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Starting Earnings of Bachelor's and Advanced Degree Graduates by Field of Study: Using Multi-Level Modeling to Estimate the Effects and Early Labor Market Consequences of Vertical and Horizontal Dimensions of Higher Education

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy at Virginia Commonwealth University

By

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Abstract

This study was conducted to better understand early labor market outcomes of higher education and the importance of the vertical and horizontal dimensions of higher education. Using College Scorecard's institution and field of study levels data and a multilevel modeling approach, it estimated and ranked typical starting earnings associated with a large spectrum of bachelor's and advanced degree programs, and discussed patterns, variations, and irregularities observed in the ranked earnings. This study also calculated advanced degree effects on the typical starting earnings associated with bachelor's and advanced degree programs, and set precedence to systematically compare the effects of major, department, institution, and institutional characteristics across these degrees.

This study provided earnings information that can be used to improve students' awareness on the varied labor market outcomes to different majors and degrees, and to facilitate their makings of economically rational major choice and degree attainment decisions. Results of this study also revealed how the relative importance of institution and field of study change from undergraduate to graduate degrees, and addressed how institutions' governance structure, finance, selectivity, and student body diversity and inclusion affect program level outcomes. This study has implications ranging from the signal values of advanced degrees, field of study, and institution, to stratification and social closure in higher education, and to how institutions of different characteristics serve students.

Keywords: early labor market outcome, earning, economic value of higher education, vertical and horizontal dimensions of higher education, stratification of higher education, degree attainment, advanced degree, field of study, major, institution, access, diversity, inclusion.

Dedication

To my mother, who has sacrificed so much to make it possible for me to pursue my dream.

Her strength, bravery, and love are my inspiration and courage to live strong every day.

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I want to first express my sincerest gratitude to my dissertation chair, Dr. Michael Broda. His immense knowledge and guidance, generous feedback, and continuous support helped me tremendously throughout the writing of this dissertation as well as the entire journey of my doctoral study. I'm very lucky to be his student.

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Chapter One – Introduction

Introduction to the Study

Human knowledge and skills have been the driving forces behind innovations that continued to improve quality of life throughout human history. These knowledge and skills were conceptualized as a form of capital as early as Adam Smith (1776). Albeit with criticisms for it treats human skills as commodities and reduces human activities to mere production (Beach, 2009), the notion of human capital was widely accepted in economic literature by the early 1960's (Schultz, 1961).

Human capital is the fuel of productivity that leads to both social and economic developments. It is especially important to today's knowledge-based economy which relies heavily on strong human resources instead of natural resources. The last few decades have witnessed incredible leaps forward in technological innovation and diffusion, and subsequently, routine-based and lower-skill jobs are gradually displaced by automation, whereas occupations requiring high cognitive and technical skills rose to prominence (Autor, 2014; Oreopoulos & Petronijevic, 2013; Valletta, 2015). Investing in a workforce capable of abstract thinking and complex problem-solving is therefore of vital importance to the further advancement of the increasingly sophisticated modern professions.

Among these investments, the most critical is irrefutably education (Alexander, 1976; G. S. Becker, 1994a; Psacharopoulos & Patrinos, 2018). Higher education, in particular, plays a central role in preparing a competent workforce with abilities to support the health and growth of the modernized world. Through research and teaching, higher education drives the expansion of human knowledge and sustains a cycle of knowledge creation and dissemination. Today, more

than one-third of jobs in the U.S. require a bachelor's degree or higher (Carnevale et al., 2015), and accompanied by the growing demand of highly educated workers, the share of Americans with tertiary degrees has sky-rocketed. Within the first two decades of this century, the number of bachelor's degree holders in the U.S. rose over 60% and reached 48 million, while the number of advanced degree holders almost doubled and reached 29 million (U.S. Census Bureau, 2019).

Generally, higher educational attainment means higher pay – one extra year of schooling has stably yielded an approximately 9% rate of return globally over the past few decades (Psacharopoulos et al., 2018). However, private economic returns to investment in higher education remain a major determinant to college attendance decisions as the labor market outcomes of tertiary education are not risk free, especially when factoring in the cost of tuition and forgone wages. While bachelor's and advanced degree holders typically make higher wages than their high school graduate counterparts, some highly educated individuals still struggle to find financially rewarding jobs. Human capital theorists often attribute the varied labor market outcomes of tertiary-educated workers to the scarcity and market demand of knowledge and skills they learned in college (Autor, 2014; Paglin & Rufolo, 1990). Subjects such as engineering, computer science, business, and health professions are more favored and better rewarded than fields like arts, humanities, and social sciences (Carnevale et al., 2015). Academic major decisions are thus pivotal to the development and accumulation of human capital, and are of paramount importance to individuals' financial well-being.

Private economic returns to higher education are not only of interest of economists, they have grabbed the attention of social scientists since the 1960s. Many studies have examined the varied labor market outcomes of tertiary-educated workers by their differential higher education choices and experiences, which are influenced by their socioeconomic background and many

other contextual factors (Gerber & Cheung, 2008). Individuals' decisions as to how to invest their human capital, such as what degree to pursue and which major and institution to choose, are often steered by their class-based considerations (Boudon, 1974; Breen & Goldthorpe, 1997). Socio-economic inequalities therefore manifest as diverse student experiences in the quantitative (sequentially arranged levels of credentials or degrees) and qualitative (field of study and institutions) dimensions of higher education – commonly referred to as the vertical and horizontal stratification of higher education (Charles & Bradley, 2002; Gerber & Cheung, 2008; Reimer & Thomsen, 2019; Torche, 2011; Triventi, 2011). Differential private economic returns to higher education can be viewed as labor market inequalities consequential to the stratified higher education system. High SES students have more advantages than their low SES student counterparts to enter prestigious institutions, selective fields of study, and advanced degree programs that are pathways to financially lucrative occupations. In contrast, low SES students are often selected or being diverted to shorter or vocational programs leading to financially less rewarding jobs (Brint & Karabel, 1989; Iannelli et al., 2018; Posselt & Grodsky, 2017; Pyne & Grodsky, 2018).

Though human capital theorists and stratification theorists have different approaches and emphases to analyze economic returns to higher education, they are not at odds with each other but are two sides of the same coin – they both point to the importance of degree attainment, institution, and field of study on private economic returns of higher education. Studies utilizing both economic and social perspectives not only calculate post-graduation earnings, but also make better sense of the formation of labor market inequalities.

Statement of Problem

Americans' perceptions of the cost and benefit of college education are found to be substantially skewed, especially among low SES families (Bleemer & Zafar, 2018). Underprivileged individuals tend to overestimate the cost and underestimate the benefit of college degrees. Their biased perceptions can deter them away from pursuing tertiary education and exacerbate income inequalities, thus information on labor market rewards to higher education are needed to improve college attendance for low SES students.

Though the benefit of college education has been widely reported, most prior studies have focused on earnings of broadly categorized fields of study at the bachelor's and sub-bachelor's degree levels. However, large earnings variations can exist across majors within a broad field, and advanced degrees, albeit have become increasingly popular, do not always lead to higher income. For instance, STEM fields typically yield higher earnings than social sciences, but graduates in biology are often not paid as well as graduates in political sciences. Even majors within the same field, such as electrical engineering and environmental engineering, could lead to very different career paths and market rewards. Although advanced degrees on average are better rewarded than bachelor's degrees, a master's degree in education may not be rewarded as well as a bachelor's degree in computer science – despite the former likely requiring a greater investment in terms of time and money. In recent years, studies to estimate earnings of graduate degrees by granular fields have emerged, but they either treated all graduate degree levels as a homogenous credential – which concealed earnings variations between different advanced degree levels, or excluded doctoral degrees – an important category of advanced degrees, from their analysis (Altonji & Zhong, 2020; Borgen & Mastekaasa, 2018; Carnevale et al., 2015). Individuals contemplating between closely related majors, especially at advanced degree levels, had little information to guide their decisions.

Most studies conducted in the U.S. had also assumed homogeneity within institutions, even though the performance of departments within institutions could widely vary. Borgen and Mastekaasa (2018) constructed a novel Institution-Field-Department cross-classified multi-level model to predict earnings of Norwegian citizens with bachelors and graduate degrees. The study found strong effects of fields and institutions, but the effects of institutions are mostly explained by the effects of their individual departments. As the quality of institutions and departments in the U.S. likely vary more considerably than those in the Nordic countries for the latter are mainly financed publicly, the effects of fields of study and U.S. institutions found in prior studies may be biased since they have largely neglected possible cluster effects of institutions and departments.

In addition, little was known as to how important institution and field of study are to graduate students relative to undergraduate students, since the effects of the horizontal and vertical dimensions of higher education were commonly studied separately. Whether and how the two dimensions interact is therefore unclear.

Research Goals

The primary goals of this study were two-fold. Firstly, it aimed to provide earnings information associated with bachelor's and advanced degree programs that can be used to facilitate students in making informed and economically rational decisions in the investment of their human capital. Secondly, it intended to determine how important institution and field of study are to graduate students relative to undergraduate students in terms of their earnings upon graduation. This study also tried to overcome limitations from previous studies by focusing on earnings of granular fields of study instead of broad fields of study, and including bachelor's,

master's, doctoral, and professional degrees instead of a combined category of graduate degrees, and also taking into account possible nested effects of institution and department.

Data

This study used institution and field of study levels data published by the U.S. Department of Education's College Scorecard, which were publicly available. The field level data files provided calculated median earnings of eight different tertiary degree level programs offered by public, private non-profit, and private for-profit institutions; and the institution level data consisted of metrics used to describe institutions' performances and background characteristics. The Scorecard data were drawn or derived from three different sources – the Integrated Postsecondary Education Data System (IPEDS), National Student Loan Data System (NSLDS), and individual tax records. IPEDS collected institution level data from institutions that were primarily participants to the Title IV federal financial aid program; NSLDS provided student level data from those who received federal grants and loans; The Scorecard linked individual level data with their tax records, then aggregated individual earnings to the field level and reported median earnings of fields.

Though the Scorecard offered rich data on a large spectrum of tertiary degree programs offered by universities nationwide, field level data collection only began in 2015 and therefore the calculation of earnings was based on recent cohorts at the point of their career entry. Many data were pooled across two consecutive years to reduce year to year variability and they were based on a sufficiently large number of students. This study used the field level data file, *FieldOfStudyData1516_1617_PP*, which provided one-year post-completion earnings by field of study for the cohort of students who received federal financial aid at any time in their academic careers and graduated in award year 2014-15 and 2015-16 with earnings measured in calendar

years 2016 and 2017 (College Scorecard, 2019, p. 4). The institution level data file used, *MERGED2016_2017_PP,* also reflected institutional characteristics in the 2015 and 2016 academic years. Both data files used were updated by the U.S. Department of Education on June 1, 2020.

Because the median earnings of fields of study provided by the Scorecard were calculated based on data collected one year after graduation of the sample population, these earnings may only reflect labor market rewards to program completion. Moreover, these earnings were collected from recipients of federal loan and financial aid, thus did not capture earnings of non-recipients that were more likely coming from families with higher socio-economic status. However, the Scorecard earnings data were found to be generally in concordance with data reported by the Census Bureau's Postsecondary Employment Outcomes (PSEO) program, though variations exist by broader categories of field of study (College Scorecard, 2019, pp. 9–11). The PSEO earnings data were collected from a smaller sample of institutions across four states, but they were based on graduates not restricted to federal loan and financial aid recipients.

Classifications of Institution, Field of Study, and Department

The Scorecard differentiated median earnings of recent graduates from different institutions, fields, and degree types using the combinations of six-digit Office of Postsecondary Education IDs (OPEIDs), four-digit Classification of Instructional Program (CIP) codes, and single-digit credential levels. While some institutions reported data at the campus level coded by eight-digit OPEIDs, the Scorecard aggregated up campus level data to institution level using the first six digits. The CIP codes were developed by the National Center for Education Statistics (NCES), which in full are six-digit numerals but can be rolled up to their first four or two digits. The two, four, and six-digit codes represent broadly, intermediately, and narrowly defined fields

of study, respectively. For example, the CIP codes 27, 2703, and 270305 correspond to the programs of mathematics, applied mathematics, and financial mathematics. The Scorecard published field level data based on four-digit CIP codes, which was granular enough to support students' major choice decisions but not too granular to suppress too much data for privacy protection. This study considered two-digit CIP codes as departments or broad fields and four-digit CIP codes as majors or granular fields. The Scorecard did not come with department level metrics; department IDs were created by rolling up four-digit CIP codes to their first two digits before appending them to their corresponding six-digit OPEIDs. Each department ID is therefore an eight-digit numeral that uniquely identifies a department and the institution it is housed in.

Definition of Key Terms (as used in this study)

1. Human Capital – refers the economic value of human knowledge, skills, and abilities that are used for production.

2. Field of Study – can be either a two-digit or four-digit CIP code. A granular field of study or a major corresponds to a four-digit CIP code, while a broad field of study corresponds to a two-digit CIP code. A two-digit CIP code associated with an institution is considered a department.

3. Academic degrees – refer to bachelor's, master's, and doctoral degrees, in contrast to professional degrees.

4. Private Economic Returns to Investment in Higher Education – refers to individual earnings or financial rewards of higher education participation, and is used interchangeably with the term private returns to higher education.

5. Starting Earning of Field of Study – refers to the median or typical first-year earnings of graduates in a field of study classified by the first four digits of a CIP code. The term is used interchangeably with initial earning of major.

6. Vertical Dimension of Higher Education – refers to the quantitative (sequentially arranged levels of credentials or degrees) dimension of higher education.

7. Horizontal Dimension of Higher Education – refers to qualitative (institutions and fields of study) dimension of higher education.

