Benefits of the Earned Doctorate: Equal for All?

Karen L. Webber

Institute of Higher Education
The University of Georgia

Scholarly Paper for 2013 AIR Forum

This paper was partially funded through AIR/NCES/NSF Grant 12-04

Abstract

The number of individuals receiving the doctorate degree in the United States continues to grow; however, little is known about the precise factors that affect wages for recent doctorate recipients over time. Detail on these factors can help to ensure a balanced supply and demand in the labor market, continued knowledge production that can contribute to the local and national economy, and greater quality of life for all individuals. Using data from approximately 12,000 respondents who completed the 1999 through 2008 *Survey of Doctorate Recipients*, this study examined factors that contribute to wage growth over time. Findings show strong wage benefits for degree recipients over the decade, and significant differences by gender, race, discipline, and foreign versus native status. Findings have strong implications for individuals who may consider doctorate or other advanced training, for institution officials, and for policies in doctorate degree education.

Introduction

Earned by less than 2% of the population, the doctorate degree holds an esteemed place in American society. Doctoral degree recipients are the primary knowledge producers in society, and hold high-ranking positions in many employment sectors, including education, government, and private industry. The level of knowledge doctorate degree holders acquire through extensive study has traditionally been high in demand in the job market, and recent projections from the Bureau of Labor Statistics (BLS) indicate that the demand for workers with a doctoral or professional degree will increase, especially in the sciences and engineering. In a report commissioned by the BLS, Sommers and Franklin (2012) project that between 2010 and 2020, the expected total growth in job openings will be 14.3%, regardless of the required education level. However, the same report indicates an anticipated increase of 19.9% for job openings that require a doctorate or professional degree. This percentage represents an increase of 876,600 jobs that will require an advanced degree. This is an encouraging sign for those seeking advanced degrees, but there are growing concerns of diminishing employment opportunities for doctorate recipients specifically. When the supply of doctorate recipients outpaces the demands of the market, the levels of unemployment can increase and/or the economic benefits relative to salaries for others holding the master's degree or less can decrease. In addition, diminished federal and state appropriations and the resulting increased reliance on tuition revenue by institutions has required students, including doctoral students, to assume a greater share of tuition, often through financial aid, thereby adding to the costs of acquiring the degree. Upon receiving the degree and securing employment, doctoral recipients may experience differences in salary and job satisfaction by gender, race, or type of employment. Like any individual seeking

to make a rational decision, doctoral students must decide if the benefits of earning this terminal degree outweigh the multiple costs.

To address labor market needs, the higher education sector holds a primary responsibility to provide and train the necessary human resources (Toutkoushian, 2005). This is true for both the undergraduate and graduate student populations, and while higher education is not fully responsible for fixing a labor supply shortfall in the job market, colleges and universities are responsible for providing students with the best possible training for the available positions. Based on projections provided by the Bureau of Labor Statistics (Sommers & Franklin, 2012), colleges and universities will continue to play a major role in training doctoral students for the growing need for employees who hold advanced degrees.

Purpose of the Study

The decision to acquire more education is seen as an investment in human capital. When students go through the process of deciding whether or not to attend graduate school and pursue a doctoral degree, they must weigh the costs, both direct and indirect, of that investment against the expected benefits. Benefits for increased education include social and cultural advantages, such as increased professional networking and higher quality of life, but the acquisition of the doctoral degree more visibly includes the economic benefits of increased wages and decreased chances for unemployment. It is estimated that, in general, an individual with a doctorate will earn approximately $1 million more over his or her lifetime than a peer with a bachelor's degree will earn (Carnevale, Rose, & Cheah, 2011). However, we do not know the precise factors that affect wages for recent doctorate recipients. A deeper understanding of the economic benefits of the earned doctorate is important to students seeking to make a rational decision regarding whether or not to enroll. More complete information can help to ensure a balanced supply and

demand in the labor market, continued knowledge production that can contribute to the local and national economy, and greater quality of life for all individuals.

This research is guided by the tenets of rational choice and human capital theories, and uses data from the 1999 through 2008 *Survey of Doctorate Recipients*. This study examined factors that contribute to wage growth for doctoral degree recipients over time, and further examined whether wage growth over the period of a decade differs by gender, race, discipline, and other individual and institutional characteristics. The growth curve model utilized in this study is an effective technique to examine wages over time (Bryk & Radenbush, 2001). Growth curve modeling has been used in a number of studies that examine time-varying covariates (e.g., Espy, Malfese, & Dilalla, 2001; Horney, Osgood, & Marshall, 1995) and allows for better estimate growth in parameters over time as well as the variance in those parameters. This study seeks to answer the following research questions:

1. What individual economic benefits accrue to doctoral degree recipients from the time of graduation (1999) to 2008?
2. Are there differences in economic benefits resulting from debt assumed and sources of financial support during degree enrollment?
3. What effect does time to degree completion have on the economic benefits obtained by doctorate degree recipients? and,
4. Are there statistical differences in the economic benefits with regard to gender, race, citizenship, discipline of degree, completion of postdoctoral work, type of work after degree completion, and characteristics of doctoral degree institution?

Conceptual Framework

Theories of human capital and rational choice guide the development of this study. Advanced levels of education increase human intellectual capital and, as a result, may benefit the individual and society through increased wages and increased productivity, respectively Although higher levels of education have associated costs, particularly foregone wages, doctoral level education most often brings high level of rewards, both in social quality of life as well as increased earnings and lower likelihood of unemployment. One primary benefit of increased education, both for undergraduate and graduate students, is the resultant increase in the student's human capital.

Based on Manski's (1977) rational utility model, DesJardins and Tourkoushian. (2005) emphasize the fact that both a student's probability of being admitted to a particular school and the financial aid package that the student is offered play important roles in a student's decisions of where to apply and then where to attend. Rational choice theory (Manski), purports that one's decision to enroll in education is based on numerous considerations, including choice of discipline, financial needs, family, and likelihood of securing employment after degree completion. Students make those choices based on the information available to them; they are bound by imperfect information and the inability to exhaustively examine every possible alternative. However, this does not preclude them from making a rational decision based on their individual preferences. The lessons learned related to undergraduate choices in higher education can largely be extended to the decision process in which graduate students engage when deciding whether or not to pursue doctoral education. Once they complete their undergraduate education, students have a choice between several options: enroll in graduate or professional school (either in the same field or a different field), pursue non-degree study or other avocational pursuits or

seek full-time employment. Like undergraduate students, graduate students also consider the potential benefits (and the likelihood of receiving those benefits) of further education as well as the costs to attain those benefits. Benefits accrued are immediately, including the desire and the joy of learning and an enhanced social status, as well as long-term, including greater earnings and a far lower likelihood of unemployment (Perna, 2004). A student's undergraduate field of study will play an important role in their decision to further their education through graduate school. For example, a student who chose to study communication for their bachelor's studies would be less likely to attend graduate school than a student who studied biology.

