complete the survey. The SED collects data on a variety of areas, including demographic characteristics, academic background, financial support, and debt level. With high response rates and comprehensive questions, the SED data depicts an accurate picture of the trends and characteristics of the doctorate recipients in the United States.

The reason to use multiple years of data is to aggregate several student-level variables to the program level so that representative numbers of programs can be captured. Using aggregate variables at the program level also gives power at level one because certain disciplines may have a small number of graduates in any given year. I aggregated race/ethnicity and gender variables at the student level. By doing so, the model calculated the number of minority and female
students for different fields of study. This also became an indirect measure of gender climate and racial/ethnic climate. If the program graduates are overrepresented or underrepresented by certain subpopulations, it may be associated with time-to-degree for students of certain subgroups. Hence, this study examined whether program demography based on gender and race/ethnicity influence doctoral time-to-degree.

Program-level (level two) data derives from the National Research Council’s (NRC) report for the National Academies of Science, Engineering, and Medicine entitled “A Data-Base Assessment of Research-Doctorate Programs in the United States.” This report gathers information on program rankings. The data set includes measures of program characteristics, such as overall program ranking, research activity ranking, diversity ranking, and median program GRE score.

Institutional-level (level three) data is drawn from the National Center for Education Statistics (NCES), which produces a series of interrelated surveys called the Integrated Postsecondary Education Data System (IPEDS). Beyond student background information, the SED includes very few variables that describe institution type. IPEDS collects data on institutional characteristics, such as minority-serving institution indicators and degree of urbanization. In addition, two aggregated variables estimating female proportion and underrepresented minority student proportion are also included at institution level.

**Conceptual Framework**

The conceptual framework is a critical part of any research design. It is the system of concepts, assumptions, expectations, beliefs, and theories that help give specific attention to the research design and research questions (Robson, 2002). Miles and Huberman (1994) explained that the conceptual framework is:
The current version of the researcher’s map of the territory being investigated ... and it explains, either graphically or in narrative form, the main things to be studied—the key factors, concepts, or variables—and the presumed relationships among them. (p. 18) Bourdieu’s (1977) cultural capital theory, Becker’s (1962;1980) human capital theory, and Berger and Milem’s (2000) organizational impact model were used collectively as the conceptual framework of this study.

Bourdieu’s (1977) cultural capital theory has been widely used in understanding power in social structures. He suggested that possession of cultural capital varies differently in social classes, with dominant classes possessing more cultural capital and underserved classes possessing less. Cultural capital often includes the knowledge base, skills, expectations, and preferences parents and family upbringings share with their children (Carter, 2003; Lareau & Weininger, 2003). These non-merit-based factors further affect how students access educational opportunities and how their personal background (e.g., gender, race/ethnicity, and parental educational background) may prevent students from furthering their education. Bourdieu (1977) suggested that the educational system became a means to legitimize and honor certain inherited cultural capitol, rather than function as a system to reduce the inequities between people, as it is closely associated with upholding the ideological dominance of upper classes.

Cultural capital theory can be used to examine how students’ personal characteristics may be associated with doctoral time-to-degree. More specifically, this study closely investigated if gender, race/ethnicity, and parental educational background are significant factors associated with time-to-degree. This study particularly examined if inequities in time-to-degree exist between different doctoral student subpopulations based on gender and race/ethnicity.
Bourdieu’s (1977) cultural capital theory has been used as a theoretical framework for investigations of college choice and student success. Using longitudinal data on postsecondary institutions, Walpole (2003) concluded that students’ SES was closely associated with their college experience. College students from high socioeconomic backgrounds got more involved in campus activities, earned higher GPAs, studied more hours, and worked less than their counterparts from lower socioeconomic backgrounds. Walpole (2003) suggested that higher education institutions tend to value and reward students who possess high-status cultural capital and are more likely to overlook students with low-status cultural capital, which leaves these students at risk for not being successful. Another study used cultural capital theory as the guiding theoretical framework examining students’ decisions to enroll in graduate school. Using longitudinal data from the 1993 National Postsecondary Student Aid Survey, Perna (2004) found that while higher shares of women enroll in programs at the sub-master’s and master’s level than men, women were less likely to enroll in doctoral programs than men. In this study, sample size for doctoral degree enrollment was too small to be included in further analysis; however, the odds of enrolling in either sub-master’s or master’s programs became comparable for women and men when measures of cultural capital were taken into account. While Bourdieu’s (1977) cultural capital theory has been widely used to study students’ experiences and college choice (Aschaffenberg & Mass, 1997; Carter, 2003; Harvey, 2019; Imdorf, Koomen, Murdoch, & Guegnard, 2017; LePeau, Snipes, Morgan, & Zimmerman, 2018; McDonough, 1997; O’Shea, 2016; Padgett, Johnson, & Pascarella, 2012; Steelman & Powell, 1991), it has been rarely applied for investigations of doctoral education (Gopaul, 2016; Vasil & McCall, 2018), especially in terms of how measures of cultural capital may be associated with doctoral time-to-degree.
In addition to cultural capital theory, this study also used human capital theory as a theoretical framework. Human capital theory has been used to study the effects of financial and non-financial factors on students’ educational achievement. Becker (1972) described all types of education as investments in human capital which lead to acquisition in skills and knowledge (Becker, 1996; Wolf, 2005). Rosen (1999) suggested that human capital is an investment “that people make in themselves to increase their productivity” (p. 381). The underlying assumption of human capital theory is that people’s choices are based upon the evaluation and decision to invest in education, training, health, and nutrition to enhance their productive capacities.

Human capital theory can be used to explain how different types of financial support affect time-to-degree. An assumption of human capital theory is that students have full and equal access to the credit market and the decision to pursue further education is to maximize their productive capability and future income. However, in reality, not everyone has the same access to credit due to their personal and academic backgrounds. For instance, students from lower socioeconomic backgrounds may forego the opportunity to pursue a doctoral degree without proper financial support. As a result, for underrepresented populations with fewer resources, different types of financial support may impact their decision to pursue, and time spent to complete, a degree.

Drawing from human capital theory (Becker, 1962; 1980), economists have primarily focused on how financial factors affect undergraduate students, especially students’ choice to enter higher education and their choice of institution. Economists have found that human capital is the main reason that individuals choose to pursue higher education (Donald, Baruch, & Ashleigh, 2017; Mincer, 1974; Olaniyan & Okemakinde, 2008; Mok, Wen, & Dale, 2016; Nel
Paez & Teelken, 2016; Rao & Datta, 1985); however, less attention has been paid to how human capital theory could affect persistence and time-to-degree, especially at the doctoral level.

The third contributor to the conceptual framework is the organizational impact model (Berger & Milem, 2000) and this model has been used to examine the impact of the institutional environment on students’ behavior and experiences. The model encompasses studies of organizational behavior of individuals and groups, culture, and climate. Existing literature has mainly focused on issues of organizational behavior at the undergraduate level (Berger & Milem, 1999, 2000; Bolman & Deal, 2008; Chory & Offstein, 2017; Thomas, 2018; Trolian, 2019) and institutional characteristics (Kuh, Kinzie, Whitt, Schuh, & Associates, 2005; Pascarella & Terenzini, 2005; Titus, 2004); yet, researchers have largely ignored the impact of organizational climate on doctoral students’ experiences and outcomes. Organizational climate is a function of “a primary emphasis on common views among organizational members, a focus on current patterns of perceptions and behaviors by organizational members, and the malleable, transitory nature of an organization’s climate” (Berger & Milem, 2000, p. 275). In this study, I built a model that used program climate and gender, race/ethnicity, and citizenship as predictors to examine the respective effects on time-to-degree.

Unlike undergraduate students’ experiences, the professional and social experiences of doctoral students are highly centralized within their academic discipline or their department (Bowen & Rudenstine, 1992; Golde, 2005; Nerad & Miller, 1997; Tinto, 1993). As a result, it is critical to understand how disciplinary context and culture shape doctoral students’ time-to-degree (Gardner, 2010b). Existing literature examining this aspect of doctoral education has largely been exploratory. For example, Golde (2005) interviewed 58 students who left a doctoral program in history, geology, biology, and English at a mid-western university and found that one
of the reasons that hindered students in their degree completion was incompatible faculty-student relationships, especially within science departments. Golde (2005) remarked that the interactions between advisors and advisees were lacking in quality, further leading to a lack of intellectual support for doctoral students. In addition, students dropped out as a result of structural isolation. Within the history doctoral program, Asian and African American students were disproportionally represented in the sample and these students lacked the opportunity to find an “intellectual and social community available to them” (Golde, 2005, p. 693). Another study conducted by Gardner (2010b) confirmed Golde’s (2005) findings. After interviewing 60 doctoral students from six disciplines at an institution, Gardner (2010b) found that engineering and mathematics departments had the lowest completion rates. The highest percentages of students within these disciplines were international students who often encountered issues related to social integration, language acquisition, and developing relationships with peers. The nature of qualitative studies limited the ability of researchers to investigate doctoral students from various disciplines at multiple institutions. This study examined the effect of disciplinary structure on doctoral time-to-degree at different institutions.

This study involves an investigation of the relationships among different levels (individual, program, and institutional) of variables that contributed to doctoral time-to-degree. The conceptual framework shown in Figure 1 represents the interrelationships among an array of variables that may predict faster time-to-degree. The rationale for choosing these variables is explained in the literature review in Chapter 2.
Figure 1. Conceptual framework.
There are three core sets of factors that may contribute to doctoral student time-to-degree: student traits, department context, and institutional affiliation. The first component of the conceptual framework is student traits, which is comprised of doctoral student demographic factors and academic and financial backgrounds, including gender, race/ethnicity, citizenship, disability status, marital status, number of dependents at different ages, parental educational background, amount of tuition remission, and sources of financial support. The second factor is a collection of departmental or program characteristics that may be associated with time-to-degree, including field of study, academic ranking of the program, research activity ranking, diversity ranking, and median program GRE. The last factor is the institutional characteristics, including female proportion, underrepresented minority proportion, institution type, Carnegie Classification, degree of urbanization, and minority-serving institution indicator. In addition, the model also investigated the interaction effects on gender (gender and female proportion at the institutional level, gender and underrepresented minority proportion at the institutional level, gender and institution type, gender and institution Carnegie Classification, gender and degree of urbanization, gender and minority-serving institution indicator). The main objective of the conceptual framework was to provide a guide that assisted in examining the relationships among a set of variables that may independently or collectively impact doctoral time-to-degree. Including all key variables in the same model allowed for a thorough investigation of the single level and multilevel relationships and acknowledged the relationships variables may exert on one another.

**Research Questions**

The purpose of this study was to understand how the critical facets of doctoral student backgrounds, department characteristics, and institutional components predict doctoral time-to-
degree and whether those effects are moderated by student gender. Multilevel modeling was used to estimate both the main and interaction effects associated with the study’s research questions. Those research questions are:

1. To what extent do student traits of gender, race, ethnicity, or citizenship, disability status, marital status, number of dependents, parents’ educational backgrounds, amount of tuition remission and types of financial support received predict doctoral time-to-degree?

2. Once controlling for student traits, to what extent does departmental context of field of study, program ranking, research activity ranking, diversity ranking, and median program GRE predict doctoral time-to-degree?

3. Once controlling for student traits and departmental context, to what extent do institutional characteristics of type, Carnegie Classification, degree of urbanization, and minority-serving institution indicator predict doctoral time-to-degree?

4. To what extent do the relationships between institutional context and doctoral time-to-degree vary by gender?

**Significance of the Study**

Due to a limited availability of quantitative data addressing time-to-degree in doctoral education at the state or national level, little is known about what factors are associated with doctoral time-to-degree. The use of a nationally representative sample is important because the data set consists of a larger sample size, which allows researchers and professionals to generalize findings and to answer the question about whether doctorate recipients have the same time-to-degree after controlling for student traits and program context. The findings from this study
contribute to doctoral education in practice, research, and policy. The knowledge provides graduate deans and higher education administrators with data on several potential differences between doctoral students who take longer or less time to obtain a degree. Further, the results provide evidence of whether student traits such as gender, race/ethnicity, citizenship, and more, predict doctoral time-to-degree, which allow us to further understand the needs of subpopulations and to develop programs that meet their needs. Additionally, the study highlights the role financial support plays for time-to-degree. Graduate program directors and faculty members may be able to use the results to change policies and practices related to scholarships, fellowships, and assistantships. Institutional planning officers and enrollment management officers at graduate schools may use the results to review institutional policies concerning doctoral student retention and doctoral program outcomes. This study also examined differences on time-to-degree that exist between students of different subpopulations. Practitioners may use the evidence derived from this study to develop policies that facilitate doctoral student integration. Those efforts may include academic support, program involvement, financial support, and mentorship, among other options.

This large-scale study also benefits researchers and scholars. I provide a model that accounts for student, program, and institutional characteristics. More specifically, the analytic approach examined if the strength of the relationships between lower-level variables (e.g., gender and outcome time-to-degree) would change as a function of higher-level variables (e.g., types of institution). The models examined multiple predictors simultaneously, which then allowed me to look at the relative relationships between predictors and time-to-degree. Future researchers could expand the model and add additional variables as data is collected.
Studies using singular theories could compartmentalize our understandings on certain phenomenon. For instance, to date, most of the existing literature on doctoral student success has heavily relied on Tinto’s (1993) theory of doctoral persistence, which discussed three stages (transition, candidacy, and doctoral completion) of graduate student persistence. However, critiques on the framework suggested that Tinto overlooked the importance of racial backgrounds on doctoral students’ experiences (Kuh & Love, 2000; Tierney, 1999). Furthermore, as St. John, Cabrera, Nora, and Asker (2000) suggested, higher education scholars have largely ignored the impact of economic aspects on students’ experiences and have mainly focused on students’ social and academic experiences. In addition, Guiffrida (2006) pointed out the importance of maintaining the cultural and familial connections to thrive in colleges and universities, which was missing in Tinto’s (1993) theory. On the other hand, studies that used only an economic lens to examine effects of financial support on completion or time-to-degree often overlooked the personal and academic measures. To account for these concerns, this study sought to integrate cultural capital theory with the human capital theory framework drawn from the field of microeconomics to examine the effects of financial and non-financial factors on doctoral student time-to-degree. The use of multidisciplinary theoretical frameworks allowed me to examine the issue from different perspectives and extend our knowledge on factors contributing to time-to-degree for doctoral students.

**Organization of the Study**

This dissertation is organized into five chapters. Chapter 1 provided a broad introduction to the study and addresses the need to further examine student and institutional level factors that affect doctoral time-to-degree. This chapter also introduced the research questions and significance of the study. Chapter 2 examines the literature on doctoral education in a more
thorough manner, paying particular attention to studies that have focused on factors affecting doctoral time-to-degree and degree completion. A wide variety of literature is examined and critiqued to provide a comprehensive rationale for this further examination of time to doctoral degree.

Chapter 3 outlines the methodology being used to conduct this research. Specifically, I provide explanations relating to the data source and how the dependent variable and independent variables are measured. Further, I discuss the different models being used in multilevel modeling. This chapter also discusses how missing data is handled.

Chapter 4 discusses results from different models, including the two-level fixed model, two-level model with gender as a random slope, and the three-level model. Specifically, I look at variables that significantly impacted doctoral time-to-degree and make meanings of them. I also answer all research questions raised in Chapter 1.

Lastly, Chapter 5 examines the results beyond statistics in Chapter 4. From theoretical, research, and practice perspectives, I make meanings of the data to further explain the theoretical framework used in this study, bridge gaps existing in current literature and inform the decision-making process related to doctoral education. I also discuss the limitations of the study and implications for future research in this area.
CHAPTER TWO: LITERATURE REVIEW

The goal of this study was to explore the extent to which doctoral students’ personal characteristics and academic backgrounds, as well as institutional and program contexts, affect their time-to-degree. While the sole focus of this study was on doctoral time-to-degree, the study was also informed by literature on doctoral persistence and completion. Studies on doctoral education have suggested that a number of factors contribute to student engagement and the time spent in earning a doctorate (Barnes, 2010; Groenvynck, Vandevelde, & Van Rossem, 2013; Herzig, 2002; Wollast et al., 2018). Due to methodological challenges, especially when estimating effects of various factors at the student level, departmental level, and institutional level, few studies have focused on creating a comprehensive quantitative model that accurately predicts time-to-degree. In the attempt to broaden the knowledge on doctoral education, this study employed a multilevel modeling technique to examine various factors associated with doctoral time-to-degree.

Beyond the work done on persistence, there exists limited research that specifically examines time-to-degree. Increased time-to-degree has been found to negatively affect degree completion (Bair & Haworth, 2004; Bowen & Rudenstine, 1992; de Valero, 2001; Levecque, Anseel, De Beuckelaer, Van der Heyden, & Gisle, 2017; Nerad & Cerny, 1993). According to one empirical study, programs with higher completion rates were those in which students were likely to complete at a faster rate (Humanity Indicators, 2012). Accordingly, the concepts of time-to-degree and completion are not mutually exclusive. Factors facilitating doctoral student completion are likely to be the same indicators that promote time-to-degree. Hence, literature on completion and persistence was used to inform this study on time-to-degree.
A meta-literature review investigated prevalent issues in doctoral education and the factors that contribute to doctoral student attrition and persistence (Bair & Haworth, 2004). A review of 118 qualitative and quantitative studies suggested that time-to-degree and doctoral degree completion are negatively correlated. That is, the longer someone remains in the program, the less likely it is that he or she will successfully obtain a doctorate degree. Therefore, even though the primary focus of the study was on time-to-degree, it was also crucial to review existing literature on degree completion. As a result, the purpose of this chapter is to present the most salient literature available on doctoral time-to-degree and degree completion. In areas that lack a breadth of empirical studies, the best available knowledge is presented. The literature review begins with an introduction of the conceptual framework that guided the proposed study and ends with an examination of the factors associated with doctoral students’ progress toward degree completion.

**Conceptual Framework**

Berger (2000) suggested that researchers should consider integrating multiple theories and models into a coherent framework. In this sense, each theory or model utilized should be viewed as one of the specific dimensions that contributes to the overall understanding of the issue. To analyze the factors associated with time-to-degree, three theories—cultural capital theory, human capital theory, and the organizational impact model—help set the underlying conceptual framework in the research design. The models complement one another and provide context for understanding different factors associated with doctoral time-to-degree. Derived from traditional critical theory, a theory that situates the issue in social, historical, and cultural contexts, Bourdieu’s (1977) cultural capital theory aims to challenge authority by situating issues within historical and cultural contexts (Lindlof & Taylor, 2002). Bourdieu’s (1977) theory helps
explain what the data regarding doctoral time-to-degree reveals, especially the inequities amongst different subpopulations.

Meanwhile, an increasing number of scholars have started using economic perspectives, more specifically, human capital theory, to examine time-to-degree and degree completion (Bartholomae et al., 2019; Becker, 1962, 1980; Chen, 2008). Additionally, the organizational impact model (Berger & Milem, 2000) focuses on organizational characteristics and peer group characteristics and posits that external environments also shape student outcomes. In this study, organizational characteristics were measured by institution size, type, minority-serving institution indicator, and degree of urbanization; peer group characteristics were measured by racial/ethnic, gender, and citizenship representation of a program. The conceptual framework for this study is based on a combination of the three models. The sections below describe the three models developed by Bourdieu (1977), Becker (1994), and Berger and Milem (2000).

**Bourdieu’s cultural capital theory.** Cultural capital theory (Bourdieu, 1977) has been used to study social issues in education, language, and science. The theory has been widely applied in sociological studies exploring how social background affects students’ educational achievement and occupational levels. Cultural capital refers to the knowledge, skills, and attitudes valued by society and is represented by different forms of cultural knowledge people possess. In other words, some people are likely to have more cultural capital as a result of their SES than others. Cultural capital theory suggests that the educational system in its entirety is a product of the middle and upper class and only serves people from the middle and upper classes, because the system has been designed to uphold the values, behavior, and language of individuals of affluent family backgrounds. Accordingly, students from higher SES backgrounds are more likely to succeed in the educational system when their family has taught them how to
understand the language being used to navigate the system. Conversely, students from lower SES backgrounds are more likely to struggle in the educational system because they have not been prepared to understand the system and their families are not a part of the culture of high SES. Bourdieu (1977) pointed out that these inequities existed before and after students enter the educational system and are fundamental to social stratification.

Different classes and class fractions are engaged in a specifically symbolic struggle to impose the definition of the social world most in conformity with their interests. The field of ideological positions reproduces in transfigured form the field of social positions. They may carry on this struggle either directly in the symbolic conflicts of everyday life or indirectly through the struggle waged by the specialists in symbolic production (full-time producers), in which the object at stake is the monopoly of legitimate symbolic violence – that is to say, the power to impose (and even indeed to inculcate) instruments of knowledge and expression of social reality (taxonomies), which are arbitrary (but unrecognized as such). (Bourdieu, 1977, p. 115)

In addition to cultural capital, habitus and field collectively work together to influence practices. Bourdieu (1977) described habitus as a “durably installed principle of regulated improvisations … which produces practices which tend to reproduce the regularities immanent in the objective conditions of the production of their generative principle” (p. 78). That is, individuals’ attitudes, behaviors, expectations, and aspirations are heavily influenced by other members of the same social group. Since perspectives of members from different social groups are largely different, people from different social classes have distinct habitus. The notion of habitus can explain how individuals internalize the objective of their chances at success by observing other people’s lives in their groups.
A doctorate degree is a terminal degree, thereby granting it esteemed status as valuable cultural and social capital. Women, racial minorities, and first-generation students, given Bourdieu’s idea on cultural reproduction, continue to be underrepresented in certain, if not all, academic disciplines. His theory says that social reproduction of education reinforces inequity, rather than overcomes it, because the educational system only serves the interests of dominant classes. Added to the issue is the expectation that graduate students acquire certain affective skills and attitudes to successfully navigate in their respective programs. Habitus, displayed by ways of knowing, SES background, and beliefs, affects whether doctoral students possess certain capital prior to their admission into doctoral programs. As a result, women, racial minorities, and first-generation students may not be prepared or equipped with certain cultural capital that will increase the likelihood of their success as measured by time to degree and completion rates. One of the main goals of this study was to examine if time-to-degree differs on the subpopulations mentioned previously as a result of the lack of certain cultural capital.