8. Vertical and Horizontal Stratification of Higher Education – refers to inequalities in the quantitative and qualitative dimensions of higher education.

Research Questions

With considerations to the research goals and the characteristics of the Scorecard data, this study answers the following research questions (RQs).

RQ1: What effects do master's, doctoral, and professional degrees have on the starting earnings of fields of study while controlling fields of study, field-specific employment rates, and institutional characteristics?

RQ2: What effects do major, department, institution, and institutional characteristics have on the starting earnings of fields of study at the bachelor's, master's, doctoral, and professional degree levels while controlling fields of study and field-specific employment rates? How do these effects change across different degree levels?

RQ3: What are the predicted starting earnings of fields of study at each degree level?

Organization of the Study

This dissertation comprises five chapters. Chapter One introduces the context of the study, explains its purpose and rationale, identifies the data of choice to serve the research goals, and formulates research questions. Chapter Two synthesizes a literature review that focuses on related theories and frameworks, common designs and methods, empirical findings, and methodological challenges. Chapter Three presents the methodology of the study – covering criteria of data selection, descriptions of selected sample, measurements of variables, results of descriptive statistics, methods of inferential statistics, process of model development, and essentials of model analysis. Chapter Four details model analysis and results. Chapter Five discusses findings, significances, and limitations of the study.

Chapter Two – Literature Review

This literature review first presents the dominant theories from social sciences that explain how students' social class and other contextual characteristics shape their college attendance decisions and educational experiences, leading to inequalities in their private economic returns from higher education participation. Patterns in varied labor market outcomes are then explained from an economic perspective. The social and economic perspectives together form the theoretical framework for this study. Common designs and methods used to estimate economic returns to higher education are discussed next, followed by selected empirical findings and methodological challenges in the literature.

Theoretical Background of Stratifications of Higher Education

The process of vertical stratification, especially at the undergraduate and sub-baccalaureate levels, has been widely studied since the 1960s. With the rapid expansion of tertiary education over the past a few decades, a sizable volume of research on horizontal stratification has also been conducted (Gerber & Cheung, 2008). The expanded access to higher education substantially increased educational opportunities and degree attainment to low SES students and students with lower academic abilities. However, contrary to what one would expect, more education for everyone did not undermine social inequalities. The rising level of degree attainment among low SES students only promoted their privileged counterparts to enter advanced degree programs, prestigious institutions, and selective fields. Class difference persisted through the mechanisms of what are called maximally and effectively maintained inequalities. Maximally maintained inequality (MMI) posits that when elite and privileged students saturate at a level of education, they will seek a higher level of educational attainment to maintain their privileged status (Raftery & Hout, 1993); and the effectively maintained

inequality (EMI) further contests that even within an equivalent level of educational attainment, inequality is still widespread (Lucas, 2001) – because high SES students can differentiate themselves from their peers through selective fields and institutions. Higher educational attainment, prestigious institutions, and lucrative study fields grant privileged students access to socially respected and financially rewarding occupations, which in turn, preserve their intergenerational privilege (Iannelli et al., 2018; Posselt & Grodsky, 2017; Reimer & Thomsen, 2019; Torche, 2011). In contrast, the stratified higher education system also deters low SES students from pursuing higher degrees (Posselt & Grodsky, 2017; Pyne & Grodsky, 2018), and diverts them to less prestigious fields and institutions (Brint & Karabel, 1989), which leads them to less rewarding professions with little upward social mobility.

The link between individuals' family background and their educational attainment and major choices can be further explained by two other theoretical constructs: rational choice theory and relative risk aversion theory (Boudon, 1974; Breen & Goldthorpe, 1997). Students' educational choices are often heavily influenced by class-based considerations of the benefits, risks, and costs associated with the available options. Endowed with more economic capital and resources, privileged students typically develop higher academic abilities. With less financial constraints, they are also more confident and better able to invest time and money in higher degrees and challenging programs, which in turn are often more rewarding (Posselt & Grodsky, 2017; Reimer & Thomsen, 2019). Underprivileged students, in contrast, are more concerned about cost and academic challenges. They can be more intimidated to take academic risks, and are therefore less likely to pursue college or graduate degrees or to enroll in academically demanding majors (Breen & Goldthorpe, 1997; Hällsten, 2010; Posselt & Grodsky, 2017; Reimer & Thomsen, 2019). Instead, they tend to settle for shorter programs and vocational

routes, as these programs still allow them attain a higher level of education than their parents, but without the extended risk of academic failure and downward mobility (R. Becker & Hecken, 2008).

Besides economic capital, individuals' cultural capital also influences their educational aspirations and choices (van de Werfhorst et al., 2013). As suggested by Bourdieu's theory of cultural reproduction (Bourdieu, 1984; Bourdieu & Passeron, 1990), social inequalities in educational attainment is tied to students' cultural capital. Students from families with different forms of capital demonstrate patterns of major choices that resemble the specializations of their parents. Those from families with strong economic capital (e.g. managers, executives, bankers) tend to study business or finance; others from homes with strong cultural capital (e.g. journalists, scientists, public sector employees, artists) likely prefer arts and humanities; and children from low SES families, endowed with little economic or cultural capital, are more inclined to enter fields focusing on technical skills related to their parents' manual jobs (van de Werfhorst et al., 2013). Families empowered with strong economic or cultural capital may also better support their children to pursue an elite education early on, which can encourage their later participation to college and graduate school. It is then of no surprise that doctoral and professional degree holders are the most likely to have highly educated parents – making the top of the educational attainment hierarchy substantially more heritable than all lower levels of degrees (Posselt & Grodsky, 2017).

Private Economic Returns as Labor Market Consequences to Stratified Higher Education

Students' choices, including which degrees and fields to study, result in a diversification of educational experiences leading to varied private returns to their educational investments (Gerber & Cheung, 2008). Economists and social scientists have typically pointed to

mechanisms stemming from the human capital perspective (G. S. Becker, 1994b; Mincer, 1974; Schultz, 1961), signaling perspective (Spence, 1973; Weiss, 1995), and social closure perspective (van de Werfhorst, 2011; Weber, 1978; Weeden, 2002) to explain patterns in the varied returns to higher education.

Human Capital Perspective

Human skills and knowledge can be seen as a form of capital fundamental to the developments of the modern world and its economy (Schultz, 1961). Under the human capital perspective, education is the most important economic investment to increase productivity of the labor force, raise individual earnings, and benefit the overall financial health of the society (Alexander, 1976; G. S. Becker, 1994a; Psacharopoulos & Patrinos, 2018). The human capital theory has become the "reigning paradigm" to study social and economic values of higher education (Beach, 2009). It is widely used to explain college-pursuit behaviors (Paulsen, 2001), estimate the effect of education on productivity (Beach, 2009), and to justify increased appropriations in education (Alexander, 1976).

Human capital is heterogeneous. Depending on the supply and demand of the specific skill, labor market rewards vary (Autor, 2014). One explanation is that scarcer skills, such as mathematical ability, can drive up the skill demand, and therefore tend to be highly valued (Paglin & Rufolo, 1990). Another related explanation, which draws from skill-biased technological change (SBTC) (Goldin & Katz, 2010) and polarization of wage distribution (Valletta, 2015), is more popularly referenced to make sense of the shifting labor market since the 1980s. As advancements in information and communication technology soared, computerization in the workforce became prevalent. Automation gradually displaced many middle-skill level jobs involving routinized activity, such as clerical work and repetitive

production, that were previously performed by mostly workers without college degrees. Consequently, the depressed demand and value of routine-based skills negatively impacted workers without post-secondary education (Autor, 2014; Valletta, 2015). Much of the labor market growth, especially since the turning of the 21st century, can be attributed to occupations that cannot be easily replaced by machines. These occupations are polarized between highly skilled, non-routine cognitive jobs—such as management, medicine, law, and engineering, and low skill non-routine manual jobs—such as food and personal services. Highly educated individuals, especially those with college or graduate degrees have benefited the most from the technology-driven labor market change. Their higher level of creativity, abstract thinking, and analytical ability are greatly desired in today's workplace to solve complex problems (Autor, 2014; Oreopoulos & Petronijevic, 2013; Valletta, 2015).

Though workers with tertiary degrees are generally paid better, their earnings can still vary a great deal because they likely developed different skill sets from education specific to their academic fields. The differences in returns to fields of study are therefore viewed as a reflection of differences in skills acquired in college, and some researchers refer high-paying fields like business, engineering, and science as high-skill fields and low-paying fields, such as education, as low-skill fields (Grogger & Eide, 1995). Reimer et al. (2008) attributed the depreciated value of low-skill fields to increased educational expansion that amplified variations in mean ability between fields. They argued that though less able students gained access to universities, they are less likely to meet admission requirements or to succeed in "hard fields" like math, science, or engineering. Instead, they are more likely to self-select or been selected into "soft fields" such as humanities or social sciences, and consequently drive down the economic value of "soft fields".

Signaling Perspective

While human capital theorists believe education increases productivity and therefore positively affects earnings, signaling theorists (Frazis, 2002) offer an alternative explanation. They cast doubt on employers' abilities to directly observe much of a worker's intrinsic qualities or skills, and suggest employers rely on education as a signal of productivity to screen job applicants (Frazis, 2002; Weiss, 1995). The signaling effect is likely stronger at career entry because that is when potential employers know the least about the true ability or productivity of the applicants (Gerber & Cheung, 2008, p. 301; Patrinos, 2016). Researchers have also found evidence to a "diploma effect", also called "credential effect" or "sheepskin effect", wherein individuals with diplomas earn more than those with a similar number of years of education but do not hold a diploma (Frazis, 2002; Jaeger & Page, 1996). This suggests a diploma carries more signal value in the labor market than years of schooling. Another important signal of productivity is one's field of study (Kim et al., 2015; Reimer et al., 2008), because fields systematically sort students' prior abilities. As higher-skilled students enter highly selective fields like medicine, law, and engineering, and lower skilled students get in less selective fields such as humanities and education, each of these fields signals the intrinsic abilities of their graduates to potential employers.

Social Closure Perspective

While human capital theorists and signaling theorists debate over the extent to which education fosters or signals productivity, social closure theorists contend that educational credentials are not so much about productivity, but a way to collectively legitimize social exclusion (van de Werfhorst, 2011; Weber, 1978). Selective licensing programs restrict labor supply and raise demand to certain occupations, creating a scarcity of qualified candidates and

ultimately enable a small group of individuals to monopolize opportunities and maximize their rewards (Weeden, 2002). The same can be said of graduate and professional schools. These advanced degree programs also institutionalize social and professional closure. Their admission requirements, including previous credentials, on top of high costs and low financial aid – especially in medicine and law, limit access to students from lower-income families (Posselt & Grodsky, 2017; Pyne & Grodsky, 2018).

Theoretical Framework

In summary, the vertical and horizontal stratification in higher education explains why the socio-economic background of tertiary-educated workers affect their higher education experiences such as their degree attainments, fields of study, and institutions of attendance. Human capital theory, as well as signaling and social closure theories, further explain why these different higher education experiences lead to different labor market outcomes. These social and economic theories together integrate the formation and consequence of the stratified higher education system into a wholistic process, as illustrated in Figure 1. This process provides a theoretical framework for this study and justifies the approach to evaluate the economic value of higher education with placed emphasis on institution, field of study, and degree attainment.

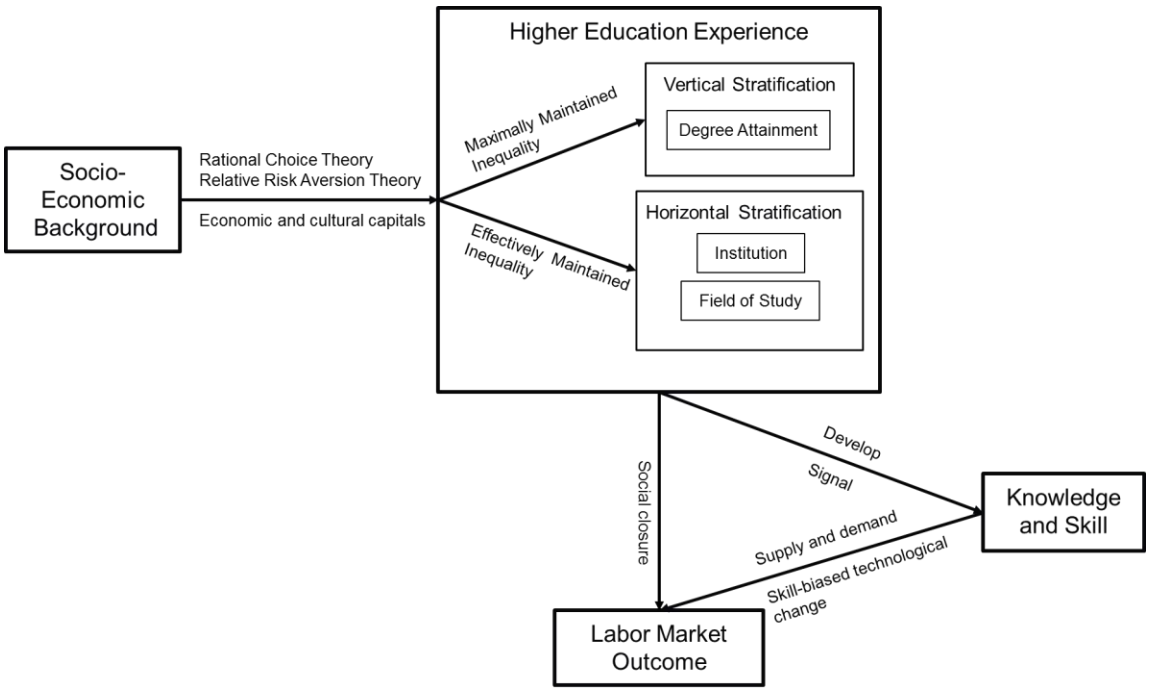

Figure 1: Theoretical framework.