DesJardins and Toutkoushian (2005) provide a thorough review of student choice models, and while many differ in the terminology used, they all generally settle on three major steps in the process: development of college aspirations, identification of and application to institutions that fulfill the aspirational goals established by the student, and a final decision made by the student based on the student's preferences. This final step in the process, the choice, has traditionally been the focus of empirical research. These models have been based on undergraduate decisions, but the process is largely the same for graduate students, and it therefore is plausible that a similar decision process occurs for doctoral students. Doctoral students must make rational decisions related to the same issues, including both direct and indirect costs. For example, doctoral students must weigh whether or not graduate education is worth the additional tuition payments that could potentially lead to greater student debt. In addition to many of the same concerns faced by undergraduate students, graduate students have other factors to consider, including family issues and responsibilities and a more focused and narrow job market based on students' specializations.

Historically, the acquisition of a doctoral degree has signified an increase in an individual's human capital. In the absence of an organization's ability to adequately ascertain an individual's exact levels of human capital, a degree can serve as a signal to the labor market that an individual is qualified for certain positions. A doctoral degree is a strong credential that signals deep knowledge, skills in specialized tools and/or techniques, and the probability of productivity. The sheepskin effect (Jaeger & Page, 1996; Olneck, 1979) is a common manifestation of a signal being sent to the market. Signaling, as described by Spence (1973), occurs when the possession of a particular credential, in this case an advanced college degree, serves as a signal to the job market that the prospective employee has the necessary knowledge, skills, and abilities to perform the job in question. Signaling occurs regardless of whether or not the credential holder actually has the human capital qualities that are signaled by the degree. In higher education, signaling has been shown to have an effect in addition to human capital in some scenarios at both the undergraduate and graduate degree levels (Hamalainen et al., 2008; Hussey, 2012). However, regardless of whether the student is pursuing the degree for the skills and knowledge they will acquire, the signal that the degree sends to potential employers, or a combination of both, students still engage in a decision-making process.

Review of Relevant Literature

The number of individuals who complete the doctorate degree has increased steadily, nearly tripling since 1971 (*Digest of Educational Statistics*, 2011). In 2009-10, there were 158,558 doctoral and professional degrees conferred from universities in the United States (*Digest of Educational Statistics*, 2011). In part, this is due to individuals realizing that the many benefits of increased education include long-term economic gains, greater lifetime earnings, increased work productivity, and higher levels of job satisfaction (Becker, 1962; 1993; Perna,

2003). Other non-economic long-term benefits include better health, longer life, enhanced decision making, and lower probability of unemployment and poverty (Baum & Payea, 2004; Perna, 2004). Educated individuals enjoy broader cognitive benefits, including intellectual tolerance and integrity, creativity, wisdom, and the desire to pursue lifelong learning. These benefits allow individuals to develop psychological competencies that include adaptability and increased understanding of leadership, astute customer behavior, civic mindedness, and more rewarding family relationships.

Differences in benefits

Despite the many benefits that can accrue from postsecondary degree completion, not all students graduate at equal rates, nor do they receive equal salary and other benefits. For example, women earn less than their male peers (Bellas, 1997; Toutkoushian & Conley, 2005; Umbach, 2007; Zhang, 2008), and minorities earn less than their majority peers (Becker, 1993). In 2010, the median weekly earnings for African-Americans age 25 and older were 24.3% less than their white peers, and women aged 25 and older earned 21.7% less than male peers (Table 3, USDL Report 13-0060). The differences in salary for those with advanced education were marginally improved in equity, but still unequal; median weekly salaries for women with a doctorate were 19.8% less than their male peers (Table 17, USDL Report 13-0060).

Time to doctoral degree

Time to degree completion can impact career choice and sector of employment. Traditional figures report that only about half of doctorate seekers graduate (e.g., Bowen & Rudenstine, 1992); however, more recent figures for time to degree indicate an overall decrease in time to doctorate degree from 8.2 to 7.5 years (Hoffer & Welch, NSF Brief, 2006), with individuals in science and engineering fields completing the degree more quickly than those in

non-science and non-engineering fields. Time to degree is an especially important variable because the longer one takes to complete the doctorate, deferred income from employment and greater educational debt is likely.

One of the first studies to measure time to degree for graduate students was performed by Abedi and Benkin (1987) who found that the source of financial support was the most important variable in predicting time to doctorate. Similar to later findings by Ziolkowski (1990), Abedi and Benkin (1987) found that doctoral students with fellowships/grants took the least amount of time on average to complete the degree, while students who were supported through off-campus employment took the longest amount of time to complete the degree. Students with fellowships and grants completed their degree roughly one-and-a-half years earlier than students who received loans. Students who relied on off-campus employment took more than four years longer on average to complete the degree than students receiving fellowships/grants (Abedi & Benkin, 1987).

Bowen and Rudenstine (1992) found that doctoral students who rely on their own financial resources are less likely to complete their doctoral studies and obtain the PhD. In addition, while teaching assistantships facilitated involvement in one's field and encouraged graduate students to complete their studies, the extra time and work required for preparation and teaching could significantly lengthen the time to degree. Further, they found that fellowships or research assistantships provided a shorter time to degree, with the difference being roughly half a year (Bowen & Rudenstine, 1992). However, Lipschutz (1993) found that teaching responsibilities may help strengthen a student's commitment to the field, while research assistantships may slow a student's own research due to extensive work on a faculty member's project.

Baird (1996) noted that students who rely on their own resources to fund their doctoral studies take one-half to two-thirds more time to complete their degrees than students with institutional support, and Breneman (1976) suggested that degree completion and time to degree are a function of the labor market and financial sources. If the labor market is strong, doctoral students have greater incentive to complete the degree, thus reducing time to degree.

Pathways to the professoriate

According to previous reports from the Survey of Earned Doctorates (e.g., *SED Summary Report*, 2006), about half of doctorate holders plan to enter employment in education, about 25% plan to enter industry or be self-employed, and about 5% plan to enter employment in industry. In an increasingly global and competitive society, some doctorate holders seek postdoctoral research experiences prior to permanent employment. Approximately one third of doctoral recipients plan to seek a postdoctoral research experience. Depending on the field, and especially for those seeking employment as a tenured faculty member, postdoctoral experience is perceived as a necessary stepping-stone to a faculty career (Zumeta, 1984; Nerad & Cerny, 1999). The postdoctoral experience can increase one's specialized knowledge and training (human capital), which can make the postdoc even more marketable in all sectors. This is especially so in postsecondary education where the number of tenured faculty positions are declining.

Labor market demands and fewer tenure-track job openings in postsecondary education are prompting more doctorate recipients to consider a postdoctoral appointment. The number of doctorate recipients in the U.S. who seek a postdoctoral research position is greater now than ever before (Stephan & Ma, 2005; NSF, 2008). According to data from the 2006 *Survey of Doctorate Recipients* (SDR), 45% of recent science, engineering, and health (SEH) doctorate recipients had completed or were participating in postdoctoral appointments, up from 41% in

1995. The increases in postdoctoral participation rates are greatest for doctorate recipients in computer/mathematics and life sciences (NSF, 2008).

