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The Effect of Loans on Time to Doctorate Degree: Differences by Race/Ethnicity, Field of Study, and Institutional Characteristics

Introduction

Graduate schools prepare students not only for future careers in academia, but also for leadership positions in government, business, non-profit organizations, and other industries. Given the likelihood of doctoral degree recipients being active in research or leadership positions, they may have considerable opportunity to influence public policy. In a global, knowledge-driven economy, the need for a highly educated workforce is vital to maintaining the nation's status and economy. Doctoral-granting institutions, therefore, play an important role in educating academicians and professionals alike who can take the lead in this highly interdependent world. Unfortunately, the nation's graduate schools fail to fully educate many students who enter doctoral programs because the programs are plagued by high attrition rates.

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According to the Council of Graduate Schools (2008), about half of all students pursuing a doctorate actually complete it. In this context, Bowen and Rudenstine (1992) argue that time to degree is an important component of doctoral degree completion. Although relatively few studies have examined time to doctoral degree, it has been found to negatively affect degree completion (Bair & Haworth, 2004; De Valero, 2001). The longer it takes to complete a doctorate, the more prone students are to attrition. During the 2005 academic year, over 400 U.S. colleges and universities awarded doctorates to over 43,000 students (Hoffer et al., 2006). Of those, just over half were female (Hoffer et al.). Underrepresented minority students accounted for 20% of earned doctorates, the largest percentage to date (Hoffer et al.). The number of degrees conferred in 2005 represents a 2.9% increase over the previous year which demonstrates not only significant interest among institutions in offering doctorate degrees but also interest among students in pursuing terminal degrees (Hoffer et al.). It also elucidates the need for heightened awareness of the time it takes students to earn doctoral degrees (Hoffer et al.).

From the student perspective, the decision to pursue a doctoral degree cannot be taken lightly. In addition to the academic responsibilities, pursuing doctoral study often means a lengthy delay in entering, or a temporary stop out from, the workforce. Moreover, doctoral study can be stressful and may lead to role conflicts with other obligations, such as family and job responsibilities. Although it is true that individuals with doctorate degrees are more likely to have higher earnings and lower unemployment rates than those with bachelor's or master's degrees (Bureau of Labor Statistics, 2003), financing doctoral studies is challenging for many graduate students. A recent report from the Council of Graduate Schools (CGS) (2006) indicates that the average cost of education for doctoral programs increased more than 50% from 1995 to 2003, regardless of institutional control. For instance, the average price of attending private institutions at the doctoral level in 2003 was $29,703, a 79% increase from $16,631 in 1995 (CGS, 2006). Nevertheless, the amount of financial assistance provided through grants or assistantships has not kept pace with the increased educational expenses, thereby leading to increases in student loan borrowing among graduate students during the same time period. Among White doctoral students, the percentage of borrowers increased from 21% in 1995 to 34% in 2003 (CGS). The percentage of borrowers increased more significantly among underrepresented minority students, jumping nearly 20%, from 25% to 43% over the same time period (CGS). The median accumulative federal loans for doctorate recipients was $44,743 in 2003/04, more than triple

the amount of $12,310 in 1995/96. This increase was higher than that for associate's, bachelor's, master's, or professional degrees (American Council on Education, 2005).

It is noteworthy that percentages of borrowers and average loan amounts are substantially different by field of study and race/ethnicity (Hoffer et al., 2006). Among doctorate recipients in 2005, graduates in engineering and physical sciences were the least likely to borrow while graduates in social sciences and humanities were the most likely to have loans (Hoffer et al.). Black, Hispanic, and American Indian doctorate recipients had substantially higher education-related debts than Whites and Asians (Hoffer et al.). In 2005, Asian doctorate recipients outnumbered Blacks in physical sciences (241 to 84) and engineering (242 to 85), and Black doctorate recipients outnumbered Asians in social sciences and humanities (296 to 198 and 172 to 140, respectively) (Hoffer et al.). Given that many federal research grants and other funding opportunities have been targeted toward science and engineering, it is clear that the differences in loan amounts by race/ethnicity are partly due to the disparities in the distribution of different racial/ethnic groups across fields of study. However, even among those in the same field, Black and Hispanic doctorate recipients were still more likely to have higher levels of debt than their Asian and White counterparts, and this pattern is consistent across all broad fields of study (Hoffer et al.).

Similarly disturbing racial/ethnic group differences in the same field exist in differing time to doctorate degrees (Hoffer et al., 2006). Among 2005 doctorate recipients in physical sciences, for instance, the median number of years from baccalaureate to doctorate award for Asians and Whites was 7.5 and 7.0 years respectively, compared to 8.0 years for Blacks (Hoffer et al., 2006). Despite the significant disparities in the levels of debt and time to degree by race/ethnicity even among students in the same field, little is known about the specific factors that affect time to doctorate degrees and the reasons for such significant disparities by race/ethnicity. Much of the focus of research on the impact of financial aid (debt in particular) has focused on undergraduate students. It is equally important to understand the impact of financial aid on graduate students, particularly since graduate students incur much higher levels of debt due to their prolonged time in higher education and because the rate of increase in debt level is significantly higher for graduate than undergraduate students.

Research Questions

This study seeks to examine factors that affect time to doctorate degree and to discern whether any significant differences exist among

various fields of study, with a particular emphasis on the effect of debt level. The research questions in the study are:

1. What are the factors that affect time to doctoral degree? Are there significant disparities by race/ethnicity, field of study, and institution?
2. What are the impacts of undergraduate and graduate debt levels on time to doctorate degree? Are there significant disparities by race/ethnicity, field of study, and institution?

Theoretical Background

Biglan (1973) provides a framework for explaining differences in academic fields. He suggests that academic fields are distinguished along three dimensions: (a) paradigm consensus in which all members subscribe to a particular body of theory, (b) degree of practical utility (hard versus soft or basic versus applied fields), and (c) concern with life as opposed to inanimate objects. The first two are of interest to this study. Regarding the first dimension, Biglan posits that the social and behavioral sciences, humanities, and other nonscience fields have less well established paradigms than the hard sciences (i.e., physical and biological sciences). In terms of utility, he identifies fields such as engineering, computer science, education, and health as having practical application. As such, those fields have specific requirements that must be included within academic programs. Furthermore, he indicates that because norms, structure, and output of the academic fields vary, student experiences are also likely to vary (Biglan, 1973). Such differences may result in variable times to doctoral degrees. It is expected that time to doctoral degree for students who enter fields that have well established paradigms will be shorter than for students who enter less delineated fields. Because there is general consensus regarding content and research design in fields with established paradigms, students become acculturated to the accepted research methodologies and practices. Students in the "softer" fields such as social sciences and humanities may have more options available in terms of what to study and what methodologies they can use. The greater flexibility and openness may lead to lengthier time to select a research topic and/or design, and ultimately, longer time to doctoral degree. It is also expected that students entering fields with greater practical utility would complete doctorates sooner because the curriculum is more clearly governed. Students in less career-oriented fields may be prone to experimentation with various types of courses and research methodologies. Greater choice in both research design and content is expected to lead to longer times to degree.

From an economic perspective, Breneman (1976) proposes a theoretical model of time to doctoral degree. He suggests that degree completion and time to doctorate are a function of the labor market (and in the case of future faculty, the academic job market) and financial sources of support for graduate study. Thus, doctoral students have a greater incentive to complete the doctorate and begin their career when the labor market is strong, thereby reducing time to degree. He also suggests that the type of financial support may affect the timeliness of degree completion. For example, time intensive forms of financial support may impede degree progress, leading to lengthier times to degree, as would be the case with teaching assistantships. On the other hand, research assistantships that align with students' dissertation topics may negatively relate to (thus shorten) time to degree (Breneman, 1976).