Designs and Methods to Estimate Economic Returns of Higher Education

Studies on economic returns of higher education have commonly used individual level and cross-sectional data to reflect earnings at career entry or returns to degree completion. There are also longitudinal studies, such as the recent work of Kim et al. (2015). The authors matched the Census Bureau's Survey of Income and Program Participation (SIPP) in 2004 and 2008 with the respondents' tax records from 1982 to 2008. They examined the trajectories of respondents' annual earnings for over a span of 20 years and estimated the long-term effect of field of study on American's earnings. The gap in median lifetime earnings among college graduates by field of study are found to be possibly greater than the median wage gap between college and high school graduates. The study provided empirical evidence that field of study is an important factor in one's income and wealth accumulation, and the effect of horizontal stratification of higher education may be even greater than the effect of vertical stratification.

While many studies in the field are observational, some have utilized instrumental variables to establish causality between education and earnings. An instrumental variable theoretically only affects an explanatory factor but not the outcome directly. It can be used to assign individuals with similar background and abilities into treatment and control groups, and therefore creates a natural experiment. To isolate an instrumental variable without picking up other unobserved effects can be a difficult task. Some well-known instrumental variables used to study returns of schooling have included the quarter of the year in which people are born (Angrist & Krueger, 1991), military draft lottery numbers (Angrist & Krueger, 1992), and college proximity (Krueger et al., 2001).

The most straightforward metric use to measure private returns to higher education is the earnings differential between college and high school graduates (Paulsen, 2001, p. 63). Carnevale et al. (2015) used the Census Bureau's American Community Survey micro data to rank and compare Americans' earnings across large groups and subgroups of academic fields. Earnings differentials across the large groups revealed that career entrants from STEM, health, and business majors are paid above average; teaching and serving, career-focused, and arts and humanities majors are paid below average; and social sciences majors are paid at the average. Earnings differentials across subgroups further documented wide variations in the earnings within large groups of fields, which demonstrated the importance of studying returns of academic fields at a more granular level.

Earnings differential may be easy to calculate and intuitive to understand, but it neglects the cost of college attendance in its calculation. A more sophisticated approach is to calculate the internal rate of return (IRR) of the investment (Paulsen, 2001, p. 65). IRR associates the benefit of investment in higher education (earnings differentials between college and high school

graduates) with its cost over time. It is essentially a cost-benefit analysis that measures profitability of the investment. The cost of the investment comprises both direct and indirect components. Direct cost refers to expenses such as tuition, fees, and books, net of subsidies such as scholarships, grants, and loans; and indirect cost concerns forgone wages due to college attendance, net of earnings from part-time employment. Because both benefits and costs of investment to higher education occur and accrue over time, future benefits and costs of the investment should be discounted using an appropriate market rate of interest to determine their present value, so that future benefits and costs can be compared in today's dollars. IRR is the discount rate at which the present value of the future return of investment breaks even with the present cost of the investment. The investment is worthwhile if the IRR is greater than the market rate of interest, which implies that the financial return in today's dollar exceeds the cost.

The common inferential statistical method used to estimate potential returns of education is Ordinary Least Square regression – often modified from the Mincer earnings function (Lemieux, 2006; Patrinos, 2016). The basic Mincer function models the logarithm of earnings (γ) as a sum of years of schooling (S) and years of potential labor market experience (X) (Lemieux, 2006), as shown in (1).

$$\log \gamma = f(S, X) = \log \gamma_0 + rS + \beta_1 X + \beta_2 X^2 \quad (1)$$

The coefficients, r, β_1 and β_2 are the rates of returns to schooling and labor market experience, respectively.

The Mincer function is argued "the most parsimonious model of earnings determination" (Lemieux, 2006, p. 129). It offers comparable estimates of the average returns to one additional year of schooling (Patrinos, 2016). Its use is also flexible – increments in earnings can be measured in dollars or percent change, and units of schooling can be measured by years or

credential level. The use of credential level is perhaps more appropriate in the context of higher education, because individuals invest in credentials rather than in years of schooling (Patrinos, 2016). Credential effects at the high school degree level and above are also found to be significant (Frazis, 2002; Jaeger & Page, 1996). This suggests that the labor market may reward more due to educational credentials rather than due to true productivity, which justifies the use of level of degrees rather than years of schooling in estimating returns to higher education.

The basic Mincer model has been criticized for leading to a "naïve" and "overly simplistic" (Grubb & Lazerson, 2007, p. 164) belief that higher levels of education is always associated with higher earnings. This misbelief conceals variations in earnings due to a number of factors such as gender, racial/ethnic, and social inequalities (Beach, 2009; Grubb & Lazerson, 2007). Though the effects of schooling and experience retained their importance in most empirical studies of earnings regressions (Lemieux, 2006), the use of the Mincer model has evolved to include a wider collection of both educational and non-educational factors. The most commonly examined factors can be categorized into the following groups.

1. Variables associated with the quantitative aspects of higher education, which are typically measured by years of schooling or degree attainment.

2. Variables describing the qualitative aspects of higher education, which cover primarily the characteristics of institutions and one's postsecondary education experiences. The former usually refers to the institution's governance structure, prestige and quality, as well as geographic location (Grubb & Lazerson, 2007); and the latter often include one's field of study, academic performance, and pathways to tertiary degrees (Gerber & Cheung, 2008).

3. Job related variables such as occupation, labor market experiences, employment sector, and firm size (Gerber & Cheung, 2008; Grubb & Lazerson, 2007).

4. Ascriptive variables such as sex/gender, race/ethnicity, and socio-economic background (Gerber & Cheung, 2008; Grubb & Lazerson, 2007; Posselt & Grodsky, 2017).

5. Prior ability, preference, and aspirations – commonly measured using high school or college entry test scores (Gerber & Cheung, 2008; Grubb & Lazerson, 2007; Posselt & Grodsky, 2017).

In addition to the above-listed factors, studies to estimate the returns to advanced degree programs should take further considerations. Altonji et al. (2020) argued that many studies failed to take into account that individuals entering the same graduate program may come from different undergraduate majors. Simple regression estimates are likely biased if the counterfactual earnings used are based on a weighted average of earnings prior to graduate school but not earnings of the specific undergraduate majors that individuals graduated from. The authors developed a Fixed Effect-College Major and Graduate Field (FE-cg) model to estimate the returns of advanced degree recipients from graduate field g and undergraduate majors c. They demonstrated that individuals with master's degrees in business administration and bachelor's degrees in engineering have different career paths and average earnings compared to individuals with master's degrees in business administration but bachelor's degrees in education. The returns to graduate degrees are therefore shown to vary by the combination of undergraduate and graduate degree fields, and calculations to the returns of advanced degree programs should therefore include individuals' undergraduate majors as a factor.

Because earnings of graduates from institutions with similar characteristics may be more alike than earnings of graduates chosen at random, some studies utilize multilevel models to account for the nested data structure. Thomas (2000) used a Hierarchical Linear Model (HLM) and estimated the effects of institutional quality, academic performance, and majors on earnings

of recent college graduates. The multilevel model required two different types of data. The individual level data came from the first follow-up of the Baccalaureate and Beyond Study (BB:93/94), and the institution level data came from the 1993 Integrated Postsecondary Education Data System (IPEDS) and the College Board's Annual Survey of Colleges. The individual level data provided metrics on the earnings, demographics, family background, educational and labor market experiences of respondents in a national sample of recent college graduates; and the institution level data described institutional characteristics such as selectivity, student-to-faculty ratio, full-time status, student body size, urban setting, and governance structure. The study found little variance in earnings between colleges after controlling individual level factors. It also found female graduates earn less on average than their male counterparts in every major. Female students are also notably under-represented in high paying majors except for health sciences, but they are three times as likely to major in education – a field which yields the lowest economic return.

One limitation in Thomas's study (2000), which is also common in existing literature, is the assumption that institutions are indivisible entities. This misassumption can conceal potential variations in quality across departments within institutions. It is possible that a lower ranked institution can still host some departments that outperform others, and vice versa, a generally high-ranked department may not fare as well being housed in a lower quality institution. Failing to consider heterogeneity across departments within institutions will likely exaggerate or underestimate the effects of institutions. Borgen et al. (2018) constructed a novel Institution-Field-Department cross-classified multi-level model to predict earnings of Norwegian citizens with bachelors and graduate degrees. The study found strong effects of fields and institutions, but the effects of institutions are mostly explained by the effects of departments. The study also

estimated and compared long-term effects of institutions, departments, and fields by conducting separate analyses for each of the first eight years after graduation. Over this period, fields had the strongest effects on graduates' earnings, followed by the effects of departments and institutions. While the effect of departments remained relatively steady over the eight years, the effects of fields and institutions were found to be increasingly important, albeit their increases demonstrated different patterns. The effects of fields rose more substantially at the beginning and less later on, while the effects of institutions decreased slightly at the beginning and then grew upward robustly. By the eighth year after graduation, the effects of institutions are almost as strong as the effects of departments.

While studies on private returns to higher education mostly measure individual level outcomes, data aggregated at the institution level can be just as useful. One recent study ranked potential returns of investment (ROI) to 4,500 institutions using net price and median earning of students at six, eight, and ten years after their initial attendance (Carnevale et al., 2019). The study found community colleges and sub-baccalaureate certificates have the highest ROI in the short term, but colleges that primarily offer bachelor's degrees have the highest ROI in the long run. Public colleges are also found to have higher ROI than private colleges shortly after graduation, while the ROI of private nonprofit colleges is higher over a course of 40 years.

Selective Empirical Findings

Empirical studies often use college degree attainment, field of study, and/or institutional quality or prestige to assess how individuals' college education affects their earnings (Gerber & Cheung, 2008). College graduates on average are paid much better than high school graduates. The lifetime average annual salary of bachelor's degree holders in the U.S. who work full time year-round is estimated at $61,000, which is almost 70% higher than the average salary of

$36,000 earned by their high school graduate counterparts (Carnevale et al., 2015). The value of a college degree has also consistently increased while the value of a high school diploma has depreciated. In recent years the wage gap between college and high school graduates has widened (Autor, 2014; Grubb & Lazerson, 2007; Oreopoulos & Petronijevic, 2013; Taylor et al., 2014), reaching a stunning average of $1 million in lifetime earnings (Carnevale et al., 2015).

Although a bachelor's degree's wage premium is high, there are greater incentives to pursue graduate education. Graduate degree holders who work full-time year-round earn an average annual salary of $78,000 over the course of their career, which is $17,000 or 28%, more than bachelor's degree holders (Carnevale et al., 2015). For both women and men, professional degree holders are reported to earn the highest amount, followed by doctoral and master's degree holders (Posselt & Grodsky, 2017). The graduate-to-bachelor's degree wage gap has also widened over the past few decades, especially since the beginning of the century. From 2000 to 2013, the earnings advantage of a graduate degree over a high school diploma rose 17%, while the earnings advantage of bachelor's degree rose 6% only (Valletta, 2015). The increasingly widening wage gap reflects a rising labor market demand for graduate or professional school trained workers over those with only a bachelor's degree.

While some scholars consider educational attainment as the "single most important factor shaping labor market opportunities in modern societies" (Gerber & Cheung, 2008, p. 300), others suggested horizontal stratification in higher education may influence lifetime earnings even more than vertical stratification (Kim et al., 2015). Indeed, the decision of what to major in can be more important than the decision of whether to attend college (Carnevale et al., 2015). Research has documented large variations in earnings among college graduates across different fields of study (Arcidiacono, 2004; Carnevale et al., 2015; Grogger & Eide, 1995; Grubb & Lazerson,

2007), to the extent that the increase in the college premium over recent decades can be attributed to only a small numbers of fields (Kim et al., 2015). The wage gap between some college majors are even larger than the average wage gap between college and high school graduates (Altonji et al., 2012; Kim et al., 2015). Just as the lifetime earnings differential between those who hold bachelor's degrees and high school diplomas averages $1 million over a career, the differential between the highest-paying and the lowest-paying majors stands at $3.4 million – where graduates from petroleum engineering earn the most at $4.8 million and graduates from early childhood education earn the least at $1.4 million (Carnevale et al., 2015).

Moreover, fields with higher-than-average pay at the graduate degree level tend to have higher pay at the undergraduate degree level (Altonji & Zhong, 2020, fig. 3), and the variation of earnings among graduate degree holders is greater than the variation among bachelor's degree holders (Carnevale et al., 2011). Some graduate majors are paid considerably less than undergraduate majors, despite graduate education requiring additional, and sometimes considerable, investment of money and time. For example, graduates with advanced degrees in education are estimated to earn an average annual salary of $60,000 over their lifetime, while graduates with a bachelor's degree in architecture and engineering major are paid on average $83,000 per year (Carnevale et al., 2015).

With respect to fields of study, there are no standardized classification systems that would otherwise make it easier to compare the effects of academic fields on earnings (Gerber & Cheung, 2008). Nevertheless, much empirical literature has found that field of study has a significant effect. Most studies have estimated individuals' earnings based on a small number of broadly defined categories such as science, business, and engineering (Finnie et al., 2018). These studies typically find returns to medical fields, law, STEM fields, and business yield higher

returns than social sciences, arts, humanities, and education (Gerber & Cheung, 2008; Grubb & Lazerson, 2007; Paulsen, 2001). However, results based on largely aggregated fields can conceal appreciable earnings variations and mask inequalities across subfields (Gerber & Cheung, 2008). For example, biology and physics are often aggregated into the same science field, but they are very different in terms of their students' gender composition, career paths, and earnings (Finnie et al., 2018; Gerber & Cheung, 2008; Reimer & Thomsen, 2019). Women are over-represented in biology and under-represented in physics (Turner & Bowen, 1999), but if physics majors are paid better than biology majors, using an aggregated science field will overestimate women's earnings and underestimate the gender wage gap. Borgen and Mastekaasa (2018) also compared different levels of aggregation of fields and demonstrated that the effects of fields on earnings are stronger when fields are granularly defined, and they inferred a greater underestimation of differentiation when fields of study are more broadly aggregated, as is the case with most of the existing literature. A few recent studies have estimated earnings using granular fields that are more relevant to academic-major choices (Altonji & Zhong, 2020; Borgen & Mastekaasa, 2018; Carnevale et al., 2015; Finnie et al., 2018), however, such studies are still scarce.