Notions of cumulative advantage posit that faculty members who graduate from select doctoral institutions, who have worked closely with faculty mentors, and who published early in their career are more productive later in their careers (Brocato & Mavis, 2005; Zhang, 2005). Because many doctorate degree recipients seek a permanent position in postsecondary education, many take on one or more postdoctorate research positions. Generally, the postdoctoral training helps strengthen one's knowledge, skills, and scholarly habits, but it is also a time in which one can develop interdisciplinary partnerships and form a network to support that may lead to long-term employment, typically a tenure-track faculty position.

In the past decade, the number of individuals employed at a postdoctoral researcher has increased, and some scholars argue that the role, quality of the experience, and career path of postdoctoral researchers have changed. Nerad and Cerny (1999) found that postdoctoral appointments can become more 'holding bays' rather than stepping stones that guarantee career advancement in the higher education sector. Cantwell (2009) further noted that the changing political economy and the entrepreneurial development of postsecondary institutions for increased revenue have largely reshaped postdoctoral work from apprenticeships that led to a heralded faculty career to temporary employment with little or no future work guarantees.

Doctoral degree completion by gender, race, and international status

Differences in doctoral degree completion by gender, race, and international status affect the overall profile of U.S. employment, human labor production, and perhaps quality of life that is sought and/or achieved by doctoral degree recipients. A better understanding of degree completion by these three important demographic characteristics is merited.

Beginning in 2005-06 and each year since, more than 50% of U.S. doctoral degrees were earned by women (*Digest of Educational Statistics,* 2010). However, considerable differences in salary and field of degree completion continue. In 2005, women earned half or more of doctorates in social/behavioral sciences and life sciences. Women earned considerably less doctorates than male peers in physical sciences, math/computer sciences, and engineering (*Science & Engineering Indicators,* 2008). Gender issues are still evident for some workers, especially in STEM fields (Xie & Schauman, 2005). When examining trends in earned doctorates in science disciplines over a 12-year period, Kulis, Sicotte, and Collins (2002) found that even after controlling for differences across fields, women had poor odds of finding faculty positions in physics and astronomy, earth sciences, and agricultural sciences.

The number and proportion of doctorates earned by minorities also increased over the past two decades. For example, Blacks, Hispanics, and Native Americans earned almost 1,600 science and engineering doctorates in 2005, about 5% of all science and engineering doctorate degrees earned that year. Gains by all racial groups contributed to this rise; science and engineering degrees earned by Blacks and Hispanics more than doubled in this period, and the number of science and engineering degrees earned by Native Americans increased by 61% (*S&E Indicators*, 2008).

Non-U.S. citizens account for the bulk of growth in science and engineering doctorates awarded in the U.S. In 2005, foreign students on temporary visas earned half or more of doctoral degrees in engineering, mathematics, computer sciences, physics, and economics. A diverse doctoral population can be beneficial; foreign scholars contribute to science by collaborating in global scientific networks, generating new knowledge, and helping to increase scientific capacity (*S&E Indicators*, 2008; Wagner, 2007). Recent reports show that foreign-born faculty members

are more productive than U.S.-born faculty members (Webber, 2012), yet more study of this issue is needed.

When accounting for the costs of a doctoral education, it is important to accurately account for all of the costs as well as the benefits. One of those costs is forgone salary; however, that cost can be slightly mitigated by the fact that institutions support most full-time doctoral students through fellowships, research assistantships, and teaching assistantships, all of which typically provide at least partial tuition remission. Funds that support doctorate level assistantships usually come from federal research grants and state appropriations (Ehrenberg, 2005). The source of financial aid and type of baccalaureate institution affect enrollment in doctoral programs, and students who do not have institutional aid have a longer time to degree completion (Bowen & Rudenstine, 1992). Edie and Waehrer (1998) report that enrollment at elite undergraduate programs increases a student's likelihood to enroll in graduate study, especially in disciplines where fellowships, teaching assistantships, or research assistantships are available. Similarly, Malcolm and Dowd (2012) found that students who receive their baccalaureate degrees from research universities are more likely to attend graduate school, and this may occur, in part, due to increased opportunities to interact with faculty members and/or participation in activities such as research at the undergraduate level.

Method and Data

Growth Models

An extensive review of the literature suggests that this study will fill an important gap in the existing body of knowledge. Growth models are an important variation of traditional multilevel models and have been shown to be useful for making projections. For example, Mankiw, Romer, and Weil (1992) notably utilized growth models to provide an analysis of

economic growth and standards of living. Growth models are also not new to the higher education sector. Porter (1965) used this method to project faculty size and salaries, and Barro (2001) and Krueger and Lindahl (2000) studied education attainment (more broadly, not specifically doctoral degree attainment). Webber (2002) focused on the positive effects of investing in education, but primarily was interested in secondary education. These have been important contributions to the field, but thus far, none have explored the growth of the benefits of receiving a doctoral degree.

The primary method of analysis for this study was a hierarchical linear growth model (HLGM). In traditional multilevel analysis, individuals or units are nested within structures (*i.e.*, students within classrooms, classrooms within schools). In growth modeling, the individual becomes the nesting structure and time is nested within the individual. In other words, repeated observations from an individual represent the level-1 state, and the attributes of the individual account for the level-2 variables (Bliese & Ployhart, 2002).

Given the longitudinal structure of data required in growth modeling, techniques that address non-independence in the responses from individuals at times 1 and 2 are required to obtain estimations that go beyond simple reporting of individual trends. Another key challenge in growth modeling is the likelihood that responses will tend to become either more variable over time or less variable over time (Bliese, 2012). These two challenges, autocorrelation and heteroscedasticity, were accounted for in our models. Evidence of autocorrelation was found, however, heteroscedasticity was not present. Finding no heteroscedasticity makes sense because there are five points in time, and the variance of salary remained constant over time. Equations for the HLM growth model and generalized linear mixed model specifications are included in Appendix A and were used for the final analyses shown in Table 4.