Literature Review

Previous research on graduate students and time to degree completion focuses largely on student characteristics and institutional/departmental factors that facilitate or hinder time to doctorate degrees. Demographic variables such as gender, race, and family obligations influence time to degree. Males typically finish in less time than females when measured either by total time (which gauges elapsed time from completion of the baccalaureate degree through completion of the doctorate, including time periods during which the student may not be enrolled) or graduate time to degree which measures time elapsed since entry into graduate school (Abedi & Benkin, 1987; Hoffer et al., 2006). The median total time to degree in 2005 among all fields of study was 9.4 years for males, compared to 10.5 years for females (Hoffer et al.). Differences also exist in time to degree by race/ethnicity (Hoffer et al.). Asian students had the shortest total time to degree (8.8 years) in 2005, followed by Hispanic (10.3), White (10.4), American Indian (12.0 years), and Black (12.7) students (Hoffer et al.). Marked variance in time to degree exists when considering field and ethnicity simultaneously. For example, the median graduate time to degree for Asian students in professional/other doctorate programs is 12.3 years, but the median time to degree of 15.7 for Black students is considerably longer, a difference of 3.4 years (Hoffer et al., 2006). For education doctorates, the median graduate time to degree is 16.6 years for Asian students, but at 20.2 years, is nearly 4 years longer for American Indian students (Hoffer et al.). Ranges for the other fields are less drastic (in the 1–2 year range) (Hoffer et al.).

Students who take less time to complete doctoral degrees tend to have fewer dependents (Wilson, 1965; Abedi & Benkin, 1987). Family re-

sponsibilities were identified as increasing the amount of time it took to earn a doctorate degree (Wilson, 1965). This result was confirmed by Siegfried and Stock (2000) who found no significant differences in age, marital status, or race but did find that parenthood delays progress considerably for women.

Academic ability and employment outlook are also related to timeliness of degree completion. Tuckman et al. (1990) found that students who earned baccalaureate degrees at first-tier doctoral-granting institutions finished their doctorate degrees more rapidly than students who earned undergraduate degrees at other types of institutions. On the other hand, inadequate skills or preparation also serve as deterrents to completing the doctorate in a timely fashion (McFarland & Coplow, 1995; Wilson, 1965). Because criteria for positions in the professoriate have increased thereby, competition and demand for jobs have also increased creating anxiety among doctoral students (McFarland & Coplow). Therefore, even talented students may remain in their programs longer to hone their research and teaching skills in an effort to increase their marketability for future careers in academia (McFarland & Caplow). Tuckman et al. (1990) explains that the body of knowledge needed to complete doctoral degrees has expanded, thereby necessitating additional time for students to learn and to produce quality work. In a study of doctoral recipients in economics, Siegfried and Stock (2000) found that when starting salaries were rising faster, students in doctoral programs completed degrees in less time.

It is important to understand the implications of financial considerations on time to degree. Full-time employment and financial pressures have been identified as barriers to completion (Bair & Haworth, 2004). Students with longer periods of full-time, pre-doctoral employment took longer to complete doctoral programs (Wilson, 1965). Abedi and Benkin (1987) found that the source of financial support was the strongest predictor of time to degree. Students who depended on their own financial sources tended to take longer and were less likely to complete a degree (Bair & Haworth, 2004). Moreover, students who intended to pursue post-doctoral study were likely to complete in a more timely fashion than students who intended to pursue outside employment (Abedi & Benkin, 1987). The researchers suggest that students who intended to pursue employment outside academia were likely to have supplemented their income with outside employment while working on their degree, thereby potentially lengthening the time to degree (Abedi & Benkin). Siegfried and Stock (2000) suggest that married students may finish their degrees faster due, in part, to the financial support generated by the spouse. Wilson (1965) concluded that students who had shorter times to degree completion had a broader base of financial support.

The type of financial support from the department or institution appears to relate to degree completion. In 2005, 71% of doctorate recipients received financial support from departmental or institutional sources, including teaching and research assistantships as well as fellowships (Hoffer et al., 2006). Wilson (1965) found that working as a teaching assistant ranked second among variables identified by students as lengthening their time to degree, yet it was identified as being the most important source of income for doctoral students. Research assistantships were the most important source of financial support for students in science fields (Wilson, 1965). Siegfried and Stock (2000) found that doctoral students in economics who had a combination of fellowships and assistantships completed their programs faster than students who relied on fellowship support alone. Likewise, Ehrenberg and Mavros (1995) found that students with fellowships had higher degree completion rates and shorter time to degree than students who received teaching assistantships. Wilson (1965) found that students serving as teaching assistants who did not have graduate research assistantships were likely to take more time to complete their degrees than students with research assistantships. He postulates that students need to hone their skills in preparation for future teaching careers which could result in slowing their degree progress (Wilson, 1965).

There is some differentiation among fields of study and patterns of student loan debt. Rapoport (1998), focusing on the period of 1993–1996, reported that U.S. citizen doctoral recipients in science and engineering incurred more debt than students in other fields. Upon graduation, 39% of science and engineering doctoral recipients reported having no debt, compared to 48% of doctorate recipients in other fields. Eight percent of doctoral recipients in science and engineering had debt levels over $30,000, compared to six percent for students in other fields. Among science and engineering fields, doctoral recipients in computer science, engineering, and math were the least burdened by debt. About half had no debt, and fewer than 5% owed more than $30,000. For non-science and engineering fields, doctoral recipients in education fared the best. Fifty-six percent of students who earned doctorates in education reported not having any debt upon graduation, and only five percent had debt levels greater than $30,000. About 10% of doctoral recipients in law, business, and architecture had debt exceeding $30,000 (Rapoport, 1998).

Rapoport (1999) indicates that underrepresented minority students were not only more likely to incur debt but to have greater levels of debt compared to White and Asian students. For the period of 1993–1996, only 27% of underrepresented minority students had no debt upon com-

pletion of a doctorate in science and engineering compared to 40% of Whites and 45% of Asians. Ten percent of underrepresented students reported debt levels of $20,000–$30,000, compared to 8% of Whites and 6% of Asians. Meanwhile, debt levels of over $30,000 were more likely to affect underrepresented minorities (12% compared to 7% for Asians and Whites). Although indebtedness varies across field, these patterns were consistent across all science and engineering fields (Rapoport, 1999).

Because completion of doctoral degrees is a time-intensive process, it is important to understand the individual, institutional, and field specific factors that influence it. Furthermore, it is necessary to explore how the accumulation of student loans while pursuing a doctorate is related to time to degree. The findings described below help identify factors that influence time to doctorate degree.

Research Methods

Data Source

The purpose of this study is to ascertain whether loan amount influences time to doctorate degree and if there are significant differences in the relationship by individual characteristics such as race/ethnicity, as well as field of study and institutional factors. A recent report from the National Science Foundation (NSF) indicates that the top 10% of doctoral institutions granted 46% of all doctorates awarded in 2005 and that most of these institutions were large, research intensive public or private institutions (Hoffer et al., 2006). In contrast to the scarcity of research on doctoral students, extensive studies have found that institutional characteristics have an independent effect on various measures of undergraduate student success even after controlling for students' own individual characteristics (Astin, 1993; Hu & Kuh, 2003; Kuh & Vesper, 1997; Pascarella & Terenzini, 1991). Because time to doctorate degree is the result of doctoral recipients' individual characteristics and of the interaction between doctoral recipients and the characteristics of the institutions that they attend, time to degree should be understood within the multi-level context in which it exists. Two national data sets (Survey of Earned Doctorates from NSF and Integrated Postsecondary Education Data System (IPEDS) from NCES) are incorporated to build comprehensive statistical models to clarify the relationship between loan amount and time to doctorate degree and to learn how this relationship varies by individual and institutional characteristics. Both data sets contain the IPEDS identification variable, thus making it possible to merge the two databases.