Besides field of study, institutional characteristics are also important to the horizontal dimension of the stratified higher education system. Variables measuring institutional selectivity such as average SAT and ACT scores, and college rankings and ratings, are among the most used proxies of institutional quality (Gerber & Cheung, 2008). Though early studies found college quality to significantly affect earnings, Gerber and Cheung critiqued them for using highly restrictive male samples and having limited control over educational attainment and labor market-related variables. Newer studies that used more representative samples, and a wider array of controls, suggest the effect of college quality depends on how it is measured. Moreover, these

studies show that the elite-institution effect may be largely or completely explained by students' individual characteristics and their academic ability prior to college attendance. Other institutional characteristics such as the highest level of degree an institution offers, and educational sector (public versus private), may also influence earnings (Gerber & Cheung, 2008). Graduates from advanced degree-granting institutions generally earn more than graduates from liberal arts colleges, and graduates from private universities typically earn more than graduates from public universities (Monks, 2000; Thomas, 2000). Though earnings are not found to differ significantly among bachelor's degree holders from for-profit and non-profit institutions, associate's degree holders graduated from for-profit institutions earn significantly less than their equally educated counterparts from nonprofit institutions. Therefore, the effect of horizontal stratification of higher education, at least in terms of college sectors, can vary from one degree level to another (Denice, 2015).

The influence of field of study versus institution on individuals' labor market outcomes may depend on the structure of a country's higher education system. Field of study may matter more in countries where institutions are publicly funded or elite institutions are uncommon, whereas in the U.S., institutions may play a more important role in the varied labor market outcomes due to wide variations in institutional prestige and quality (Borgen & Mastekaasa, 2018; Reimer & Thomsen, 2019). The effects of field of study and institution may be also mediated by labor market related factors such as occupation, experience, and employment sector (Borgen & Mastekaasa, 2018). Whether an individual's occupation aligns with his or her field of study, and if he or she engages in career-development training, may also influence lifetime earnings (Carnevale et al., 2015; Gerber & Cheung, 2008). The difference in earnings by occupation can be explained by the difference in the skills required by the occupation (Paglin &

Rufolo, 1990). Typically those with bachelor's degrees working in occupations related to management, health professions, and STEM fields are paid higher than those work in health support, education and personal services (Oreopoulos & Petronijevic, 2013). Those who work in the private sector are found to earn more than their counterparts in the public sector (Psacharopoulos & Patrinos, 2018). One study also found STEM PhDs have a higher tendency to work in the education sector but they are paid less than their peers working in the government and business sectors (Craft et al., 2017).

Empirical research provides evidence that higher degrees on average yield higher earnings, and field of study, institutional characteristics, as well as labor market related variables can also affect individual earnings. The effect of field of study is generally found to be significant, despite the fact that fields are typically defined as broad categories of academic disciplines without uniform standards. More studies are needed to estimate economic returns of granular fields to better understand labor market outcomes of academic majors. Possible nested effects of institutions and departments should also be examined as they are often neglected in existing studies. There is also a lack of research exploring whether the effects of fields and institutional characteristics are consistent across different tertiary degree levels. More studies are needed to better understand the relationship between horizontal and vertical stratification in higher education.

Methodological Challenges in the Literature

A major methodological challenge in this area of research comes from selection bias. Because students enrolled in elite institutions and high paying fields tend to share similar family backgrounds and traits, it is difficult to determine whether institutional prestige and fields of study cause unequal labor market outcomes, or whether they are merely manifestations of

diverse student backgrounds, preferences, motivations, and abilities. Therefore, regression models should include a wide spectrum of factors as controls to reduce selection bias. Neglecting selection effects will likely overestimate the contribution of high-paying institutions and fields and underestimate the contribution of low-paying institutions and fields (Gerber & Cheung, 2008; Reimer & Thomsen, 2019). Selection problems can also occur after graduation, despite that being often overlooked in the literature. If graduates from certain fields have a higher tendency of not entering the job market or have a higher unemployment rate, the effects of fields can also be under or overestimated (Reimer & Thomsen, 2019).

Unfortunately, there is a shortage of quality data for research in the area of higher education stratification, especially at a large scale. Researchers often rely on data from surveys designed to serve other purposes, which may not provide the desired variables to adequately control for selection bias. Data on advanced degree programs and granularly classified fields are also scarce, which has limited existing studies to analyzing returns of baccalaureate and sub-baccalaureate degrees and broadly classified academic fields.

Chapter Three - Methodology

Chapter Three first explains the criteria of data selection and describes the selected sample and variables, as well as how the variables were measured. It then presents results of descriptive statistics, and rationalizes the choice of inferential statistical methods needed for further data analysis. Finally, it details the process of model development, and outlines how the models were analyzed to answer the research questions.

Sample Selection Criteria

This study used the College Scorecard data at both field and institution levels, and different criteria were involved in sample selection at each level before merging the two sets of data.

Sample Selection from the Field Level Data File

Observations included in the Scorecard's field level data file comprised four-digit CIP codes across eight different types of tertiary degrees and credentials (N=216,638) that were offered by public, private non-profit, and private for-profit institutions located in the 50 states, District of Columbia, and U.S. territories. This study first limited its sample to fields offered at bachelor's, master's, doctoral, and professional degree levels (N=117,950) from institutions located within the 50 states and the District of Columbia (N=113,268), as earnings associated with institutions located in the U.S. territories such as Puerto Rico and Guam may be very different. In addition, because the Scorecard aggregated eight-digit OPEIDs to six-digit OPEIDs, median earnings of academic majors from branch campuses were not differentiated from earnings of main campuses. Observations from branch campuses were therefore duplicates and were excluded (N=107,331). Further exclusions were made to observations with privacy

suppression in earnings (*N*=26,357), count of degree completers (*N*=24,866), and count of degree completers with earnings (*N*=24,866). In addition, observations from for-profit institutions were also excluded (*N*=24,024), because after applying the above selection criteria, for-profit institutions had a very small sample size, especially at the doctoral and professional degree levels. At last, duplicates beyond the first copy with the same OPEIDs, CIP codes, and degree levels were also excluded (*N*=24,009).

Sample Selection from the Institution Level Data File

After selecting samples from the Scorecard's field-level data file, similar selection criteria were applied to its institution-level data file. From all institution-level observations ($N_{institution} = 7{,}238$), this study excluded those located outside of the 50 states and the District of Columbia ($N_{institution} = 7{,}081$) and all branch campuses ($N_{institution} = 5{,}416$), as well as one duplicated observation based on the six-digit OPEID ($N_{institution} = 5{,}415$). Observations with null or privacy suppressed data in the institution level control variables were then dropped as well ($N_{institution} = 1{,}426$).

Sample Selection from Merged Data File

The samples selected from the field level data file (*N*=24,009) was then merged with the sample selected from the institution level data file ($N_{institution} = 1{,}426$) based on the six-digit OPEID in order to limit the scope of the field-level observations only to those selected institutions. However, the merging of the two levels of data created more observations (*N*=24,158) because not all field-level and institution-level data matched due to inconsistencies in data reporting. Only matched data were kept (*N*=22,459) for further data analysis. The merged

sample represents field-level observations which covered 298 different major types (four-digit CIP codes) offered from 10,950 departments in 1,277 institutions.

Description of the Selected Sample

In summary, the selected sample of this study are fields of study classified by four-digit CIP codes that are associated with bachelor's, master's, doctoral, and professional degrees offered by public and private non-profit institutions' main campuses located within the 50 states and the District of Colombia. The fields of study included in the selected sample were primarily associated to institutions participating in the Title IV federal aid program. Table 1 describes the selected sample size by degree level and institution sector. Observations at the bachelor's (73.22%) and master's (23.94%) degree levels took up most shares of the total observations in the selected sample. The small share of observations at the doctoral (.98%) and professional (1.86%) degree levels were in part due to the fact that fewer institutions offered these degrees, and fewer majors were offered at these degree levels. A higher percentage of data were also privacy suppressed at the doctoral degree level, likely due to small numbers of completers in the pooled measurement years. Almost two-thirds of the total observations in the selected sample were reported from public institutions (64.43%) and about one third were from private non-profit institutions (35.57%).

Table 1

Sample Size by Degree Level and Institution Sector

Degree Levels	Public	Private Non-Profit	Total
Bachelor's			
Frequency	11,065	5,379	16,444
Row Percentage	67.29	32.71	100.00
Column Percentage	76.47	67.33	73.22
Master's			
Frequency	3,026	2,351	5,377
Row Percentage	56.28	43.72	100.00
Column Percentage	20.91	29.43	23.94
Doctoral			
Frequency	134	86	220
Row Percentage	60.91	39.09	100.00
Column Percentage	0.93	1.08	0.98
Professional			
Frequency	245	173	418
Row Percentage	58.61	41.39	100.00
Column Percentage	1.69	2.17	1.86
Total			
Frequency	14,470	7,989	22,459
Row Percentage	64.43	35.57	100.00
Column Percentage	100.00	100.00	100.00

Measurements and Descriptions of Variables

A variety of field level and institution level variables were used in this study. The measurements and descriptions of these variables were taken from the Scorecard's data documentation (College Scorecard, 2019, 2020). Table 2 lists and describes all variables, including their names, acronyms, mean, standard deviation, minimum, and maximum values. All monetary measures have been transformed by natural log to reduce right skewness.

Table 2

Description of Variables (N=22,459)

Variable	Mean	*SD*	Min	Max	Acronym
		Field Level Variable			
Field of study (4-digit CIP code)	3394.44	1720.43	100	5401	P_CIPCODE
Degree level 1=bachelor's degree 2=master's degree 3=doctoral degree 4=professional degree	1.31	.59	1	4	P_CREDLEV
Employment rate	.96	.04	.30	1	P_EMPLOYMENT_RATE
Outcome variable					
Natural log of median first-year earnings	10.61	.40	9.16	12.25	P_LNMD_EARN_WNE
		Institution Level Variable			
Governance structure 1=public 2=private non-profit	1.36	.48	1	2	CONTROL
Institutional finance					
Natural log of net tuition revenue per full-time student	9.35	.55	5.96	10.68	LNTUIFTE
Natural log of instructional expenditures per full-time student	9.30	.51	7.48	11.69	LNINEXPFTE
Natural log of average faculty monthly salary	9.10	.24	8.07	10.01	LNAVEFACSAL
Admission rate	.65	.20	.05	1	ADM_RATE_ALL
Race and gender composition					
Percent of Black student	.11	.13	0	.97	UGDS_BLACK
Percent of Hispanic student	.12	.13	0	.95	UGDS_HISP
Percent of Asian student	.07	.07	0	.40	UGDS_ASIAN
Percent of female student	.55	.09	0	1	UGDS_WOMEN
Student full-time/part-time status					
Percent of part-time students	.12	.10	0	.83	PPTUG_EF
Student family background					
Percent of first-generation students	.31	.10	.09	.65	PAR_ED_PCT_1STGEN
Natural log of students' median family income	10.8	.40	9.28	11.72	LNMD_FAMINC
Time to degree completion					
four-year completion rate	.42	.21	0	1	C100_4

Note. N = sample size, *SD* = standard deviation, Min = minimum, Max = maximum

Outcome Variable

Data on students receiving federal grants and loans were drawn from NSLDS and were linked with their tax records before they were aggregated to the four-digit CIP code level and

reported as median earnings of fields of study (P_MD_EARN_WNE). Individual earnings were measured as the sum of wages and deferred compensation from all non-duplicate W-2 forms and positive self-employment earnings from IRS Form 1040 Schedule SE – Self-Employment Tax. The earnings values were adjusted to 2018 dollars. To better understand the value of completion of each degree program for new career entrants, median earnings of fields (P_MD_EARN_WNE) were calculated based on only those who successfully graduated, and the earnings were reported one year after their graduation. Earnings calculations excluded those who subsequently enrolled in school, died, had load deferments for military service, and did not work during the measurement year (College Scorecard, 2019, p. 4). Students who completed multiple awards were measured multiple times only if the awards were completed in different institutions, from different four-digit CIP codes, or from different credential levels. The study transformed the earnings data by natural log, which visibly reduced right skewness in the data, as shown in Figure 2.

Privacy Suppression. The selected sample of this study excluded observations with earnings data suppressed for privacy protection. Though the Scorecard's data documentation did not reveal the exact suppression rule to reduce risk of disclosure, it affirmed that the reportable fields represent a large share of student completers (College Scorecard, 2019, p. 7).