Data

Data was captured from 10 different datasets provided by the National Science Foundation, *Survey of Doctorate Recipients*. The 1999 dataset had an unweighted total sample of approximately 12,060 respondents (number rounded) which we were used to examine their academic and professional trajectories at four more points in time: 2001, 2003, 2006, and 2008. Missing data for some of the predictor variables led to a final analytic sample size of approximately 9,980. That is, the total number of observations upon which the models were fitted was approximately 49,880 cases.[1]

Results

Table 1 displays the demographic characteristics of doctorate recipients who completed the 1999 SDR survey, and who responded to follow up surveys in subsequent years, 2001 through 2008. Due to sample selection procedures for a repeated panel study, every data collection point was associated with an approximate reduction of respondents. For example, of the 27,740 respondents to the 1999 survey, 22,380 responded to the 2001 survey; similarly, the next follow-up did not account for 4,340 respondents of the 1999 and 2001 surveys; 2006 and 2008 lost approximately 2,680 and 3,300 participants, respectively. These numbers render a total of 12,060 doctorate recipients who were followed over a 10-year period. With a sample of over 12,000 respondents, nearly three quarters of the doctorate recipients were male (72.9%) and white (76.7%). Just over 80 percent of the doctorate recipients who responded to the 1998-1999 survey were born in the U.S., and 5% of this sample completed a postdoctoral training experience immediately after degree completion. Doctorate recipients earned their degree in a

[1] Models excluding the variables with missing cases and the magnitude of the coefficients along with their statistical significance remained unchanged. Those missing cases do not affect inferences made from these models, as that missing data happened at random (Gelman, Carlin, Stern, & Rubin, 2003). To comply with NSF standards, all numbers reported are rounded.

variety of fields, with just over 28% earning a doctorate in the social sciences and psychology; 25.6% in biology, agriculture, and environmental sciences; nearly a fifth in physical sciences; and 16% in engineering. The majority of doctorates were earned from public institutions (66.8%) and from Research I universities (76.1%). Additional descriptive analyses (not shown in table) revealed the average age for doctorate recipients in this sample was 44.7 years (SD=8.5) in 1999, and the average years to degree was 22.1 (SD=8.6)[2].

(Insert Table 1 about here)

Table 2 offers demographic information for respondents over time. As expected, variables such as marital status changed over time. Married respondents increased modestly from 1999 to 2006, but decreased in 2008. The change in marital status indicates that some individuals may have been married, divorced or widowed, and/or married again over the ten-year period. Similarly, the flow of respondents into and out of each employment sector changed over time. For example, in 1999, 50.1% of the respondents were employed in education, but steadily dropped over the decade, whereas those who worked in business/industry increased over the decade.

Table 3 shows average salaries for respondents across the decade. Although the salary of doctorate recipients in 1999 was just over $73,000 and rose to $115,000 in 2008, salaries varied by employment sector. As shown in Table 3, the largest number of doctorate recipients entered the education sector, primarily postsecondary education, but consistently earned the lowest salaries.

(Insert Tables 2 and 3 about here)

[2] The average years to degree found in our sample is higher than other figures reported (e.g., Freeman, Weinstein, Marincote, Rosenbaum, & Solomon, 2001), and may be due to our broad sample across all eligible disciplines).

To answer the research questions posed in this study, a series of hierarchical linear growth models (HLGM) was developed. As described in the methods section above, prior to the final models shown in Table 4, a series of initial analyses were completed to test for autocorrelation and heteroscedasticity, shown in Appendix A. Table 4 provides results from the hierarchical linear growth models of factors contributing to salary variation over the decade 1999-2008. Models 1-3 include fixed effects for time invariant variables, and model 4 includes additional variables for job sector that are time variant. Each model included a variable for time point to account for naturally increasing salary across each time point 1999 through 2008. As expected, time was a significant positive contributor to salary in all models, meaning that salary increased over time. In addition to time, the first model included variables related to gender, international birth status, race, marital status, and number of dependent children. As shown, being married had a positive effect on salary, while being female, U.S.-born, Hispanic, or Black had a negative effect on salary. In the second model, additional variables related to time to degree, debt, and institution level were added. Results showed that time to degree had a negative effect, and individuals who earned their doctorate degree from a Research I institution earned higher salaries compared to peers who earned their doctorate degree from a Research II or Doctorate-Granting institution.

Previous literature (e.g., Kim & Otts, 2010; Belasco, Trivette, & Webber, 2013) prompted our rationale to include level of academic debt. Findings shown in Table 4 indicate that having any level of debt from doctoral education did not have a significant effect on salary for respondents who answered this question, but there was a significant positive effect for respondents who did not answer this question. If individuals who did not answer this question

had no debt, then we might reasonably argue that having debt from doctoral education did not affect salary, yet having no debt was a significant contributor to later salary.

A third model shown in Table 4 included additional variables related to discipline of doctorate degree. As shown, earning a degree in psychology had a negative effect on salary, while earning a degree in computer sciences, physical sciences, engineering, or health sciences contributed positively.

The final model shown in Table 4 included variables for employment sector. As shown, compared to individuals who worked in business and industry, those who worked in education earned significantly lower salaries. The strength of this finding confirms the descriptive difference in salary by sector shown in Table 3.

(Insert Table 4 about here)

Limitations

Findings from this study are based on self-reported data, and include only those respondents for which there was data over the decade 1999-2008. It is possible that respondents could misreport their salary or other information, and it is possible that individuals who responded to the surveys over time were more biased in some way (e.g., more positive about their employment than average). In addition, because the SDR is not a true longitudinal study, but a repeated panel study, only a sample of individuals is captured at each time point, and may not reflect salary or other outcomes for all doctorate recipients.

Although not measured in this study, the benefits of continued education that extend beyond human capital are important to acknowledge. Where human capital embodies skills and knowledge acquired by an individual, social capital includes the important, albeit intangible, benefits that exist and contribute to one's productivity through social relationships (Coleman,

1988). Social structures and norms can enhance a doctoral students' understanding of behaviors and attitudes needed to be successful during graduate study. For example, established peers may share knowledge of a faculty member's expectations and unwritten standards that may be necessary for doctoral student completion with new students. When this happens, new students may benefit from tacit as well as direct information on how to be successful in completing all work tasks under tight timelines.

Discussion

Following a sample of over 10,000 respondents from the *Survey of Doctorate Recipients* over a decade from 1999 to 2008, this study examined factors that contribute to wage growth and whether wages over the period differed by gender, race, discipline, and other individual and institutional characteristics. Findings showed that the doctorate recipient's wage growth over time is indeed affected by several important demographic and institutional factors. Over the decade, wages climb, but benefits are greater for some individuals and less for others. Hierarchical growth model analyses found that female recipients consistently earned lower wages over the decade than their male peers. Those respondents who were married, those who took less time to complete their degree, and those who earned their doctorate degree from a Research I institution received greater wages over the span of the decade than their unmarried peers, those who took longer, and those who earned their doctorate degree from institutions other than Research I institutions. The largest percentage of doctorate recipients reported working in the education sector, but those employed in the education sector earned significantly less wages than peers in business and industry. Academic discipline of the doctorate degree also had a significant effect; as expected degree recipients from computer sciences, engineering, and health sciences earned significantly more wages than peers with a doctorate in business, and

respondents with a degree in psychology earned less wages than peers in the referent group, business. Since women earned the majority of doctorate degrees in psychology, they may be experiencing the effects of both gender and discipline on wage benefits.

In early models (shown in Table 4), Black and Hispanic doctorate holders earned lesser wages; however, when additional demographic and institutional variables were added to the model, the effect of race no longer remained significant. This finding indicates that once other individual and institutional characteristics are controlled, salaries by race are not significantly different. Similarly, in the first two models, U.S.-born doctorate degree holders reported significantly lower wages, but once additional variables in models 2 and 3 were added to control for additional variance, the difference between foreign- and U.S.-born salaries was no longer significant. This finding indicates that once academic discipline and employment sector were controlled, U.S.- and foreign-born doctorate recipients earn roughly the same salaries. Future analysis of the interactions by birth country and discipline may shed additional light on this finding.