Student level variables are derived from the Survey of Earned Doctorates (SED) in 2005 which was conducted by the National Science Foundation. The data from the 2005 SED consists of all individuals receiving a first research doctorate (second doctorates are not included) from U.S. academic institutions in the 12-month period ending on June 30, 2005. The data from the 43,354 respondents represent over 400 U.S. colleges and universities. Given that the SED offers census data, it is not necessary to conduct any statistical techniques to adjust for sampling error or design effect. Of the 2005 doctorate recipients, 65% were U.S. citizens and 35% were non U.S. citizens with permanent residency or temporary visas (Hoffer et al., 2006). The patterns of the sources of financial support and education-related loans for doctorate recipients are significantly different by citizenship status, especially between U.S. citizen and temporary visa holders (Hoffer et al.). This study focuses on individuals who are either U.S. citizens or non U.S. citizens with naturalized status or permanent visas and who finished their undergraduate education in the United States. The total sample size is thus reduced to 21,683, and this data set is used for descriptive analysis.

Institutional level variables are derived from the Integrated Postsecondary Education Data System (IPEDS, 2005) database which offers institutional structural characteristics (e.g, institutional size or Carnegie classification) and racial/ethnic composition of the field of study.

Variables

The dependent variable, time to doctorate degree, is referred to as graduate time to degree (GTD) because it measures the elapsed time from entrance into graduate school through completion of the doctorate (Hoffer et al., 2006).

Individual level variables are grouped into three categories: individual background variables, education experience variables, and finance variables.

(1) Individual background variables include gender, race (Black, Hispanic, and Asian students with White being the reference group), age, and parental education. Mother's and father's levels of education were combined as a single variable: if neither parent attained a bachelor's degree, the students were considered to be first-generation college students. If at least one of the parents attained a bachelor's degree or higher, the students were considered to be continuing generation. These individual background variables were selected based on the general significant findings in time to doctorate degree literature (Abedi & Benkin, 1987; Hoffer et al., 2006; Rapoport, 1999).

(2) Education experience variables include the number of years elapsed from completion of the baccalaureate degree to entry into a doc-

toral program, changing major status (whether students changed their field of study from undergraduate to graduate school), selectivity of the institutions where students completed their bachelor's degrees (75th percentile of the SAT math scores of entering college freshmen),[1] and postgraduate plans. Two variables, the number of years students spent from baccalaureate award to the entry of doctoral program and changes in field of study, are important considerations given that there are significant differences by field of study. The median number of years since bachelor's degree attainment until the entry of a doctoral program ranges from an average of 1.0 year in engineering to 4.3 years in education (Hoffer et al., 2006). The proportion of students staying in the same field of study ranges from 30% in education to 59.5% in science, technology, and math (STEM) fields and 74.8% in engineering (Hoffer et al.). Postgraduate plans refer to whether students intend to pursue a postdoctoral fellowship/traineeship or to seek employment.

(3) Finance variables include total amount of education related debts from any source and primary source of financial support (fellowship/scholarship and research assistantship with teaching assistantship being the reference group). Loans for undergraduate and graduate education are combined and divided into three categories based on frequency distribution of the variable—low amount ($20,000 or less), medium amount ($20,001 to $50,000), and high amount ($50,001 or more). Students in each category are compared to students who do not have loans. According to the statistical report from NSF (Hoffer et al., 2006, Table 22), significantly large percentages of doctorate recipients among U.S. citizens, 65% at the undergraduate and 61.9% at the graduate levels, do not have loans. To maximize the number of cases in the statistical analysis, this study categorizes the amount of loans into three categories and compares each category with students who have no loan debt for both undergraduate and graduate education. This approach, additionally, allows us to examine the non-linear relationship between the amount of loans and time to doctoral degree.

Institutional level variables that are associated with time to doctoral degree are categorized into structural characteristics and student composition (Astin et. al., 1996; National Center for Education Statistics, 1996; Thomas, 2000; Tinto, 1993). Structural characteristics of the doctorate institutions are Carnegie classification, institutional size (full-time equivalent undergraduate students), and in state tuition for full-time graduate students. Carnegie classification is a dichotomous variable that refers to whether the institution is research extensive or research intensive. Tuition is an important variable given that the level of tuition for graduate education may not only influence the amount of money doctoral students borrow but also the time to doctoral degree by encourag-

ing (or discouraging) students to complete their degree because of the burden of high tuition. Student composition variables represent the peer group effect of the field at the same institution (Bryk & Thum, 1989; Rumberger, 1995). The student composition variable used in this study is the racial/ethnic distribution of the doctorate recipients, specifically the percentage of minority doctorate recipients in the same field at the same institution. The percentage of minority doctorate recipients is an important variable given that research focusing on undergraduate students finds that the density of similar racial/ethnic group populations tends to increase students' various college outcome measures (Chang, Astin, & Kim, 2004; Chang, Denson, Saenz, & Misa, 2006). By examining if the proportion of minority doctoral students on campus matters in relation to time to doctoral degree, this study seeks to clarify if the same is true for doctoral student outcomes as well.

Statistical Analysis

As indicated in the previous section, time to degree and doctorate recipients' levels of debt are significantly different by race/ethnicity even among students in the same field of study (Hoffer et. al., 2006). Previous literature indicates that whereas undergraduate education is largely viewed as an institutional responsibility, graduate education is more often seen as a departmental responsibility due to its decentralized nature (Bowen & Rudenstine, 1992). Therefore, to clarify if the relationship between amount of debt and time to degree differs by race/ethnicity within the same field, a separate set of multivariate statistical analyses are conducted by the broad field of study as defined by NSF: education, engineering, humanities, biological/biomedical sciences, physical sciences, and social sciences.

Because students within colleges (or within the same field of study) are more similar than those who attend different institutions and because students are influenced by the characteristics of the colleges they attend, students are not randomly distributed across colleges. Rather, they are grouped within institutions. Recognizing the nested structure of the data, this study uses Hierarchical linear models (HLM) that allows researchers to more accurately assess estimates of the effects of level-2 variables (e.g., college) on level-1 outcome measures (e.g., student) (Thomas, 2000). The level-1 equation in HLM analysis is as follows:

$$Y_{ij} = \beta_{0j} + \beta_{1,j\sim6,j}(\text{individual background characteristics})_{ij} + \beta_{7,j\sim10,j}(\text{college experience variables})_{ij} + \beta_{11,j\sim15,j}(\text{finance variables})_{ij} + r_{ij}$$

(i=individual student, j=institution)

Y_{ij} represents time to doctoral degree for student i of institution j. β_{0j} represents the intercept of institution j, β_{1j} represents the slope of variable X_1 of institution j, and r_{ij} represents the residual for individual i of institution j. On subsequent level 2 analysis, the level 1 intercept and slopes become dependent variables being predicted from level 2 variables:

$\beta_{0j} = \gamma_{00} + \mu_{0j}$
(γ_{00} is the grand mean of time to doctoral degree and μ_{0j} is the random effect for institution j)

$\beta_{pj} = \gamma_{p0} + \mu_{pj}$
(γ_{p0} is the grand mean of independent variable *p* and μ_{pj} is the random effect for institution j)

In this study, only the intercept term is considered random parameter[2] and the mathematical equation for the effect of institutional variables on the level 1 intercept term is as follows:

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(\text{research extensive})_j + \gamma_{02}(\text{tuition})_j + \gamma_{03}(\text{institutional size})_j + \gamma_{04}(\%\text{ of minority doctorate recipients})_j + \mu_{0j}$$

Treating missing data requires particular attention in HLM analysis. The HLM models assume the data files are complete and do not allow for missing data. In level-1 (individual level) analysis, any observations with missing data are deleted using listwise deletion, and in level-2 (college level), any data containing missing values are automatically deleted. Additionally, the college-level data in the study were unbalanced (i.e., the number of individual survey respondents varied at each college). To have an appropriate amount of variance at level-2 analysis, college data that have three or fewer individual cases were not included in the HLM analysis. The final sample sizes in HLM analysis by field of study are as follows: Education (*N* = 2,051), Engineering (*N* = 1,387), Humanities (*N* = 2,310), Biological/biomedical sciences (*N* = 2,360), Physical Sciences (*N* = 1,540), and Social Sciences (*N* = 2,612).