Cultural capital theory has been used to guide studies on how the American education system may reinforce rather than aid in overcoming social inequities (Aschaffenburg & Mass, 1997; Dumais, 2002; Gustafsson, Nilsen, & Hansen, 2018; Roscigno & Ainsworth-Darnell, 1999; Scherer & Siddiq, 2019; Sullivan, 2001; Tramonte & Williams, 2010). Using data from the Surveys of Public Participation in the Arts from 1982, 1985, and 1992, Aschaffenburg and Mass (1997) investigated the impact of cultural capital on student academic achievement, concluding that cultural capital played a significant role in predicting school success. Additionally, they found a significant interaction between parental cultural capital and their children attending college. Students whose parents had a college education were more likely to attend college than those whose parents did not receive a college education. Aschaffenburg and
Mass (1997) concluded that their study confirmed Bourdieu’s cultural capital theory that cultural capital from both parents and students affects educational attainment. While this study is one of the first of few studies that have examined how parents’ cultural capital could affect children’s educational achievement in the United States, the limitation of the data set prevented the researchers from further investigating the extent to which parental educational achievement facilitated children’s college graduation or graduate school choices.

Another study conducted by Roscigno and Ainsworth-Darnell (1999) examined the relationship between racial inequity in educational achievement and family background. Drawing data from the National Education Longitudinal Survey, the researchers found that parental educational background and family SES were significant predictors of their children’s educational achievement. The authors further concluded that family SES background varied significantly by racial/ethnic groups and the gap that existed in educational attainment was a function of the differences in cultural capital and family educational resources (Roscigno & Ainsworth-Darnell, 1999).

Research conducted in European countries also suggested similar results. Guided by Bourdieu’s (1977) cultural capital theory, Sullivan (2001) investigated how the distribution of cultural capital among different social classes affects children’s educational achievement. After surveying 557 pupils in year 11 (16 years old) at four schools, Sullivan (2001) found that parents’ social class and educational background were strongly associated with their cultural capital. Parents’ cultural capital was found to be the most significant factor associated with pupils’ cultural activities. The findings supported Bourdieu’s (1977) theory that cultural capital could be transmitted from parents to students.
Another study guided by Bourdieu’s (1977) theory confirmed that cultural capital significantly correlates with school performance and college choice (Kosutic, 2017). After analyzing data from 534 high school seniors in Croatia, the scholar confirmed that the material dimension of cultural capital was significantly associated with school achievement. Additionally, the analysis confirmed that students who embodied more material cultural capital were more likely to enroll in universities. The study validated Bourdieu’s theory that students from privileged social backgrounds were more likely to perform better academically and tended to have higher education aspirations.

A more recent study also confirmed the significance of cultural capital measured by SES on student performance (Scherer & Siddiq, 2019). The researchers conducted a meta-analysis to examine the relationship between students’ SES and their performance on information and communication technology (ICT) literacy. Using three-level random-effects modeling, they found a significant and positive correlation, indicating that students coming from more affluent families perform better in ICT tasks than their peers from lower socioeconomic families. While ICT literacy is relatively new in K-12 education, the significance of SES on ICT literacy testifies that inequities are prevalent in education due to the variation in cultural capital.

While existing literature supported Bourdieu’s (1977) theory that family SES and parental educational level are highly associated with students’ educational achievement, the research has been limited to high school and undergraduate levels. Scholars have not yet examined whether, and to what extent, parental educational level and family SES plays a role in students’ educational attainment at the doctoral level. More specifically, researchers who focus on doctoral student success are not yet certain if those factors are associated with doctoral time-to-degree. This current study used Bourdieu’s (1977) theory as one of the underlying theoretical
frameworks to examine whether differences exist on doctoral time-to-degree based on gender, race/ethnicity, and parental educational background (measured by data on first-generation student status).

**Human capital theory.** Despite its relevance to education, the use of human capital theory to investigate college student persistence and degree completion has been scarce (Chen, 2008). The majority of the research in the higher education realm using human capital theory has focused on using financial factors, such as financial aid, to explain students’ college-going behavior at both the undergraduate and graduate level (Caucutt & Kumar, 2003; Cordoba & Ripoll, 2012; Hansen & Weisbrod, 2003; Ionescu, 2009; Wegmann, Cunningham, & Merisotis, 2003). Drawn from the field of microeconomics, human capital refers to knowledge, talents, skills, and understandings possessed by an individual or society, typically acquired through training and education, that can be contributed to the workforce (Becker, 1994; Davenport, 1999; Paulsen, 2000). Becker (1994) argued:

> Schooling, a computer training course, expenditures on medical care, and lectures on the virtues of punctuality and honesty are capital too in the sense that they improve health, raise earnings, and add to a person’s appreciation of literature over much of his or her lifetime. (p. 15)

Becker (1994) suggested that education and workforce training are the most important means to create human capital. A college degree has a greater impact on earning than any other means (Becker & Murphy, 2007). Furthermore, Becker and Murphy found that the premium on a graduate degree increased from 50% in the 1980s to over 100% in the 2000s. Hence, human capital theory assumes that individuals perceive college attendance as an investment to increase
their stock of human capital. According to Becker (1994), students’ investment in human capital will lead to higher productivity upon graduation and will be rewarded by higher future earnings.

Most scholars have utilized human capital theory to study the effect of financial factors on retention and degree completion at the undergraduate level and they have used the theory to investigate the impact of financial components such as tuition, grants, loans, and work-study on college attendance and degree completion (Bartholomae et al., 2019; Becker, 1992; Chen & Desjardins, 2010; Dwyer, McCloud, & Hodson, 2012; Heller, 1999; Hilmer, 1998; Lips, 2011; Miller, 2018; Narayan, 2005; Paulsen & St. John, 2002; Shin & Milton, 2006; Simkovic, 2013). Most researchers have found that financial aid was positively related to student persistence and degree attainment. However, in recent years, an increasing number of scholars have suggested there is no statistically significant relationships between monetary aid and student degree attainment (Herzog, 2008; St. John, Paulsen, & Carter, 2005). By examining 5,000 freshmen at a public university using propensity score matching, Herzog (2008) argued that the effect of financial aid on first-year student persistence was a function of their need level and students’ academic experiences. In addition, student loans as a form of financial aid have been positively associated with attrition and reduction in course loads (Baker & Montalto, 2019; Dwyer et al., 2013). Other researchers have confirmed Herzog’s findings, suggesting that different patterns of educational choices existed within and across racial groups (Goldrick-Rab & Kelchen, 2015; St. John et al., 2005). African Americans were highly sensitive to financial aid in persistence; whereas their White counterparts, due to overall advantaged economic conditions, were less sensitive to financial aid. In addition, levels of parents’ education and students’ aspirations were also associated with persistence (St. John et al., 2005).
At the graduate level, research has contributed to understanding the effect of various types of financial support on doctoral degree completion (Ampaw & Jaeger, 2011; Ehrenberg & Mavros, 1995; Hoffer et al., 2006; Kim & Otts, 2010; Mendoza, Villarreal III, & Gunderson, 2014; Pollon, Herbert, Chahine, & Falenchuk, 2013; Siegfried & Stock, 2000). Hoffer et al. (2006) found that 71% of doctorate recipients relied on financial support, including teaching assistantships, research assistantships, and fellowships, to complete the degree. However, the effects of different types of financial support on doctoral student outcomes have been conflicting. Previous research suggested that students with research assistantships completed their programs faster than students with other types of support (Ampaw & Jaeger, 2011; Siegfried & Stock, 2000). On the other hand, students holding teaching assistantships and fellowships had a significant and positive effect on doctoral student retention (Mendoza et al., 2014). It is still unclear whether the effect of financial support on doctoral time-to-degree differs within and across racial groups. The current study analyzed data that assists in answering this question.

Despite its applicability to higher education, human capital theory has received some criticism. Benson (1978) stated, “human capital theory rests on two basic assumptions: Education helps develop skills of work, that is, improves the capacity of the worker to be productive; and earned income reflects marginal productivities of different categories of workers” (p. 101). Benson (1978) suggested that the value of education as a means to enhance productivity and life quality is likely to “depend upon the production mix—what is produced and the capital provided for that production” (p. 72). He further argued:

Outside a few professional fields, there is little association between educational attainment and the ability to perform in a given line of work. The salary and wage
differentials reflect, not differences in performance, but the simple regard that employers hold for educational attainments per se. (Benson, 1978, p. 94)

As a result, students’ time-to-degree in a doctoral program may not only be influenced by economic factors, but also by their decisions on how to improve their productive capacities. To account for these limitations, my model not only includes financial factors that may impact time-to-degree, but also analyzes a series of student traits, as well as department and institutional characteristics informed by doctoral persistence theory and the organizational impact model, to predict time-to-degree.

Another study determined that students do not face the same amount of costs attending college (Goldrick-Rab, Harris, & Trostel, 2009). Students from higher socioeconomic families are likely to face lower costs, as their parents may provide them with monetary and non-monetary means to attend college. Furthermore, the human capital perspective has failed to consider that education costs are different for students of different backgrounds. Students from lower socioeconomic backgrounds tend to be less prepared academically than their counterparts from higher socioeconomic families (Adelman, 2006; Walpole, 2007). Research has suggested that the level of academic preparedness among students of different family backgrounds can explain some of the variations in student outcomes, especially how preparedness may impact degree completion for racial/ethnic minority students and low-income students (Adelman, 2006). To account for the issue, this study included parental educational background, in addition to financial support, as one of the predictors. This study examined how different predictors may impact doctoral time-to-degree after controlling for race/ethnicity, gender, and parental educational background.
Regardless of its limitations, human capital theory has its merits. It is a relatively new approach to use this theory to serve as an overarching framework investigating how different factors interact collectively, and act individually, to impact doctoral time-to-degree. Although researchers have started using economic lenses to examine student persistence at the undergraduate level, research that applies this theory at the doctoral level has been slow to emerge. Additionally, human capital theory perceives education as an investment in which students evaluate future monetary and non-monetary returns acquired from a PhD degree against the costs associated with enrolling in a doctoral program. In this sense, the time students invest in completing a doctoral program in the hope of enhancing their own productivity and human capital are also influenced by economic factors, among other factors. The study provides a model that can explain students’ decision on time-to-degree from an economic lens.

**Organizational impact model.** Berger and Milem’s (2000) model has been used to examine the impact of an institution’s peer group characteristics and student experience on undergraduate student outcomes (Chory & Offstein, 2016; Reason, 2009; Terezini & Reason, 2005; Thomas, 2018; Trolian, 2019; Williams, Berger, & McClendon, 2005). The model posits that student background and institutional characteristics collectively influence an institution’s peer group characteristics and student experiences. In turn, institutional characteristics and student traits shape student outcomes (Berger & Milem, 2000). Building on organizational behavior theory (Bolman & Deal, 2008), Berger and Milem (2000) distinguished two categories within the construct of organizational characteristics: (a) structural demographic features; and (b) organizational behavior. The structural demographic features include size, selectivity, control (public versus private), and location; the organizational behavior features include the norms and shared culture of organizational personnel and systems.
Structural demographic features are critical in shaping the student college-going process including choice, admission, and enrollment (Berger & Milem, 2000). For instance, Berger and Milem (2000) posited that institutional selectivity positively influenced academic achievement and degree completion. In addition, they found that size was an important factor impacting retention and degree completion, arguing that students at larger institutions might not be fully involved in activities that provide support for disadvantaged students. However, it can also be argued that larger institutions may have more resources to support student academic and social integration, which would further promote time-to-degree and degree completion. Thus, additional exploration is needed to investigate the effect of institution size and type on time-to-degree, especially at the doctoral level.

Drawn from organizational theory, organizational behavior can take on one or more of the five dimensions, including bureaucratic, political, collegial, symbolic, and systemic (Birnbaum, 1988; Bolman & Deal, 2008). These dimensions, Berger and Milem (2000) argued, shaped peer group characteristics and student experiences. Peer group characteristics include psychological, behavioral, and structural characteristics of students at an institution. Berger and Milem (2000) hypothesized that students’ experiences in, and perceptions of, the institutional environment, as demonstrated by their behaviors in academic, social, and functional realms, collectively impact student outcomes.

Largely focused on undergraduate education, the organizational impact model has been used to examine the effect of institutional characteristics such as selectivity, size, and control on student persistence and degree completion (Astin, 1993; Pascarella & Terenzini, 2005). As a part of structural demographic characteristics, selectivity was often used as an indicator of educational quality in single level and multilevel analyses. Using the Beginning Postsecondary
Students Survey, Perna (1998) found a positive relationship between institutional selectivity and degree attainment. Control (private versus public) has also been found to positively affect student persistence and degree completion (Astin & Oseguera, 2005; Oseguera, 2005; Titus, 2006). Pike and Graunke (2015) used panel data to examine the effects of institutional characteristics on one-year retention and confirmed that the size of an institution measured by total student enrollment had a significant and positive effect on retention, while the proportion of part-time students negatively impacted retention rates.

Berger and Milem’s (2000) model of peer group characteristics has been rarely used to examine time-to-degree. Titus (2004) used an aggregate variable to measure institutional commitment, which derived from individual students’ measures. He found that aggregate institutional commitment positively affected four-year retention rates. Another study conducted by Oseguera and Rhee (2009) used multilevel modeling to examine retention climate. They included an aggregated variable measuring student academic preparation and found that academic preparation had a positive impact on six-year retention rates. Pike and Graunke (2015) created fixed and random effect models to examine retention and confirmed that the proportion of students receiving federal grants negatively correlated with retention, while the proportion of underrepresented minority students had no effects on retention rates.

This study aggregated the gender, race/ethnicity, and citizenship variables at the student level and formed three new variables measuring peer group demography at the program level. The reason to aggregate the three student-level variables is to capture demographic numbers at the program level. Further, the aggregate variables provided more power at level one in the hierarchical analysis, as certain programs may only have a small number of graduates in any
given year. This study sought to examine the impact of organizational factors, particularly program demography, discipline, and rankings on doctoral students’ time-to-degree.

While all of the existing literature using an organizational impact model has focused on persistence and degree completion at the undergraduate level, it can be argued that graduate students would follow a similar pattern. As with undergraduate students, the academic and social environment doctoral students are exposed to (beyond other personal background factors) greatly shape their academic experiences and outcomes. However, unlike undergraduate students’ experiences, academic and social integration for doctoral students is largely experienced within their department and discipline (Tinto, 1993). As Tinto (1993) suggested, “Graduate persistence is, at one and the same time, both more local and more national in character than is undergraduate persistence” (p. 234). Since disciplines all have their own norms, cultures, values, and code of conduct (Austin, 2002), rather than focusing this matter at the institutional level, it is critical to look at doctoral time-to-degree at the departmental or disciplinary level. Unfortunately, only a handful of systematic studies have been conducted investigating the implications of the impact of factors beyond the individual level on doctoral time-to-degree (Bowen & Rudenstine, 1992; Golde, 2005; Nerad & Miller, 1996; Slay, Reyes, & Posselt, 2019). As a result, this study investigated the program context (level two) and institutional characteristics (level three) using the organizational impact lens. The model also employed aggregated variables (e.g., gender, race/ethnicity), as well as academic discipline and ranking to examine the effect of program climate on doctoral time-to-degree.

Considering the limitations of human capital theory, such that one cannot measure certain factors, including the impact of culture, gender, identity, history and other latent factors (Davis, 2003; Fine, 2002; Folbre, 1994) on doctoral student time-to-degree, I combined Bourdieu’s
(1977) cultural capital theory and the organizational impact model in conjunction with the human capital theory. The three models are used collectively as an overarching framework of this study. With a framework that considers both financial and non-financial factors that impact time-to-degree, I built a model that can explain to what extent individual characteristics, program context, and institutional traits may inhibit or promote faster degree completion.

The next section of this literature review focuses on empirical findings on doctoral education and doctoral retention beginning with an overview of the national trends in doctoral education followed by student and program characteristics that can be attributed to degree completion and time-to-degree.

**National Trends in Doctoral Education**

At the national level, doctoral student retention and attrition rates are quite concerning. The seven-year completion rate for students in engineering was 48% while the attrition rate was 36% (Sowell et al., 2015). In life sciences, the seven-year completion rate was 52% and the attrition rate was 31% (Sowell et al., 2015). In physical and mathematical sciences, the seven-year completion and attrition rate were 39% and 47%, respectively. Lastly, for social and behavioral sciences students, the seven-year completion and attrition rates were 38% and 33%, respectively (Sowell et al., 2015). These completion and attrition rates also varied significantly by gender, race/ethnicity, citizenship.

At the same time, internationalization in higher education has resulted in a new level of competition in recruiting talented students globally. For many years, the United States has been the top choice for the world’s best students, especially for those who wanted to pursue advanced degrees beyond the undergraduate level. International doctoral students account for 24% of the total graduate population (Marginson & van der Wende, 2007). Over 380,000 international
students were enrolled in graduate programs in United States’ institutions in 2015-2016 (Institute of International Education, 2016); yet, higher education around the world has changed substantially in the past 20 years, which will likely impact the number of foreign graduate students in the United States in the future. One of these changes in international higher education is the increase of access to higher education institutions in many countries. European countries have established consistent standards to attract international students by offering affordable tuition and fees, as well as working opportunities before and after students graduate from European institutions (Becker & Kolster, 2012). In addition, countries such as China and India that have historically sent large numbers of students to United States’ graduate schools have been focused on improving their domestic graduate programs as a way to expedite economic development. Institutions within the United States have also established satellite campuses in China and the Middle East to attract students to study locally. Accordingly, the number of international graduate students in the United States is shrinking. Although the application rate to United States’ graduate programs increased by 4% between 2010 and 2011, first-time enrollment decreased by almost 2% during that same period (Council of Graduate Schools, 2012). This increase in international competition intensifies the need for addressing the vulnerabilities in the United States system of graduate education.

The next section of this literature review focuses on how institutional factors, as well as students’ backgrounds, both personal and academic, contribute to doctorate attainment and time-to-degree.

**Institutional factors.** The effect of institutional factors on degree completion has been well researched (Astin, 1984; Bean & Metzer, 1987; Billson & Brooks-Terry, 1987; Golde, 1998; Hoffer & Welch, 2006; Kerlin, 1997; Leatherman, 2000; Lovitts, 2001; Okahana, Klein,
Allum, & Sowell, 2018; Okahana & Zhou, 2017; Pascarella, 1989; Pascarella & Terenzini, 1979; Spady, 1971; Tinto, 1993; Tuckman et al., 1990). In 2017, approximately 75% of the doctoral degrees were awarded through institutions with the highest research activity and approximately 16% of the doctoral degrees were awarded through universities with higher research activity (NSF, 2018). Only 9% of the degrees were from other types of colleges and universities collectively, as defined by Carnegie Classification (NSF, 2018). Institutional type may be one factor that impedes doctoral completion since the learning environment at research universities tends to be highly competitive (Lovitts, 2001). Often, the competitive learning environment deters doctoral students from seeking moral support with fellow doctoral students within the department. This environment may also prevent students from voicing their needs and discontent (Gardner, 2010b; Golde, 1998; 2000; Lovitts, 2001).

In addition to affecting degree completion, research suggests that time-to-degree is associated with institutional type (Hoffer & Welch, 2006). The aggregated time-to-degree was lowest at institutions with very high research activity. In 2003, the median time lapse between bachelor’s degree and doctorate was 9.9 years at doctoral-extensive universities in comparison to 13.7 years at doctoral-intensive universities and 11.7 years at other types of institutions (Hoffer & Welch, 2006). Further, the median age of doctorate recipients varied greatly at different types of institutions: 32.8 years at doctoral-extensive institutions, 38.8 years at doctoral-intensive institutions, and 35.6 years at other types of institutions (Hoffer & Welch, 2006). Significant differences also existed between disciplines at research universities (NSF, 2017a). For instance, 82% of the doctorate recipients in engineering received their degree from universities with the highest research activities, in comparison to 15% at universities with higher research activities and 2% at universities with moderate research activities. However, with their counterparts in
education, 59% of the doctorate degrees were awarded by universities with the highest research activities, 30% and 8% were from universities with higher and moderate research activities, respectively (NSF, 2017a).