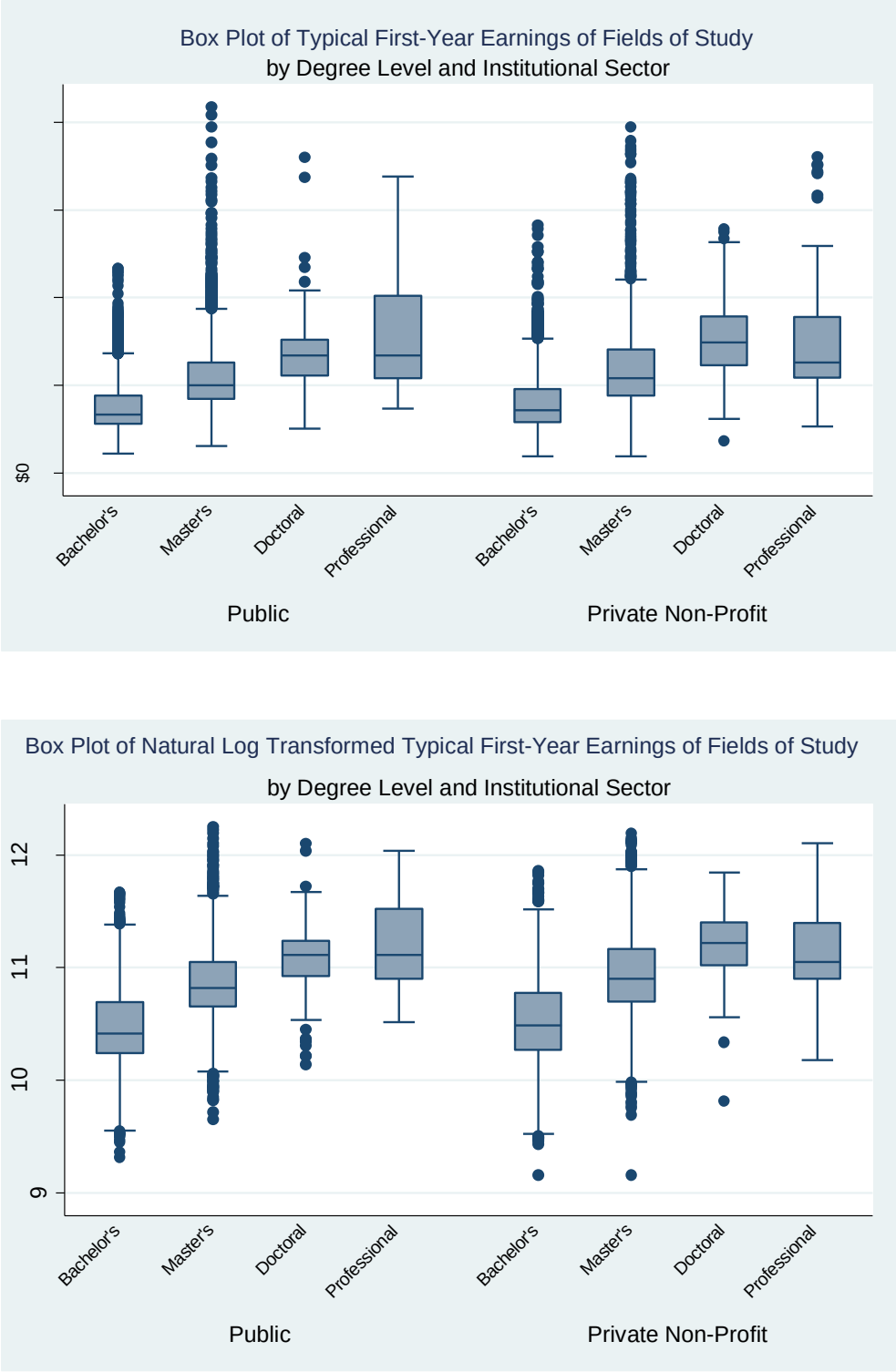

Figure 2: Box Plots of Typical First-year Earnings of Fields of Study (four-digit CIP Codes) by Degree Level and Institutional Sector Before and After Natural Log Transformation

Field of Study Level Variables

This study included three variables at the field level: field of study or four-digit CIP code (P_CIPCODE), degree level (P_CREDLEV), and employment rate (P_EMPLOYMENT_RATE). Field of study and degree level are both categorical variables. The selected sample of this study comprised 298 four-digit CIP codes across four degree-levels – with 273 at the bachelor's degree level, 204 at the master's degree level, 38 at the doctoral degree level, and 13 at the first professional degree level. This study considered bachelor's degrees the base level, master's degrees above the level of bachelor's degrees, and doctoral and professional degrees above the level of master's degrees. Doctoral and professional degrees were also treated as equivalent degree levels because the number of years it takes to complete these degrees are comparable and either one is a prerequisite of the other.

Employment rate (P_EMPLOYMENT_RATE) was not directly provided by the Scorecard, it was calculated as the ratio of the number of degree completers with earnings in the measurement year (EARNINGSCOUNT) to the number of degree completers (TITLEIVCOUNT). It describes the proportion of graduates in each unique combination of majors, institutions, and degree levels that was employed during the first year after their graduation.

Institution Level Variables

Institution level predictors included in this study are related to institutional governance structure, finance, and admission rate; student body's racial and gender composition, full-time/part-time status, and family background; as well as time to degree completion. Institutional governance structures (CONTROL) can be either public or private non-profit. Institutional

finance consists of three natural log transformed measures -- net tuition revenue per full-time student (LNTUIFTE), instructional expenditures per full-time student (LNINEXPFTE), and average faculty monthly salary (LNAVEFACSAL). The net tuition revenue per full-time student was calculated using tuition revenue minus discounts and allowances and dividing it by the number of full-time undergraduate and graduate students. Similarly, instructional expenditures per full-time student was calculated using instructional expenditures and dividing it by the number of full-time students. The average faculty monthly salary was calculated using the total salary outlays and dividing it by the number of months worked for all full-time nonmedical instructional staff. Admission rate (ADM_RATE_ALL) was calculated as the total number of admitted undergraduates across all branches of an institution divided by the total number of undergraduate applicants across all branches of the institution. Students' race and gender compositions were measured by percentages of Black students (UGDS_BLACK), Hispanic students (UGDS_HISP), Asian students (UGDS_ASIAN), and female students (UGDS_WOMEN). These measures were calculated based on the total fall enrollment of undergraduate degree-seeking students. Students' full-time/part-time status was measured by the percentage of part-time degree/certificate-seeking undergraduates (PPTUG_EF), which was also based on fall enrollment. Students' family background consisted the share of students in the rolling two-year pooled entry cohorts that were self-reported as first-generation (PAR_ED_PCT_1STGEN) on their Free Application for Federal Student Aid (FAFSA) and the natural log of the median family income (LNMD_FAMINC) of the entry cohorts. Time to degree completion (C100_4) was measured based on the completion rate for full-time, first-time students who graduated within four years.

Descriptive Group Differences

A comparison of the average earnings associated with different institutional sectors and degree levels is visualized in Figure 3. The average earnings were calculated based on the typical first-year earnings of majors categorized by four-digit CIP codes. Figure 3 shows that the higher the degree level, the higher the average first-year earnings for both public and private non-profit institutions. Doctoral degrees offered by private non-profit institutions have the highest average first-year earning ($76,644.20), while bachelor's degrees offered by public institutions have the lowest average first-year earning ($37,554.90) – and the former more than doubles the latter. Private non-profit institutions have higher average first-year earnings than public institutions at all degree levels except for professional degrees.

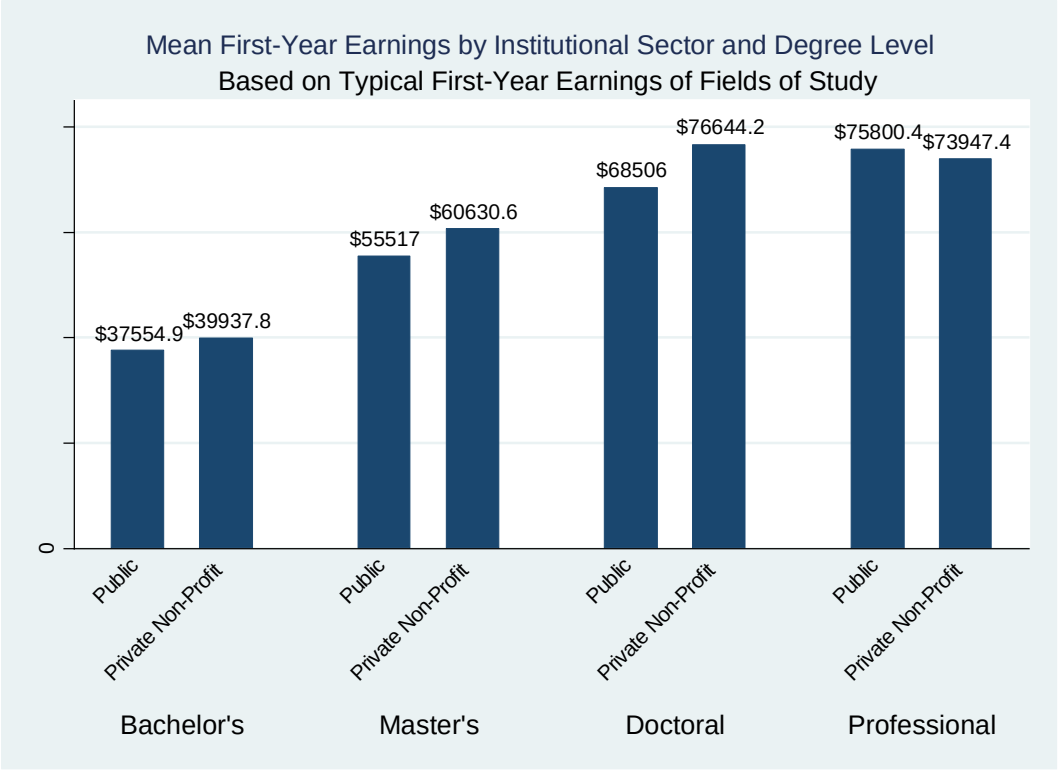

Figure 3. Mean First-year Earnings by Institutional Sector and Degree Level Based on Typical First-year Earnings of Fields of Study (four-digit CIP Codes)

Figure 4 shows a comparison of average first-year earnings of broad fields of study classified by two-digit CIP codes calculated based on median earnings of four-digit CIP codes. Most reported broad fields were offered at the bachelor's (*N*=36) and master's (*N*=34) degree levels and less at the doctoral (*N*=15) and professional (*N*=4) degree levels. Fields related to engineering, computer and information sciences, and health professions appear to have the highest average first-year earnings across all degree levels, while others related to arts and humanities – such as English, theology, and philosophy can be found on the lower side of the earnings spectrum.

Figure 4 also reveals a positive correlation between degree levels and average first-year earnings for all broadly categorized fields except for social sciences. However, the irregularity emerged in the field of social sciences is likely due to its extremely small sub-sample size at the doctoral degree level (*N*=1). In many cases, broad fields with higher average earnings at the bachelor's degree level also appear to have higher earnings at the advanced degree levels, though earnings differentials between degree levels vary by field. For example, Figure 4 shows the field of physical sciences has a higher average earning than the field of education at the bachelor's degree level, but the latter has a higher average at the doctoral degree level.

Figure 4. Mean First-year Earnings of Broad Fields of Study (two-digit CIP codes) Based on Median First-year Earnings of Granular Fields of Study (four-digit CIP codes)

Methods

Because RQ1 aims to quantify the effects of all advanced degrees, answering RQ1 involved the use of all data in the selected sample. On the other hand, RQ2 and RQ3 required using data at the bachelor's, master's, doctoral, and professional degrees separately, as these two research questions are interested in the effects of major, department, institution, and institutional characteristics, as well as earnings associated with majors, at each degree level. Therefore, a total of five models – each covering a different subset of the selected sample, were needed to address the three research questions.

A multilevel modeling approach was used to develop the models because earnings of majors offered by the same department and institution are likely more similar than earnings of majors chosen at random. An Institution – Department – Major hierarchical model, as shown in Figure 5, would allow the total variance in the median earnings to be partitioned between-institutions, within-institution between-departments, and within-department between-majors. The variances at the institution and department levels can be used to quantify the effects of unobserved characteristics of these clusters, which can help to explain correlations between median earnings of majors within the same institution and department.

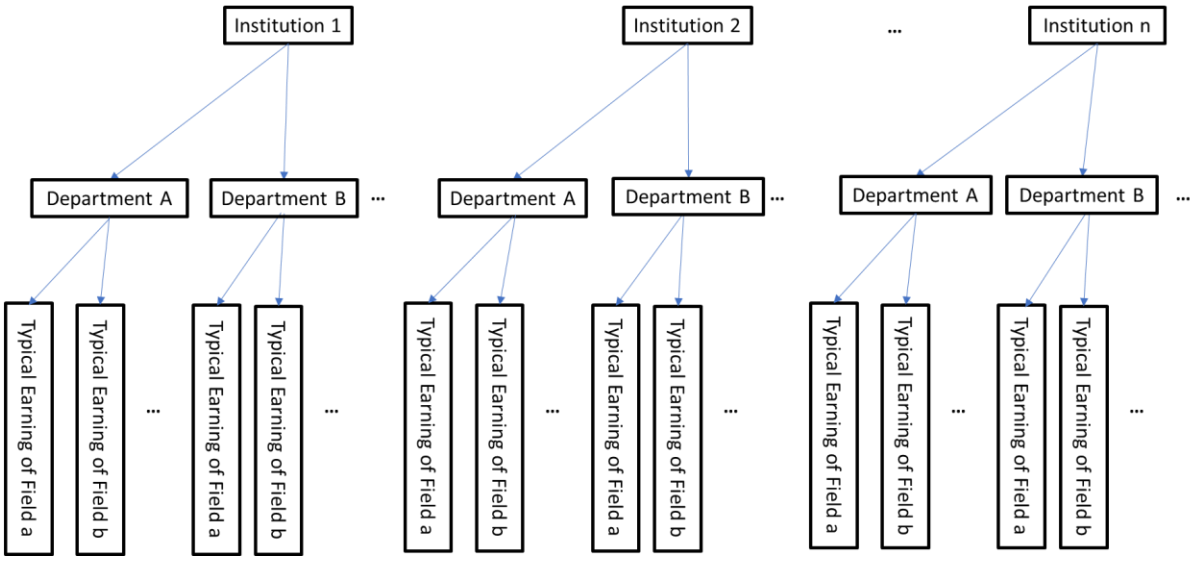

Figure 5. Institution – Department – Major three levels hierarchical model structure.