Research Findings

Descriptive statistical analyses were conducted to examine if there are differences in time to doctoral degree and the amount of undergraduate and graduate debt by field of study (Table 1). As expected, students in humanities took the most amount of time to complete their doctoral

degrees (8.28 years), followed by students in education (7.54 years) and social sciences (7.34 years). Students in engineering and biological sciences fared relatively well, at 6.50 and 6.22 years, respectively. Students in physical sciences took the least amount of time to earn doctorates (6.11 years). Doctorate recipients in education were the least likely to borrow as undergraduates (23.1%). Biological and physical science majors were the most likely to borrow as undergraduate students (45.4% and 46.8%, respectively), followed by students in social sciences (37.5%), humanities (36.8%), and engineering (36.5%). Although education majors were less likely than students in other majors to borrow, they borrowed at the highest levels, accumulating nearly $20,000 in undergraduate debt alone. There was not much range in the amount of undergraduate debt among fields of study, with engineering majors borrowing the least with an average of $18,200, and social science and education majors amassing the greatest debt levels at $19,100 and $19,400, respectively. The story is quite different at the graduate level. Social science and humanities doctorates were twice as likely to borrow at the graduate level (52% and 49.2%, respectively) than engineering, physical science, and biological science majors (21.3%, 28%, and 28.4%, respectively). Engineering students remained the least likely to borrow. Percentages of graduate borrowers in social sciences, humanities, and education increased considerably over undergraduate levels. Education majors were considerably more likely to borrow at the graduate level than at the undergraduate level (23.1% and 37.8%, respectively), whereas students in engineering, physical, and biological sciences were less likely to borrow as graduate students than as undergraduates. Overall, graduate debt levels were greater than those of undergraduate levels regardless of field of study. The largest average debt level among doctoral students was in the social sciences, in which case students averaged nearly $40,000 in debt. Not only were social science doctoral recipients the most likely to borrow, they borrowed the most. Education and humanities majors were also more likely to borrow as graduate students and to accumulate large loan amounts ($33,000 in education and $33,200 in humanities). Borrowers in engineering had the lowest loan amounts ($24,400), followed by physical science ($25,000) and biological sciences ($27,500). Students in these fields were not only the least likely to borrow, they tended to borrow the least.

Among the students who did not have undergraduate loans, significantly large percentages, ranging from 48.8% in social science to 83.5% in engineering did not borrow loans for their graduate education either. From a different angle, 30.6% of the students in social science and 53.1% in engineering did not have loans from undergraduate or graduate

school. Among those who had loans both from undergraduate as well as graduate programs, the correlation coefficient between the amount of loans from undergraduate and graduate education was .085 and statistically significant at .000 level. Given the significant association between the percentage distribution of borrowers versus non-borrowers from undergraduate and graduate education and the correlation between undergraduate and graduate loans, this study used combined loan amounts from undergraduate and graduate education as a single variable and examined the effect of total loan amounts on time to doctoral degree.

Focusing on the borrowers, Table 2 indicates the average amount of combined undergraduate and graduate loans by individual as well as institutional categorical variables across fields of study.[3] In the biological sciences, men have higher loan amounts than women ($28,700 compared to $26,100). Black doctorate recipients had the highest loan amounts among biological science majors ($33,000), followed by White ($27,700), Latino ($26,200), and Asian ($22,800) students. There was a very large differential between Asian and Black students (more than $10,000) in biological sciences. Among engineering doctoral recipients, males borrowed more than females ($25,500 and $24,300, respectively). Latino and Asian engineering students borrowed at relatively low levels ($22,200 and $20,600, respectively), but Black and White students, in contrast, borrowed more ($27,800 and $26,200, respectively). In the physical sciences, males borrowed more than females ($26,900 compared to $25,200). Black students borrowed more than White, Asian,

TABLE 1

Graduate Time to Doctorate with Percentage of Borrowers and Average Debt Incurred at Undergraduate and Graduate Levels by Field of Study.

		Undergraduate debt		Graduate debt	
	Time to doctoral degree	% of borrowers	Average debt	% of borrowers	Average debt
Biological sciences	6.22	45.4	1.86	28.4	2.75
Engineering	6.50	36.5	1.82	21.3	2.44
Physical sciences	6.11	46.8	1.84	28.0	2.50
Social sciences	7.34	37.5	1.91	52.0	3.77
Humanities	8.28	36.8	1.83	49.2	3.32
Education	7.54	23.1	1.94	37.8	3.30
TOTAL	7.14	36.4	1.87	38.6	3.76

Note 1. The use of NSF data does not imply NSF endorsement of the research methods or conclusions contained in this report.
Note 2. Average debt was calculated only for the students with loans. Debt amount is coded every $10,000. Therefore, average debt of 2.33, for example, indicates $23,300.
Sources. Institute for Scientific Information, Inc. and National Science Foundation, Division of Science Resource Statistics, Special tabulations.

TABLE 2

Average Cumulative Undergraduate and Graduate Loan Amount by Individual and Institutional Variables Across Field of Study

		Biological sciences	Engineering	Physical sciences	Social sciences	Humanities	Education
Gender	Male	2.87	2.55	2.69	3.83	3.42	3.34
	Female	2.61	2.43	2.52	3.86	3.39	3.29
Race	White	2.77	2.62	2.66	3.77	3.36	3.10
	Black	3.30	2.78	2.88	4.47	4.35	3.96
	Latino	2.62	2.22	2.33	4.29	3.40	3.72
	Asian	2.28	2.06	2.43	3.58	2.64	2.98
Parent education	First generation	3.02	2.80	3.07	4.22	3.93	3.36
	Continuing generation	2.61	2.40	2.43	3.65	3.19	3.25
Financial source	Fellowship	2.55	2.14	2.49	3.16	2.77	2.89
	TAship	3.02	2.85	2.95	3.37	3.22	3.04
	RAship	2.75	2.64	2.56	3.18	3.14	2.91
Future plan	Postdoc	2.63	2.21	2.58	3.81	3.25	3.53
	Employment	2.68	2.58	2.65	3.80	3.31	3.18
Major status	Same major	2.70	2.45	2.59	3.92	3.40	2.93
	Changed major	2.84	2.85	2.81	3.64	3.45	3.48
Doctoral institution	Research extensive	2.68	2.51	2.62	3.63	3.40	3.29
	Research intensive	2.96	2.97	2.98	4.66	3.74	3.29

Note 1. Average debt was calculated only for the students with loans. Debt amount is coded every $10,000. Therefore, average debt of 2.33, for example, indicates $23,300.

Note 2. The use of NSF data does not imply NSF endorsement of the research methods or conclusions contained in this report.

Sources. Institute for Scientific Information, Inc. and National Science Foundation, Division of Science Resource Statistics, Special tabulations.

and Latino students ($28,800 compared to $26,600, $24,300, and $23,300, respectively). In the social sciences, males and females borrowed at the same rate ($38,300–$38,600). Black and Latino students borrowed at considerably higher levels ($44,700 and $42,900) than White ($37,700), and Asian ($35,800) students. Asian students borrowed significantly less than their counterparts. Among humanities students, males accumulated greater loan debt than females ($34,200 and $33,900, respectively). The largest differential in loan amounts between racial/ethnic groups was in humanities. At the high end, Black students graduated with an average of $43,500 debt, compared with Latino ($34,000), White ($33,600), and Asian ($26,400) students. Among doctoral recipients in education, males borrowed more than females ($33,400 compared to $32,900). Black and Latino education students borrowed more ($39,600 and $37,200, respectively) than Asian ($29,800) and White ($31,000) students.