Implications

An increasingly technological and global world is one factor that prompts the continued need for individuals with advanced knowledge and skill. Doctoral study that refines an individual's cognitive acuity can lead to new knowledge. That new or refined knowledge is critical for continued economic strength. Authorities have predicted substantial growth in the labor market for doctorate degree holders (Sommers & Franklin, 2012), indicating that those earning a doctoral degree in the United States will continue to hold an esteemed place in society.

The finding that doctorate recipients who earned their degree from Research I institutions reported the highest salaries may indicate advantages in access to senior scholars in their

discipline, superior facilities, and/or the kinds of research in which they become involved. Since Research I institutions also receive the highest amount of external funding compared to other 4-year institutions, it is possible that officials at Research I universities can award higher and/or more frequent graduate funding. Graduate assistantships provide needed funds that make doctoral study possible for many, particularly in engineering and the sciences, and prestigious academic fellowships may greatly assist doctorate earners in subsequent postdoctoral appointments and/or full-time employment.

It is possible that several forces in the early 21st century have come together to create an oversupply of doctorate degree holders, at least in some fields. Such an oversupply might result in employers seeking employees that hold a more advanced degree even if the job duties do not require it. An oversupply can lead to greater competition for certain jobs such as tenure-track academic appointments. Limited tenure-track appointments may then push individuals to seek greater training such as postdoctoral appointments, not necessarily to receive unique, advanced skill, but simply because the job market demands it. This potential scenario mitigates the original and economically beneficial rationale for advanced training and could lead to students with higher debt loads, lower quality of life, and lower value for overall human capital benefits of advanced education and training.

The oversupply of doctorate degrees (Carnevale, Smith, & Melton, 2011), particularly in some STEM fields, may prompt continued or even greater competition in all employment sectors. Fewer tenure-track postsecondary appointments may push more workers into the long-term part-time worker category where wages are low and hours are high. The oversupply of doctorate degrees may encourage more degree completers to seek employment in government or business and industry rather than education. While it is possible that knowledge production will

continue at similar or even greater levels, the pursuit of new knowledge and its transformation into revenue gains are a fundamental part of the research university. In addition to possible regional and national economic impacts, the lessening of researchers striving for and achieving new knowledge may have adverse effects on institutional coffers, institutional image, and the quality of instruction. Graduate students often choose to study at specific institutions so as to study with a particular faculty scholar. In addition, researchers often bring their findings into the classroom, and may serve as a way to attract highly able students. If new doctorate recipients choose not to pursue an academic career, an adverse impact may be felt in many and unintended areas, including advanced biomedical, engineering, and other science fields that are often on the cutting edge of new scientific development.

Relatedly, individuals pursuing the postdoctoral appointment may need to closely gauge the return on investment for this advanced study. Although postdoc training may greatly enhance one's chances of employment in certain disciplines, the competition for limited tenure-track positions is currently prompting some to remain in a low-paying, high stress postdoc position for multiple years, further taxing and/or jeopardizing the long-term benefit of the specialized training. Institutional officials should ensure the creation of policies that monitor postdoc salaries and maximum length of time for continuing in such a position. If, after a specified time, the employer values the postdoc researcher's skills, movement into other academic research positions should be pursued and/or required.

The significant difference in salary by gender and race also requires attention. The finding that salaries by race were not significantly different in the final model is a hopeful sign; however, it is possible that the limited sample herein may not reflect all minority doctorate recipients. In general, women and minorities do report lower salaries (NSF Report 13-304)

Unequal salaries for select groups may speak to the unequal value held for minority and female doctorate employees. In addition, the challenges experienced to balance work and family is well documented. Family friendly personnel policies are limited, and although there is a growing number of work sites that offer job leaves or stop-outs, few women or men opt to take advantage, partly out of lack of knowledge of the policy or because of social pressure to not take advantage of such policies for fear of being seen as "weak" or "not able to cut it" (June, 2010; Mason, 2011; Ward & Wolf-Wendel, 2012). Institution officials may wish to expand parental leave policies, allow for "stop-the-clock" periods or movement to a temporary part-time tenure track, and better publicize the programs available. Most importantly, senior administrators, department chairs, and faculty peers must work to change the culture that does not value working women and that expects women to take on the majority of child care, household tasks, and perhaps also elderly parent care. Despite the fact that new doctorate degree recipients in 2013 have been reared well after the last large feminist movement in the early 1970s, many individuals, young and old, still cling to outdated stereotypes of women's value in the home but not in the lab or university classroom. An equally discouraging finding is that the status of some professions decline when the majority of workers move from male to female (e.g., K-12 teachers, dieticians, psychologists) (*Women in the APA*, 2006). Our findings herein call for additional study of wages for doctorate degree recipients by gender as well as for continued push for policies that seek greater gender equity for working women.

Individuals may also use our findings of significant differences in wage growth by important demographic and institutional characteristics as they consider whether or not to pursue doctoral education. Like other individuals who make rational decisions (Manski, 1977), potential doctoral students must attempt to determine if future salary and other benefits will outweigh the

costs of deferred earnings and possible detriments to quality of life that occur during doctorate study. Especially for individuals in some subgroups, such as women and minorities, this decision may be difficult and require thorough consideration. However, with these hesitancies noted, findings herein do, overall, confirm that receipt of the doctorate degree is beneficial and should provide long-term financial benefits to the recipient.

Finally, it is important to note that these findings are just one piece of a larger puzzle. This particular research does not speak to the many social and cultural benefits that can accrue from earning a doctoral degree. However, the findings presented here are important. In order to make a more informed decision, students considering whether or not to pursue the doctorate degree can include this information in a larger equation that also incorporates their multiple other individual preferences. Future earnings are an important factor when considering the decision to enroll in a doctorate program, but by no means should be the only contributing factor. Rational decisions can be better made with more complete information, and the findings of this study contribute to that ever-growing body of knowledge.

The author wishes to acknowledge and thank members of 'Team K' for their assistance on this research project - Manuel González Canché, Lijing Yang, Drew Pearl, and Sharon Johnson.

References

Abedi, J., & Benkin, E. (1987). The effects of students' academic, financial, and demographic variables on time to the doctorate. *Research in Higher Education*, *27*(1), 3–14.

Baird, L. (1996). Documenting student outcomes in graduate and professional programs. *New Directions in Institutional Research, 90*, 77-87.

Barro, R. J. (2001). Human capital and growth. *The American Economic Review*, *91*(2), 12–17.

Baum, S. & Payea, K. (2004). *Education pays 2004: The benefits of higher education for individuals and society*. Princeton: College Entrance Examination Board.

Becker, G. (1962). Investment in human capital: A theoretical analysis. *The Journal of Political Economy, 70*, 9-49.

Becker, G. (1993). *Human capital: A theoretical and empirical analysis with special reference to education*. Chicago: University of Chicago Press.