An analysis of the null models was conducted first to determine whether the data in each of the five subsets of the selected sample were nested. Multilevel and multiple linear regression models were then developed accordingly to analyze data with and without nested structures. The following subsections present the analysis of the null models followed by the final models' development process – including steps taken to reduce possible multicollinearity between majors and to mitigate violations of normality, nonlinearity, and homoscedasticity assumptions.

Null Models

The null models can be written in the form:

$$Y_{ijk} = \gamma_{000} + \mu_{i00} + \mu_{ij0} + e_{ijk} \quad (1)$$

where Y_{ijk} is the median earning of academic major i in department j and institution k, γ_{000} is the grand mean, μ_{i00} is the deviation from institution mean to the grand mean, μ_{ij0} is the deviation from the department mean to the institution mean, and e_{ijk} is the deviation from the

academic major mean to the department mean. Stata IC version 14.2 was used to estimate the models, and the significance of the models were tested using the likelihood ratio (LR) test. Intraclass Correlation Coefficients (ICCs) between institutions, $\rho_{institution}$, and within institution between departments $\rho_{department}$, were also calculated. The ICCs represent the proportions of the total variance that could be explained by the grouping of the institutions and departments, as shown in (2) and (3):

$$\rho_{institution} = \frac{\sigma_k^2}{\sigma_i^2+\sigma_j^2+\sigma_k^2} \quad (2)$$

$$\rho_{department} = \frac{\sigma_j^2+\sigma_k^2}{\sigma_i^2+\sigma_j^2+\sigma_k^2} \quad (3)$$

where σ_i^2, σ_j^2, and σ_k^2 are variances between majors, departments, and institutions respectively. The ICCs can also be interpreted as the correlations between the median earnings of majors in the same institution, and between the median earnings of majors in the same institution and department. For null models that are significant ($p < .05$) with sufficiently large ICCs ($\rho > .05$), multilevel modeling techniques were used for further data analysis. Otherwise, the units of analysis were assumed independent, and multiple linear regression was used instead.

Table 3 shows results of the five null models. When considering all observations in the selected sample, that is, considering all majors from the bachelor's degree and up, institution and department clusters were found to significantly affect median earnings of majors ($p < .05$), and they also explained substantial shares of the total variation in the earnings ($\rho_{institution} = 11\%$ and $\rho_{department} = 55\%$). However, when examining each degree level separately, institution and department clusters only significantly affected the median earnings of majors at the

bachelor's and master's degree levels ($ps < .01$), but not at the doctoral or professional degree levels ($ps > .84$).

Table 3.

Results of Null Models

	NModel All Degrees	**NModel1 Bachelor's**	**NModel2 Master's**	**NModel3 Doctoral**	**NModel4 Professional**
Variance					
Between Institution	0.02	0.01	0.01	0.00	0.00
	(0.00)	(0.00)	(0.00)		(0.00)
Within Institution Between Departments	0.07	0.06	0.06	0.02	0.00
	(0.00)	(0.00)	(0.00)	(0.03)	(0.00)
Within Departments Between Majors	0.07	0.04	0.06	0.09	0.13
	(0.00)	(0.00)	(0.00)	(0.03)	(0.01)
Likelihood Ratio Test χ^2	7157.78	5631.65	824.66	0.35	0.00
Likelihood Ratio Test $p-$value	0.00	0.00	0.00	0.84	1.00
AIC	15525.53	6503.42	3051.40	144.59	325.56
BIC	15557.60	6534.25	3077.76	154.78	341.70
ICC					
$\rho_{institution}$	0.11	0.12	0.05	0.00	0.00
	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)
$\rho_{department}$	0.55	0.65	0.51	0.21	0.00
	(0.01)	(0.01)	(0.02)	(0.30)	(0.00)
Total Number of Observations	22459.00	16444.00	5377.00	220.00	418.00
Number of Institutions	1277.00	1263.00	910.00	133.00	220.00
Observation per Institution					
Mean	17.60	13.00	5.90	1.70	1.90
Min	1.00	1.00	1.00	1.00	1.00
Max	121.00	90.00	44.00	8.00	6.00
Number of departments	10950.00	10008.00	3306.00	198.00	303.00
Observation per department					
Mean	2.10	1.60	1.60	1.10	1.40
Min	1.00	1.00	1.00	1.00	1.00
Max	22.00	17.00	10.00	4.00	5.00

Notes. NModel = null model applied to all observations, NModel1 = null model applied to observations at bachelor's degree level, NModel2 = null model applied to observations at master's degree level, NModel3 = null model applied to observations at doctoral degree level, NModel4 = null model applied to observations at professional degree level. Standard errors in parentheses.

A comparison of the ICCs, as visualized in Figure 6, also shows that the percentage of the total variation in the data that could be explained by institution and department clusters

decreased as the level of degree increased. At the bachelor's degree level, institution and department clusters explained 12% and 65% of the total variation in the data respectively. The percentages decreased to 5% and 51% at the master's degree level and below .01% and 21% at the doctoral degree level. At the professional degree level, neither institution nor department cluster explained any variation in the data ($\rho s < .01$).

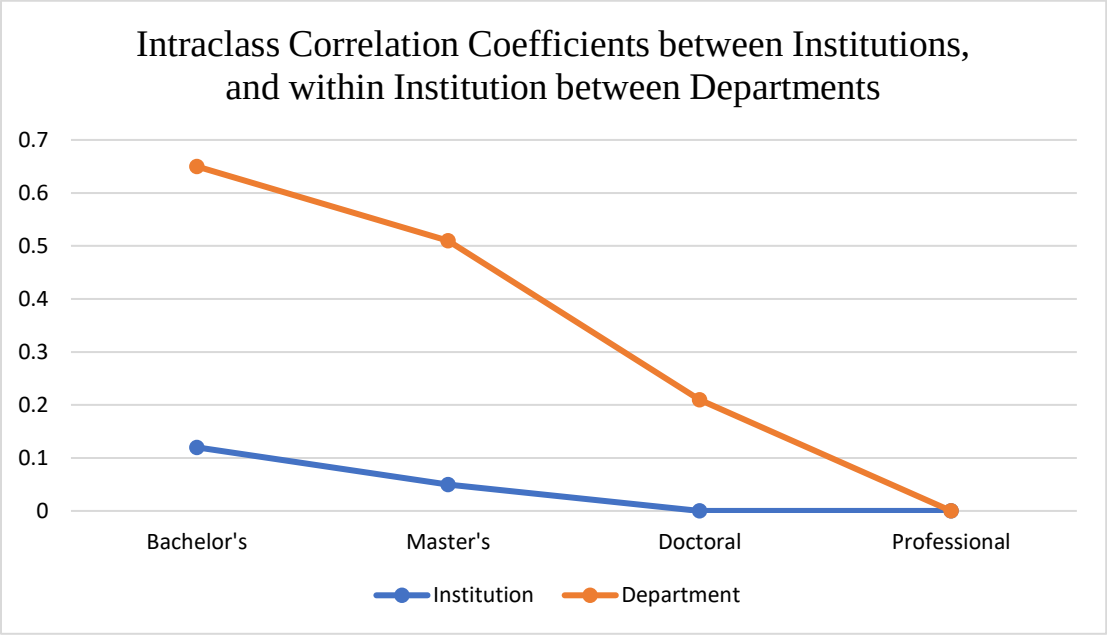

Figure 6. Intraclass Correlation Coefficients between Institutions, and within Institution between Departments

Results of the five null models suggested the use of multilevel modeling techniques were only necessary for the overall selected sample, as well as its subsets at the bachelor's and master's degree levels. Multiple linear regression models were then used to analyze data at the doctoral and professional degree levels.

Final Models

For simplicity of reference, the five models were named Model, Model1, Model2, Model3, and Model4. The first one was used to analyze data at all degrees, and the latter four were applied to data at the bachelor's, master's, doctoral, and professional degree level, respectively.

Model forms. Model, Model1, and Model2 have an Institution-Department-Major multilevel structure, and they can be written in a system of three equations as shown in (4), with notations described in Table 4.

(4)

$$\begin{cases} Y_{ijk} = \sum_{s=0}^{l} \pi_{sjk} a_{sijk} + e_{ijk}, & a_{0ijk} = 1 \\ \pi_{sjk} = \sum_{t=0}^{m} \beta_{stk} x_{tjk} + r_{sjk}, & x_{0jk} = 1 \\ \beta_{stk} = \sum_{v=0}^{n} \gamma_{stv} w_{vk} + u_{stk}, & w_{0k} = 1 \end{cases}$$

Table 4

Description of Notations in the Multilevel Models

Notations	Descriptions
Level 1	major level
Y_{ijk}	natural log transformed median earnings of major i in department j and institution k
l	number of predictors at level 1
a_{sijk} for $s = 1, \dots, l$	predictors at level 1, which are listed in Table 2
π_{sjk} for $s = 1, \dots, l$	coefficients of level 1 predictors
π_{0jk}	intercept at level 1
e_{ijk}	random effect at level 1
Level 2	department level
x_{tjk} for $t = 1, \dots, m$	predictors at level 2, which do not exist
β_{stk} for t $= 1, \dots, m$	coefficients of level 2 predictors, which do not exist
β_{s0k}	intercept at level 2
r_{sjk}	random effects at level 2
Level 3	institution level
w_{vk} for $v = 1, \dots, n$	predictors at level 3, which are listed in Table 2
γ_{stv} for $v = 1, \dots, n$	coefficients of level 3 predictors
γ_{st0}	intercept at level 3
u_{stk}	random effects at level 3

Notes: Because the Scorecard data did not include department level variables, there are no department level predictors. The level-2 equation can thus be written more succinctly as $\pi_{sjk} = \beta_{s0k} + r_{sjk}$.

Model3 and Model4 are multiple linear regression models, they can be written in a simpler form as shown in (5).

$$Y_i = \sum_{s=0}^{l} \pi_{si} a_{si} + e_i, \ a_{0i} = 1 \tag{5}$$

where Y_i is major i, l is the number of all predictors, a_{si} for $s = 1, \dots, l$ are predictors, π_{si} for $s = 1, \dots, l$ are the corresponding coefficients of predictors, π_{0i} is the intercept, and e_i is the random error.

Model assumptions and adjustments. To prevent the occurrence of severe multicollinearity between closely related programs, the major with the largest number of observations was selected as the base category for each of the five models. Model, Model1, and Model2 have the same base category, which is the program of business administration, management and operations (CIP code 5202). The base category for Model3 is educational

administration and supervision (CIP code 1304), and for Model4 is law (CIP code 2201). The variance inflation factor (VIF) values, as displayed in Appendix A, were found mostly well below 5 and none above 10. Therefore, multicollinearity is not a severe threat to the models.

The five models' standardized residuals (SRs) were also predicted to assess whether the assumptions of normality, nonlinearity, and homoscedasticity were met. Appendix B shows the histogram of each model's standardized residuals, and the plot of the standardized residuals versus fitted values. All five models' standardized residuals appear to be almost normally distributed, and the residuals seem generally uncorrelated with the fitted values except for model4 – where the variance of errors forms a concave down nonlinear trend. To reduce the impact of nonlinearity in Model4, robust estimates were produced using Stata's vce(robust) command, and this robust version of Model4 is referred to as Model4R. For the other four models (Model, Model1-3), only outliers ((SR>|3|) posed concern to model fitness. These outliers do not necessarily indicate bad data but can be reflections of large variations in the median starting earnings of majors. Removing the outliers resulted in a loss of a small share of observations, as shown in Table 5. The models without outliers are named ModelO, Model1O, Model 2O, and Model3O.

Table 5

Numbers and Shares of Outliers Removed in the Final Models

	All Degrees		**Bachelor's**		**Master's**		**Doctoral**		**Professional**	
	Model	**ModelO**	**Model1**	**Model1O**	**Model2**	**Model2O**	**Model3**	**Model3O**	**Model4**	**Model4R**
Number of observations	22,459	22,339	16,444	16,391	5,377	*5,348*	220	217	418	418
Number and percent of outliers removed		120 (.53%)		53 (.32%)		29 (.54%)		3 (1.36%)		0 (0%)

Model Analysis Outlines

To answer RQ1, fixed effects of advanced degrees were estimated from ModelO. To answer RQ2, random effects of institution, department, and major, estimated from Model1O and Model2O, were reported in standard deviations – following suit of what Borgen and Mastekaasa have demonstrated in their work based on a Norwegian sample (2018). The standard deviations of the random effects represent the percent changes in the model outcomes by moving up one standard deviation in the distributions of the institution, department, and major effects, and therefore, they describe the effects of higher-paying institutions, departments, and majors. A comparison of these random effects revealed how the importance of higher-paying institution, department, and major changed from bachelor's to master's degree levels. Their combined effects were also used to estimate the total effects of the horizontal dimension at bachelor's and master's degree levels, and were used to compare with the effects of the vertical dimension in terms of advanced degrees as well.

Though the random effects of institution, department, and major were only estimated at bachelor's and master's degree levels – since the models at doctoral and professional degree levels do not have a multilevel structure, fixed effects of predictors related to institutional characteristics were estimated at all four degree-levels. Estimates with different sets of predictors related to institutional characteristics were also reported to unveil the sensitivities of these predictors. Since the variables included in this study were measured in different scales, model estimates were also standardized into variable impacts in percentage terms for easier interpretation.