Borrowing patterns by gender and race differed across fields of study. Men borrowed more in all fields of study, except social science. Black students borrowed more in all fields whereas Asian students ranked lowest in all fields except physical science. Despite differences in borrowing levels by gender and race, many individual variables were consistent across most fields of study. First generation students borrowed more regardless of field of study than continuing generation students. Teaching assistants borrowed considerably more than their peers who were awarded fellowships or research assistantships in all fields. With the exceptions of social science and education majors, students planning to enter postdoctoral programs accumulated less debt than students who planned to enter the labor market. In all fields except the social sciences, students who changed their major borrowed more than students who did not change majors.

Doctoral recipients who attended research intensive institutions borrowed more than those who attended research extensive institutions, and this finding is consistent across all fields of study except education. Doctoral recipients in education had equal amount of loans regardless of whether they attended research extensive or intensive institutions. Across all fields of study, however, doctoral recipients in the social sciences borrowed more than their counterparts in any other major.

To examine whether significant differences exist in time to doctoral degree and cumulative loan amounts by individual and institutional characteristics across field of study, six separate sets of Hierarchical Linear Modeling procedures were conducted. Results are presented in Table 3.

Biological Sciences

In the biological sciences, doctorate recipients with large loan amounts (over $50,000) took significantly less time to complete doctoral degrees than their counterparts with no loans, after controlling for individual and institutional variables. Among the individual-level variables, age, continuing generation status, selectivity of undergraduate institution and changing major status were positively related to graduate time to degree in the biological sciences. In other words, older students (B = 0.479, $p < 0.001$), continuing generation students (B = 0.190, $p < 0.01$), students who attended selective institutions (B = 0.002, $p < 0.001$), and those who changed majors (B = 0.155, $p < 0.05$) took longer to graduate than their counterparts. The same is true of students who entered doctoral programs sooner after completion of an undergraduate degree (B = –0.472, $p < 0.001$), indicating that the sooner the students enter the doctoral program after completing their undergraduate degree, the longer

the students take to complete their doctoral degrees. Students with research assistantships (B = –0.366, $p < 0.01$) and fellowships (B = –0.347, $p < 0.01$) took less time to complete than students with teaching assistantships. Students who planned to seek postdoctoral career opportunities following receipt of the doctorate (B = –0.138, $p < 0.05$) took less time to graduate than their counterparts seeking employment. In terms of institutional variables, students who attended institutions with higher graduate tuition rates (B = 0.008, $p < 0.01$) had significantly longer times to doctorate degree than students who attended less expensive institutions, even after controlling for other individual and institutional variables. Thus, the higher the tuition, the longer students took to complete doctorate degrees in biological sciences.

Engineering

Consistent with students in biological sciences, engineering students who borrowed in the low and medium ranges did not differ significantly in terms of time to doctoral degree than non-borrowers, while students with loan amounts exceeding $50,000 (B = –0.621, $p < 0.01$) had significantly shorter time to degree than non-borrowers. Time since baccalaureate attainment (B = –0.706, $p < 0.001$) and being awarded fellowships (B = –0.830, $p < 0.001$) or research assistantships (B = –0.771, $p < 0.001$) were also negatively associated with time to doctoral degree. Doctoral students who had fellowships and research assistantships (compared with students who had teaching assistantships), and students who waited longer before entering doctoral programs after receiving undergraduate degrees took less time to complete their degree. Age (B = 0.669, $p < 0.001$) and selectivity of baccalaureate institution (B = 0.003, $p < 0.001$) were positively related to graduate time to degree in engineering. Hence, the older the student and the more selective the institution where students completed their undergraduate degrees, the greater the student's time to degree. In terms of institutional level variables, tuition was the only institutional factor that was predictive of graduate time to degree in engineering. The higher the tuition, the longer the time to degree (B = 0.020, $p < 0.01$).

Physical Sciences

In the physical sciences, students who had loan amounts between $20,001–50,000 (B = –0.412, $p < 0.001$) and greater than $50,000 (B = –0.818, $p < 0.001$) took significantly less time to finish doctoral degrees than their counterparts who did not have loans. On the contrary, students with loans of less than $20,000 presented no significant difference in time to degree compared to their counterparts without loans. Primary financial

support continues to be a significant factor. Doctoral students who received fellowships in the physical sciences took significantly less time to complete degrees (B = –0.214, $p < 0.05$) than their counterparts who had teaching assistantships as a primary source of financial support during the doctoral program. On the contrary, age, selectivity of undergraduate institution, and changing major were positively associated with time to graduate degree. Students who were older (B = 0.501, $p < 0.001$), graduated from more selective baccalaureate institutions (B = 0.002, $p < 0.001$), or changed their major from undergraduate to graduate school (B = 0.307, $p < 0.01$) took longer to complete doctorates. Students who enrolled in doctoral programs relatively soon after completion of baccalaureate degrees (B = –0.505, $p < 0.001$) finished degrees more slowly than their counterparts. It is particularly interesting that for the physical sciences, only individual variables were significant predictors of graduate time to degree. No institutional variables had unique impacts on time to degree.

Social Sciences

HLM analysis for the students in social sciences failed to yield a significant association between loans (regardless of the amount of loans) and time to doctoral degree, meaning that having loans did not necessarily shorten (or lengthen) time to doctoral degree, as compared to nonborrowers. Among the individual variables, age (B = 0.467, $p < 0.001$), race (being Black, B = 0.593, $p < 0.01$), continuing generation status (B = 0.351, $p < 0.01$), selectivity of baccalaureate institution (B = 0.005, $p < 0.001$), and changing majors (B = 0.357, $p < 0.01$) are positively related to time to doctoral degree whereas having fellowships (B = –0.485, $p < 0.001$), postdoctoral research plans (B = –0.306, $p < 0.01$), and years since baccalaureate attainment (B = –0.452, $p < 0.001$) are negatively associated with time to doctoral degree. Thus, students who are older, Black (as compared to White students), continuing generation, and those who graduated from highly selective baccalaureate institutions or changed majors took longer to complete their degree. On the other hand, students who delayed entry to doctoral program, received fellowships (as compared to teaching assistantships), and planned to participate in postdoctoral research after degree completion took less time to complete doctorates than their counterparts. It is worth emphasizing that Black students, particularly in the social sciences, took significantly longer to complete their doctoral degrees than their White counterparts, even after controlling for all other individual and institutional variables. Among the institutional variables, students who attended more expensive institutions (i.e., higher tuition for graduate school) had significantly longer time to doctorate than students who attended less expensive institutions (B = 0.014, $p < 0.05$).

TABLE 3
Relationship Between Individual and Institutional Level Variables and Graduate Time to Degree

	Biological sciences	Engineering	Physical sciences	Social sciences	Humanities	Education
Intercept	6.22***	6.47***	6.65***	6.71***	8.09***	7.46***
College level variables						
Research extensive	0.166	0.467	–0.244	0.378	0.226	0.608
% Minority	0.002	–0.017	0.007	–0.001	–0.009***	–0.002
Tuition	0.008**	0.020**	0.000	0.014*	0.015**	0.015
FTE	–0.000	0.010	0.003	–0.005	0.005	0.004
Student level variables						
Age	0.479***	0.669***	0.501***	0.467***	0.582***	0.655***
Gender	0.097	–0.017	–0.103	0.050	–0.003	0.218
Asian	–0.028	0.091	–0.094	0.136	0.291	–0.021
Black	0.137	0.035	0.409	0.593**	0.337	0.023
Latino	0.016	–0.319	0.263	0.179	–0.514*	–0.328
Continuing generation	0.190**	0.183	0.087	0.351**	0.135	0.425**
Time since BA attainment	–0.472***	–0.706***	–0.505***	–0.452***	–0.575***	–0.674***
Selectivity (BA)	0.002***	0.003***	0.002***	0.005***	0.006***	0.005***
Changing major	0.155*	0.107	0.307**	0.357**	0.063	–0.136
Fellowship	–0.347**	–0.830***	–0.214*	–0.485***	–0.324**	–0.433
RAship	–0.366**	–0.771***	–0.101	–0.035	–0.403	–0.308*
Postdoc	–0.138*	–0.039	–0.070	–0.306**	–0.332	0.100
Loan $20,000 or less	–0.080	–0.028	–0.155	0.071	–0.074	–0.559**
Loan $20,001 to $50,000	–0.106	–0.121	–0.412***	–0.015	–0.184	–0.694***
Loan $50,001 or more	–0.415**	–0.621**	–0.818***	–0.214	–0.470**	–10.364***
Intra-class correlation	4%	15%	19%	5%	3%	8%
Reliability	0.33	0.46	0.52	0.45	0.28	0.50