Belasco, A., Trivette, M., & Webber, K. (2013). (submitted for consideration, February, 2013). Advanced degrees of debt: Analyzing the patterns and determinants of graduate student borrowing.

Bellas, M. (1997). Disciplinary differences in faculty salaries: Does gender bias play a role? *Journal of Higher Education, 68*(3), 299-321.

Bliese, P. (2012). *Multilevel modeling in r (2.4): A brief introduction to r, the multilevel package and the nlme package*. April.

Bliese, P., & Ployhart, R. (2002). Growth modeling using random coefficient models: Model building, testing, and illustrations. *Organizational Research Methods, 5* (4), 362{387.

Bowen, W. G. & Rudenstine, N. L. (1992). *In pursuit of the PhD*. Princeton, NJ: Princeton University Press.

Breneman, D. (1976). The PhD production process. In J. Fromkin, D. Jamison, & R. Radner (Eds.). *Education as an industry*, Cambridge, MA: Ballinger.

Brocato, J., & Mavis, B. (2005). The research productivity of faculty in family medicine departments at US medical schools: a National study. *Academic Medicine, 80*(3), 244-252.

Cantwell, B. (2009). *International postdocs: Education migration and academic production in a global marke*t. Unpublished doctoral dissertation. University of Arizona, Tucson. UMI: 3352591.

Carnevale, A., Rose, S.J., & Cheah, B. (2011). *The college payoff: Education, occupations, lifetime earnings*. Georgetown, MD: Center on Education and The Workforce.

Coleman, J.S., (1988). Social capital in the creation of human capital *AJS, 94*, supplement, S95-S120.

DesJardins, S. & Toutkoushian, R. (2005). Are students really rational? The development of rational thought and its application to student choice. In J. Smart (Ed.). *Higher education: Handbook of theory and research*, volume 20, (pp. 191-240).

Digest of Educational Statistics (2010). Retrieved at: http://nces.ed.gov/programs/digest/d10/

Edie, E.& Waehrer, G. (1998). The role of the option value of college attendance in college major choice. *Economics of Education Review, 17* (1), 73-82.

Ehrenberg, R. G. (2005). The perfect storm and the privatization of public higher education (CHERI Working Paper #77). Retrieved from Cornell University, ILR School site: http://digitalcommons.ilr.cornell.edu/workingpapers/59/

Espy, K. A., Molfese, V. J., & DiLalla, L. F. (2001). Effects of Environmental Measures on Intelligence in Young Children: Growth Curve Modeling of Longitudinal Data. *Merrill-Palmer Quarterly*, *47*(1), 42–73.

Freeman, R., Weinstein, E., Marincote, E., Rosenbaum, J., & Solomon, F. (2001). Competition and careers in Biosciences. *Science*, *294*, 2293-2294.

Gappa, J. M., Austin, A. E., & Trice, A. G. (2007). *Rethinking faculty work: Higher education's strategic imperative*. San Francisco, CA US: Jossey-Bass.

Gelman, A., Carlin, J., Stern, H., & Rubin, D. (2003). *Bayesian data analysis*. Boca Raton, FL: Chapman and Hall/CRC.

Hämäläinen, U., & Uusitalo, R. (2008). Signalling or human capital: Evidence from the Finnish polytechnic school reform. *Scandinavian Journal of Economics*, *110*(4), 755–775. doi:10.1111/j.1467-9442.2008.00560.x

Hoffer, T.B. & Welch, V.W. (2006). *Time to degree of US research doctorate recipients.* NSFBrief, Arlington, VA: National Science Foundation.

Horney, J., Osgood, D. W., & Marshall, I. H. (1995). Criminal careers in the short-term: Intra-Individual variability in crime and its relation to local life circumstances. *American Sociological Review*, *60*(5), 655.

Hussey, A. (2012). Human capital augmentation versus the signaling value of MBA education. *Economics of Education Review*, *31*(4), 442–451. doi:10.1016/j.econedurev.2011.12.004

Jaeger, D.A. & Page, M.E. (1996). Degrees matter: New evidence on sheepskin effect in the returns on education. *The Review of Economics and Statistics, 78*(4), 733-740.

June, A.W. (2010). Family friendly policies fall short when professors worry about backlash. *Chronicle of Higher Education*, February 14, 2010.

Keita, G., Cameron, L., & Burrwell, T. (2006). *Women in the American Psychological Association*. Retrieved at: http://www.apa.org/pi/women/committee/wapa-2006.pdf

Kim, D., & Otts, C. (2010). The effect of loans on time to doctorate degree: Differences by race/ethnicity, field of study, and institutional characteristics. *Journal of Higher Education, 81*(1), 1-32.

Krueger, A. B., & Lindahl, M. (2000). *Education for growth: Why and for whom*? Cambridge, MA.

Lipschutz, S. S. (1993). Enhancing success in doctoral education: From policy to practice. In L. L. Baird (ed.), *Increasing Graduate Student Retention and Degree Attainment. New Directions for Institutional Research, 80*, 69-80.

Kulis, S., Sicotte, D., & Collins, S. (2002). More than a pipeline problem: Labor supply constraints and gender stratification across science disciplines. *Research in Higher Education, 43* (6), 657-691.

Malcolm, L. & Dowd, A. (2012). The impact of undergraduate debt on the graduate school enrollment of STEM baccalaureates. *The Review of Higher Education, 35*(2), 265-305.

Mankiw, N. G., Romer, D., & Weil, D. N. (1992). A contribution to the empirics of economic growth. *The Quarterly Journal of Economics*, *107*(2), 407-437.

Manski, C.F.(1977). The structure of random utility models. *Theory and Decision, 8*(3), 229-254.

Mason, M.A. (2011). How to change workplace culture on parenting. *Chronicle of Higher Education*. January 12, 2011. Retrieved at: http://chronicle.com/article/The-Future-of-the-PhD/131749/

Nerad, M. & Cerny, J. (1999). Postdoctoral patterns, career advancement, and problems. *Science, 285* (1533-1535).

Nerad, M. & Cerny, J. (2002). Postdoctoral appointment and employment patterns of science and engineering doctoral recipients ten-plus years after PhD completion: Selected results from the "PhDs—Ten Years Later" Study, *Communicator, 35*(7), 1-11.

National Science Foundation (2006). *Survey of Earned Doctorates* summary report. Retrieved from http://www.nsf.gov/statistics/doctorates/pdf/sed2006.pdf

National Science Foundation (NSF). (2008). Postdoc participation of science, engineering, and health doctorate recipients. Retrieved July 13, 2012 from http://www.nsf.gov/publications/orderpub.jsp

NSF Report 13-304 (2013). *Women, minorities, and persons with disabilities in science and engineering.* Arlington, VA: National Science Foundation.

Olneck, M., (1979). The effects of education. In C. Jencks (Ed.), *Who gets ahead? The determinants of economic success in America*, (pp. 159-190), New York: Basic Books.

Perna, L. W. (2003). The private benefits of higher education: An examination of the earnings premium. *Research in Higher Education, 44,* 451–472.