**Disciplinary context.** Research on doctoral education suggests that the academic department has a more significant influence on doctoral students than the institution as a whole (Bowen & Rudenstine, 1992; Johnson et al., 2017; Nerad & Miller, 1996). Unlike undergraduate students who are more likely to be influenced by institutional climate, doctoral students are more apt to be affected by their academic departments since admissions policies, financial support, requirements for completion, faculty-student relationships, and curriculum design are established and overseen by each department or program (Cockrell & Shelley, 2011; Golde, 2005; Greene, 2015; Joy, Liang, Bilimoria, & Perry, 2015; Lovitts, 2001; Tinto, 2003; Zhou & Okahana, 2019). Becher (1981) described academic disciplines as fields that “embodied in collections of like-minded people, each with their own codes of conduct, sets of values, and distinctive intellectual tasks” (p. 109). As Lovitts (2001) pointed out, the departments differ in culture, socialization process, academic rigor, and degree expectations; such differences are likely to significantly impact the experiences of the faculty, staff, and students. Studies focusing on the impact of disciplinary context on doctoral student completion have largely focused on one discipline at one institution (Cohen, 2011; Gardner, 2010a; Green & Kim, 2005; Kim et al., 2018; Liechty, Liao, & Schull, 2009; Malone, Nelson, & Nelson, 2004; Potvin & Tai, 2012; Richards, McLoughlin, Ivy, & Gaudreault, 2017). Moreover, most of the research has focused on the demographic characteristics of students who completed, or who have dropped out from, their program (Ampaw & Jaeger, 2011; Gardner, 2010b; Grove & Wu, 2007; Most, 2008).
Grove and Wu (2007) tested whether individual-level characteristics, including GRE scores, the identity of reference letter writers, and the quality of baccalaureate institutions predicted PhD completion in economics. Probit analysis was used to estimate what *ex ante* information contained in application files predicted degree completion. The researchers found that the probability of obtaining a doctorate in economics increased by 24% if an applicant had a prominent reference letter writer; 15% if an active researcher wrote a letter; 8% for every 50-point increase in one’s GRE quantitative score; and 3% for every 50-point increase in one’s GRE verbal score (Grove & Wu, 2007). They further concluded that the quality of baccalaureate institution did not affect doctoral completion. Grove and Wu’s (2007) model is far from comprehensive in predicting PhD completion in economics; the model does not address other critical factors at either individual level (e.g., types of assistantships, parental educational attainment, etc.) or program level (e.g., academic discipline, quality of PhD program, program climate, etc.) that may impact time-to-degree and degree completion.

Another study conducted by Potvin and Tai (2012) examined doctoral time-to-degree in physical sciences. They used multiple regression methods to analyze survey results from 3,220 respondents between 2005 and 2006. The authors found that the following factors all negatively impacted doctoral time-to-degree: years of required coursework, number of courses taught during graduate school, age, number of comprehensive exams taken, dissertation topic change, advisor change, and master’s degree awarded upon leaving another program. Potvin and Tai’s (2012) model is one of the most comprehensive models that captured the effect of different factors on time-to-degree; however, the model was only able to explain 19.9% (adjusted R²) of the variance that affected time-to-degree and it only focused on physical sciences. The study includes predictors at program and institutional levels that affect time-to-degree.
Scholars Zhou and Okahana (2019) investigated the effect of department support on doctoral completion and time-to-degree among 5001 doctoral programs at 212 universities. Using multiple regression, the researchers concluded that department financial support significantly affected doctoral time-to-degree: departments with more students on teaching assistantships and fellowships were more likely to have longer time-to-degree (Zhou & Okahana, 2019). One limitation of the study was its lack of controlling of observed factors associated with progression.

Studies that focused on doctoral completion in multiple disciplines have largely been exploratory (Gardner, 2009; 2010b; 2011; Golde, 2005; Le & Gardner, 2010; Szelényi, 2013); only a few have used quantitative approaches to investigate the issue (Ampaw & Jaeger, 2011; Ehrenberg, 1995; Kim & Otts, 2010; Zhou & Okahana, 2019). Researchers conducted a study to examine factors affecting doctoral students’ satisfaction with their advisors and found that advising behaviors differed greatly among different fields of study (Zhao, Golde, & McCormick, 2007). Another study conducted by Gardner (2010) contrasting the socialization experiences in high and low completing departments suggested that disciplinary contexts greatly influenced students’ experiences. In the institution Gardner (2010) studied, departmental climates and cultures, in particular, “factored into higher and lower completion rates at this institution” (p. 74). As a result, degree completion rates varied greatly among different academic disciplines.

Students in STEM disciplines generally complete at a higher rate and with a shorter time-to-degree than their counterparts in social sciences and humanities (Bair & Haworth, 2005; Bowen & Rudenstine, 1992; Council of Graduate Schools, 2007; Nettles & Millett, 2006; NSF, 2011). Existing literature has mainly focused on student-level characteristics and students’ perception of the department’s climate. More research is needed to examine this matter beyond
the individual level. This study investigated the effects not only of student characteristics, but also of program climate by using aggregate variables such as gender, race/ethnicity, and citizenship at the disciplinary level on time-to-degree.

**Students’ Background Characteristics**

In addition to institutional context and disciplinary factors, research demonstrates that a collection of factors in students’ personal and academic backgrounds are also associated with doctoral degree completion and time-to-degree. This section focuses on how students’ citizenship, gender, race/ethnicity, marital status, disability status, educational attainment of parents, and academic preparation contribute to doctoral persistence.

**Citizenship.** In the 2016–2017 academic year, 123,500 international students were enrolled in doctoral programs in higher education institutions in the United States (Institute of International Education, 2018). International doctoral students’ graduation rates have been substantially higher than those of American students in every academic discipline with an overall, cumulative, 10-year doctoral completion rate of 67% versus 54% for American students (Council of Graduate Schools, 2008). Additionally, international students from science, technology, engineering, and mathematics fields generally have higher completion rates than their peers in social sciences and humanities. In engineering, the cumulative 10-year PhD completion rate was 70% for international students in comparison to 58% for their American counterparts; in life sciences, 66% (international) versus 58% (domestic); in math and physical science, 68% (international) versus 51% (domestic; Council of Graduate Schools, 2008). It is worth noting, however, that after year seven, the proportion of 10-year graduation rate for domestic students (24%) was significantly higher than international students (12%; Council of Graduate Schools, 2008).
Existing literature on international students has been mainly focused on their adjustment to the United States higher education system (Petress, 1995; Tseng & Newton, 2002). Only a few articles about international students speak about the population at the graduate level and have focused on international students’ social interactions with their American peers (Chapdelaine & Alexitch, 2004; Le & Gardner, 2010; Trice, 2004). Within the limited studies on international doctoral students, most have shown a distinct connection between citizenship and time-to-degree, indicating that international students complete doctoral degrees at a faster pace than American students (Bowen & Rudenstine, 1992; Henderson, Clark, & Woods, 1998; Zwick & Braun, 1988). However, Gardner (2009) found that the engineering program in her study tended to have a high percentage of international faculty and doctoral students and language barriers and pressure to secure funding to stay in the country often obstructed foreign doctoral students from completing their degrees. International students also experienced transitioning issues such as problems with social integration and ambiguity in understanding expectations (Gardner, 2010a). It is also unclear what factors motivate international doctoral students to complete in shorter periods of time than students from the United States, despite the disadvantages mentioned. The discrepancies of research findings on completion rates of international students warrant further investigation of how different factors at the individual and institutional levels may affect international students’ time to doctoral degree.

**Race/ethnicity.** Efforts to increase enrollments among underrepresented racial minority (URM) populations can be seen throughout education levels (NCES, 2016). However, the lack of representation of minority doctoral students and faculty persists across all academic disciplines (Ellis, 2001; Gandara & Contreras, 2009; Solorzano, Rivas, & Velez, 2005; Yosso, 2006). In 2015, African American and Latin American students accounted for 14.4% and 9.6%
of doctoral student enrollment, respectively (NCES, 2017). Yet only 8% of doctoral degrees were awarded to African American students and 7% to Latin American students in the same year. Additionally, seven-year completion rates for URM students remained low while seven-year attrition rates continued to increase. In engineering, 48% of URM students were able to graduate in seven years while only 38% of URM students in social and behavior sciences were able to graduate within that same timeframe (Okahana, Feaster, & Allum, 2016). For time-to-degree, Asian students took the shortest total time at 8.8 years and their Hispanic, American Indian, and African American counterparts took 10.3 years, 12.0 years, and 12.7 years, respectively, to obtain their degrees (Hoffer et al., 2006).

In addition, URM students were found more likely to incur debt than White and Asian students (Rapoport, 1999). The Council of Graduate Schools (2006) reported that the percentage of borrowers increased substantially for URM students from 25% in 1995 to 43% in 2003; whereas, the percentage of borrowers among White doctoral students increased from 21% to 34% during the same period. A higher level of loans can be detrimental to degree completion and time-to-degree given that the source of financial support is the strongest predictor of time-to-degree (Abedi & Benkin, 1987). Research also suggested that students who rely on their own financial support are less likely to complete a degree (Bair & Haworth, 2004; Christie & Munro, 2003). It is still unclear, however, if different types of financial support play a role in time-to-degree of doctoral students of different races/ethnicities. As a result, this study analyzed data to answer the question: “How do financial support and debt level affect doctoral time-to-degree once race/ethnicity is controlled?”

Scholars have suggested that the racism inherent in the social practices of higher education impact and complicate African American and Hispanic students’ doctoral experiences
Researchers found that URM students experienced individual and institutional racism on a regular basis (Lewis et al., 2004). In addition, URM students often encountered racism, stereotyping, and assumptions while interacting with faculty members in their respective departments (Barker, 2014; 2016; Griffin et al., 2012; Kim-Prieto, Copeland, Hopson, Simmons, & Leibowitz, 2013; Posselt, 2018; Slay et al., 2019). Furthermore, minority students struggled with feelings of cultural isolation and tokenism, presented in forms such as being the lone person of color in a class, a lack of mentoring from faculty of the same racial/ethnic group, and being expected to represent their racial/ethnic groups (Fernandez, 2018; Gay, 2004; Gildersleeve, Croom, & Vasquez, 2011; Howard-Hamilton et al., 2009; Laursen & Weston, 2014; Levin, Jaeger, & Haley, 2013; Lewis et al., 2004; McNair, 2003; Sanchez-Hucles & Davis, 2010; Squire et al., 2018; Watt, 2003). Through survey research that examined the perceptions of minority doctoral students in special education programs, African American and Asian participants indicated less satisfaction with their experiences than their White and Latin American counterparts (Wasburn-Moses, 2007).

Furthermore, African American students reported feeling less prepared overall for their positions and less successful publishing research in refereed journals in comparison to their White and Latin American peers (Wasburn-Moses, 2007). Research shows that URM students obtain doctorate degrees at a disproportionately lower rate than their White counterparts, especially in science and engineering fields (NSF, 2009; Tull, Rutledge, Carter, & Warnick, 2012; Woodrow Wilson National Fellowship Foundation, 2005). However, the majority of the studies in this area have been qualitative inquiries that have focused on the experiences of minority graduate students.
(Griffin et al., 2012; Lewis et al., 2004; Nettles, 1990). More research based on a larger sample of diverse students is needed to investigate the intersection of academic backgrounds, debt level, and institutional factors on minority students’ time-to-degree.

**Gender.** The American Council on Education (2008) reported that the number of postsecondary degrees awarded increased between 1995 and 2005, with women accounting for 68% of the increase in master’s degrees and 84% of the increase in doctorates. While females earned 52% of doctorates in biological and agricultural sciences in 2012-2013 and 62% of doctorates in social and behavioral sciences, female representation in STEM fields was significantly lower in STEM fields with only 23% in engineering, 26% in mathematical sciences, and 35% in physical and earth sciences (Allum, 2014). Ott, Markewish, and Ochsner (1984) found 30 years ago that gender was not a significant predictor in graduate persistence except when interacting with the department and field of study. After examining 1,454 doctoral students at the University of Maryland using logistic regression, Ott et al. (1984) concluded that the predicted retention rates for male students in agricultural and life sciences (59.2% versus 43.9%) and mathematical, physical sciences and engineering (62% versus 31.5%) were significantly higher than for female students. Similarly, 20 years later, Stiles (2003) reported that female students were 16% less likely to graduate from their doctoral programs than male students. Through the use of survival analysis, Stiles (2003) confirmed that the effects of gender are greater on doctoral students’ earlier years of doctoral education. The study found no statistically significant difference in degree completion by gender after the seventh year. Lott, Gardner, and Powers’ (2009) longitudinal study of doctoral student persistence in STEM disciplines found that attrition rates for women remained similar to their male counterparts prior to the seventh year; female doctoral students’ attrition rates became twice as high as male
doctoral students’ after the seventh year. However, we have also seen literature reporting no difference between male and female on doctoral completion (Mastekaasa, 2005; Spronken-Smith, Cameron & Quigg, 2018). Using survival analysis, Ampaw (2010) examined doctoral student retention and graduation at a public institution. The results indicated that gender was not a significant predictor impacting doctoral degree completion. Existing literature has conflicted findings on the effect of gender on doctoral time to degree completion. In addition, the majority of the existing literature focused on one field of study or at one or just a few institutions. This study sought to examine the effect of gender at the national level in four broad fields of study.

Female doctorate students often encounter challenges in academia. A mixed-method study of 160 Stanford University alumnae analyzing factors affecting women’s progress toward obtaining their doctorate degrees indicated that they often experienced self-doubt about being pioneers in their disciplines (Maher, Ford, & Thompson, 2004). Family issues also challenged women to fully engage academically (Cao, 2001; Maher et al., 2004). Through a comparative examination of 202 female students in counseling and clinical doctoral programs, Gregor and O’Brien (2015) found that female’s willingness to compromise their career was one of the factors that predicted their overall leadership aspirations. A lack of role models and mentoring relationships also was shown to greatly impact female doctoral students’ degree progression, especially after students finish course work and move on to the dissertation stage (Erickson, 2012; Smith, 1995; Tinto, 1993). As Quinlan (1999) described, “Women often have different needs and concerns from their male counterparts… [and they] face a complex, interrelated set of career issues that may be outside men’s experience” (p. 32). Such differences include feelings of isolation, high stress levels and low self-efficacy, all of which may present challenges for female doctoral students in establishing mentoring relationships with faculty members. Although many
studies have discussed gender differences in undergraduate enrollment and degree completion, fewer studies have focused on graduate populations. Those studies that have addressed the graduate population were largely based on qualitative research of a handful of female doctoral students; however, few quantitative studies that used more representative datasets have explored gender differences in doctoral education and gender’s impact on time-to-degree (Ampaw & Jaeger, 2011; Lott et al., 2009; Nerad & Cerny, 1991; Stiles, 2003). More research should be conducted to examine how gender interacts with institutional context that impacts doctoral time-to-degree.

**Marital status.** The vast majority of studies on doctoral education have examined the differences in degree completion by gender, but very few studies have used marital status as one of the background factors to measure time-to-degree and doctoral degree completion. In a limited number of unpublished doctoral dissertations that accounted for marital status as one of the variables, the majority of the research suggested that the variable is not a salient factor for doctoral attrition (Abedi & Benkin, 1987; Lee, 2003; Malmberg, 2004; Pauley, 1998; Rockinson-Szpakiw, Spaulding & Knight, 2015; Spaulding & Rockinson-Szpakiw, 2012; Tinto, 1993). Abedi and Benkin (1987) conducted a study to investigate the effects of a set of demographic, financial, and academic variables on predicted time-to-degree. Participants (N = 4,225) of the study were drawn from the data set collected from the SED. The researchers concluded that the following variables demonstrated significant predictability on time-to-degree: (a) postdoctoral plans, (b) number of dependents, (c) field of study, (d) gender, and (e) citizenship. The investigators did not find any statistically significance relationship between doctoral recipients who were married and those who were single when it came to how long it took to complete their doctorate. Interviews of 76 doctoral recipients confirmed that having a supportive partner
contributed to the emotional well-being of doctoral students, which ultimately helped them to obtain their doctorate (Spaulding & Rockinson-Szpakiw, 2012).

Using a multiple regression procedure, Sheridan and Pyke (1994) examined the impact demographic (gender, marital status, age, and citizenship), academic (undergraduate and graduate GPA), and financial factors (funding sources) had on time-to-degree in both master’s and doctoral programs. Approximately 395 participants of this study were master’s students and 79 were doctoral students. The researchers concluded that marital status, among many other demographic and academic factors (i.e., undergraduate GPA, graduate GPA, gender, age, leaves of absence) did not serve as a significant predictor of time-to-degree and degree completion. Sheridan and Pyke (1994) suggested that marital status was not a significant predictor of length of time-to-degree completion at the doctoral level due to the small sample size of doctoral students in their study. Multiple regression, similar to any other statistical modeling, is sensitive to sample size. Without a large sample, the researchers may not have been able to accurately pinpoint significant predictors that affect doctoral time-to-degree.

Price (2005) conducted a study to examine how students’ gender and marital status affected graduate outcomes of students in humanity disciplines. The coefficients from the multinominal logit model were used to analyze a data set comprised of 11,000 graduate students from 100 departments over a 20-year period. Price (2005) found that after controlling for individual characteristics, married male students were 75%, 66%, and 39% more likely to complete their doctoral degree by years four, five, and six, respectively, than their single counterparts. On the other hand, married female students were 25%, 32%, 17%, and 9% more likely to complete by years four, five, six, and seven, respectively. Price’s (2005) findings about
marital status as a significant predictor to doctoral time-to-degree contradicted what Sheridan and Pyke (1994) found in their study.

Even though a number of quantitative studies have suggested that marital status did not serve as a salient predictor of doctoral degree completion and time-to-degree, qualitative researchers on this topic found that doctoral students’ experiences can be affected by their marital status. Research suggested that it is crucial for doctoral students to maintain a balance between their academic responsibilities and personal obligations, so they have time to fulfill both roles (Bennett, 2006; Gold, 2006). However, the expectation is often challenging to achieve for doctoral students with family responsibilities. Rockinson-Szpakiw et al. (2015) found that doctoral students with family obligations often were not as involved in academic studies and family lives when compared to their peers who were single as a result of different time commitments outside of school. If doctoral students chose to focus on research, it seemingly affected their relationships with family members. On the other hand, being more involved in family activities may have contributed to doctoral students making insufficient connections with colleagues and faculty members. A review of the literature has suggested conflicting findings on the effect of marital status on doctoral time-to-degree. Thus, more research needs to examine this particular effect.

**Disability status.** Research on doctoral students with disabilities is scarce. Little emphasis has been given to doctoral students with any type of disability and little mention has been made regarding how students’ disabilities have affected their experiences and degree completion. Data on individuals with any type of disability in doctoral education is not as widely available as other demographic information such as gender, race/ethnicity, age, academic status, etc. However, surveys from the National Postsecondary Student Aid Study (NPSAS) and
the SED ask questions about doctoral students’ disability status. Such information gives insight into one of the major issues facing many doctoral students.

The SED definition of disability includes blind/visually impaired; physical/orthopedic disability; deaf/hard of hearing; learning/cognitive disability; vocal/speech disability; and other/unspecified disability. The SED reported that 7.2% (N = 3,930) of all doctorate recipients in 2017 had one or more disabilities. In terms of their field of study, 31.6% of doctoral recipients with one or more disabilities were from non-science and non-engineering fields while 20.2% and 6.4% of the doctoral recipients with one or more disabilities came from science and engineering fields, respectively (NSF, 2017). In terms of types of disabilities, the majority of doctoral recipients that reported having one or more limitations reported having some type of physical disabilities (5.5%) and fewer reported having some type of cognitive limitations (3.1%; NSF, 2017).

In comparison, the most recent NPSAS data reported a larger number (7%) of doctoral students in academic year 2007–2008 as having some type of disability (NCES, 2009b). Female doctoral students were more likely to report having a disability than their male counterparts (8% versus 7%). In regards to academic field, 9% of doctoral students in social and behavioral sciences reported having some type of disability while 5% of students in health and humanities reported having a disability. Doctoral students in life sciences and education were the second largest group of students among the number of students in different fields that reported having a disability (7%), followed by students in math, engineering, and computer science (all 6%).

Despite the figures provided by the NSF and NCES on the participation of students with one or more disabilities at the doctoral level, it is unclear how disabilities impact doctoral degree
completion and time-to-degree. This study has incorporated disability status as one of the predictors in the models to predict doctoral time-to-degree.

**Educational attainment of parents.** In addition to students’ personal characteristics such as gender, race/ethnicity, citizenship, marital status, and disability status that have an impact on degree completion and time-to-degree, studies have shown that students’ educational opportunity is highly related to the educational attainment of their parents (Andres, Adamuti-Trache, Seul Yoon, Pidgeon, & Thomsen, 2007; Blau & Duncan, 1967; Davis-Kean, 2005; Dubow, Boxer, & Huesmann, 2009; Hamilton & Hamilton, 2006; Posselt & Grodsky, 2017; Walsh & Kurpius, 2016). In a longitudinal study that examined the long-term effects of parents’ education on children’s educational success (N = 856), Dubow et al. (2009) found a strong correlation between parental educational attainment and students’ educational aspirations. Students with highly educated parents were found to be more likely to develop higher educational aspirations by age 19, which ultimately resulted in a higher level of adult educational attainment. An NSF (2013) report corroborated previous literature that students with parents who had a high school degree or lower continued to be underrepresented in both doctoral and professional programs while students with parents who had a doctorate or professional degree were increasingly overrepresented.

In another study, Davis-Kean (2005) investigated how parents’ educational background and income affected students’ academic achievement (N = 868). Using structural equation modeling, the researcher found that the number of years of education that parents received was strongly correlated with how they interacted with their children in terms of structuring their home environment to promote academic achievement. More specifically, more than 50% of the variance in the model was explained by parents’ educational attainment (Davis-Kean, 2005).
In a more recent study, Torche (2011) drew on five longitudinal data sets to examine the intergenerational association on class, occupations, and income between men and women. Torche (2011) found that parental educational and financial background had a strong impact on their children’s attainment of a high school degree and an advanced degree. Parental resources had an even stronger impact for advanced degree holders’ choices on university and field of study.