Sources. Institute for Scientific Information, Inc. and National Science Foundation, Division of Science Resource Statistics, Special tabulations.
Note. The use of NSF data does not imply NSF endorsement of the research methods or conclusions contained in this report.
*$p < 0.05$, **$p < 0.01$, and ***$p < 0.001$

Humanities

In the humanities, age, race, time since baccalaureate attainment, selectivity of undergraduate institution, fellowships, and loan amounts of greater than $50,000 were significant predictors of time to doctorate. Age (B = 0.582, $p < 0.001$) and selectivity of undergraduate institution (B = 0.006, $p < 0.001$) were positively associated with time to degree, indicating that older students and students who attended more selective undergraduate institutions were more likely to take longer to complete

their degrees. Latino students took less time to complete doctoral degrees in humanities than White students (B = –0.514, p < 0.05). Students who delayed enrollment into doctoral programs after earning a bachelor's degree completed doctorates more quickly than those who enrolled sooner in graduate programs (B = –0.575, $p < 0.001$), as did students who received fellowships (compared with those who received teaching assistantships) (B = –0.324, $p < 0.01$). Finally, students with loan amounts exceeding $50,000 completed faster than students who did not borrow (B = –0.470, $p < 0.01$). Tuition and the percentage of minority doctorate recipients in the same field at the same institution are the institutional level variables that predicted time to degree in humanities. For example, higher tuition levels correspond with longer time to doctoral completion (B = 0.015, $p < 0.01$), whereas higher percentages of minority students correspond with shorter time to doctoral degree (B = –0.009, $p < 0.001$).

Education

Many individual factors but no institutional factors were predictive of graduate time to degree for students in education. Loan amounts of $20,000 or less (B = –0.559, $p < 0.01$), between $20,001–$50,000 (B = –0.694, $p < 0.001$) and greater than $50,000 (B = –1.364, $p < 0.001$) were negatively associated with time to degree. Thus, students who borrowed, regardless of the amount of loans, took significantly less time to doctorate than non-borrowers. Interestingly, the larger the loan amount, the shorter the time to doctorate degree. Age (B = 0.655, $p < 0.001$), continuing generation status (B = 0.425, $p < 0.01$), and selectivity of undergraduate institution (B = 0.005, $p < 0.001$) were positively related to time to degree, whereas time since baccalaureate attainment (B = –0.674, $p < 0.001$) and receiving a research assistantship (B = –0.308, $p < 0.05$) were significant negative predictors of time to degree after controlling for other individual and institutional variables. Education students who delayed entry into doctoral programs and those whose primary source of financial support was a research assistantship took less time than their counterparts to complete doctoral degrees. It is interesting to note that students with fellowship support were not significantly different in terms of time to degree than students who received teaching assistantships.

Similarities and Differences Across Fields of Study

By conducting six separate HLM analyses, it was possible to compare the common and unique factors that predict time to doctorate across the different fields of study. Gender was the only individual variable that

was not predictive of time to degree. Age, time elapsed since baccalaureate attainment, and selectivity of undergraduate institution predicted graduate time to degree across all fields of study. In addition, except for the social sciences, borrowing over $50,000 was a common predictor of time to degree. With the exception of education, receiving a fellowship significantly influenced time to doctoral degree. Having a research assistantship was a significant negative predictor for students in the biological sciences, engineering, and education. Continuing generation status increased time to doctorate degree in the biological and social sciences and education. Changing major from undergraduate to doctoral program significantly lengthened time to degree for students in the biological, physical, and social sciences. None of the institutional level variables was common to all fields of study. Graduate school tuition was, however, a significant factor in several fields including biological sciences, engineering, social sciences, and humanities.

In contrast, some predictors were unique to specific fields of study. Individual level variables that were predictive only within one or two fields included race/ethnicity, planning to do postdoctoral research, and having loan amounts of less than $20,000 or between $20,001–$50,000. To summarize, race was significant only in two fields of study, social sciences and humanities. In the social sciences, Black students took longer to complete their degrees than their White counterparts. In humanities, Latino students had significantly shorter times to degree than White students. No significant differences were found between Asian and White students in any field. In biological sciences and social sciences, students who plan to have a postdoctoral research experience after degree completion had shorter time to degree than their counterparts seeking employment. Students with less than $20,000 in loans were significantly different from non-borrowers only in education. Among institutional level variables, the percentage of minorities in the same field of study at the same institution was uniquely predictive of time to doctorate degree only in humanities. Variables that did not have a significant relationship with time to degree include Carnegie classification and institutional size (full-time enrollment).

Conclusion and Implications

The median amount of federal student loans that doctoral students had borrowed at the time of graduation in 2003/04 was $44,743, nearly four times the amount of $11,500 borrowed among 1992/93 graduates. This dramatic increase was faster than for students pursuing degrees at any other level (American Council on Education, 2005). Nevertheless,

research efforts on borrowing patterns and their association with students' various outcome measures have mainly focused on undergraduate students. Given the considerable extent of time that students commit to doctoral study—the median graduate time to degree among students in all fields was 8.2 years in 2005 (Hoffer et. al, 2006)—and given that time to degree is an important indicator of doctoral students' attrition rates (De Valero, 2001), this study that focuses on graduate debt and its relationship with time to doctoral degree is timely. The results generate significant implications for policy makers who need to be aware of the impact of increasing reliance on loans, particularly among doctoral students.

Breneman's model of doctoral degree completion was supported. This study confirmed that the type of financial support students receive in graduate school influences time to degree completion. Except for the social sciences, students with large loan amounts (greater than $50,000) took less time to graduate than non-borrowers in all fields of study, yet students with lower loan amounts completed degrees at the same pace in which non-borrowers did (except for one instance each, in education and physical sciences, where lower loan amounts were associated with shorter time to doctoral degree). This finding is rather surprising given the previous research findings that indicate that loan amount is negatively related to various student outcome measures, probably because of loan aversion behavior. However, the fact that having large loan amounts was related to shorter time to degree does not necessarily mean that doctoral students do not present similar loan aversion behavior as do undergraduates (e.g., Kim, 2007). Instead, this finding suggests that the students with large loan amounts may be more motivated to complete a degree and enter the workforce as quickly as possible so they do not accumulate additional debt and can begin to reduce the volume of loans by entering repayment earlier.

One important limitation of this study is that it only offers information about the students who managed to complete their doctoral degrees but not about those who did not. Given that the overall cumulative 10-year doctorate completion rate is 57% (Council of Graduate Schools, 2008), this limitation may be the reason why loans (and particularly large loan amounts) are associated with shorter time to doctoral degree. Students who drop out of doctoral programs might be quite distinct from the students who complete degrees, in terms of loan aversion or loan tolerance behavior. Thus, the fact that students stayed and managed to complete doctoral degrees may already indicate that they have higher tolerance levels with loan amounts as compared to students who did not complete a doctorate.