Perna, L. W. (2004). Understanding the decision to enroll in graduate school: Sex and racial/ethnic group differences. *Journal of Higher Education, 75*(5), 487-527.

Porter, R. C. (1965). A growth model forecast of faculty size and salaries in United States higher education. *The Review of Economics and Statistics*, *47*(2), 191–197.

Raudenbush, S. W., & Bryk, A. S. (2001). *Hierarchical linear models: Applications and data analysis methods* (Vol. 1). Sage Publications, Incorporated.

Schultz, T. W. (1961). Investment in human capital. *American Economic Review*, *51*(1), 1–17.

Schuster, J. & Finkelstein, M. (2006). *The American faculty: The restructuring of academic work and careers*. Baltimore: Johns Hopkins Press.

Science & Engineering Indicators. (2008). Arlington, VA: National Science Foundation.

Sommers, D. & Franklin, J. (2012). Employment outlook 2010-2020. *Monthly Labor Review*, 3-20.

Spence, M. (1973). Job market signaling. *Quarterly Journal of Economics*, *87*(3), 355–374.

Stephan, P.E. & Ma, J. (2005). The increasing frequency and duration of the postdoctorate career stage. *American Economic Review, 95*(2), 71-75.

Toutkoushian, R. K. (2005). What Can Institutional Research do to Help Colleges Meet the Workforce Needs of States and Nations? *Research in Higher Education, 46*(8), 955–984. doi:10.1007/s11162-005-6935-5

Toutkoushian, R. K., & Conley, V. M. (2005). Progress for women in academe, yet inequities persist: Evidence from NSOPF:99. *Research in Higher Education, 46*(1), 1-28.

Umbach, P. D. (2007). Gender equity in the academic labor market: An analysis of academic disciplines. *Research in Higher Education, 48*(2), 169-192.

US Department of Labor, Bureau of Labor Statistics. (2006). *Usual weekly earnings of wage and salary workers Fourth quarter 2012*. USDL Report 13-0060. Washington, DC: US Department of Labor.

Ward, K., & Wolf-Wendel, L. (2012). *Academic motherhood*. Brunswick, NJ: Rutgers University Press.

Webber, D. J. (2002). Policies to stimulate growth: Should we invest in health or education? *Applied Economics*, *34*, 1633–1643.

Webber, K.L. (2012). Research productivity of foreign- and US-born faculty: Differences by time on task. *Higher Education*. 64, 709-729.

Xie, L. & Schauman, K. (2003). *Women in science*. Cambrdge, MA: Harvard University Press.

Zhang, L. (2005). Advance to graduate education: The effect of college quality and undergraduate majors. *Review of Higher Education, 28*(3), 313-338.

Zhang, L. (2008). Gender and racial gaps in earnings among recent college graduates. *Review of Higher Education*, *32*(1), 51-72.

Ziolkowski, T. (1990, Spring). The Ph.D. squid. *The American scholar*, 177-195.

Zumeta, W. M. (1984). *Extending the educational ladder: The changing quality and value of postdoctoral study*. Lexington, Mass.: Lexington Books.

Table 1.
Demographic Characteristics of 1998-1999 Doctorate Recipients in SDR Survey

	N	%*
Gender		
Male	8790	72.9
Female	3260	27.1
Race		
Asian	1660	13.7
Hispanic	580	4.8
Native American	60	0.5
Black	490	4.1
White	9250	76.7
US Born		
Yes	9730	80.7
No	2330	19.3
Post-Doctoral Position		
Yes	580	4.8
No	11480	95.2
Discipline of Ph.D.		
Biology, Agriculture, Environmental Sciences	3090	25.6
Computer Science	260	2.1
Math Statistics	530	4.4
Physical Sciences	2340	19.4
Psychology	1780	14.7
Social Sciences	1640	13.6
Engineering	1930	16.0
Health Sciences	490	4.1
Level of Debt		
No debt	2590	21.5
Debt 10K or less	1620	13.5
Debt 20k	760	6.3
Debt 30K	580	4.8
Unknown/Did not report	6350	52.7
Sector of Employment Immediately After Degree Completion		
Education	6040	50.1
Government	1190	9.9
Business and Industry	4820	40.0
Control of Ph.D. Institution		
Public	8040	66.8
Private	4010	33.2
Carnegie Classification of Ph.D. Institution		
Research I	9180	76.1
Research II	1290	10.7
Doctoral Granting	1180	9.8
Comprehensive	50	0.4
Special	350	2.9

*All Ns are rounded. Due to rounding, numbers may not equal 100

Table 2

Demographic and Employment Sector by Time

	1999		2001		2003		2006		2008		Total Observations	
	N	%	N	%	N	%	N	%	N	%	N	%
Married:												
No	2080	20.9	1980	19.8	2040	20.4	1890	19	2060	20.7	10050	20.1
Yes	7890	79.1	8000	80.2	7940	79.6	8080	81	7910	79.3	39820	79.8
Employed In:												
Education	4980	50	4920	49.3	480	49	4740	47.5	4600	46.1	24130	48.4
Government	990	9.9	1000	10	1020	10.3	970	9.7	1020	10.3	5005	10
Bus & Industry	4000	40.1	4060	40.7	4060	40.7	4260	42.8	4350	43.6	20740	41.6
Employed in Postsecondary Education:												
Research I	1980	19.9	1860	18.6	1870	18.8	1790	17.9	1700	17.1	9200	18.4
Research II	340	3.4	340	3.4	330	3.4	310	3.1	300	3	1620	3.3
Doctorate-Granting	540	5.4	530	5.3	530	5.3	550	5.5	520	5.2	2660	5.3
Other PSI	1700	17.1	1730	17.3	1770	17.7	1780	17.8	1760	17.6	8750	17.5
Not in PSI	5120	51.4	5190	52.1	5230	52.4	5370	53.8	5500	55.2	26420	53.0
Total N	9980	100	9980	100	9980	100	9980	100	9980	100	49880	100

All Ns are rounded.

Table 3

Average Salary By Sector

		1999		2001		2003		2006		2008	
	N	$	SD	$	SD	$	SD	$	SD	$	SD
Education	6040	$62,051	33634.9	$71,738	38400.7	$80,893	46255.9	$90,175	52639.4	$104,336	61027.4
Government	1190	$72,189	32501.9	$81,560	29861.1	$90,055	44364.4	$99,310	43552.2	$112,799	48085.5
Business & Industry	4820	$86,999	57066.5	$99,846	64921	$107,503	71213.6	$117,001	78359.7	$130,464	84982.6
Total sample	12060	$73,031	45959.1	$83,951	51856.6	$92,441	58762.3	$101,807	64749.3	$115,623	71665.6

All Ns are rounded.