Though the majority of the existing literature suggests that parents’ education level has a direct, positive effect on students’ academic achievement, the majority of literature has focused on the impact at the undergraduate level. None of the studies have examined how parental educational background, if any, may impact doctoral students’ time-to-degree. This particular study analyzed data to investigate how parents’ educational background may contribute to students’ time to obtain the doctorate degree.

**Financial Resources**

The availability of financial resources (e.g., assistantships, fellowships, and loans) for supporting students throughout doctoral programs has been cited as a critical factor affecting degree completion and time-to-degree (Abedi & Benkin, 1987; Adam, 2007; Baird, 1997; Hoffer et al., 2006; Kim & Otts, 2010; Lovitts, 2001; Mendoza et al., 2014; Mwenda, 2010). Research exploring financial aid options available to doctoral students has consistently found that the type of financial support students received in graduate school influences time-to-degree (Abedi & Benkin, 1987; Ampaw & Jaeger, 2011; Breneman, 1976; Kim & Otts, 2010; Zhou & Okahana, 2019).

Research has also suggested that students who receive assistantships are more likely to complete a doctoral degree (Ampaw & Jaeger, 2011; Ehrenberg & Mavros, 1995; Mendoza et
al., 2014). Using propensity score weights, researchers concluded that teaching assistantships positively impacted within-year retention outcomes more than those that did not receive assistantships or fellowships (Mendoza et al., 2014). However, they were not able to find a significant relationship between research assistantships and within-year retention. Ampaw and Jaeger (2011) examined how student characteristics, financial aid, and labor market conditions affect degree completion of doctoral students in science, engineering, and mathematics at a research-extensive institution. Using event history analysis, they found that students with research assistantships were 67% more likely to complete than students who had other types of assistantships. In addition, male doctoral students were more likely to hold research assistantships than female students. In a study that examined doctoral students in four academic disciplines at an elite institution, Ehrenberg and Mavros (1995) found that completion rates and time-to-degree were sensitive to the types of financial support doctoral students received. Using an econometric estimation of competing risk model, they confirmed that students who received fellowships or research assistantships during at least half of their doctoral education had a substantially higher completion rate than their counterparts. However, another study by Lovitts (2001) found that the highest attrition rates for doctoral students were for African American and Latin American students who received certain types of fellowships that “were used to recruit minorities into graduate programs, but because these forms of support are not integrative, they did not lead to the completion outcomes they were designed to achieve” (p. 85).

While previous studies all agreed that some type of financial support in doctoral studies facilitate student persistence and time-to-degree, consensus still has not been reached in terms of the impact of various types of financial support on doctoral outcomes. This study used a model that adds cross-level interaction effects to existing knowledge on how financial support
contributes to faster time-to-degree. More specifically, the study examined the effects of different types of financial support as they interact with academic disciplines and with institutions.

Through a study of 43,354 respondents who received a first research doctorate from 400 colleges and universities within the United States, Kim and Otts (2010) found that students with more than $50,000 in loans took less time to earn their degrees than non-borrowers in all fields of study (e.g., biological sciences, engineering, physical sciences, humanities, and education) except the social sciences. In education and physical sciences, lower loan amounts were associated with a shorter time-to-degree. However, in the fields of biological sciences, engineering, humanities, and social sciences, students with lower loan amounts completed degrees at the same pace as their non-borrower counterparts.

Scholars have shown that the availability and sources of financial support substantially impact degree completion and time-to-degree (Ampaw & Jaeger, 2011; Greene, 2015; Kim & Otts, 2010; Pyke & Sheridan, 1993; Xu, 2014). However, it is not yet clear how financial support affects degree attainment and time-to-degree when interacting with race/ethnicity, field of study, and program rankings. Furthermore, existing studies on doctoral time-to-degree have either focused on only one institution or have used data sets that are rather dated. This study examined the same issue using a recent, large national data set with information from all doctoral granting institutions nationwide. The next section focuses on the other dependent variable presented in the multilevel model: time-to-degree.
Time-to-Degree

In addition to the personal background, academic background, and financial resources of doctoral students, time-to-degree itself is one of the most important indicators of attrition rates (de Valero, 2001). In the early 1960s, Berelson argued the following:

[If] the preparation of college teachers and the national distribution of graduate study are the two major issues in graduate education today, then the duration of doctoral study is probably the third … There is hardly a recent discussion of graduate education in which this note is not played loud and strong. (as cited in Tuckman, Coyle, & Bae, 1989, p. 93)

The average time-to-degree of a doctorate recipient increased over 20% from the 1960s to the 1980s. The impact of that increase was especially salient for mathematics, computer sciences, health sciences, psychology, and social sciences, which have had a more than 25% rise in time-to-degree (Tuckman et al., 1989). In addition, Tuckman et al. (1989) found that a collection of multiple factors contributed to time-to-degree including, “availability of student support, labor-market conditions, socio-demographic characteristics of degree recipients, and the characteristics of both undergraduate and graduate degree-granting institutions” (p. 4).

After conducting a meta-analysis synthesizing results from multiple quantitative studies that addressed time-to-degree, Bowen and Rudenstine (1992) concluded that (a) approximately half of doctoral students complete the degree six to 12 years after entering their respective program; (b) time-to-degree varies significantly and systematically by field of study; (c) programs in the form of a cohort have shorter time-to-degree; (d) students who rely on personal sources of financial support take longer to complete their degree than their counterparts who rely on teacher assistantships and fellowships; (e) proper dissertation advising, clear program objectives and guidelines, and flexible funding contribute to shorter time-to-degree; and (f) the
selection of an appropriate dissertation topic is positively associated with shorter time-to-degree. Bowen and Rudenstine’s (1992) study focused on doctoral programs in arts and sciences at 10 elite universities and covered data from 1962 to 1986.

The National Association of Graduate-Professional Students (NAGPS) surveyed over 32,000 doctoral students and recent doctoral recipients about their satisfaction with doctoral program factors such as time-to-degree and program climate. The results showed that more than 40% of the respondents were concerned with their progress toward degree completion, which was a result of not receiving a clear, annual assessment of this progress. In addition, one-third reported having little interaction with faculty members who kept track of their degree progress. Also, over one-third of the respondents believed that insufficient funding slowed their progress toward degree completion (NAGPS, 2000).

Existing literature suggests that a wide array of factors all have an impact on doctoral time-to-degree; however, it is still unclear how different disciplines’ cultures and requirements affect time to doctorate. Bowen and Rudenstine (1992) argued that “completion rates and time-to-degree vary more systematically with discipline of study than any other variable” (p. 123). Certainly, more research is needed to investigate which factors affect time-to-degree beyond the individual level. Therefore, this study used the data set from SED to examine how student characteristics, academic background, program context, and institutional factors independently and collectively affect time-to-degree.

This section of the literature review covers the most important issues in doctoral education: attrition and degree completion rates. It has been estimated that approximately 50% of the enrolled doctoral students drop out from their respective programs without attaining the doctorate degree (Lovitts & Nelson, 2000; Powers, 2004). Considering that the number of
students who graduate with a doctorate degree is approximately 40,000 every year, the number of doctoral students who leave without a degree each year is around 40,000 as well (Hawlery, 2003). Unfortunately, the issue of high doctoral attrition has not been effectively solved. As Lovitts (2001) explained, “The situation is worse than that. For large segments of the country’s faculty members and administrators, the problem does not exist because the problem – and the students who leaves – is largely invisible” (p. 1). The remainder of the section addresses factors that contribute to doctoral drop-out that have not yet been discussed in this chapter.

Gaps in the Literature

Doctoral student retention and time-to-degree have become specific goals of the Council of Graduate Schools and colleges and universities nationwide. However, research supported by empirical data to show the impact of personal, academic, and financial factors on time-to-degree for doctoral students is still limited when compared to research on student retention and time-to-degree at the undergraduate level. In addition, the majority of the existing literature on doctoral education has been from exploratory studies with relatively small sample sizes. Some studies have examined sources of financial support in doctoral degree completion (e.g. Ampaw & Jaeger, 2011; Hoffer et al., 2006; Kim & Otts, 2010; Mendoza et al., 2014; Zhou & Okahana, 2019) and others have explored how gender, race/ethnicity, and academic aptitude may have impacts (e.g., Gardener, 2010a; Green & Kim, 2005; Felder et al., 2014; Golde, 2000; Okahana et al., 2016; Okahana et al., 2018); however, researchers have not yet presented a model that investigates direct effects of personal, program, and institutional factors on doctoral time-to-degree. Moreover, rarely has there been a model that examines cross-level interaction effects on time-to-degree. For instance, the differences in time-to-degree between male and female students may be associated with institutional affiliations rather than by gender itself. Through
multilevel modeling, I present a model that explains how gender interacts with other variables (i.e., private versus public institutions; city versus non-city institutions; etc.) to impact time-to-degree. Further, this study also investigated program and institutional effects on time-to-degree.

Additionally, the existing studies on doctoral time-to-degree rarely have focused on the impact on time-to-degree beyond students’ personal backgrounds. Little is known about the program and institutional effects on time to doctoral degree, and the lack of knowledge in this area also warrants further examination of the influence of academic disciplines and program demography on time-to-degree between female and male doctoral students. For example, little research has been conducted on the effects of gender or racial/ethnic representation on time-to-degree of students in different institutions. The relationships between institution affiliations and time-to-degree, as well as the ones between program and time-to-degree after controlling for student level characteristics need further investigation.

By using the secondary data set acquired from the Survey of the Earned Doctorate from 2002-2012 that contains information from over 450,000 respondents, this study examined possible relationships among students’ backgrounds and institutional and program factors individually and collectively. Multilevel modeling techniques measured differences not only at the student level but at the institutional and program levels. Furthermore, I investigated how a combination of factors at different levels interact and affect doctoral time-to-degree. The next chapter addresses the data source, variable measures, and statistical methods used to analyze the data. Additionally, approaches to avoid multicollinearity and manage missing data are also explained.
CHAPTER THREE: METHODOLOGY

Multilevel modeling was used to examine an array of factors at individual, program, and institutional levels using a national data set (Survey of the Earned Doctorate) obtained from the NSF. Building on previous literature, as well as Bourdieu’s (1977) cultural capital theory and Becker’s (1994) human capital theory, the purpose of this study is twofold. First and foremost, I hope to advance our knowledge on the effects of students’ demographic information, academic background, and financial support on doctoral time-to-degree by using advanced statistical approaches to reduce estimation biases. In addition, using a nationally representative data set, I intended to investigate the institutional impact that universities have on time-to-degree once individual level and program level factors have been accounted for. This section provides an overview of the research design, compilation of data, and statistical analysis techniques that are employed. It is divided into four major parts: a description of the data sources, a description of the research design, a description of the measures, and a description of the models.

Data Sources

This study analyzes historical data collected from the SED, sponsored by NORC for six federal agencies (National Science Foundation, National Institutes of Health, United States Department of Education, United States Department of Agriculture, National Endowment for the Humanities, and National Aeronautics and Space Administration). The SED data contains a nationally representative sample of doctoral recipients who received their doctorate degree in 2002-2012 academic year. The NSF is a federal agency survey collecting data on the characteristics of individuals receiving doctoral degrees from all accredited United States institutions. On average, approximately 48,000 United States doctoral recipients complete the SED annually by reporting their demographic backgrounds and funding sources. The data set is
crucial in analyzing characteristics of doctoral recipients and trends of doctoral education. In addition to the SED data, program-level data is obtained from the NRC measuring program characteristics. Measures include fields of study, overall program ranking, research activity ranking, diversity ranking, and median program GRE score of admitted doctoral students. Lastly, institutional-level data is acquired from Integrated Postsecondary Education Data System (IPEDS), which includes institutional information on Carnegie Classification, institution type, degree of urbanization, and minority-serving institution indicator. In addition to institution affiliations, I calculated proportion of female students and underrepresented minority students at each institution to investigate whether percentages of female and URM students have an impact on doctoral time-to-degree.

The SED dataset acquired is used to investigate the effects of the independent variables (i.e., individual-, program-, and institutional-level effects) on the dependent variable of time to doctoral degree. The data comes from a large sample of doctoral students from all accredited U.S institutions. In addition, because the datasets contain student and program information from multiple institutions, it allows for examination of program variations and institutional variations in time-to-degree. Multilevel modeling is used to analyze the dataset and accomplish these investigations.

There are two limitations in using the SED data set. First and foremost, the dataset does not contain information on all the factors that may have contributed to time-to-degree. For instance, the effects of other possible variables that may impact time-to-degree such as student–faculty relationships, peer relationships, family support, professional development, and academic involvement cannot be investigated using existing secondary data. Another limitation is that the academic programs may not be completely matched and comparable due to the different program
names used at different doctoral granting institutions around the country. This may cause inaccurate estimations when some programs have to be dropped if a match does not occur.

Although the dataset does have some limitations, it is the most appropriate source of comprehensive, nested data for analyzing doctoral time-to-degree. In addition, the SED data set is the most comprehensive data existing that tracks characteristics of doctoral recipients around the country.

Measures

The conceptual framework guiding this study, which has been discussed in Chapters One and Two, posits that, at the student level, various demographic characteristics, academic backgrounds, and financial factors have an influence on doctoral students’ time-to-degree. In the meantime, the program context and institutional level characteristics also exert an impact on doctoral students’ academic achievement. The following section discusses the variables and measures included in the multilevel model in details.

Dependent variable. The primary outcome measure of interest in the proposed analyses, which is the dependent variable, is time-to-degree. The existing literature suggests three prevalent ways to measure time-to-degree: total time-to-degree, elapsed time-to-degree, and registered time-to-degree. Total time-to-degree is defined as the number of years from completion of a baccalaureate to the completion of a doctorate (Henderson et al., 1998). It also includes time students were not enrolled in doctoral studies. Elapsed time-to-degree refers to the number of years that elapsed between entering a doctoral program to the time the doctorate is obtained, including periods of breaks from academic involvement (Bowen & Rudenstine, 1992). Registered time-to-degree includes only the number of years that a student is registered in a doctoral program (Henderson et al., 1998). For the purposes of this study, elapsed time-to-
degree is used because I am interested in the time span from when students enter a program to when they complete it. Because this variable is represented by the number of years enrolled in a doctoral program, it is considered a count variable (Agresti, 2001). Students must have successfully completed the degree program to be assigned a value for this variable.

**Independent variables.** Given the nested data structure, with doctoral recipients nested within programs and programs nested within institutions, multilevel analytical approach is used to analyze the data. There are three major sets of independent variables. First, student-level variables represent students’ demographic characteristics, parental educational background, amount of tuition remission and sources of financial support. Second, program-level variables capture the effects of fields of study, rankings (overall program ranking, research activity ranking, and diversity ranking), and median program GRE. Lastly, institutional level variables capture the effects of institution characteristics such as institution type, Carnegie Classification, degree of urbanization, and minority-serving institution indicators.

**Student characteristics.** Student-level (Level 1) variables shown in Table 1 includes demographic characteristics and variables that describe the students’ academic backgrounds. In addition, Level 1 variables also contain a set of variables that describe types of financial support doctoral recipients received.
Table 1

Variables at the Student Level

<table>
<thead>
<tr>
<th>Variables Name</th>
<th>Variable Label</th>
<th>Coding</th>
<th>Theory Linked to Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demographic Characteristics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FEMALE</td>
<td>Female student</td>
<td>0=No, 1=Yes</td>
<td>Cultural Capital Theory</td>
</tr>
<tr>
<td>AMERIND</td>
<td>American Indian/Alaska Native race indicator</td>
<td>0=No, 1=Yes</td>
<td>Cultural Capital Theory</td>
</tr>
<tr>
<td>HAWAIIAN</td>
<td>Native Hawaiian/Pacific Islander race indicator</td>
<td>0=No, 1=Yes</td>
<td>Cultural Capital Theory</td>
</tr>
<tr>
<td>ASIAN</td>
<td>Asian race indicator</td>
<td>0=No, 1=Yes</td>
<td>Cultural Capital Theory</td>
</tr>
<tr>
<td>HISPANIC</td>
<td>Hispanic origin indicator</td>
<td>0=No, 1=Yes</td>
<td>Cultural Capital Theory</td>
</tr>
<tr>
<td>BLACK</td>
<td>Black race indicator</td>
<td>0=No, 1=Yes</td>
<td>Cultural Capital Theory</td>
</tr>
<tr>
<td>CITZ</td>
<td>American citizen</td>
<td>0=No, 1=Yes</td>
<td>Cultural Capital Theory</td>
</tr>
<tr>
<td>HANDICAP</td>
<td>Disability status</td>
<td>0=No, 1=Yes</td>
<td>Cultural Capital Theory</td>
</tr>
<tr>
<td>MARITAL</td>
<td>Married</td>
<td>0=No, 1=Yes</td>
<td>Human Capital Theory</td>
</tr>
<tr>
<td>DEPEND5</td>
<td>Number of dependents – ages 5 and younger</td>
<td>Continuous</td>
<td>Human Capital Theory</td>
</tr>
<tr>
<td>DEPEND18</td>
<td>Number of dependents – ages 6-18</td>
<td>Continuous</td>
<td>Human Capital Theory</td>
</tr>
<tr>
<td>DEPEND19</td>
<td>Number of dependents – ages 19 and older</td>
<td>Continuous</td>
<td>Human Capital Theory</td>
</tr>
<tr>
<td>EDHS</td>
<td>Parent’s education- high school graduate or some college</td>
<td>0=No, 1=Yes</td>
<td>Cultural Capital Theory</td>
</tr>
<tr>
<td>EDMS</td>
<td>Parent’s education – Master’s</td>
<td>0=No, 1=Yes</td>
<td>Cultural Capital Theory</td>
</tr>
<tr>
<td>EDPHD</td>
<td>Parent’s education – PHD</td>
<td>0=No, 1=Yes</td>
<td>Cultural Capital Theory</td>
</tr>
<tr>
<td>Financial support</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TIREMS</td>
<td>Tuition remission – full or partial</td>
<td>0=No, 1=Yes</td>
<td>Human Capital Theory</td>
</tr>
<tr>
<td>SRCEA</td>
<td>Fellowship, scholarship</td>
<td>0=No, 1=Yes</td>
<td>Human Capital Theory</td>
</tr>
<tr>
<td>SRCEB</td>
<td>Grant</td>
<td>0=No, 1=Yes</td>
<td>Human Capital Theory</td>
</tr>
<tr>
<td>SRCEC</td>
<td>Teaching assistantship</td>
<td>0=No, 1=Yes</td>
<td>Human Capital Theory</td>
</tr>
<tr>
<td>SRCEE</td>
<td>Other assistantship</td>
<td>0=No, 1=Yes</td>
<td>Human Capital Theory</td>
</tr>
<tr>
<td>SRCEF</td>
<td>Traineeship</td>
<td>0=No, 1=Yes</td>
<td>Human Capital Theory</td>
</tr>
<tr>
<td>SRCEH</td>
<td>Loans (from any source)</td>
<td>0=No, 1=Yes</td>
<td>Human Capital Theory</td>
</tr>
<tr>
<td>SRCEI</td>
<td>Personal savings</td>
<td>0=No, 1=Yes</td>
<td>Human Capital Theory</td>
</tr>
<tr>
<td>SRCEJ</td>
<td>Other financial support</td>
<td>0=No, 1=Yes</td>
<td>Human Capital Theory</td>
</tr>
</tbody>
</table>
Program characteristics. In addition to student background information, independent variables at program-level (Level 2) are also hypothesized to impact doctoral student time-to-degree. More specifically, field of study, program rankings, and median program GRE score (shown in Table 2) may also affect the length of time students spent in completing the doctoral degree.

Table 2

Variables at the Program Level

<table>
<thead>
<tr>
<th>Variables Name</th>
<th>Variable Label</th>
<th>Coding</th>
<th>Theory Linked to Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>HARDPURE</td>
<td>Hard Pure</td>
<td>0=No, 1=Yes</td>
<td>Organizational Impact Model</td>
</tr>
<tr>
<td>SOFTPURE</td>
<td>Soft Pure</td>
<td>0=No, 1=Yes</td>
<td>Organizational Impact Model</td>
</tr>
<tr>
<td>SPFTAPPLIED</td>
<td>Soft Applied</td>
<td>0=No, 1=Yes</td>
<td>Organizational Impact Model</td>
</tr>
<tr>
<td>SRANK95</td>
<td>Overall Ranking</td>
<td>Continuous</td>
<td>Organizational Impact Model</td>
</tr>
<tr>
<td>RESACT95</td>
<td>Research Activity Ranking</td>
<td>Continuous</td>
<td>Organizational Impact Model</td>
</tr>
<tr>
<td>DIV95</td>
<td>Diversity Ranking</td>
<td>Continuous</td>
<td>Organizational Impact Model</td>
</tr>
<tr>
<td>GRE</td>
<td>Median Program GRE</td>
<td>Continuous</td>
<td>Organizational Impact Model</td>
</tr>
</tbody>
</table>

Institutional characteristics. I also analyze data on institutional types (shown in Table 3) that are considered an institutional-level variable (Level 3). The independent variables at the institutional level are hypothesized to impact the time-to-degree for doctoral students at different colleges and universities. The variables are categorized based on Carnegie Classifications and types of institutions. In addition, I also incorporate measures for HBCU and minority-serving institution indicators, and degree of urbanization.
Table 3

Variables at the Institutional Level

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Variable Label</th>
<th>Coding</th>
<th>Theory Linked to Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>GCLIMATE</td>
<td>Female Proportion</td>
<td>Continuous</td>
<td>Organizational Impact Model</td>
</tr>
<tr>
<td>RCLIMATE</td>
<td>URM Proportion</td>
<td>Continuous</td>
<td>Organizational Impact Model</td>
</tr>
<tr>
<td>PHDCARN</td>
<td>Doctoral institution Carnegie classification</td>
<td>Categorical</td>
<td>Organizational Impact Model</td>
</tr>
<tr>
<td>PHDCARNP</td>
<td>Doctoral institution Carnegie public indicator</td>
<td>0=No, 1=Yes</td>
<td>Organizational Impact Model</td>
</tr>
<tr>
<td>PHDMSI</td>
<td>Doctoral institution minority-serving institution indicator</td>
<td>0=No, 1=Yes</td>
<td>Organizational Impact Model</td>
</tr>
<tr>
<td>URBANC</td>
<td>Degree of urbanization city indicator</td>
<td>0=No, 1=Yes</td>
<td>Organizational Impact Model</td>
</tr>
<tr>
<td>URBANN</td>
<td>Degree of urbanization non-city indicator</td>
<td>0=No, 1=Yes</td>
<td>Organizational Impact Model</td>
</tr>
<tr>
<td>GCLIMATE</td>
<td>Female Proportion</td>
<td>Continuous</td>
<td>Organizational Impact Model</td>
</tr>
</tbody>
</table>

Multilevel Modeling

Educational data often has a nested data structure. As a result, conventional structural equation modeling with them may lead to biased structural regression coefficients due to structural equation modeling’s inability to examine hierarchically nested systems (Muthen & Satorra, 1989). Without considering the similarities and differences among members within groups, researchers may report biased estimates of the model’s parameters, standard errors, and fit indexes (Heck, 2001). Multilevel modeling is considered a more flexible research method for analyzing nested, longitudinal data than other statistical methods (Raudenbush & Bryk, 2002; Singer & Willett, 2003; Snijders & Bosker, 1999). This analytical approach allows for a simultaneous examination of the effects of institutional-level, program-level, and student-level variables while accounting for the non-independence of observations within groups (Kaplan,
The use of multilevel modeling is appropriate for this study because it allows an examination of both indirect and simultaneous effects within and between the levels of higher education institutions.