In addition, it may be that doctoral students are choosing to take more time until the completion of doctoral degrees (perhaps because of the need to work) rather than relying as heavily on student loans. Since the number of years of full-time graduate study is not included in the HLM analyses, it is not clear if students who had larger loan amounts were primarily full-time graduate students who, by virtue of their enrollment patterns, would likely complete doctorates in a more timely fashion. If this is the case, the negative relationship between large loan amounts and time to doctoral degree is not purely caused by the loan amount but rather by the students' commitment to graduate studies. All in all, although students who incur such large amounts of debt tend to take less time to earn a doctorate, the debt may be burdensome and could have effects on many aspects of the student's life including future career choices.

Assistantship and fellowship support is also related to timeliness of doctoral degree completion. Consistent with findings of other studies, students who had teaching assistantships, a time intensive form of financial support for graduate students, took longer to complete doctoral degrees than students with fellowships or research assistantships (Ehrenberg & Mavros, 1995; Wilson, 1965). This significant relationship is consistent across all fields of study. Although teaching assistantships are an important source of income for many doctoral students, financial support providers who are interested in moving students through doctoral programs relatively quickly (particularly for groups of students who reportedly take longer to complete degrees) may want to consider awarding fellowships and research assistantships rather than teaching assistantships. Graduate deans, department chairs, and faculty members should carefully consider the time and effort teaching assistants must commit to teaching responsibilities, and they should inform students that accepting a teaching assistantship may increase the amount of time that it takes students to complete doctoral degrees. For students who desire a career in academia, the additional time may be a positive tradeoff for the experience they receive. However, for students who wish to pursue other employment options, a teaching assistantship may delay degree completion. It is important that policy makers consider the type of financial support provided to doctoral students not only because is it associated with time to degree but also because it is related to doctoral degree completion (Ehrenberg & Mavros, 1995; Lovitts, 1997).

In this context, it is particularly noteworthy that higher percentages of Black students received fellowships than their Asian and White counterparts in the same field of study, but significantly lower percentages of Black and Latino students received research assistantships compared

with Asian and White students. This finding is generally consistent across all fields of study (see Appendix D). Fellowships and research assistantships not only provide financial benefits for the recipients but also provide credentials and research experience that doctoral students are expected to have upon graduation. The fact that significantly lower percentages of Black students received research assistantships suggests that Black students are disadvantaged not only in terms of time to degree but perhaps in terms of research experience, as well. Previous research on undergraduate students found that work experience, particularly if it is related to the students' career goal or major, increases the odds of student success in terms of persistence or graduation (e.g., Kim, 2007). Differences in financial support are also due in part to the availability of assistantship and fellowship funds by discipline. Students of color, who are represented most heavily in the social sciences and humanities, have less likelihood of receiving assistantships and fellowships since the funds are more heavily concentrated in other disciplines. Therefore, it is important for policy makers to seek remedies for the disparities in financial support across disciplines. Providing more opportunities to participate in research projects and providing greater fellowship support are important strategies that can support groups of students who lag behind in various measures of student outcomes, such as time to doctoral degree.

The implications of time to degree for students who delay entry into doctoral programs are of particular interest. These students take shorter time to complete doctoral degrees than those who enter doctoral programs immediately following completion of an undergraduate degree, all other individual and institutional variables being equal. This could happen for many reasons including their readiness for graduate school, desire, or sheer determination to complete their degree. It is also possible that they use the time prior to graduate school to brush up on academic skills or to prepare financially for the transition to graduate school by working full-time. In previous research, time to degree is often referred to by two similar but very distinct definitions: Total time to degree (TTD) measures elapsed time from completion of the baccalaureate degree through completion of the doctorate, including time periods during which the student may not be enrolled. The second measure, used in this study, is referred to as graduate time to degree (GTD) and includes the amount of time from enrollment in graduate school until completion of the doctorate (Hoffer et al., 2006). Although this study finds that large loan amounts shorten time to doctoral degree (GTD), the same is not necessarily true for total time to doctoral degree (TTD). Therefore, it is important to pay particular attention to the definition of time to degree when interpreting research findings.

Although students who delay entry into doctoral programs are likely to be older, the relationship of these two variables (delayed entry and age) with time to degree is unique in that older students take longer to complete doctoral degrees than younger students but students who delay entry are likely to complete degrees more quickly than those who enter doctoral programs shortly after completion of baccalaureate degrees. This finding may demonstrate the need for older students to attend part-time or to select only courses that are offered at convenient times. The growth of online doctoral programs and other innovative educational technologies that allow greater flexibility may be of benefit to such students; however, the tradeoff may be that older students may require time to learn new technology skills before they are able to benefit from such opportunities. Additionally, continuing generation students and students who attended selective baccalaureate institutions also took longer to complete doctorates in certain fields. Future research should explore the seemingly contradictory findings regarding age and delayed entry, as well as the reasons that continuing generation status and selectivity of baccalaureate institution are related to lengthier times to degree. Another area of exploration involves the influence of labor market demands on time to doctorate, as Breneman (1976) proposed. Inquiry into the means (processes, incentives, etc.) by which to expedite completion of the doctorate is also warranted.

Future studies should continue to explore the relationship between financial support and time to degree. Greater exploration of the characteristics of students with the highest loan amounts ($50,000 and above) may help reveal reasons that these students are able to complete degrees faster than non-borrowers and may provide insight into methods that can help speed up the completion rate of doctoral degrees for other students. Previous studies have indicated that doctoral students who had a broader base or multiple types of financial support completed programs at a faster pace than other students (Siegfried & Stock, 2000; Wilson, 1965). Future studies should, therefore, consider how multiple sources of financial support interact to influence time to degree completion.

The study confirms Biglan's (1973) notion that student experiences vary by discipline. In this case, doctoral study in the hard sciences (physical and biological sciences and engineering), with their established paradigms, was found to be shorter in comparison to the humanities and social sciences. Disciplines defined by Biglan as having practical utility (i.e., engineering, science) were generally found to have shorter times to doctoral degree than other disciplines. An exception is education, in which case, doctoral study is second only to social sciences in time to doctorate degree.

Finally, the institutional characteristics in this study (with the exception of tuition and percentage of minority students) did not make a significant difference in time to degree. The intra-class correlation (ICC) generated from a one-way random effect ANOVA range from 3% for humanities to 19% for the physical sciences, meaning that the portion of the total variance that occurs between colleges ranges from 3% in humanities to 19% in physical sciences. This suggests that the effects of institutional characteristics could vary significantly depending on the field of study. In addition, the error terms associated with the intercept are significant at the 0.001 level (except for humanities), indicating that there is significant variability among colleges in their average time to doctoral degree within the same field of study. Therefore, future research should also consider other institutional and departmental factors that influence time to doctorate and that may explain a greater proportion of the variance within each field of study.

The Survey of Earned Doctorates (SED) dataset represents the best national data available for examining the relationship between financial support and time to doctoral degree. By incorporating SED data with IPEDS data, this study expanded the possibility of research beyond individual level analysis. Nevertheless, lack of appropriate variables in the dataset restricts the construction of an extensive statistical model at this time. For example, the SED stopped collecting information on the number of years of full-time study during the doctoral programs in 2001 but did not begin collecting information on doctorate recipients' financial support patterns (particularly undergraduate and graduate loans) until 2001. Therefore, it is not possible to clarify if borrowing patterns and the amount of loans are related to students' employment or enrollment status. NSF should consider incorporating some additional questions into the SED survey in order to enhance the quality of data and the potential to generate more quality research, thereby leading to a more comprehensive understanding of doctorate recipients. It is against this background that the CGS "Ph.D. Completion Project" is particularly promising. By collaborating with NSF as well as individual institutions, CGS is constructing a comprehensive dataset that provides information not only on doctorate recipients but also on dropouts.