The four models used to answer RQ2 were also used to predict median starting earnings of majors, which answered RQ3. The predicted earnings were ranked by degree level and were

also used as the basis to calculate advanced-to-bachelor's degree earnings differentials – also ranked by degree level. These rankings helped to bring out patterns, variations, and irregularities in the earnings.

Chapter Four – Analysis and Results

This chapter first presents model estimates, including variable effects and standardized variable impacts. It explains how they are analyzed and interpreted to make sense of the importance of key elements in the vertical and horizontal dimensions of higher education. It also identifies and analyzes patterns, variations, and irregularities emerged from ranked earnings and earnings differentials found in Appendices E and F. Key findings of this study are summarized at the end of the chapter.

Estimates of Models

All five models (Model, Model1, Model2, Model3, and Model4) and their robust versions (ModelO, Model1O, Model2O, Model3O, and Model4R) were found significant ($p < .01$), and their estimates are listed in Table 6. Estimates between each pair of these models can be seen to differ only slightly. Results of this study are based on the analysis of estimates from the robust versions of the five models. Estimates of Model1O, Model2O, Model3O, and Model4R with different sets of control variables can be found in Appendix C.

Table 6

Estimates of Models

Variable	All Degrees		Bachelor's		Master's		Doctoral		Professional	
	Model	**ModelO**	**Model1**	**Model1O**	**Model2**	**Model2O**	**Model3**	**Model3O**	**Model4**	**Model4R**
	N=22,459	*N*=22,339	*N*=16,444	*N*=16,391	*N*=5,377	*N=5,348*	*N*=220	*N*=217	*N*=418	*N*=418
Major Level variables										
Degree level										
Master's	0.34***	0.34***								
Doctoral	0.62***	0.62***								
Professional	0.62***	0.65***								
Employment rate	0.79***	0.75***	0.66***	0.63***	0.83***	0.80***	0.31	0.31	2.50***	2.50***
Institution Level variables										
Private non-profit institution	0.01	0.01	0.01	0.01	0.04***	0.04***	0.11*	0.11*	-0.02	-0.02
Institutional finance										
Natural log of net tuition revenue per full-time student	0.02**	0.02**	0.03**	0.02**	-0.01	-0.01	0.01	0.01	0.01	0.01
Natural log of instructional expenditures per full-time student	0.02*	0.02*	0.03**	0.03**	0.03*	0.02*	0.00	0.00	0.02	0.02
Natural log of average faculty monthly salary	0.17***	0.17***	0.17***	0.17***	0.19***	0.18***	0.13	0.13	0.34 ***	0.34**
Admission rate	-0.09***	-0.08***	-0.11***	-0.11***	-0.05*	-0.04	-0.03	-0.03	0.01	0.01
Race and gender composition										
Percent of Black students	-0.05*	-0.04*	-0.04	-0.04	-0.02	-0.02	0.04	0.04	-0.11	-0.11
Percent of Hispanic students	0.02	0.03	-0.02	-0.02	0.11***	0.13***	-0.13	-0.13	0.1	0.1
Percent of Asian students	0.31***	0.28***	0.30***	0.29***	0.50***	0.50***	0.40	0.40	0.07	0.07
Percent of Female students	-0.12***	-0.11***	-0.15***	-0.14***	-0.01	-0.01	-0.05	-0.05	0.33	0.33*
Percent of part-time status	0.33***	0.33***	0.39***	0.39***	0.12**	0.12**	-0.04	-0.04	0.18	0.18
Student family background										
Percent of first-generation Students	0.14**	0.14**	0.18**	0.18**	0.16*	0.16*	0.57	0.57	-0.27	-0.27
Natural log of students' median family income	0.11***	0.11***	0.13***	0.13***	0.07***	0.07***	0.20*	0.20*	-0.06	-0.06
Four-year completion rate	-0.01	-0.01	0.00	0.01	-0.01	-0.02	-0.18	-0.18	0.06	0.06
Standard Deviation of Random Intercepts										
Institution	0.06	0.06	0.07	0.07	0.04	0.04				
	0.00	0.00	0.00	0.00	0.00	0.00				
Department	0.07	0.07	0.07	0.07	0.09	0.09				
	0.00	0.00	0.00	0.00	0.00	0.00				
Major	0.15	0.14	0.13	0.12	0.15	0.14				
	0.00	0.00	0.00	0.00	0.00	0.00				
Model Fitness										
Likelihood ratio test χ^2	1664.72	1825.97	1816.70	2021.68	261.13	299.14				
Likelihood ratio test p - value	0.00	0.00	0.00	0.00	0.00	0.00				
F Statistic							11.64	12.22	32.97	
p – value							0.00	0.00	0.00	
AIC	-16023.69	-18210.55	-15320.06	-16380.38	-3197.90	-3789.33	-89.54	-89.93	-113.62	-119.62
BIC	-13473.51	-15662.06	-13084.82	-14146.08	-1741.54	-2334.16	86.92	75.69	-4.66	-22.77
R^2							0.78	0.78	0.69	0.69
Adjusted R^2							0.71	0.71	0.67	

Notes: A model with suffix O has outliers (SR>|3|) removed; A model with suffix R yields robust estimates using Stata's vce(robust) command. ***Significant at .001 level; **Significant at .01 level; *Significant at .05 level.

Variable Impacts

Because the model outcomes were measured in a log scale and the predictors also came with different units, three exponential transformations were needed to standardize the impacts of predictors on the starting earnings of majors in the original scale. The impact of each variable in percentage terms are summarized in Table 7, and the derivation of the transformation formulas are explained in Appendix D.

Table 7

Summary of Variable Impact on Median Starting Earnings of Majors in Percentages

Variable	All Degrees ModelO	Bachelor's Model1O	Master's Model2O	Doctoral Model3O	Professional Model4R	Transformation Formula Applied
Major Level Variables						
Degree Level						
Master's	40.49%					1
Doctoral	85.89%					1
Professional	91.55%					1
Employment rate	0.75%	0.63%	0.80%	0.31%	2.53%	2
Institution Level Variables						
Private non-profit institution	1.01%	1.01%	4.08%	11.63%	-1.98%	1
Institutional finance						
Net tuition revenue per full-time student	0.02%	0.02%	-0.01%	0.01%	0.01%	3
Expenditures per full-time student	0.02%	0.03%	0.02%	0.00%	0.02%	3
Average faculty monthly salary	0.17%	0.17%	0.18%	0.13%	0.34%	3
Admission rate	-0.08%	-0.11%	-0.04%	-0.03%	0.01%	2
Race and gender composition						
Percent of Black student	-0.04%	-0.04%	-0.02%	0.04%	-0.11%	2
Percent of Hispanic student	0.03%	-0.02%	0.13%	-0.13%	0.10%	2
Percent of Asian student	0.28%	0.29%	0.50%	0.40%	0.07%	2
Percent of female student	-0.11%	-0.14%	-0.01%	-0.05%	0.33%	2
Percent of part-time students	0.33%	0.39%	0.12%	-0.04%	0.18%	2
Student family background						
Percent of first-generation students	0.14%	0.18%	0.16%	0.57%	-0.27%	2
Students' median family income	0.11%	0.13%	0.07%	0.20%	-0.06%	3
Four-year completion rate	-0.01%	0.01%	-0.02%	-0.18%	0.06%	2
Standard Deviation of Random Intercepts						
Institution	6.18%	7.25%	4.08%			1
Department	7.25%	7.25%	9.42%			1
Major	15.03%	12.75%	15.03%			1

Notes: Depending on the scale of a variable, one of the three following exponential transformations was needed to calculate its impact. Formula 1, written as $(e^{x} - 1) \cdot 100\%$, was applied to all categorical variables and random intercepts, where x is the corresponding fixed or random effect of the variable. Formula 2, written as $(e^{.01x} - 1) \cdot 100\%$, was applied to all rates related variables with values between 0 and 1. Formula 3, written as $[(1.01)^{x} - 1] \cdot 100\%$, was applied to predictors that are measured in a natural log scale. See Appendix D for derivations of the transformation formulas.

Effects of Advanced Degrees

Advanced degrees are the main components of the vertical dimension of higher education, and their effects were found highly significant ($ps < .001$) and substantial. On average, the median starting earnings of master's, doctoral, and professional degree programs were found to be 40%, 86%, and 92% higher than the median starting earnings of bachelor's degree programs respectively.

Because the majority of master's and all doctoral degree programs included in this study have matching four-digit CIP codes at the bachelor's degree level, they can be viewed as direct extensions of bachelor's degree programs, and their effects can be considered as the effect of higher degree attainment. However, most professional degree programs included in this study do not share the same CIP codes with bachelor's degree programs. Given that professional degrees are made of a small number of career-focused fields primarily related to lucrative professions, it may be more appropriate to attribute the large effect of professional degrees to the joint incentives of higher degree attainment and higher-paying majors – which makes the effect of professional degree inseparable from the effect of major.

Effects of Major, Department, and Institution

Major, department, and institution are key elements of the horizontal dimension of higher education, and their effects were found to vary by degree level. Among them, major was found the most impactful to the median starting earnings of programs at all degree levels. As shown in Table 7, the random effects of department and institution are considerably smaller than the random effects of major at the bachelor's and master's degree levels. Their cluster effects are also too small to be included in the models at the doctoral and professional degree levels. Specifically, bachelor's degree majors paying one standard deviation above the mean were found to have a near 13% advantage, which is almost twice as high as the 7% advantages associated

with departments and institutions paying one standard deviation above the mean. Similarly, high-paying master's degree majors were found to have an over 15% advantage, which is also notably greater than the 9% and 4% advantages associated with high-paying departments and institutions. Figure 7 also shows the impact of institution at the bachelor's degree level is the same as the impact of department but smaller than the impact of major. However, the impact of institution weakens from bachelor's to master's degree level, whereas the impacts of department and major strengthen from bachelor's to master's degree level.

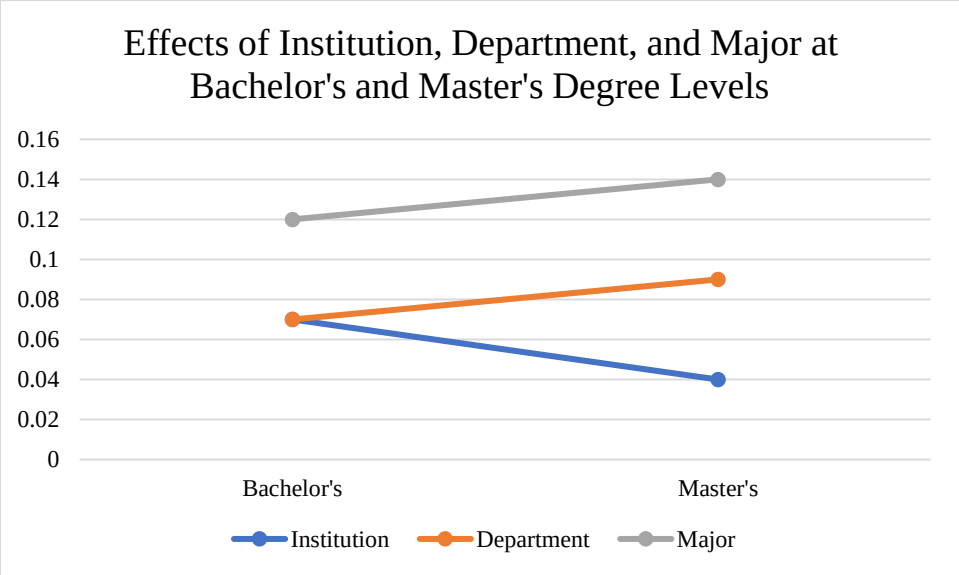

Figure 7. Effects of Institution, Department, and Major at Bachelor's and Master's Degree Levels

In addition, the effect of institution was found robust against the effect of department. It can be seen in Table 8 that the effect of institution is not affected at the bachelor's degree level, and is only affected to a minor extent at the master's degree level, by the inclusion of the effect of department. In contrast, the effect of major at both bachelor's and master's degree levels is more affected by the inclusion of the department effect. Specifically, the major effects reduced from 14% to 12% at the bachelor's degree level and from 17% to 14% at the master's degree level when the department cluster was introduced into the models. Therefore, the performances

of departments can be seen to affect program-level outcomes more than institution-level outcomes.

Table 8

Effects of Institution, Department, and Major on Median Starting Log Earnings of Majors

Standard Deviation of Random Intercepts	Without Department		With Department	
	Bachelor's	Master's	Bachelor's	Master's
Institution	0.07	0.05	0.07	0.04
	0.00	0.00	0.00	0.00
Department			0.07	0.09
			0.00	0.00
Major	0.14	0.17	0.12	0.14
	0.00	0.00	0.00	0.00

Effects of the Vertical and Horizontal Dimensions of Higher Education

Since institution, department and major are key components to the horizontal dimension of higher education, the sum of their random effects was used to approximate the total effect of the horizontal dimension. The combined effects of institution, department, and major at the bachelor's and master's degrees could be quantified as .26 and .27 respectively, since $.07 + .07 + .12 = .26$ and $.04 + .09 + .14 = .27$. Hence the effect of the horizontal dimension was found 1% stronger at the master's degree level than at the bachelor's degree level.

In addition, based on the method Borgen and Mastekaasa used in their study (2018), it can also be shown that the effect of the horizontal dimension is comparable to the effect of the vertical dimension. Considering the median starting earning of a high-paying (one standard deviation above the mean) bachelor's degree program offered by a high-paying department in a high-paying institution and a low-paying (one standard deviation below the mean) bachelor's degree program offered by a low-paying department in a low-paying institution, the advantage of the former program over the latter can be estimated using the formula $e^{(.12+.07+.07)\cdot 2} - 1$, which is 68%. This difference is notably larger than the 40% advantage associated with master's

degrees, but smaller than the 86% and 92% advantages associated with doctoral and professional degrees.