The data is analyzed using HLM software.

**A fully unconditional model.** A preliminary analysis was conducted to ensure that sufficient variability exists at all levels to warrant continuation with analyses (Raudenbush & Bryk, 2002). The preliminary analysis is termed a fully unconditional model. That is, no predictor variables are specified at any level. A fully unconditional model denotes how variation in an outcome measure is allocated across three different levels (students, academic programs, and institutions). The student-level model is given by:

\[
TTD_{ijk} = \pi_{0jk} + e_{ijk},
\]

Where

- \( TTD_{ijk} \) is the time spent to complete a doctoral degree for student \( i \) in academic program \( j \) and institution \( k \);
- \( \pi_{0jk} \) is the mean time spent to complete a doctoral degree of academic program \( j \) in institution \( k \); and
- \( e_{ijk} \) is a random student effect, that is, the deviation of student \( ijk \)’s time from the program mean. These effects are assumed normally distributed with a mean of 0 and variance \( \sigma^2 \).

In the level 2 model (*program level*), we view each academic program mean, \( \pi_{0jk} \), as an outcome varying randomly around some institution mean:

\[
\pi_{0jk} = \beta_{00k} + r_{0jk},
\]

where

- \( \beta_{00k} \) is the average time spent to complete a doctoral degree in institution \( k \);
\( r_{0jk} \) is a random program effect. That is, the deviation of academic program \( jk \)’s mean from the institution mean. These effects are assumed normally distributed with a mean of 0 and variance \( \tau_x \). Within each of the \( k \) institutions, the variability among academic programs is assumed the same.

The level-3 model (institutional level) represents the variability among institutions. The institution means on average time spent to complete a doctoral degree, \( \beta_{00k} \), varies randomly around the grand mean:

\[
\beta_{00k} = \gamma_{000} + u_{00k},
\]

where

\( \gamma_{000} \) is the grand mean;
\( u_{00k} \) is the random institution effect. That is, the deviation of institution \( k \)’s mean from the grand mean. These effects are assumed normally distributed with a mean of 0 and variance \( \tau_{\beta} \).

For optimal use of multilevel modeling, the outcome variable must vary across all levels. In this study, more specifically, the model partitions the total variability in the outcome \( Y_{ijk} \), time-to-degree, into its three components: (level 1) among students within academic programs, \( \sigma^2 \); (level 2) among academic programs within institutions, \( \tau_{\pi} \); and (level 3) among institutions, \( \tau_{\beta} \). ICC (intraclass correlation coefficient or intracluster correlation coefficient) is reported to demonstrate the variability in the outcome, time-to-degree, within academic programs, among programs within institutions and among institutions (Raudenbush et al., 2004).

The proportion of variance within programs is represented by

\[
\frac{\sigma^2}{\sigma^2 + \tau_{\pi} + \tau_{\beta}};
\]

The proportion of variance among programs within institutions is denoted by

\[
\frac{\tau_{\pi}}{\sigma^2 + \tau_{\pi} + \tau_{\beta}};
\]
The proportion of variance among institutions is shown as

$$\tau_\beta / (\sigma^2 + \tau_\pi + \tau_\rho).$$

Several basic questions are answered using the unconditional model: (1) How much variability is there among different doctorate granting institutions? (2) How much variability is there within academic programs among doctorate granting institutions? (3) Is the variability among doctorate granting institutions statistically significant?

**Conditional model for institution model.** The fully unconditional model presented above provides estimation of variability at all three levels—students, academic programs, and institutions. Assuming that a portion of the variability at each level can be accounted for by measured variables at each level, student background characteristics, academic backgrounds, financial condition, program characteristics, and institutional characteristics could be used as predictors to investigate doctoral time-to-degree. In addition, some of the relationships at the student or program levels may vary randomly among these predictors. For instance, research suggested that minority (Hispanic, American Indian, and African American) doctoral students tend to complete at lower rate than their Asian counterparts (Hoffer et al., 2006). The race/ethnicity difference may depend on academic programs (e.g., engineering versus social sciences) or gender (e.g., female versus male). In this situation, the regression coefficient representing the racial effect may vary depending on characteristics of students and academic programs. Scholars have also found that family planning, such as marital status or number of dependents, is likely to be associated with time to degree. However, the difference may also depend on gender (Mason, Goulden & Frasch, 2009). Female doctoral students’ family planning are more likely to be associated with lower time-to-degree than their male counterparts. In addition to race/ethnicity and family planning, this model also examines the relationships
between academic discipline and time to degree as well as program demography and time to
degree, moderated by gender. As a result, a random coefficients regression model is presented at
each level.

The Level 1 (student level) random coefficients regression model for time-to-degree with
predictor variables and a random student-level error is expressed as:

\[ \text{TUD}_{ijk} = \pi_{0jk} + \pi_{1jk}a_{1ijk} + \pi_{2jk}a_{2ijk} + \ldots + \pi_{pjk}a_{pijk} + e_{ijk}, \]

where

- \( \text{TUD}_{ijk} \) is the time to doctoral degree of student \( i \) in academic program \( j \) and institution \( k \);
- \( \pi_{0jk} \) is the intercept for academic program \( j \) in institution \( k \);
- \( a_{pijk} \) are \( p = 1, \ldots, P \) student characteristics that predict time-to-degree;
- \( \pi_{pjk} \) are the corresponding level-1 coefficients that indicate the direction and strength of
  association between each student characteristic, \( a_p \), and the outcome in
  academic program \( jk \); and
- \( e_{ijk} \) is a level-1 random effect that represents the deviation of student \( ijk \)’s time-to-degree from
  the predicted time-to-degree based on the student-level model. These residual student
  effects are assumed normally distributed with a mean of 0 and variance of \( \sigma^2 \).

The variable blocks in this model represent variety of student background information, including
students’ demographic characteristics, their academic backgrounds, types and sources of
financial support, as well as their debt level upon completing the degree.

The level 2 (program level) model for time to doctoral degree is represented by:

\[ \pi_{pjk} = \beta_{p0k} + \sum_{q=1}^{Q_p} \beta_{pqk} X_{pjk} + r_{pjk} \]

where

- \( \beta_{p0k} \) is the intercept for institution \( k \) in modeling the program effect \( \pi_{pjk} \).
$X_{pj}k$ is a program characteristic used as a predictor of the program effect $\pi_{pj}k$;

$\beta_{pqk}$ is the corresponding coefficients that represents the direction and strength of association between program characteristics $X_{pj}k$ and $\pi_{pj}k$; and

$r_{pj}k$ is a level-2 random effect that represents the deviation of program $jk$’s level-1 coefficient, $\pi_{pj}k$, from its predicted value based on the program-level model.

The variables included at the program level help explain how program characteristics might affect average time to doctoral degree. These variables include academic programs and rankings.

The level-3 (institution-level) model for time to doctorate degree is represented by:

$$\beta_{npk} = \gamma_{pq0} + \sum_{q=1}^{Qp} \gamma_{pq} W_{sk} + u_{pqk}$$

where

$\gamma_{pq0}$ is the intercept term in the institution-level model for $\beta_{pqk}$;

$W_{sk}$ is a institution characteristic used as a predictor for the institution effect, $\beta_{pqk}$;

$\gamma_{pq}W_{sk}$ is the corresponding level-3 coefficient that represents the direction and strength of association between school characteristic $W_{sk}$ and $\beta_{pqk}$; and

$u_{pqk}$ is a level-3 random effect that represents the deviation of school $k$’s coefficient, $\beta_{pqk}$, from its predicted value based on the institution-level model.

The variables included at the institutional level describe how different types of higher education institutions affect doctoral students’ average time to completing a doctoral degree. These variables include types of institution, HBCU indicator, urbanization of the institution, and size of the institution.

Research questions 1-3 are addressed in detail by using this random coefficients regression model. As a reminder, those questions are: (1) To what extent do student traits predict
doctrinal time-to-degree? (2) Once controlling for student traits, to what extent does departmental context predict doctoral time-to-degree? (3) Once controlling for student traits and departmental context, to what extent do institutional characteristics predict doctoral time-to-degree?

**Multicollinearity Diagnostics**

Multicollinearity refers to a statistical phenomenon where highly inter-correlated predictor variables exist in regression models; such a state violates the basic assumptions of ordinary least squares (OLS). Causes of multicollinearity vary. Sometimes it is due to improper use of dummy variables, such as failure to exclude one category in the model, whereas other cases may be caused by including a variable that is computed from other variables or including similar variables multiple times, such as including time finished coursework and time completed preliminary exam in the same model.

To account for the issue, multicollinearity diagnostics is conducted to measure how much predictors are related to other predictors in the model and how this relationship affects the stability and variance of the regression estimates. To perform the diagnostics, I produce a set of condition indices in STATA that indicate the existence of one or more near-dependencies in the model. Then, I examine the predictors that are signaled as near dependencies and determine how to proceed with the variables.

**Missing Data and Data Screening**

Incomplete data is almost universal in quantitative education research and it may be caused by a variety of reasons: study attrition, non-response items, lost data, data entry error, or a flawed research design. Researchers may view missing data as problematic. In multivariate analysis of large sample surveys, if researchers simply treat the missing data by deleting the cases, a small proportion of missing data on different variables would add up to a large number
of missing cases. On the other hand, if researchers use the traditional way to treat missing data by substituting estimated values for missing values, it would often lead to biased parameter estimates and biased standard error estimates. Hence, improper ways to treat missing data often leads to the loss of statistical power, biased parameter estimates, and inferences based on available data that are not representative to the entire sampling population.

However, missing data may also be used to the advantage of the researchers when it is used in missing-data designs (Graham, Taylor, & Cumsille, 2001; Graham, Taylor, Olchowski, & Cumsille, 2006) in which researchers are able to use partial data to generate conclusions that are valid and representative to the full sample. The modern missing data techniques, including maximum likelihood estimation algorithms (Dempster, Laird, & Rubin, 1977; Enders, 2001) and multiple imputation (Rubin, 1987), have been proved to accurately and effectively estimate the parameters. Furthermore, researchers can also use the missing data techniques to apply assumptions on weaker data sets (Allison, 2003).

In this study, I employ multiple imputation (MI) to cope with the issue of missing data. To start, I introduce random variation into the imputation process and generate several data sets, each with different imputed values. Second, I perform the chosen statistical analysis on each of the imputed data sets. Five imputations have been conducted on all of the models. Lastly, I combine the results of the analyses into a single set of parameter estimates, standard errors, and test statistics. However, Schafer and Olsen (1998) pointed out that MI, just like any other statistical technique, depends on certain assumptions. The MI procedure assumes that the data are from a continuous multivariate distribution and the missing data is missing at random (MAR). MAR is the most widely-used assumption in the missing data design, in which the design assumes that the probability that a variable is missing only depends on the available
information – values of other observed variables (Rubin, 1976; Lu & Copas, 2004). In addition, the MI procedure assumes that the data comes from a multivariate normal distribution when either regression or the Markov chain Monte Carlo (MCMC) method is used. After the assumptions of the MI procedure are met and the procedure is complete, the estimators should be approximately unbiased and would justify the use of the normal z-table for p-values and confidence intervals.

**Summary of Chapter**

The purpose of the proposed research is to examine the relationships between personal and academic backgrounds, program components, institutional contexts, and time-to-degree among doctoral students using the Survey of Eared Doctorate derived from 2002-2012. Five research questions were developed to address these relationships. The first three research questions address the main effects of student, program, and institutional characteristics on time to degree, respectively. Research questions 4 and 5 explored whether the relationships between institutional characteristics and time to degree were moderated by gender or race/ethnicity. Instead of using doctoral student records at only one institution, I use a large, national data set collected from all doctorate granting institutions nationwide in the hopes of obtaining more in-depth insights into the relationships between the various predictors and time-to-degree.

Only numerical data is analyzed, thereby using a quantitative method approach. Descriptive statistics are reported to describe the characteristics of survey respondents. A three-level multilevel model is used to consider the predictive relationships between the individual, program, and institutional predictors and time-to-degree outcomes and a two-level model was used to investigate the extent to which gender moderated the effects of institutional characteristics on time to degree. The results generated, outlined in Chapter Four, are used to
determine how doctoral time-to-degree is predicted by students’ personal backgrounds as well as the doctoral program and doctorate-granting institutional contexts.
CHAPTER FOUR: RESULTS

To date, factors that are associated with doctoral time-to-degree continue to be unclear. Prior to the current study, there was yet to exist a study that used a model to comprehensively examine the relationships between student, program, and institution characteristics and doctoral time-to-degree. In the attempt to bridge the gap in the literature, this study pulled data from three sources (NSF, NRC, and IPEDS) and investigated factors associated with time-to-degree at the student, the program, and the institutional levels.

Chapter four provides detailed descriptions of results from data analyses. This chapter starts by offering an overview of the data and descriptive analyses of the variables. In addition, three multilevel models that include imputed data are described to address the research questions raised in chapter one.

Descriptive Analyses

Two models are presented in this chapter: an institution model that only contains student level and institutional level characteristics (students nested within institutions) and a program model including student, program, and institutional characteristics (students nested within programs and programs nested within institutions).

Due to the nature of two different data sources for student and program measurements, program name at program level could not be completely mapped to Survey of the Earned Doctorates (SED) variables at student level. One of the variables in NRC data is Program Name, and it needed to be mapped to variable Field of Study in SED data set to merge the two data sets for further analysis. For example, in the SED data, there was a Field of Study called Biochemistry at Johns Hopkins University. On the other hand, three programs were under the overarching umbrella of Biochemistry in the NRC data: Biochemistry and Molecular Biology,
Biological Chemistry, and Molecular and Computational Biophysics. Another example was the Economics field, the only field of study in the SED data. However, in NRC data, three programs at Harvard University fell under the category of Economics: Business Economics, Economics, and Political Economy and Government.

To merge two data sets from student and program levels, I employed a weighted average measure. The program model used the number of students enrolled in different programs as a measure to weight other variables in the NRC data set, and new variables were generated based on the weighted values. Going back to the Johns Hopkins example, 44 students were enrolled in Biochemistry and Molecular Biology Program, 55 in Biological Chemistry Program, and 64 in Molecular and Computational Biophysics Program. Weights were calculated based on the number of students enrolled in each program and a new variable Field was generated to map to SED data at student level. Since program level data (NRC) was from 2006 and program rankings and program characteristics are likely to change over the years, the three-level model only used student level data (SED) between 2006 and 2009 to ensure the accuracy of the analyses. In the following section, I present descriptive statistics for all three models at different levels.

**Student level variables.** Student level variables of the institution model (N = 442,730) were derived from the SED administered by NSF between 2002 and 2012 while the program model (N = 52,321) used SED data between 2006 and 2009. The average response rates of SED were approximately 95%, warranting accuracy and completeness for the data used in this study and preventing coverage error, non-response error, and measurement error that are typically problematic in data analyses using survey results. Tables 4.1 through 4.3 describe number of students and demographic information about survey respondents in the institution model.
(students nested within institutions) and program model (students nested within programs and programs nested within institutions).

It is worth noting that the data shown in Tables 4.1 through 4.3 are presented prior to Multiple Imputations, which were conducted to gain an accurate understanding of the original raw data. In addition, standard deviation for continuous variables were included whereas standard deviation for dummy-coded variables were not calculated. In the institution model (students nested within institutions), Biglan’s (1973) fields of study were part of the student-level variables. On the other hand, Biglan’s field of study became program-level variables in the program model (students nested within programs and programs nested within institutions).

Using Biglan’s Classifications, fields of study in the SED data were listed in Appendix C.

Table 4

Student Level (Level-One) Variables - Descriptive Statistics

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Institution Model</th>
<th>Program Model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean</td>
</tr>
<tr>
<td>Time-To-Degree</td>
<td>442,730</td>
<td>9.82</td>
</tr>
<tr>
<td>Female</td>
<td>230,696</td>
<td>.46</td>
</tr>
<tr>
<td>Male</td>
<td>272,473</td>
<td>.54</td>
</tr>
<tr>
<td>Hispanic</td>
<td>27,581</td>
<td>.006</td>
</tr>
<tr>
<td>American Indian</td>
<td>5,149</td>
<td>.001</td>
</tr>
<tr>
<td>Native Hawaiian</td>
<td>1,733</td>
<td>.00</td>
</tr>
<tr>
<td>Asian</td>
<td>125,609</td>
<td>.27</td>
</tr>
<tr>
<td>Black</td>
<td>29,146</td>
<td>.06</td>
</tr>
<tr>
<td>White</td>
<td>306,845</td>
<td>.66</td>
</tr>
<tr>
<td>Non-Handicapped</td>
<td>495,230</td>
<td>.98</td>
</tr>
<tr>
<td>Handicapped</td>
<td>8,282</td>
<td>.02</td>
</tr>
<tr>
<td>US Student</td>
<td>307,798</td>
<td>.65</td>
</tr>
<tr>
<td>International Student</td>
<td>166,431</td>
<td>.35</td>
</tr>
<tr>
<td>Married</td>
<td>255,108</td>
<td>.57</td>
</tr>
<tr>
<td>Never Married</td>
<td>139,520</td>
<td>.31</td>
</tr>
<tr>
<td>Other (Divorced/Separated/Widowed)</td>
<td>56,088</td>
<td>.10</td>
</tr>
<tr>
<td># of Dependents &lt; 5</td>
<td>442,136</td>
<td>.27</td>
</tr>
<tr>
<td># of Dependents 6 -18</td>
<td>442,136</td>
<td>.20</td>
</tr>
<tr>
<td># of Dependents &gt;19</td>
<td>442,136</td>
<td>.07</td>
</tr>
<tr>
<td>Parental Education – High School</td>
<td>120,640</td>
<td>.27</td>
</tr>
<tr>
<td>Parental Education - College</td>
<td>172,005</td>
<td>.39</td>
</tr>
</tbody>
</table>
Due to small sample size, two variables in marital status and two in type of financial support were combined. In marital status, survey respondents who identified as divorced, separated, or widowed were merged as one variable named other (divorced/separated/widowed). In type of financial support, respondents who received assistantship (other than TA or RA), traineeship, or other financial support were lumped together under the umbrella of other financial support.

During data analysis, I found that father’s highest degree attainment and mother’s highest degree attainment are moderately correlated where $r = 0.57$ in the institution model and $r = 0.58$ in the program model. To avoid multicollinearity, father’s highest degree attainment and mother’s highest degree attainment were collapsed using the highest degree received by either parent. A new variable was created called parental education attainment. For instance, if a
respondent’s father had a college degree and his/her mother had a master’s degree, the mother’s master’s degree was used as highest degree.

It is worth noting that the program model sample was a relatively small subset of the larger institution model population, yielding a different average time-to-degree (8.55 years vs. 9.82 years). For instance, 46% females were represented in the institutional model and only 39% were represented in the program model. In addition, 27% Asian, 66% White, and 35% international students were represented in the institutional model in comparison to 35% Asian, 61% White, and 45% international students in the program model. Furthermore, the proportion of fields of study in the institutional model was fairly even, whereas most fields of study in the program model focused on Hard Pure (38%) and Hard Applied fields (30%). Based on the different representations of student demographics, it was reasonable to believe that the institutional model depicts an overall picture of doctoral recipients nationally, whereas the program model was more STEM focused.