APPENDIX A

Variables in HLM models

College level variables	
Research extensive	0=research intensive, 1=research extensive
% minority	Continuous Min=0 Max=100
Tuition	Continuous Min=3 Max=34 (coded every $1,000 dollars)
FTE	Continuous Min=2 Max=47 (coded every 1,000 students)
Student level variables	
Age	Continuous Min=23 Max=46
Gender	0=male, 1=female
Asian	0=non-Asian, 1=Asian
Black	0=non-Black, 1=Black
Latino	0=non-Latino, 1=Latino
Continuing generation	0=first generation, 1=continuing generation
Time since BA attainment	Continuous Min=0 Max=14
Selectivity (BA)	Continuous Min=390 Max=800
Changing major	0=stayed in the same major, 1=changed major
Fellowship	0=no, 1=yes
RAship	0=no, 1=yes
Postdoc	0=no, 1=yes
Loan $20,000 or less	0=no, 1=yes
Loan $20,001 to $50,000	0=no, 1=yes
Loan $50,001 or more	0=no, 1=yes

Note. The use of NSF data does not imply NSF endorsement of the research methods or conclusions contained in this report.

Sources. Institute for Scientific Information, Inc.; and National Science Foundation, Division of Science Resource Statisitcs, Special tabulations.

APPENDIX B

Percentage Distribution of Borrowers by Individual and Institutional Variables Across Field of Study

		Biological sciences	Engineering	Physical sciences	Social sciences	Humanities	Education
Gender	Male	60.5%	46.8%	59.7%	69.2%	67.6%	52.6%
	Female	57.9	47.4	57.3	69.6	67.6	50.7
Race	White	59.0	44.5	58.0	67.8	66.2	47.5
	Black	77.4	53.4	79.6	78.7	83.2	70.7
	Latino	66.8	68.5	71.6	83.8	80.4	62.2
	Asian	51.2	51.9	56.9	68.7	59.6	45.4
Parent education	First generation	72.1	56.0	73.2	75.5	73.3	50.9
	Continuing generation	54.7	43.8	53.8	66.6	65.4	51.8
Financial source	Fellowship	56.8	47.4	55.2	65.7	62.4	57.6
	TAship	64.8	63.1	71.7	73.1	73.3	59.2
	RAship	65.9	51.2	59.7	71.1	75.0	65.2
Future plan	Postdoc	60.6	53.4	58.4	74.1	66.5	63.3
	Employment	56.3	45.0	58.7	68.1	67.8	49.5
Major status	Same major	59.5	45.8	59.3	72.9	68.245.3	
	Changed major	59.1	52.1	57.1	60.9	65.0	54.8
Doctoral institution	Research extensive	58.0	47.7	59.3	68.7	68.2	53.3
	Research intensive	63.2	41.5	56.5	71.1	64.6	46.2

Note. The use of NSF data does not imply NSF endorsement of the research methods or conclusions contained in this report.

Sources. Institute for Scientific Information, Inc.; and National Science Foundation, Division of Science Resource Statistics, Special tabulations.

APPENDIX C

Descriptive Statistics for the Variables: Means and Standard Deviation

	Biological sciences	Engineering	Physical sciences	Social sciences	Humanities	Education
Research extensive	0.83 (0.37)	0.77 (0.42)	0.79 (0.41)	0.84 (0.37)	0.93 (0.25)	0.88 (0.32)
% minority	29.11 (21.66)	52.35 (18.94)	37.14 (18.13)	30.52 (29.06)	53.31 (20.89)	51.88 (34.09)
Tuition	12.75 (11.11)	11.65 (10.34)	11.58 (10.20)	11.00 (9.81)	12.04 (10.59)	9.14 (8.50)
FTE	20.13 (9.96)	19.09 (10.86)	19.21 (10.57)	21.26 (9.92)	21.97 (10.02)	23.14 (9.87)
Age	31.29 (4.82)	32.03 (5.94)	30.63 (4.91)	34.42 (7.06)	36.33 (7.41)	41.96 (9.36)
Gender	0.51 (0.50)	0.20 (0.40)	0.31 (0.46)	0.61 (0.49)	0.49 (0.50)	0.67 (0.47)
Asian	0.12 (0.33)	0.15 (0.36)	0.09 (0.29)	0.06 (0.24)	0.05 (0.21)	0.03 (0.17)
Black	0.03 (0.18)	0.04 (0.21)	0.03 (0.16)	0.06 (0.24)	0.04 (0.21)	0.10 (0.29)
Latino	0.04 (0.200	0.03 (0.17)	0.03 (0.17)	0.06 (0.23)	0.05(0.21)	0.05 (0.23)
Continuing generation	0.77 (0.42)	0.76 (0.43)	0.75 (0.43)	0.73 (0.45)	0.76 (0.43)	0.55 (0.50)
Time since BA attainment	2.34 (3.72)	2.65 (4.64)	1.68 (3.68)	4.03 (5.38)	4.96 (5.90)	10.67 (8.78)
Selectivity (BA)	672 (65.45)	684 (61.74)	668 (68.41)	666 (66.34)	670 (68.36)	630 (65.00)
Changing major	0.25 (0.43)	0.17 (0.38)	0.17 (0.38)	0.29 (0.45)	0.16 (0.37)	0.68 (0.46)
Fellowship	0.65 (0.48)	0.38 (0.49)	0.33 (0.47)	0.28 (0.45)	0.32 (0.47)	0.12 (0.32)
RAship	0.17 (0.37)	0.40 (0.49)	0.45 (0.50)	0.13 (0.34)	0.01 (0.10)	0.07 (0.25)
Postdoc	0.49 (0.50)	0.20 (0.49)	0.44 (0.50)	0.23 (0.42)	0.06 (0.24)	0.04 (0.19)
Loan $20,000 or less	0.27 (0.45)	0.22 (0.42)	0.28 (0.45)	0.20 (0.40)	0.25 (0.43)	0.19 (0.39)
Loan $20,001 to $50,000	0.20 (0.40)	0.17 (0.37)	0.20 (0.40)	0.22 (0.42)	0.23 (0.42)	0.19 (0.40)
Loan $50,001 or more	0.10 (0.30)	0.08 (0.27)	0.10 (0.29)	0.24 (0.43)	0.20 (0.40)	0.16 (0.37)

Note 1. Standard deviation is in parenthesis.

Note 2. The use of NSF data does not imply NSF endorsement of the research methods or conclusions contained in this report.

Sources. Institute for Scientific Information, Inc.; and National Science Foundation, Division of Science Resource Statisitcs, Special tabulations.

APPENDIX D

Percentage of Students Who Received Financial Support by Race/Ethnicity

		Biological sciences	Engineering	Physical sciences	Social sciences	Humanities	Education
Fellowship	Asian	75.1	32.7	27.2	29.9	42.7	14.4
	Black	71.3	59.3	52.7	38.3	42.3	17.3
	Latino	70.0	50.0	42.5	35.8	29.0	13.8
	White	59.3	35.5	30.8	21.8	27.9	7.6
Research	Asian	10.9	47.1	48.3	12.9	0.7	8.1
assistantship	Black	6.7	11.1	23.6	6.8	1.8	2.8
	Latino	13.0	28.4	19.2	8.2	1.0	5.2
	White	17.3	36.8	42.8	11.1	0.9	4.9
Teaching	Asian	5.3	4.9	15.6	14.9	27.3	6.3
assistantship	Black	11.2	10.2	24.5	12.6	19.1	4.0
	Latino	7.3	6.2	15.5	13.2	43.2	5.0
	White	9.1	6.1	17.0	20.7	32.9	6.7

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

Sources. Institute for Scientific Information, Inc.; and National Science Foundation, Division of Science Resource Statisitcs, Special tabulations.

Notes

[1]Given that baccalaureate institutions of doctorate recipients do not directly affect their time to doctorate degree, the characteristics of baccalaureate institutions are used as individual level variables compared to the characteristics of doctorate institutions, which directly affect time to doctorate and are thus used as institutional variables.

[2]We have tried to include random effects for the slopes of level-1 variables (i.e., random slopes) but there was a convergence problem. Thus we conducted random intercept, level-1 and level-2 fixed slope model.

[3]The percentage distributions of borrowers by individual and institutional characteristics across field of study are presented in Appendix B.

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