Table 4 *Growth Trend Analysis for Salary Variation*

	Model 1 SocioDem	Model 2 Ph.D.Inst	Model 3 Ph.D. Field	Model 4 Sector
(Intercept)	11.12***	11.21***	11.09***	11.22***
	(0.02)	(0.02)	(0.03)	(0.03)
Tme Point	0.11***	0.11***	0.11***	0.11***
	(0.00)	(0.00)	(0.00)	(0.00)
Female	-0.27***	-0.22***	-0.18***	-0.17***
	(0.01)	(0.01)	(0.01)	(0.01)
USborn	-0.04***	-0.06***	-0.02	-0.02
	(0.02)	(0.02)	(0.02)	(0.02)
Hispanic	-0.09***	-0.05**	-0.05**	-0.03
	(0.02)	(0.02)	(0.02)	(0.02)
Black	-0.06**	-0.03	-0.03	-0.01
	(0.03)	(0.03)	(0.02)	(0.02)
Asian	-0.01	0.01	0.00	-0.02
	(0.02)	(0.02)	(0.02)	(0.02)
Native American	-0.10	-0.07	-0.08	-0.08
	(0.07)	(0.07)	(0.07)	(0.07)
Married	0.06***	0.05***	0.05***	0.05***
	(0.01)	(0.01)	(0.01)	(0.01)
Number dependent children	-0.01***	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)
Time to degree		-0.02***	-0.02***	-0.02***
		(0.00)	(0.00)	(0.00)
Unknown Debt		0.14***	0.18***	0.18***
		(0.01)	(0.01)	(0.01)
Debt $1- 10K		-0.02	-0.01	0.00
		(0.02)	(0.02)	(0.02)
Debt $10.1-20K		-0.05**	-0.03	-0.02
		(0.02)	(0.02)	(0.02)
Debt $20.1-30PK		-0.01	0.01	0.01
		(0.01)	(0.01)	(0.01)
Degree from Research II		-0.10***	-0.08***	-0.09***
		(0.02)	(0.02)	(0.02)
Degree from Doct-Granting		-0.09***	-0.06***	-0.07***
		(0.02)	(0.02)	(0.02)
Degree from Spec or Comp		-0.01	0.02	0.00
		(0.03)	(0.03)	(0.03)
Biology, Agricult, Env Sci			0.02	-0.01
			(0.02)	(0.02)
Computer Science			0.24***	0.20***
			(0.04)	(0.04)
Math, Statistics			-0.01	-0.02
			(0.03)	(0.03)
Physical Sciences			0.05***	0.00
			(0.02)	(0.02)
Psychology			-0.06***	-0.11***
			(0.02)	(0.02)
Engineering			0.23***	0.16***
			(0.02)	(0.02)
Health Sciences			0.14***	0.12***
			(0.03)	(0.03)
Education Job Sector				-0.20***
				(0.01)
Government Job Sector				-0.02
				(0.01)
AIC	99598.11	99112.19	98859.09	98402.78
BIC	99756.82	99341.43	99150.05	98711.37
Log Likelihood	-49781.06	-49530.10	-49396.55	-49166.39
Num. obs.	49880	49880	49880	49880

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$. Referent groups are White race, Research I institutions, business discipline, and business & industry job sector.

Appendix A

Models Used for Analyses

Step	HLM	GLMM	Implementation
Unconditional means model	$Y_{ij} = \beta_{0j} + \epsilon_{ij}$ $\beta_{0j} = \gamma_{00} + \eta_{0j}$	γ_{00} η_{0j} ϵ_{ij}	$\ln Y_{ij} = \gamma_{00} + \eta_{0j} + \epsilon ij$
Model time as a linear function	$Y_{ij} = \beta_{0j} + \beta_1(T)_{ij} + \epsilon_{ij}$ $\beta_{0j} = \gamma_{00} + \eta_{0j}$	$\gamma_{00} + \beta_1(T)_{ij}$ η_{0j} ϵ_{ij}	$\ln Y_{ij} = \gamma_{00} + \beta_1(T)_{ij} + \eta_{0j} + \epsilon ij$
Model time as a cuadratic function	$Y_{ij} = \beta_{0j} + \beta_1(T)_{ij} + \beta_2(T^2)_{ij} + \epsilon_{ij}$ $\beta_{0j} = \gamma_{00} + \eta_{0j}$	$\gamma_{00} + \beta_1(T)_{ij} + \beta_2(T^2)_{ij}$ η_{0j} ϵ_{ij}	$\ln Y_{ij} = \gamma_{00} + \beta_1(T)_{ij} + \beta_2(T^2)_{ij} +$ $\eta_{0j} + \epsilon ij$
Model Slope time variability	$Y_{ij} = \beta_{0j} + \beta_{1j}(T)_{ij} + \beta_2(T^2)_{ij} + \epsilon_{ij}$ $\beta_{0j} = \gamma_{00} + \eta_{0j}$ $\beta_{ij} = \gamma_{10} + \eta 1j$	$\gamma_{00} + \gamma_{10}(T)_{ij} + \beta_2(T^2)_{ij}$ $\eta_{0j} + \eta 1j(T)_{ij}$ ϵ_{ij}	$\ln Y_{ij} = \gamma_{00} + \gamma_{10}(T)_{ij} + \beta_2(T^2)_{ij} +$ $\eta_{0j} + \eta(T)1j + \epsilon ij$
Autocorrelation Error structure	$Y_{ij} = \beta_{0j} + \beta_{1j}(T)_{ij} + \beta_2(T^2)_{ij} + \epsilon_{ij}\rho_1$ $\beta_{0j} = \gamma_{00} + \eta_{0j}$ $\beta_{ij} = \gamma_{10} + \eta 1j$	$\gamma_{00} + \gamma_{10}(T)_{ij} + \beta_2(T^2)_{ij}$ $\eta_{0j} + \eta 1j(T)_{ij}$ $\epsilon_{ij}\rho_1$	$\ln Y_{ij} = \gamma_{00} + \gamma_{10}(T)_{ij} + \beta_2(T^2)_{ij} +$ $\eta_{0j} + \eta(T)1j + \epsilon ij\rho_1$
Heteroskedastic Error structure	$Y_{ij} = \beta_{0j} + \beta_{1j}(T)_{ij} + \beta_2(T^2)_{ij} + \epsilon^*_{ij}\rho_1$ $\beta_{0j} = \gamma_{00} + \eta_{0j}$ $\beta_{ij} = \gamma_{10} + \eta 1j$ where $Var(\epsilon^*_{ij}\|x_{ij}) \neq \sigma^2$ for all i	$\gamma_{00} + \gamma_{10}(T)_{ij} + \beta_2(T^2)_{ij}$ $\eta_{0j} + \eta 1j(T)_{ij}$ $\epsilon^*_{ij}\rho_1$ where $Var(\epsilon^*_{ij}\|x_{ij}) \neq \sigma^2$ for all i	$\ln Y_{ij} = \gamma_{00} + \gamma_{10}(T)_{ij} + \beta_2(T^2)_{ij} +$ $\eta_{0j} + \eta(T)1j + \epsilon^* ij\rho_1$ where $Var(\epsilon^*_{ij}\|x_{ij}) \neq \sigma^2$ for all i