**Program Level Variables**

Program level variables in the model came from the Assessment of Research Doctoral Programs from the NRC in 2006. Using rigorous methodology, NRC calculated rankings on overall program quality ranking, research activity ranking, and diversity ranking. The assessment also included information on program median GRE scores on verbal and quantitative reasoning. Additionally, the field of study variables were recoded based on the Biglan’s (1973) Classification of Academic Disciplines: Hard Pure, Hard Applied, Soft Pure, and Soft Applied. Table 5 describes the number of programs and program characteristics in the institution model.
Table 5

*Program Level Variables - Descriptive Statistics*

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hard Pure</td>
<td>24</td>
<td>.38</td>
<td>-----</td>
</tr>
<tr>
<td>Hard Applied</td>
<td>19</td>
<td>.30</td>
<td>-----</td>
</tr>
<tr>
<td>Soft Pure</td>
<td>18</td>
<td>.29</td>
<td>-----</td>
</tr>
<tr>
<td>Soft Applied</td>
<td>2</td>
<td>.03</td>
<td>-----</td>
</tr>
<tr>
<td>Program Ranking</td>
<td>63</td>
<td>21.24</td>
<td>23.60</td>
</tr>
<tr>
<td>Research Activity Ranking</td>
<td>63</td>
<td>21.07</td>
<td>23.88</td>
</tr>
<tr>
<td>Diversity Ranking</td>
<td>63</td>
<td>29.92</td>
<td>28.34</td>
</tr>
<tr>
<td>Median Program GRE</td>
<td>63</td>
<td>693.61</td>
<td>73.99</td>
</tr>
</tbody>
</table>

**Institution level variables.** Institutional variables in the model used characteristics collected by IPEDS. IPEDS contains nine interrelated survey components collected over three periods each year, reflecting the most accurate information on an institution.

Since the two-level model did not include any program level characteristics, gender and racial proportions were aggregated based on the percentages of female and underrepresented racial minorities (URM) institutionally. The proportion female variable was calculated based on the total number of female doctoral students in an institution divided by the total number of doctoral students in an institution. Proportion URM variable equaled the number of underrepresented minority students (non-White, non-Asian) in an institution divided by the total number of students in that institution. Table 6 depicts the number of institutions that were included in the analysis and institutional backgrounds.

Two variables, Carnegie Classifications and urbanization, have been reorganized. Master’s college/university, Bachelor’s college/university, and special focus institutions were merged into one variable. Institutions located in suburban, town, or rural areas were lumped together as one variable.
Table 6

*Institution Level Variables - Descriptive Statistics*

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Institution Model</th>
<th>Program Model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean</td>
</tr>
<tr>
<td>Proportion Female</td>
<td>445</td>
<td>.55</td>
</tr>
<tr>
<td>Proportion URM</td>
<td>445</td>
<td>.39</td>
</tr>
<tr>
<td>Private</td>
<td>201</td>
<td>.45</td>
</tr>
<tr>
<td>Private For-Profit</td>
<td>5</td>
<td>.01</td>
</tr>
<tr>
<td>Public</td>
<td>239</td>
<td>.54</td>
</tr>
<tr>
<td>Research University with high research activity</td>
<td>151</td>
<td>.35</td>
</tr>
<tr>
<td>Doctoral/Research University</td>
<td>107</td>
<td>.24</td>
</tr>
<tr>
<td>Other College/University (Master’s, Bachelor’s, Special Focus Institution)</td>
<td>179</td>
<td>.41</td>
</tr>
<tr>
<td>City</td>
<td>315</td>
<td>.71</td>
</tr>
<tr>
<td>Other (Suburban, Town, Rural)</td>
<td>120</td>
<td>.29</td>
</tr>
<tr>
<td>Minority-Serving Institution</td>
<td>37</td>
<td>.08</td>
</tr>
<tr>
<td>Non-Minority-Serving Institution</td>
<td>408</td>
<td>.92</td>
</tr>
</tbody>
</table>

**Multilevel Modeling Results**

Due to the nature of clustered data and oftentimes failure to account for the structure of observations, standard errors from traditional regressions tended to be smaller than the actual standard errors. As a result, the underestimation was more likely to increase Type I error, rejecting a true null hypothesis and concluding that the results were statistically significant when they might not be (Kreft & De Leeuw, 1998; Raudenbush & Bryke, 2002). With a data structure of doctoral recipients nested with academic programs, which were then nested within higher education institutions, it was ideal to employ a multilevel modeling approach to examine the operative hypotheses. Furthermore, multilevel modeling was able to investigate interactions at both student and institutional levels. For example, in this study, I allowed the level-one gender slope to vary by institutions to predict differences in the gender effect between universities. Examining interaction relationships between two levels cannot be achieved in ordinary least squares regression (OLS) or correlation procedures.
An unconditional model was created for the two-level model (students nested within institutions) and the three-level model (students nested within programs and programs nested within institutions), respectively. The intraclass correlation coefficients (ICC) were calculated to determine the amount of variance associated with program and college affiliation. In the two-level model, the unconditional model yielded an ICC of 22%, which indicated that 22% of the variability in predicting doctoral time-to-degree was accounted for by institutional affiliation. In the three-level model, three ICCs were calculated, yielding variance between students as 79%, variance explained by program affiliation 16%, and explained by institutions 5%.

Results from the generalized hierarchical linear models are shown as follows. Table 7 provides the coefficients, standard errors, and levels of significance for the full model from the two-level model and the full model from the three-level model. The unconditional model, model with student level variables (within model), model with both student and institution level variables (between model), and lastly the random slope model which allows female to vary by institution (full model) are presented in the Appendix.

Results from the institution model and program model are fairly consistent. Since the institution model was more nationally representative than the program model, I present results from the institution model. At the end of the discussion, I highlight notable differences between program model and institution model.

Gender had a relatively small association with doctoral time-to-degree. Female students took one month longer to graduate than male students. The institution model also allowed female to vary as a random slope at the institution level. None of the variables I included to model the female slope were statistically significant.

At the student level, the models confirmed that race/ethnicity, citizenship, disability status, marital status, number of dependents at different ages, parental education attainment,
amount of tuition remission, and type of financial support were all significant predictors to doctoral time-to-degree. Specifically, Hispanic students took five months shorter than White students to obtain their doctorate while Asian and Black students took approximately two months and four months longer, respectively, to complete. US students on average took eight more months than their international counterparts to obtain a doctorate. In addition, students with disabilities took 17 months longer to complete their degree than those without disabilities. In terms of marital status, students who were married as well as students who were divorced, separated, or widowed completed their degree at a slower pace than their peers who were never married, by approximately 16 months.

The institution model found that number of dependents also had a significant association to time-to-degree. Interestingly, with every one dependent increase in dependents under the age of five, students’ time-to-degree would decrease by 9.5 months. On the other hand, with every one dependent increase in dependents between ages six and 18, students’ average time-to-degree would increase by seven months; every one dependent increase in dependents older than 18 years old would result average time-to-degree to increase by 15 months.

Parental highest education achievement was another significant predictor to doctoral time to degree attainment. In comparison to students who had a parent who had a college degree, students whose parents had a high school degree took 12 more months to complete while students who had a parent with a master’s degree or a doctorate took seven months and five months less time to complete, respectively.

Amount of tuition remission and type of financial support also significantly predicted doctoral time-to-degree. Students who had no tuition remission or partial tuition remission all took significantly longer time to obtain their doctorate than their peers who had full tuition
remission. More specifically, students with no tuition remission would take 21 months longer to complete, while students who had 2/3 tuition remission would take nine months longer to complete when compared with their peers with full tuition remission. In comparison to students on research assistantships, students who relied on loans and personal savings took 11 months and 47 months longer to complete, respectively. Students who relied on teaching assistantships spent five more months to complete. Students on fellowships also took longer to complete by two months.

At the institution level, the models found type of institution and institutions’ Carnegie Classifications to be significant factors associated with time-to-degree. Female proportion as well as degree or urbanization were not significant predictors at the institutional level. Students at private institutions on average took five more months to complete their doctorate than their peers at public institutions. In addition, students at doctoral/research universities and students at Masters/Bachelors or special focus institutions all took significantly longer time to complete than students at research universities with high research activity by seven months and 12 months, respectively.

Proportion of URM students was significantly associated with time to degree attainment. With every 10% increase in URM representation at the institution level, student time to degree attainment would increase by three months. The model found that students studying at non-minority-serving institutions took 12 months longer than their counterparts at minority-serving institutions.

At the program level, fields of study, median program GRE, and program diversity ranking were significant predictors associated with doctoral time-to-degree. In comparison to students in Hard Applied fields, students in Hard Pure fields took nine months shorter to
complete their doctorate, while students in Soft Pure fields took ten months longer to complete. I found that median program GRE score was a significant predictor to time-to-degree. With every 100 point increase in median program GRE score, students on average completed the degree at a faster pace by over eight months.

To account for program level differences, I also modeled the effect of program rankings, including overall program ranking, research activity ranking and diversity ranking on time to degree attainment. Neither overall program ranking nor research activity ranking significantly impacted time-to-degree. On the other hand, program diversity ranking was associated with time-to-degree. Diversity ranking was measured by the number of faculty and students who were female and minority. The program model confirmed that students who studied in an environment that had higher percentages of female and racial minorities tended to complete the degree faster than their counterparts who had fewer female and minority representations in the academic programs.

Results from institution model and program model were consistent with a few exceptions. At the student level, gender was not a significant predictor to time-to-degree in the program model. Female and male students completed their degrees at a similar pace. Additionally, Black students took the same amount of time to graduate compared to White students. US students and international students also used the same amount of time to graduate.

While the institution model found that number of dependents between the age of six and 18, as well as dependents older than 19, significantly impacted students’ time to degree attainment, they were not associated with longer time to graduation in the program model. In terms of types of financial support received, students on fellowships completed their degree at the same pace as students on research assistantships.
At the institution level, students’ time-to-degree was not affected by proportion of URM in the program model. However, the institution model found that proportion of URM affected time it took students to earn their doctorate.

Table 7

*Full-Model Results from Institution Model and Program Model*

<table>
<thead>
<tr>
<th></th>
<th>Institution Model</th>
<th>Program Model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>Std. Error</td>
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<tr>
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<tr>
<td>Male (Reference)</td>
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<tr>
<td>Female</td>
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<tr>
<td>Female × Female Composition</td>
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<td>0.43</td>
</tr>
<tr>
<td>Female × URM Composition</td>
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<td>0.74</td>
</tr>
<tr>
<td>Female × Private</td>
<td>-0.05</td>
<td>0.69</td>
</tr>
<tr>
<td>Female × Doctoral/Research University</td>
<td>-0.08</td>
<td>0.09</td>
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<tr>
<td>Female × Other College/University (Master’s, Bachelor’s, Special Focus Institution)</td>
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<tr>
<td>Female × Other (Suburban, Town, Rural)</td>
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<td>Female × Minority-Serving Institution White (Reference)</td>
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<td>Native Hawaiian</td>
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<td>Asian</td>
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<tr>
<td>Black</td>
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<td>Other Race (American Indian, Native Hawaiian)</td>
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<td>Handicapped (Reference)</td>
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<td>Non-Handicapped</td>
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<td>US Student</td>
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<td>Married</td>
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<tr>
<td>Other (Divorced/Separated/Widowed)</td>
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<tr>
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<td># of Dependents 6 -18</td>
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<td># of Dependents &gt;19</td>
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Table 7 (continued).

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<th>Variable</th>
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<td>1.11***</td>
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<tr>
<td>2/3- Less than full Tuition Remission</td>
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<td>0.03</td>
<td>0.90***</td>
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Program Level

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<td>Hard Pure</td>
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<td>Soft Pure</td>
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<td>Soft Applied</td>
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<td>Program Median GRE</td>
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<td>Diversity Ranking</td>
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Institutional Level

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<tr>
<td>Proportion Female</td>
<td>0.59</td>
<td>0.66</td>
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<td>Proportion URM</td>
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<td>0.98</td>
<td>4.97</td>
<td>2.98</td>
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<td>Public (Reference)</td>
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<td>Private</td>
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<td>0.14</td>
<td>0.23*</td>
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<tr>
<td>Research University with high research</td>
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<td>activity (Reference)</td>
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<td>Bachelor’s, Special Focus Institution)</td>
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<tr>
<td>Other (Suburban, Town, Rural)</td>
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<td>0.16</td>
<td>-0.02</td>
<td>0.11</td>
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<td>Non-Minority-Serving Institution (Reference)</td>
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<td>Minority Serving Institution</td>
<td>-0.98*</td>
<td>0.45</td>
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</table>

*** p < .001, ** p < .01, * p < .05
Results

This study investigated the impact of individual, program, and institutional characteristics on doctoral time-to-degree. Four research questions were developed to guide the study. Next, I provide results of the data analysis that answers each research question.

1. To what extent do student traits of gender, race/ethnicity, citizenship, disability status, marital status, number of dependents, parental educational backgrounds, sources, and types of financial support received predict doctoral time-to-degree?

Cultural Capital Theory was the predominant approach used to understand the driving factors that were associated with doctoral time-to-degree in this study. As shown in research question one, a series of variables representing Human Capital Theory and Cultural Capital Theory were used to construct the multilevel models. Results of this study suggested that race/ethnicity and parental highest education attainment significantly and consistently impacted time-to-degree.

In comparison to the reference group of White students, Hispanic students took significantly shorter time to obtain the doctorate while Asian students consistently took longer time to complete the degree. In the institution model, Black students also took significantly longer time than their White counterparts to complete; the difference between Black and White students was not statistically significant in the program model.

I also explored to what extent parental educational backgrounds were associated with time to degree completion. Results from the analysis showed that parental educational background played a significant role in students’ educational achievement measured by doctoral time-to-degree. Specifically, students whose parents who only had a high school degree consistently and significantly spent longer time to complete their doctorate degree when
compared to the reference group whose parents had a college degree. On the other hand, students whose parents had advanced degrees (master’s and PhD) consistently took significantly shorter time to obtain the degree when compared to the reference group of students whose parent had a college degree.

Additionally, US students were found to complete their degree at a statistically significantly slower pace than their counterparts of international students in the institution model. The difference was not statistically significant in the program model.

Human Capital Theory was another primary approach used to guide the study. Under the human capital construct, marital status, number of dependents, physical abilities, amount of tuition remission, and type of financial support all significantly affected time to degree completion. In both models, students with physical disabilities took significantly longer time to complete their doctorate by over 16 months. In addition, the models confirmed that marital status was strongly associated with doctoral time-to-degree. Students who were never married took less time to complete than their peers who were married or separated/divorced/widowed. In the institution model, the difference of time to completion between married and never married students was 16 months whereas the difference was approximately 12 months in the program model.

I investigated the impact of number of dependents at different age groups on students’ time to obtain the doctorate and found that the number of dependents under the age of 5 positively impacted time-to-degree, contrary to my prior belief. In the institution model, number of dependents between six and 18 as well as number of dependents over the age of 18 negatively impacted doctoral time-to-degree. However, the difference was not statistically significant in the program model.
I also examined the impact of tuition remission and types of financial support on time-to-degree. Students who had full tuition remission were consistently found to complete the degree at a faster pace than any other types of tuition remission (no tuition remission, less than 1/3 tuition remission, 1/3-2/3 tuition remission, 2/3 tuition remission to less than full tuition remission). Specifically, in comparison with students who had full tuition remission, students who did not receive any tuition remission took more than 20 months to complete in the institution model. In the program model, while the difference between non-tuition remission receivers and full tuition remission receivers decreased to 12 months, it was still significant. Furthermore, in terms of type of financial support, students who relied on personal savings took significantly longer than their peers who had research assistantships. In the institution model, the difference between the two groups was as long as four years whereas in the program model, the difference between the two groups was approximately three years.

2. To what extent does departmental context of field of study, rankings, and program demography predict doctoral time-to-degree?

In addition to Cultural Capital Theory and Human Capital Theory, measures from the Organization Impact Model were also used to predict time to doctoral completion. In terms of fields of study, students in hard pure fields completed the degree faster by over eight months in comparison to hard applied fields. Students in soft pure fields, however, took significantly longer time than their counterparts in hard applied fields by approximately 10 months. I did not find any differences on time-to-degree between students in soft applied fields and hard applied fields.
I found that median program GRE score was a significant predictor to time-to-degree. With every 100 point increase in median program GRE score, students on average completed the degree at the faster pace by eight months.

I also modeled the effect of program rankings, including overall program ranking, research activity ranking, and diversity ranking on time to degree attainment. Neither overall program ranking nor research activity ranking significantly impacted time-to-degree. On the other hand, program diversity ranking was associated with time-to-degree. Diversity ranking was measured by the number of faculty and students who were female and minority. The program model confirmed that students who studied in an environment that had higher percentages of female and racial minorities tended to complete the degree faster than their counterparts who had fewer female and minority representations in the academic programs.

3. To what extent do institutional characteristics of female demography, URM demography, institution type, degree of urbanization, and MSI indicator predict doctoral time-to-degree?

Literature on institutional impact on doctoral time-to-degree has always been scarce. To date, it is still unclear if institutional characteristics play a role on degree progress. This study incorporated several variables that measured institutional characteristics including proportion of female students, proportion of URM, types of institution, Carnegie Classification of institutions, degree of urbanization, and minority-serving institutions. I failed to find consistent and significant relationships of proportion of female students and degree of urbanization on doctoral time-to-degree.

It is worth noting that Carnegie Classifications of institutions is a significant predictor of time-to-degree in both models. Doctoral students studying in doctoral/research universities,
master’s colleges/universities, bachelor’s colleges/universities, or special focus institutions all completed the degree at a significantly slower pace than their peers at research universities with high research activity. In addition, students at private institutions on average took longer time to complete than those at public institutions.

I found metrics measuring diversity in the institution model, including the proportion URM and the minority-serving institution indicator, significantly associated with time-to-degree. Specifically, with every 10% increase in the representation of URM students at the institutional level, students’ time-to-degree would increase by 2.5 months. However, students at non-minority-serving institutions took 12 months longer to complete the doctoral degree than students at minority-serving institutions.

4. To what extent do the relationships between institution characteristics and doctoral time-to-degree vary by gender?

Due to the complexity of the models and limited number of records in the three-level model, interaction effects were only examined in the two-level model (students nested within institutions). I investigated the relationships between institution characteristics and doctoral time-to-degree varied by gender. Institution characteristics included proportion female, proportion URM, institution type, institution’s Carnegie Classification, degree of urbanization, and minority-serving institution. Model results suggested that the relationships between institution background and doctoral time-to-degree did not vary by gender.

Summary

In this study, I constructed two models, the institution model with students nested within institutions and the program model with students nested within programs and programs nested within institutions, to examine the impact of individual, program, and institutional factors on
doctoral time-to-degree. At the student level, race/ethnicity, disability status, parental educational background, amount of tuition remission, and types of financial support consistently predicted doctoral time-to-degree. Additionally, at the program level, program median GRE score, program diversity ranking, and academic disciplines were found to be significant predictors of time-to-degree. At the institution level, institution type and Carnegie Classifications of institution consistently predicted doctoral time-to-degree.

Chapter Five explains the findings in detail. I examined the findings in the context of existing literature and theories that guided the study. I also discuss implications and practical applications based on findings of the study.
CHAPTER FIVE: DISCUSSION AND CONCLUSION

The objective of my research was to present a model that predicts time-to-degree among doctoral students based on individual backgrounds, departmental components, and institutional affiliations. More specifically, this study used multilevel modeling to examine how doctoral students’ personal backgrounds (e.g., gender, race/ethnicity, citizenship, disability status, marital status, number of dependents, and parental education background); financial support reception; department and program components (e.g., field of study, graduate program rankings, median program GRE); and institutional contexts (e.g., proportion female, proportion URM, institution type, Carnegie Classification, degree of urbanization, minority-serving institution) function individually to affect doctoral time-to-degree. The study also highlighted elements that may attribute to discrepancies in time-to-degree of several subpopulations (e.g., female, racial minorities, and first-generation students). Additionally, the study aimed to investigate the institutional impact that universities have on time-to-degree once individual level and program level factors have been accounted for.

The findings of my study suggest that race/ethnicity significantly and consistently has an impact on time-to-degree. Additionally, parental highest educational achievement played a significant role in students’ educational achievement measured by doctoral time-to-degree. Similarly, factors such as marital status, disability status, amount of tuition remission, and type of financial support all significantly and consistently affected time to degree completion.

The results of my study also exhibited a significant and consistent relationship between program factors and doctoral time-to-degree. Departmental factors include the field of study, program diversity rankings and median program GRE. Several predictors at the institutional level also significantly impacted time-to-degree for doctoral students, including institution type,
institutions’ Carnegie Classification, minority-serving institution indicator, and proportion of female students measured by the percentage of female students in an institution. However, institutional characteristics such as degree of urbanization of the institution were insignificant to time-to-degree for doctoral students.

I also investigated whether the connection between institutional affiliations and time-to-degree for doctoral students varied by gender. Model results indicated that the relationships between institution background and doctoral time-to-degree did not vary by gender.

The following section discusses the questions and results as derived from my study. This part also situates my findings in the current literature, as well as addresses implications for research, policy, practice, and theory. I next explore, in greater depth, the results obtained for each of the research questions within the context of the prior research.

**Research Question 1**

1. *To what degree do student traits of gender, race/ethnicity, or citizenship, disability status, marital status, number of dependents, parental educational backgrounds, amount of tuition remission and types of financial support receive predict doctoral time-to-degree?*

Results of this study suggest that race/ethnicity significantly and consistently impacted time-to-degree. In comparison to the reference group of White students, Hispanic students took significantly shorter time to obtain the doctorate while Asian and Black students took significantly longer time to finalize the degree. Additionally, international students were found to complete their degree at a significantly faster pace than their counterparts of domestic students.
Previous researchers found that African American and Latin American students accounted for 14.4% and 9.6% of doctoral student enrollment in 2005, respectively (NCES, 2017). While we have seen an increase in the participation in doctoral education by URM students in most recent years (NSF, 2018), only 8% of doctorate degrees were granted to African American students and 7% to Hispanic or Latino students around the same time. Percentage of American Indian or Alaska Native doctoral recipients has remained under 1%. For time-to-degree in 2005, Asian American students took the shortest total time, 8.8 years, and their Hispanic, American Indian, and African American counterparts took 10.3 years, 12 years, and 12.7 years, respectively, to obtain their degrees (Hoffer et al., 2006). My study suggests that it took Asian American students approximately two more months to complete the doctorate than their White peers, holding all other factors equal. On the other hand, African American students took significantly longer time to graduate than their White counterparts by approximately four months. My study contradicts Hoffer et al.'s (2006) study and showed that Hispanic students completed their doctoral degree at a significant faster pace than their White counterparts. More specifically, holding all other factors equal, Hispanic students on average took approximately four and half months shorter than White students to complete. It is worth emphasizing that this study only investigated completers and their time-to-degree. Existing data of this study was not able to examine students that dropped out of doctoral programs and their characteristics. While Hispanic students may seem that they take less time to graduate than their peers, they comprised less than 1% of the doctoral recipients in the Institution Model and approximately 6% in the Program Model. Combining with enrollment data provided by NCES (2017), it is possible that there may be a large number of students that exited their programs without the degree. These Hispanic students were unaccounted for in this study.
Scholars have proposed that the racism deep-rooted in the higher education social practices impact and upset African American students’ experiences (Allen, 1992; Clark, Dyar, Maung, London, & Gibbs, 2016; Mcgee & Martin, 2011; D’Augelli & Hershberger, 1993; Howard-Hamilton et al., 2009; Lewis et al., 2004; Solorzano, 1998; Wasburn-Moses, 2007). Researchers found that underrepresented students experienced individual and institutional racism on a regular basis (Lewis et al., 2004). In addition, minority students often encountered racism, stereotyping, and assumptions while interacting with faculty members in their respective departments (Griffin et al., 2012). Moreover, minority students battle with sentiments of social segregation and tokenism, displayed in a model such as being the sole individual of a different skin color in a class, an absence of mentorship of the same racial/ethnic background, and being relied upon to represent their racial/ethnic group (Gay, 2004; Howard-Hamilton et al., 2009; Lewis et al., 2004; McNair, 2003; Steele, Aronson, & Kruglanski, 1995; Watt, 2003;).

Through studies that probed the concepts of minority doctoral students in specialized curriculum programs, African American and Asian colleagues indicated less satisfaction with their experiences than their White and Latin American counterparts (Wasburn-Moses, 2007). Furthermore, African American students reported feeling less prepared overall for their positions and for successfully publishing research in refereed journals in comparison to their White and Hispanic/Latino American peers (Wasburn-Moses, 2007). Research shows that URM students obtained doctorate degrees at a disproportionately depressed pace than their White peers, especially in engineering and scientific fields (NSF, 2009; Tull et al., 2012; Woodrow Wilson, 2005). However, most of the studies in this area are qualitative inquiries in nature that have concentrated on experiences of minority graduate students (Griffin et al., 2012; Lewis et al., 2004; Nettles, 1990). My findings are in line with previous researchers and have confirmed that
minority students such as African American and Asian students do spend a longer time earning their doctorate in comparison to their White counterparts. However, my findings contradict with existing literature related to Hispanic/Latino students’ experience in higher education and graduate education. In comparison to the reference group of White students, Hispanic students took significantly shorter time to obtain their doctorate by approximately four and half months. The significance may be caused by the overrepresentation of White students and underrepresentation of Hispanic students in the sample. Approximately 66% of the population in the dataset was White, while only 0.6% was Hispanic. Nevertheless, the significance of race/ethnicity on doctoral time-to-degree cannot be underestimated. Minority students face institutional racism, isolation, and hegemonic ideologies while pursuing their doctorate degree, especially at PWIs; these challenges inevitably impact their persistence and time-to-degree (Acosta et al., 2015; Barker, 2011, 2016).

I also explored to what extent parental educational achievement impacted time to doctorate degree completion. Results from this analysis showed that parental educational background played a significant role in students’ educational achievement measured by doctoral time-to-degree. Specifically, students whose parents only had a high school degree consistently and significantly spent longer time completing their doctorate degree when compared to the reference group whose parents had a college degree by 12 months. On the other hand, students with at least one parent who had an advanced degree (e.g., master’s or Ph.D.) consistently took lesser time to obtain the doctorate degree when contrasted to the reference group of students whose parent had a college degree by six months and five months, respectively.

Previous studies show a strong relationship between parental educational attainment and students’ educational aspirations. Past research has disclosed that students’ educational
achievement is highly associated to the educational attainment of their parents (Andres et al., 2007; Blau & Duncan, 1967; Davis-Kean, 2005; Dubow et al., 2009; Hamilton & Hamilton, 2006). In a longitudinal study that examined the impacts of parents' training on children's educational achievement, Dubow et al. (2009) found a strong association between parental educational attainment and students’ educational achievement. Students with highly educated parents were found to be more likely to develop higher education aspirations by 19, and this ultimately resulted in an immense level of educational attainment as an adult.

In another study, Davis-Kean (2005) investigated how parents’ educational background and income affected students’ academic achievement. The researcher found that the number of years in education that parents received was strongly correlated with how they interacted with their children in terms of structuring their home environment and promoting academic achievement. More specifically, more than 50% of the variance in the model was explained by parents’ educational attainment.

In a more recent study, Torch (2011) examined intergenerational mobility in terms of SES, career choices, earnings, and household income using five longitudinal datasets. Torch (2011) found that the intergenerational association is significantly strong among those with low educational achievement and those with advanced degrees. Parental educational background was among a few factors that explained children’s choice in college, field of study, and future earnings. Since parental education background is often associated with family income and SES, parents that have bachelor’s or advanced degrees are more likely to have the financial resources, academic qualifications, and communities that can support in various facets of a student’s academic journey. On the other hand, first generation doctoral students often experience
isolation, financial challenges, and lack of support from both parents and faculty (Gardner & Holley, 2011).

Though the majority of the existing literature suggests that parents’ education level has a direct, positive effect on students’ academic achievement, many have focused on the impact at the undergraduate level. This study sought to extend our knowledge on the impact of parental education background on children’s education achievement and confirmed a consistent, positive association between parental education achievement and the length of time their children took to obtain their doctorate. Parental education level in this study was measured by the highest educational achievement of either side of parent. For instance, if a student’s mother has a Master’s degree and his/her father has a PhD, the father’s degree was included in the analyses.

Educational capital is an important aspect of cultural capital theory (Bourdieu, 1977). Findings from my study support the notion in cultural capital theory that middle class to upper middle class families who are generally educated at a higher level than working class families provide more support to their children, even at the doctoral level. Not only can they help coach their children on homework throughout their school year, parents who have advanced degrees also play a positive role in supporting their children in their doctoral years. Parents with advanced degrees often are more involved in students’ academic journeys, helping them navigate the higher education system and identify resources available. Undeniably, different forms of capital in the United States higher education system assist some students while obstructing others who do not have previous knowledge or experience.

Human capital theory (Becher, 1962; 1980) was another primary approach used to guide the study. Under the human capital construct, marital status, physical abilities, and source and type of financial support all significantly affect time to degree completion. Students who were
never married consistently took a shorter time to finalize the degree than their fellows who were married, divorced, separated, or widowed. It is likely that students who were never married have less responsibilities and commitments than those who were married, divorced, separated, or widowed. Unmarried students tend to have more time to focus on schoolwork and research as a doctoral student; however, past studies found that matrimonial status did not serve as an important predictor of time-to-degree or productivity (Seagram, Gould, & Pyke, 1998; Sheridan & Pyke, 1994; Yang & Webber, 2015). In a study that examined 698 graduate students admitted to various disciplines at a university, Sheridan and Pyke (1994) did not find marital status to be a significant predictor associated with length of time-to-degree at the doctoral level although the researchers have also pointed out that the result may have been due to sample size deficiency. My study contradicted findings from Sheridan and Pyke (1994), finding instead that marital status indeed impacted doctoral time-to-degree. The findings from this study were in line with more recent studies confirming that marital status does impact doctoral success (Lott et al., 2009; Wollast et al., 2018). After examining 1,509 doctoral students at two European institutions, Wollast et al. (2018) confirmed that marital status was one of the four factors that significantly affected doctoral dropout rate. Students that were married were more likely to graduate in eight years. Contrary to the findings in Wollast et al.’s (2018) study, this study found that being single positively associated with time-to-degree. The location where the three studies occurred may have contributed to these differences. While my study drew a sample of doctoral recipients from United States’ institutions, the other two studies occurred in Europe and Canada (Sheridan & Pyke; Wollast et al., 2018).

Research on doctoral students with disabilities has always been scarce. Students with disabilities face many challenges in the higher education setting, such as negative attitudes and
stereotypes, lack of accommodation, and inadequate resources. As a result, the ways students with disabilities are being treated play a vital role in their success or failure in higher education (Fichten, 1988; Rao, 2002; Williamson, 2000). In one study, Junco (2002) found that faculty’s negative attitudes towards students with disabilities prevented students from advocating for themselves. This study extended our knowledge about a subpopulation within doctoral students: doctoral students with disabilities. The study concluded that students who reported having disabilities consistently took significantly more time to complete their doctorate degree than students who did not have any disabilities by over 16 months. While it may be normal for students with disabilities to take longer to complete their degree, since students with disabilities often request an extension on exams and assignments, we also have to take into consideration that prolonged time to degree has two major consequences. First, lengthy time-to-degree is often associated with higher attrition rate. Secondly, lengthy time-to-degree incurs additional costs, including opportunity costs, forgone earnings, and tuition and fees that students have to undertake.

I also investigated the effect of tuition remission and types of financial support to time-to-degree. Students who had full tuition remission were consistently found to complete the degree at a faster pace than any other types of tuition remission (no remission, less than a third tuition remission, a third to two-thirds tuition remission, fewer than complete tuition remission). Past research investigating financial help and assistance accessible to doctoral students has consistently found that the sort of financial help students gets in school impacts time-to-degree (Abedi and Benkin, 1987; Ampaw and Jaeger, 2011; Breneman, 1976; Kim & Otts, 2010). Research has likewise proposed that students who receive assistantships will most often fully finalize their doctoral degree (Ampaw & Jaeger, 2011; Ehrenberg & Mavros, 1995; Mendoza et
al., 2014). On the other hand, this study extends our knowledge that students who relied on personal savings or loans took significantly longer than their peers who had research assistantships. It is very likely that students who had relied on personal savings and loans had to complete their doctorate on a part-time basis. As a result, it is also “normal” that they take longer time to graduate than full-time doctoral students. However, the main concerns with student loans is not simply the total balance students are left to repay in addition to years of accrued interests. Another reality facing doctoral recipients is that their salary may not sufficiently cover loan payment upon graduation, especially for those that graduated from for-profit institutions (Deming, Goldin, & Katz, 2018; Perna, Kvaal, & Riz, 2017).

My student-level models provided insightful findings. Race/ethnicity, marital status, number of dependents under the age of five, parental education background, amount of tuition, and types of financial support, all consistently and significantly impacted doctoral time-to-degree. My student level findings accounted for approximately 78% of the individual variance in both Program Model and Institution Model, indicating that the student level models have incorporated a majority of demographic factors associated with time-to-degree.

**Research Question 2**

2. To what extent do departmental context of the field of study, rankings, and median program GRE predict doctoral time-to-degree?

Past research on doctoral education suggests that academic department has a more significant influence on doctoral students than the institution as a whole (Bowen & Rudenstine, 1992; Greene, 2015; Joy et al., 2015; Nerad & Miller, 1996; Zhou & Okahana, 2019). Unlike undergraduate students who are more likely to be influenced by institutional climate, doctoral students are more apt to be affected by their academic departments since admissions policies,
financial aid, completion requirements, and curriculum design are all established and overseen by each faculty or program (Golde, 2005; Joy, Liang, Perry, & Bilimoria, 2014; Lovitts, 2001; Main, 2018; Tinto, 2003; Main, 2018). After analyzing departmental data from two research-intensive institutions, Main (2018) concluded that completion rates for female doctoral students were higher in departments with a higher proportion of female faculty. Additionally, female doctoral students who worked with female advisors had higher completion rates in comparison to female students who worked with male advisors. My study confirmed Main’s (2018) findings that representation of female faculty positively and strongly impacted doctoral student outcomes.

As Lovitts (2001) pointed out, the departments differ in funding, culture, socialization process, academic rigor, and degree expectations; such differences greatly impact the experiences of the faculty, staff, and students. Research that concentrated on the impact of disciplinary context on doctoral completion has largely focused on one discipline at one institution (Arocho, 2017; Cohen, 2011; Gardner, 2010a; Green & Kim, 2005; Kim, Benson, & Alhaddab, 2018; Liechty et al., 2009; Malone et al., 2004; Potvin & Tai, 2012). Moreover, most of the research has concentrated on the demographic traits of students who completed or who dropped out from their program (Ampaw & Jaeger, 2011; Gardner, 2010b; Grove & Wu, 2007; Most, 2008). This particular study examined departmental characteristics of 63 doctoral programs. In addition to fields of study and GRE, the models also incorporated metrics that have rarely been included in previous research, such as academic rigor measured by research activity ranking and proportion of female and minority faculty measured by diversity ranking. This study extends our knowledge on departmental factors that impact doctoral time to degree. To a certain extent, findings of the study inform department head and graduate schools on pathways to shorten doctoral time-to-degree.
In addition to cultural capital and human capital theories, measures from the organization impact model (Berger & Milem, 2000) were also used to predict time to doctoral completion. I found that median program GRE score significantly impacted time-to-degree. More specifically, with every 100-point increase in median program GRE score, average time-to-degree decreased by eight months.

It has been long debated whether GRE scores predict graduate student performance. After examining 74 doctoral students enrolled in an educational administration program, Lindle and Rinehart (1998) found that GPA, analytic score on GRE, and the number of courses taken predicted faculty perceptions of student scholarship. GRE analytic scores also significantly related with faculty ratings. Other research on a larger scale also confirmed that GRE scores predict graduate student performance in a variety of areas (Kuncel, Hezlett, & Ones, 2001; Powers, 2004). Grove and Wu (2007) tested whether individual-level characteristics including GRE scores predicted Ph.D. completion in economics. Researchers found that the likelihood of obtaining a doctorate in economics expanded by 8% for every 50 points increase in one’s GRE score and by 3% for every 50 points increase in one’s GRE verbal score. On the other hand, studies suggested that GRE score had no impact on student completion (Burton & Wang; Sternberg & Williams, 1997; Walpole, Burton, & Kanyi, Jackenthal, 2002). Petersen et al. (2018) found that doctoral male students that left STEM programs had significantly higher GRE scores than those that graduated. GRE scores also failed to predict time-to-degree or first year attrition of male engineering students at four institutions. The discrepancies in findings may be due to different populations examined in different studies. While it is important to consider one gender (e.g., male students) or one program (e.g., education), it is also critical to obtain a holistic perspective of the role GRE played in doctoral time to degree at all fields at the national level.
This study sought to answer the question. Caution should be used to consider the impact of GRE on individual time-to-degree since the variable is aggregated at the program level. Further, even though students in programs with lower median GRE score may take longer to graduate, they are still completers regardless of time taken to complete. It is unclear from this study whether individual GRE score or program median GRE score affect doctoral student attrition.

Previous studies that focused on doctoral completion in multiple disciplines have largely been exploratory (Gardner, 2009; 2010; 2011; Golde, 2005; Le & Gardner, 2010; Szelényi, 2013) and only a few have used quantitative approaches to investigate the issue (Ampaw & Jaeger, 2011; Ehrenberg, 1995; Kim & Otts, 2010). A study that investigated factors affecting doctoral students’ satisfaction with their advisors found that advising behaviors differed greatly among different fields of study (Zhao et al., 2007). Another study conducted by Gardner (2010) comparing the socialization involvement in immense and depressed completion departments suggested that disciplinary contexts greatly influenced students’ experiences. In the institution she studied, departmental cultures and climate, in particular, “led to higher and lower completion rates at this institution” (p. 74). As a result, degree completion rates varied greatly among different academic disciplines. Research showed students in STEM disciplines generally complete at a higher rate and with a shorter time-to-degree than their counterparts in humanities and communal sciences (Haworth & Bair, 2005; Bowen, 1992; NSF, 2017).

I found that academic disciplines consistently and significantly affected doctoral time-to-degree. Students in soft pure and soft applied disciplines spent a significantly longer time to complete their doctorate contrasted with the reference group of hard applied disciplines. A few reasons may have contributed to why students in non-STEM fields took longer time to graduate than STEM fields: students in social sciences and education fields are more likely to be part-time
students. Their full-time job often prevents them from taking on a full doctoral course load or to focus exclusively on course work and research (Gardner & Gopaul, 2012). Additionally, students in social sciences and humanities take approximately four years to reach doctoral candidacy while students in STEM fields only take two to three years to reach the dissertation stage (Humanities Indicators, 2014).

My institution model enabled an investigation and integration of fields of study, program median GRE score, program overall ranking, research activity ranking, and diversity ranking at disciplinary level of analysis. These findings suggest that fields of study, in addition to median GRE and diversity ranking, significantly predict doctoral time-to-degree. On the other hand, program ranking and research activity ranking had no association with time-to-degree. An examination of the ICC showed that 16% of the variance was explained by these variables.

This study attempted to build models that explain factors that impact doctoral outcome beyond student characteristics. By incorporating departmental indicators, this study furthers our understanding of the level of complexity of doctoral education and measures institutions may consider taking to ensure student success at the departmental level. The importance of knowing the significance of program diversity ranking on doctoral time-to-degree should not be overlooked. This study is one of few that addressed faculty diversity and its impact from a quantitative perspective (Squire & McCann, 2018).

**Research Question 3**

3. *To what extent does institutional characteristics of proportion female, proportion URM, type, Carnegie Classification, the degree of urbanization, and minority-serving institution indicator predict doctoral time-to-degree?*
To date, it is still unclear if institutional characteristics play a role in doctoral degree progress. This study incorporated several variables that measured institutional characteristics, including proportion of female and URM students, type of institution, degree of urbanization, and whether institutions are minority-serving institutions (e.g., HBCU, Hispanic-serving institutions). While degree of urbanization had no association with time to degree, Carnegie classifications of institutions significantly impacted time-to-degree. Doctoral students studying in doctoral/research universities and other colleges/universities (master’s universities, bachelor’s universities, and special focus institutions) consistently completed the degree at a significantly slower pace than their peers at research universities with high research activity. In addition, students at private institutions consistently took longer time to graduate than those at public institutions. Lastly, it is also worth noting that students at minority-serving institutions took almost a year less to graduate than students at non-minority serving institutions.

The effect of institutional factors on undergraduate student experience and student outcomes has been well researched (Astin, 1984; Bean, 1987; Billson & Brooks, 1987; Collins et al., 2017; Delia Deckard, 2017; Golde, 1998; Ilhan, 2017; Rodríguez Amaya et al., 2018; Tinto, 1993; Welch & Hoffer, 2006). However, less attention has been paid to the effect of institution affiliations on doctoral student outcomes. According to NSF (2017), 82% of the doctorate recipients in engineering received their degree from universities with highest research activities, in comparison to 15% at universities with higher research activities and 2% at universities with moderate research activities. However, with their counterparts in education, 59% of the doctorate degrees were awarded by universities with highest research activities, and 30% and 8% were from universities with higher and moderate research activities, respectively. The institutional type may be one factor that impedes doctoral completion since the learning
environment at research universities tends to be highly competitive (Lovitts, 2001). Nevertheless, this study showed that doctoral students take less time to graduate from universities with highest research activities institutions than from those with lower level of research activities. Different levels of funding availability may have contributed to this phenomenon. Students tend to receive more resources and support services at universities with highest research activities, such as scientific writing support, funding to attend or present their research at conferences, or services to identify potential career paths. These resources may facilitate their research and enhance productivity.

While a plethora of studies have been conducted on doctoral student experience and outcomes, they have largely been focused at one institution (Campbell, 2015; Mathur et al., 2018; Mendoza-Denton et al., 2017; Ugwu & Adamuti-Trache, 2017). The limitation of study sites restricted researchers’ ability to examine to what extent institution context may impact doctoral student outcomes. Findings of this study found that doctoral students at public institutions took less time to graduate than their peers from private institutions. It is likely that with larger doctoral student populations at public institutions, students can find groups and peers that share similar interests. Community support is critical “in helping doctoral students combat their reported lack of support and isolation” (Shavers & Moore, 2014, p. 31). Shavers and Moore suggested that students chose not to quit their doctoral programs because they did not want to disappoint their communities that they formed at a public institution. The sense of belonging and community, among other factors, may simultaneously contribute to doctoral student productivity.

The missions and operations of minority-serving institutions are different from predominantly white institutions. At minority-serving institutions the need to educate a large
percentage of URM students is fulfilled (Gasman & Conrad, 2015). The level of influence of minority-serving institutions at the undergraduate level has emerged in the research over the last decade (Flores & Park, 2013; Fryer & Greenstone, 2010; Jackson & Rudin, 2019; Villarreal & Santiago, 2012). Using propensity score matching, Flores and Park (2015) investigated the effect of enrolling in a minority-serving institution on degree attainment of Hispanic and Black students. While initial differences did exist on degree attainment of URM students enrolled at minority-serving institutions in comparison to those at a predominantly white institutions, there was no longer a difference on bachelor’s degree completion rates of Hispanic and Black students after matching students with similar characteristics. This study extends our knowledge of the importance of minority-serving institutions beyond undergraduate level and suggests that these institutions have a positive impact on doctoral time-to-degree. With a history and mission of inclusiveness, minority-serving institutions promote a culture of affirmation and social justice and cultivate a sense of belonging that students may not always experience at predominantly white institutions.

My program model allowed for an examination and incorporation of various institution affiliations, including proportion female and URM, institution type (public vs. private), institution research activity, degree of urbanization, and minority-serving institution indicator. The findings suggest that institution type, research activity, and minority-serving institution indicator consistently and significantly impacted doctoral time-to-degree, whereas degree of urbanization and proportion of female students had no effect on time-to-degree. When we discuss doctoral students, persistence, and time-to-degree, we should note that not every adult learner is pursuing a doctorate at a public institution with very high research activity. Some may
be completing coursework or research at a private PWI with moderate to low research activity. Institution affiliations play a vital role in doctoral time-to-degree.

This study attempted to build a comprehensive model that furthers our understanding of doctoral time-to-degree. Student engagement and success can rarely be achieved unilaterally; rather, it is a continuous collaborative effort of the student, faculty, department, and institution. The wide range of measures that portray institution affiliations furnish more nuanced understanding of the complex nature of doctoral education.

**Research Question 4**

4. *To what extent do the association between academic disciplines and doctorate time-to-degree vary by gender?*

Due to the complexity of the models, interaction effects were only examined in the institution model (students nested within institutions). While I attempted to examine the random gender slope in the program model, the models failed to converge because of lost cases at program level and institution level.

Model outcomes suggest that the correlation between institution affiliations and doctorate time-to-degree did not vary by gender. The insignificance of interaction effects partially confirmed conclusions from previous literature that academic department has a bigger influence on doctoral students than the institution as a whole (Greene, 2015; Main, 2018; Zhou & Okahana, 2019). Unlike undergraduate students, doctoral students spend more time socializing and integrating into the discipline, rather than the institution. As a result, departmental culture and demography may have played a more salient role in doctoral student outcomes than overall institution context (Gardner, 2010; Golde, 2005; Joy et al., 2015).
Limitations of the Study

The current research faced a range of limitations partly hindering significant and consistent results. Previous researchers derived their data from exploratory qualitative studies that had small sample sizes, hence data was not representative of a larger doctoral student population. Additionally, complex studies have been limited by outdated data sources (Bowen & Rudenstine, 1992). Moreover, there has been limited access to large, representative datasets.

This study drew from the most representative national data of the SED administered by NSF. This survey data was ideal for the objectives of this study as the large national sample of doctoral recipients allowed for a close examination on the effects of factors (i.e., gender, race/ethnicity, citizenship, parental educational background, financial support, institutional type, urbanization, etc.) on time-to-degree for doctoral students at the individual, departmental, and institutional level. However, secondary data also has some limitations. The main limitation was that variables included in estimation models were limited to available variables in the SED data. For example, variables that measure doctoral student relationships and/or engagement are not included in the dataset. Several scholars have discussed the importance of faculty-student relationships and academic integration on doctoral degree persistence, including time-to-degree (Barnes & Gardner, 2007; Gardner, 2005; Golde, 2005; Main, 2018; Stolzenberg, 2006; Tinto, 1993). In addition, the SED data relied on self-reported data and only described characteristics of those individuals who earned a doctorate degree without considering attributes of those students enrolled in doctorate program who never graduated. Therefore, bias may occur as a result of not accounting for the differences between the entry group and the completion group. In addition, the data set does not contain information on all factors that may have contributed to
time-to-degree, for example variables such as: student-faculty relationship, peer relationship, family support, professional development, and academic involvement.

The 2006 NRC program rankings included a wide range of programs yet still missed by many doctoral programs offered at institutions with lower research activities. In addition, academic programs may not be completely matched and comparable due to the different program names used at different doctoral-granting institutions around the country; hence, this may cause inaccurate estimations when examining program level impact.

Despite the limitations of the SED data, it is the most appropriate data set because it includes a nationally representative sample of doctorate recipients and covers a wide array of variables from personal background to financial background of doctorate earners. Additionally, findings of this study have extended our existing knowledge on doctoral time-to-degree. The models used a newer dataset to examine doctoral recipients between 2002 and 2012. The models also allowed an investigation of program level and institutional level variables beyond student level. Lastly, model results shed lights on the importance of tuition remission and financial support at the student level, program diversity ranking at the program level, and institution affiliations at the institutional level, on time to degree completion.

**Implications of the Study**

**Implications for theory.** I employed Bourdieu’s (1977) cultural capital theory, Becker’s (1962; 1980) human capital theory, and Berger and Milem’s (2000) organizational impact model to examine various components at the student, program, and institution level that impact doctoral time-to-degree. These three theories not only served as the overarching framework to construct the models but helped make meaning of the significance of the variables.
Bourdieu’s (1977) cultural capital theory and Becker’s (1962; 1980) human capital theory constitute established theoretical lenses that have proven to be applicable to students’ experience and college choice (Aschaffenberg & Mass, 1997; Carter, 2003; Harvey, 2019; Imdorf et al., 2017; LePeau et al., 2018; McDonough, 1997; O’Shea, 2016). Higher education institutions tend to value and reward students who possess high-status cultural capital and are more likely to overlook students with low-status cultural capital, leaving them at risk for low engagement and success (Walpole, 2003). Additionally, education outcomes are often affected by financial and non-financial factors (Wolf, 2005). The third contributor to the framework, the organizational impact model (Berger & Milem, 2000) has been used to examine the impact of the departmental and institutional environment on students’ behavior and experiences. Berger and Milem (2000) also hypothesizes that institutional structural demographics characteristics (e.g., institution type, location, selectivity) influence student outcomes. The model comprises studies of organizational behavior of individuals and groups, culture, and climate.

My findings supported the research and highlighted the value of these three theories for understanding how individual, department, and institution simultaneously impact doctoral student outcomes. The implications for theory are twofold. First, the connection of cultural capital theory (Bourdieu, 1977) and human capital theory (Becker’s; 1962; 1980) offers a solid lens to examine the impact of individual demographics on doctoral time-to-degree. Second, beyond individual level, the organizational impact model (Berger & Milem, 2000) provides a worthy lens to investigate the effect of the learning environment, be it department or institution, on student degree progress. The Berger and Milem (2000) model has been used to investigate the effect of peer group and institutional characteristics on student outcomes measured by
persistence. This study suggested that the model can also be applied in doctoral education to
guide the examination of doctoral time-to-degree.

**Implications for policy and practice.** The results from this research contribute to
doctoral education in practice and policy. The knowledge provides graduate deans and higher
education administrators with data on several potential differences between doctoral students
who take longer or less time to obtain the degree. I have three specific implications for policy.
The first implication concerns providing services to doctoral students, especially to marginalized
student groups. Since the department, rather than institution, is the locus of the doctoral student
experience, the faculty-student relationship is one of the most critical components that either
facilitates or impedes time to doctoral completion. URM students are often times first-
generation students who rarely receive guidance on education from their parents. As a result, it
is critical that faculty provide clarifications on departmental expectations, outcomes, and
opportunities throughout students’ graduate years (Holley & Gardner, 2012; Howard, 2017;
Martinez, 2018; Roksa, Feldon, & Maher; 2018). It is also important that faculty pay attention
to students’ identity. Results of this study provide evidence on whether characteristics of a
student background, such as race/ethnicity, disability status, and parental education achievement
predict doctoral time-to-degree, which allow us to further understand the needs of
subpopulations and to develop programs that meet their needs. For instance, graduate schools
should take a lead into forming support groups to meet needs of different doctoral student
subpopulations. The groups should be led by a faculty advisor and clearly outline goals and
outcomes. Graduate program directors and deans can become more student-centered by listening
to different student groups and providing more intentionally designed programs geared toward
different student subpopulations with varying needs, including but not limited to minority
students, students with disabilities, and first-generation students (Barker, 2016; Deacon et al., 2017; Gardner, 2013; Jones, Wilder, & Osborne-Lampkin, 2013; Papay, Grigal, Hart, Kwan, & Smith, 2018; Pope & Edwards, 2016).

Additionally, the study highlighted the role financial support plays for time-to-degree. Students on full tuition remission completed their degree significantly faster than students with no tuition remission or partial tuition remission. Additionally, students that relied on loans or personal savings completed the degree at a significantly slower pace than students on assistantships and fellowships. It is incumbent that graduate schools provide adequate information about student loans and possible consequences for indebtedness upon graduation. Graduate program directors and faculty members may be capable of using the results to change practices and policies connected to tuition remission, scholarships, fellowships, and assistantships. Institutional planning officers and enrollment management officers at graduate schools might use findings regarding financial support on time-to-degree while reviewing institutional policies concerning doctoral student retention and doctoral program outcomes. For example, this study showed that students on research assistantships consistently take shorter time to graduate than students with teaching assistantships. Practitioners should explore the possibility of substituting teaching assistantships with research assistantships and incorporating teaching as a part of the research assistantships. Since financial support is a significant predictor of time-to-degree in this study, administrators may consider incorporating this information to analyze program-level data and make informed decisions. For instance, administrators may incorporate the two variables including amount of tuition remission and types of financial support and build statistical models that are tailored to student demographics of their own institutions and examine doctoral time-to-degree at the institution or department level.
The study also attempted to examine differences on time-to-degree in different fields. Since students in soft pure (e.g., philosophy and sociology) and soft applied fields (e.g., business studies and education) complete at a significantly slower pace than their peers in hard applied fields (e.g., engineering), changes should be considered in terms of creating a better streamlined process by adding more intermediate goals in students’ doctoral education journey (Gittings, Bergman, Shuck, & Rose, 2018; Lake, Koper, Balayan, & Lynch, 2018). The intermediate goals may be frequent discussions on professional development opportunities, reflections on progress made so far as a doctoral student, or expectations of doctoral students at different stages of the doctoral process.

**Implications for future study.** This research has supplemented the literature related to time-to-degree for doctoral students in several unique and meaningful ways. It has also helped reveal several factors ripe for future research and analysis. I will address each of those, and comment on any pertinent findings from this study that inform those recommendations.

First, the discrepancies of research findings on the rates of completion of international students give way to further research and investigation of how different factors at the individual and institutional levels may affect international students’ time to doctoral degree. Previous research by Gardner (2009) found that the engineering program in her study tended to have an immense percentage of global faculty and doctoral students and barriers in language, and pressure to find funding to reside in the country, often obstructed foreign doctoral students from completing their degrees. International students also experienced transitioning issues such as problems with social integration and ambiguity in understanding expectations (Gardner, 2010). While international doctoral students seem to complete their doctorate studies in shorter periods of time than students from the United States, it is still unclear whether time-to-degree for
international students varies by fields of study. Measuring international student time-to-degree in STEM and non-STEM areas, especially in fields where different levels of English competency are required to complete the degree, can further our understanding of this student population.

Second, research shows that URM students obtain doctorate degrees at a disproportionately more depressed rate than their White colleagues, especially in engineering and science-related fields (NSF, 2009; Tull et al., 2012; Woodrow Wilson, 2005). However, most of the studies in this area have been qualitative in nature (Griffin et al., 2012; Lewis et al., 2004; Nettles, 1990). Hence, I recommend additional research based on a larger sample of diverse students is needed to investigate the intersection of academic backgrounds, debt level, and institutional factors on minority students’ time-to-degree.

Third, many studies have discussed gender discrepancies in undergraduate admissions and degree completion, while fewer studies have focused on graduate populations. Those studies that have addressed the graduate population were largely based on qualitative research of a handful of female doctoral students; however, few methodologically rigorous studies have explored gender differences in doctoral education and gender’s impact on time-to-degree (Ampaw & Jaeger, 2011). Therefore, more research should be conducted to examine how gender interacts with other demographic and academic factors that impact doctoral time-to-degree, such as number of dependents and fields of study.

Fourth, some of the quantitative research has suggested that marital status is an insignificant predictor to completion of doctoral degree and time-to-degree while qualitative researchers on this topic found that doctoral students’ experiences can be affected by their marital status. Research suggests it is vital for students in their doctoral studies to maintain harmony between their academic duties and personal obligations, so they have time to fulfill
both roles (Bennett, 2006; Golde, 2006; Rockinson-Szapkiw et al., 2017). However, the expectation is often challenging to achieve for doctoral students with family responsibilities (Brown & Nichols, 2012) and “[F]amily and personal relationships are sometimes strained and can even break down as a result of a student's involvement in their studies (Wellington & Sikes, 2006, p. 731). A study of 64 doctoral couples in psychology revealed that over 50% of the participants experienced a breakup or a divorce in the time it took to complete their degree (Pedersen & Daniels, 2001). Gilbert (1982) found that doctoral students with family obligations often were not as involved in academic studies and family lives when compared to their colleagues who were single as a result of different time commitments outside of school. Doctoral students’ choice to focus on research seemingly impacts their relationships with family members. Similarly, being more involved in family activities may lead to doctoral students making insufficient connections with colleagues and faculty members. A review of the literature has suggested conflicting findings on the impact of marital status on time-to-degree; thus, more research is needed to examine this particular effect. Additional research should also focus on how gender, race/ethnicity, citizenship, and age may interact with marital status to impact time-to-degree.

Lastly, the existing studies on doctoral time-to-degree rarely have focused on the impact on time-to-degree beyond students’ personal backgrounds. Little is known about the program and institutional effects on time to a doctorate degree and the insufficient knowledge in this area also warrants further examination of the influence of academic disciplines and program demography on time-to-degree between female and male doctoral students. For example, insufficient research has been undertaken on effects of gender or racial/ethnic representation on time-to-degree of students in different programs. The association amid program demography
and time to doctorate degree, as well as the ones between program and time-to-degree, after controlling for gender, need further investigation.

This study has advanced the body of knowledge related to duration to a doctorate degree. The use of data that includes all United States accredited institutions and a more sophisticated methodological approach refined the existing body of knowledge with respect to the factors that influence doctoral time-to-degree. Future research should extend this work by further honing the methodological approach and by identifying more recent and comprehensive sources of data. The role of time-to-degree will become more important as students keep track of how they spend their time and how it affects their degree completion. Understanding which individual student level, program level, and institution level factors influence time-to-degree can help improve doctoral studies.
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## APPENDIX A

### Table 8

*Two Level Model Predicting Doctoral Time-To-Degree*

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<tr>
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<th>Unconditional Model</th>
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<td>Coefficient</td>
<td>Std. Error</td>
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<td>Female $\times$ URM Composition</td>
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<th>Standard Error</th>
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Institutional Level (Level Two)

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<td>Non-Minority-Serving Institution</td>
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*** p < .001, ** p < .01, * p < .05
## APPENDIX B

### Table 9

*Three Level Model Predicting Doctoral Time-To-Degree*

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<td>Std. Error</td>
<td>Coefficient</td>
<td>Std. Error</td>
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<td><strong>Intercept, β₀</strong></td>
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<td>0.67***</td>
<td>0.07</td>
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<tr>
<td><strong># of Dependents &lt; 5</strong></td>
<td>-0.30*</td>
<td>0.06</td>
<td>-0.30*</td>
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<tr>
<td><strong># of Dependents 6 -18</strong></td>
<td>0.46</td>
<td>0.21</td>
<td>0.46</td>
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</tr>
<tr>
<td><strong># of Dependents &gt;19</strong></td>
<td>0.02</td>
<td>0.22</td>
<td>0.03</td>
<td>0.21</td>
</tr>
<tr>
<td><strong>Parental Education – High School</strong></td>
<td>0.60***</td>
<td>0.05</td>
<td>0.58***</td>
<td>0.05</td>
</tr>
<tr>
<td><strong>Parental Education – College (Reference)</strong></td>
<td></td>
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<tr>
<td><strong>Parental Education - Master</strong></td>
<td>-0.38***</td>
<td>0.05</td>
<td>-0.38***</td>
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<tr>
<td><strong>Parental Education - PhD</strong></td>
<td>-0.28***</td>
<td>0.05</td>
<td>-0.29***</td>
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</tbody>
</table>
Table 9 (continued).

<table>
<thead>
<tr>
<th>Financial Support</th>
<th>Category</th>
<th>Level One</th>
<th>Level Two</th>
<th>Level Three</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Tuition Remission</td>
<td>1.02*** 0.10</td>
<td>1.02*** 0.10</td>
<td>1.02*** 0.06</td>
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</tr>
<tr>
<td>Less than 1/3 Tuition Remission</td>
<td>1.39*** 0.23</td>
<td>1.35*** 0.23</td>
<td>1.36*** 0.20</td>
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</tr>
<tr>
<td>1/3-2/3 Tuition Remission</td>
<td>1.17*** 0.13</td>
<td>1.11*** 0.13</td>
<td>1.11*** 0.10</td>
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</tr>
<tr>
<td>2/3- Less than full Tuition Remission</td>
<td>0.97*** 0.09</td>
<td>0.90*** 0.09</td>
<td>0.90*** 0.07</td>
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</tr>
<tr>
<td>Full Tuition Remission (Reference)</td>
<td>0.01 0.06</td>
<td>-0.10 0.05</td>
<td>-0.10 0.05</td>
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</tr>
<tr>
<td>Fellowship</td>
<td>-0.04 0.08</td>
<td>-0.03 0.09</td>
<td>-0.03 0.09</td>
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</tr>
<tr>
<td>Grant</td>
<td>0.35* 0.06</td>
<td>0.13* 0.06</td>
<td>0.13* 0.06</td>
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</tr>
<tr>
<td>Teaching Assistantship</td>
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<td></td>
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<tr>
<td>Research Assistantship (Reference)</td>
<td>Loans 1.17*** 0.19</td>
<td>0.85*** 0.16</td>
<td>0.85*** 0.16</td>
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<tr>
<td>Personal Savings</td>
<td>3.13*** 0.18</td>
<td>2.93*** 0.13</td>
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</tr>
<tr>
<td>Other Financial Support</td>
<td>1.89*** 0.15</td>
<td>1.85*** 0.15</td>
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</table>

Program Level (Level Two)

<table>
<thead>
<tr>
<th>Program</th>
<th>Level One</th>
<th>Level Two</th>
<th>Level Three</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hard Pure</td>
<td>-0.71*** 0.08</td>
<td>-0.73*** 0.07</td>
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<tr>
<td>Hard Applied (Reference)</td>
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<tr>
<td>Soft Pure</td>
<td>0.85*** 0.12</td>
<td>0.83*** 0.09</td>
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</tr>
<tr>
<td>Soft Applied</td>
<td>-0.04 0.12</td>
<td>-0.05 0.13</td>
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<tr>
<td>Program Median GRE</td>
<td>-0.007*** 0.00</td>
<td>-0.007*** 0.00</td>
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<tr>
<td>Program Ranking</td>
<td>0.00 0.00</td>
<td>0.00 0.00</td>
<td></td>
</tr>
<tr>
<td>Research Activity Ranking</td>
<td>0.00 0.00</td>
<td>0.00 0.00</td>
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</tr>
<tr>
<td>Diversity Ranking</td>
<td>-0.01*** 0.00</td>
<td>-0.01*** 0.00</td>
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</table>

Institutional Level (Level Three)

<table>
<thead>
<tr>
<th>Institutional</th>
<th>Level One</th>
<th>Level Two</th>
<th>Level Three</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female Demography</td>
<td>-0.32 0.78</td>
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<tr>
<td>URM Demography</td>
<td>4.97 2.98</td>
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</tr>
<tr>
<td>Private</td>
<td>0.23* 0.10</td>
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<td></td>
</tr>
<tr>
<td>Public (Reference)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Research University with high research activity (Reference)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Doctoral/Research University</td>
<td>0.41* 0.17</td>
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</tr>
</tbody>
</table>
Table 9 (continued).

<table>
<thead>
<tr>
<th>Category</th>
<th>Effect Size</th>
<th>SE</th>
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</thead>
<tbody>
<tr>
<td>Other College/University (Master’s, Bachelor’s, Special Focus Institution)</td>
<td>0.68*</td>
<td>0.27</td>
</tr>
<tr>
<td>City (Reference)</td>
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</tr>
<tr>
<td>Other (Suburban, Town, Rural)</td>
<td>-0.02</td>
<td>0.11</td>
</tr>
</tbody>
</table>

*** p < .001, ** p < .01, * p < .05
APPENDIX C

Table 10.
Biglan Classification of Academic Disciplines

<table>
<thead>
<tr>
<th>HARD PURE</th>
<th>HARD APPLIED</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Life Sciences (Agricultural Sciences/Natural Resources,</td>
<td>• Computer &amp; Information Sciences</td>
</tr>
<tr>
<td>Biological/Biomedical Sciences, Health Sciences)</td>
<td>• Engineering</td>
</tr>
<tr>
<td>• Mathematics</td>
<td></td>
</tr>
<tr>
<td>• Physical Sciences (Astronomy, Atmospheric Science &amp;</td>
<td></td>
</tr>
<tr>
<td>Meteorology, Chemistry, Geological &amp; Earth Sciences,</td>
<td></td>
</tr>
<tr>
<td>Ocean/Marine Sciences, Physics)</td>
<td></td>
</tr>
<tr>
<td>SOFT PURE</td>
<td>SOFT APPLIED</td>
</tr>
<tr>
<td>• Humanities (History, Foreign Languages &amp; Literature,</td>
<td>• Business Management/Administration</td>
</tr>
<tr>
<td>Letters, Other Humanities)</td>
<td>• Communication</td>
</tr>
<tr>
<td>• Psychology</td>
<td>• Education (Research &amp; Administration, Teacher</td>
</tr>
<tr>
<td>• Social Sciences</td>
<td>Education, Teaching Fields, Other Education)</td>
</tr>
</tbody>
</table>