Effect of Major-Specific Employment Rate

It is also worth noting that the major-specific employment rate was found to be positively related to the median starting earnings of majors at all degree levels, as shown in Table 7. However, its effect is not significant ($p > .05$) at the doctoral degree level. On average, academic degree programs with a 1% higher employment rate are associated with modest earnings advantages that are well below 1%, whereas professional degrees are linked to a higher advantage of 2.53%. In addition, though this study cannot imply a causal relation between employment rate and earnings, their positive relation could suggest that higher employment rate is a benefit accompanying higher paying majors.

Effects of Institutional Characteristics

Most institutional level predictors included in this study were found to have significant ($ps < .05$) effects to bachelor's and master's degree programs, but not to doctoral or professional degree programs. The effects are also generally small in magnitude. Only two variables – institution's share of Black students and four-year graduation rate, were found to not have significant effects at any degree level ($ps > .05$). However, the estimates listed in Table C1 and C2 reveal that the share of Black student effect would be strongly significant to both bachelor's and master's degree programs ($ps < .01$), if variables related to student body's socio-economic status were not added to the models. Hence, the share of Black student effect can be largely explained by the student body's family background. On the other hand, the non-significant effect of an institution's four-year graduation rate may be due to the data being collected from graduates only, which excluded a sizable population of students enrolled in degree programs but did not complete the degree.

To make better sense of how different aspects of institutions affect typical starting earnings of majors, significant predictors related to institutional characteristics were grouped into five domains, as shown in Table 9. These domains reflect institution's governance structure, finance, access/selectivity, racial and gender diversity, and inclusion of non-traditional and low SES students.

Table 9

Domains of Instructional Characteristics

Domain	**Variables**
Governance structure	Public
	Private non-profit
Finance	Net tuition revenue per full-time student
	Instructional expenditures per full-time student
	Average faculty monthly salary
Access/Selectivity	Admission rate
Diversity	Percent of Black students
	Percent of Hispanic students
	Percent of Asian students
	Percent of female students
Inclusion	Percent of part-time students
	Percent of first-generation students
	Students' median family income

Governance Structure

Private non-profit institutions were found to affect academic degree programs positively and affect professional degree programs negatively. The effects are very small and are only significant at the master's ($p < .001$) and doctoral ($p < .05$) degree levels. The effect would also be significant to bachelor's degree programs, if predictors related to institutional finance were not introduced into the model, as revealed by the estimates listed in Table C1. This suggests that the private non-profit institution effect is more robust to master's and doctoral degree

programs, but the effect to bachelor's degree programs is largely explained by institutional finance.

The magnitude of the private non-profit institution effect was also found to increase with respect to academic degree levels. Specifically, bachelor's degree programs offered at private non-profit institutions are on average paid only 1% higher than their peer programs offered at public institutions, but the advantage grows to 4% at the master's degree level and 12% at the doctoral degree level. In contrast, a 2% penalty was found associated to professional degree programs offered by private non-profit institutions.

Finance

The effects of all three variables included in institutional finance were found highly significant to bachelor's degree programs ($ps < .01$), but not to advanced degree programs. Programs offered by better financed institutions are rewarded slightly better, except for the effect of net tuition revenue per full time student at the master's degree level, which was found marginally negative but non-significant ($p > .05$). The average increase in the initial earnings of majors associated with a 1% higher net tuition revenue per full-time student or a 1% higher expenditure per full-time student is no more than .03% at any degree level. The advantage associated with institution's average faculty monthly salary is comparably larger, though still modest. The increase in the initial earnings of academic degree programs accompanied by a 1% higher average faculty monthly salary is up to .18%, and the associated increase to professional degree programs is .34%.

Access, Diversity, and Inclusion

Variables related to institutions' access, diversity, and inclusion were all measured based on selected undergraduate student samples. These variables were therefore best suited to model bachelor's degree level outcomes, and their effects to bachelor's degree programs were found

mostly significant ($ps < .05$). Admission rate and share of female students are the only two significant predictors with negative effects at the bachelor's degree level. A 1% higher admission rate yields a .11% penalty to the initial earnings of bachelor's degree programs, and a 1% higher share of female students is linked to a .14% penalty. The Share of Black and Hispanic students were also found associated with small penalties, but the estimates in Table C1 reveal their effects are not significant ($ps > .05$) after controlling other variables, and they are largely explained by the student body's socioeconomic background. In contrast, the effects of the share of Asian students, part-time students, first-generation students, as well as student body's median family income were found highly significant ($ps < .01$) and positive at the bachelor's degree level. Specifically, a 1% higher share of Asian students, part-time students, and first-generation students, as well as a 1% wealthier student body can respectively yield a .29%, .39%, .18%, and .13% earnings advantage in bachelor's degree programs.

It is interesting to note that all inclusion, and some diversity related variables, were found to have significant effects ($ps < .05$) to master's degree level outcomes – despite that these variables were measured based on selected undergraduate student samples. The effects of these significant predictors are also uniformly positive. Their significances, however, mostly diminish at the doctoral and professional degree levels, with only two exceptions. The student body's median family income still remains a significant ($p < .05$) and positive predictor to doctoral degree programs; and the share of female students, though significantly ($p < .001$) and negatively affects bachelor's degree programs, affects professional degree programs significantly ($p < .05$) and positively.

Expected Median Starting Earnings of Majors

The final models used in this study predicted median starting earnings of 273 bachelor's degree programs, 204 master's degree programs, 35 doctoral degree programs, and 13

professional degree programs. The predicted outcomes are ranked by degree level in Appendix E.

Not all majors included in this study are associated to all degree levels, but as high as 92% of master's degree programs and all doctoral degree programs have matching bachelor's degree programs sharing the same four-digit CIP codes. In contrast, only 38% professional degree programs have a direct match at the bachelor's degree level. This is not surprising because most professional degrees only require two years of prior college education (U.S. Department of Education, 2020) and are less dependent on bachelor's degree completions.

The expected initial earnings of majors vary substantially so that the highest-paid 10% bachelor's degree programs were found to fare better than 63% of master's degree programs, 23% of doctoral degree programs, and 31% of professional degree programs. The rankings in Table E1-E3 reveal that the most lucrative academic degree programs are commonly associated with health professions, engineering, computer sciences, as well as business and management; whereas the least remunerative majors tend to be related to arts and humanities – but can also touch on programs in other fields such as social sciences, agriculture, communication technologies, and recreation related studies. Table E4 further shows that among all professional degree programs included in this study, educational administration and supervision (CIP code 1304) has an expected pay exactly at the median; programs paid above the median are uniformly related to health professions, but some health profession related programs, as well as law and theology are paid below the median.

Earnings related to engineering (CIP code 14) and business (CIP code 52) fields were found almost always better ranked, as shown in Table E1 to E3 – despite that these fields cover a large number of different subfields. However, not all fields yield earnings that are consistent across subfields. For example, majors related to health professions (CIP code 51) and biological

and biomedical sciences (CIP code 26) can be found on both the higher and the lower ends of the earnings spectrum, as shown in Table E1. Within the field of health professions, the earnings of practical nursing (CIP code 5139) and registered nursing (CIP code 5138) are ranked number one and nine among 273 bachelor's degree programs, but communication disorders sciences and services (CIP code 5102) and medical illustration and informatics (CIP code 5127) are ranked number 238 and 244 on the same list of programs. Similarly, within the field of biological and biomedical sciences, the earning of biomathematics (CIP code 2611) is ranked number 2 but ecology (CIP code 2613) and zoology (CIP code 2607) are ranked number 259 and 264 respectively.

Earnings Differentials between Advanced and Bachelor's Degrees by Major

Not only does earning vary by major at all degree levels, the additional earning associated with advanced degree attainment also differs by major. Though many better paid majors at the bachelor's degree level appear better paid at the advanced degree levels, an investment in an advanced degree in these majors does not necessarily give larger marginal benefits, at least initially. Appendix F lists the master's-to-bachelor's and doctoral-to-bachelor's earnings differentials for all majors with matching four-digit CIP codes offered at these degree levels. Professional-to-bachelor's degree earnings differentials are excluded because most programs offered at these degree levels do not match. The earnings differentials were calculated based on the predicted median starting earnings of majors, and they were ranked from the highest to the lowest within each broader field so that the advantage associated with advanced degree attainment in closely related majors could be easily compared. For example, as shown in Table F1, with an initial earning of $40,925.15, it is more rewarding to complete a bachelor's degree in business administration, management and operations (CIP code 5202) than in its closely related program – entrepreneurial and small business operations (CIP code 5207), which has an initial earning of $36,022.54. However, the former program has a master's-to-bachelor's earnings

differential of $27,500.30, which is notably smaller than the $34,378.98 earnings differential associated with the latter program, thus makes the completion of a master's degree in the latter program more rewarding.

In addition, some majors also seem to require an advanced degree to optimize their labor market rewards. For example, as shown in Table E1-E3, the initial earnings of a bachelor's, master's, and doctoral degree in physics (CIP code 4008) are $34,320.49, $70,850.69 and $130,642.52 respectively, which makes a master's and doctoral degree in physics about twice and four times more valuable than a bachelor's degree in the same field. The ranking of the initial earning of physics is also moved up from slightly above the median among bachelor's degree programs to the very top among doctoral degree programs.

Summary of Findings

Results of this study revealed that the vertical dimension of higher education – in terms of advanced degrees, and the horizontal dimension – in terms of major, department, and institution, have substantial and comparable effects on the median starting earnings of majors. Advanced degrees, on average, yielded considerably higher initial earnings than bachelor's degrees. Among which, professional degree programs had the highest expected earnings, followed by doctoral and master's degree programs. The total effect of the horizontal dimension was found slightly higher at the master's degree level than at the bachelor's degree level. Institution, department, and major were found to have important effects to bachelor's and master's degree programs. At the bachelor's and master's degree levels, the effect of institution was found smaller relative to the effects of department and major, and the institution effect also decreased from bachelor's to master's degree level while the department and major effects increased. It can thus be seen that the choice of institution is less consequential than the choice of field of study to typical graduates from bachelor's degree programs in terms of their fist-year

earning. The choice of institution becomes even less important in terms of initial earnings as the level of degree increases, while the choice of field, especially major, becomes more important.

Though the effect of institution was found comparably small, it is robust against the effect of department at the bachelor's and master's degree levels; whereas the effect of major could be more explained by the effect of department. This suggests that the performance of department is important to the performance of major, but it barely affects the performance of institution.

This study also examined the effects of major-specific employment rate and a number of institutional characteristics. Employment rate was found to positively affect the median starting earnings of majors at all degree levels. This positive relation also suggests that higher employment rates are benefits to higher-paying fields. Institutional characteristics, such as governance structure, finance, access, student body racial and gender diversity, as well as inclusion of nontraditional and low SES students, were also found to affect the median starting earnings of majors. However, these effects are generally small and are significant primarily at the bachelor's and master's degree levels.

Private non-profit institution appeared to benefit master's and doctoral degree programs more than bachelor's degree programs. Its small effect to bachelor's degree programs was largely explained by institutional finance, in terms of net tuition revenue per full-time student, expenditure per full-time student, and faculty's monthly salary. Better financed institutions were found associated with higher median starting earnings at the program level. While the effects of net tuition revenue per full-time student and expenditure per full-time student varied only modestly across degrees, faculty's monthly salary affected professional degree programs notably more than academic degree programs.

Access, diversity, and inclusion related variables were measured based on selected undergraduate student samples only. Access, in terms of admission rate to undergraduate degree programs, was found to negatively impact the initial earnings of majors at the bachelor's degree level. Therefore, bachelor's degree programs associated with selective institutions yielded better initial pays. However, undergraduate degree-based admission rate did not have significant effects to advanced degree programs. This is not of surprise as advanced degree programs often have different admission requirements. Most diversity and inclusion related variables were found to have significant effects to both bachelor's and master's degree programs, but most of their effects lost significance at the doctoral and professional degree levels. It can thus be speculated that students enrolled in bachelor's degree programs may have a high level of resemblance to students enrolled in master's degree programs, but not to students enrolled in doctoral or professional degree programs.

The effect of student body diversity was found to vary depending on the share of minority and female students, as well as degree level. The percentage of Asian students significantly and positively affected both bachelor's and master's degree programs, and so did the percentage of Hispanic students to master's degree programs. In contrast, the percentage of Black students negatively affected both bachelor's and master's degree programs, and so did the percentage of Hispanic students to bachelor's degree programs. However, the negative effects associated with the shares of Black and Hispanic students were not significant and were largely explained by the student body's socioeconomic status. In addition, the percentage of female students was found to negatively affect bachelor's degree programs but positively affect professional degree programs.

Institutions with wealthier undergraduate students, in terms of their median family income, were found linked to higher initial earnings of majors at all three academic degree levels. This is expected as privileged students are more likely to enroll in selective institutions

and lucrative fields leading to higher incomes. Surprisingly, institutions with higher percentages of part-time students and first-generation students were also found to affect the initial earnings of bachelor's and master's degree programs positively. This finding provided evidence showing that institutions engaged in the inclusion of non-traditional and low SES students yielded favorable early labor market outcomes.

This study also ranked expected median starting earnings of majors at the bachelor's degree level and above. Large variations of earnings were observed between fields, within fields between majors, and across degree levels. The predicted earnings were also used to calculate and rank major-specific earnings differentials between advanced and bachelor's degrees, which appeared to vary greatly as well. These variations are consistent with the large field and advanced degree effects found in this study.

Chapter Five – Discussions

Implications

This study was conducted to better understand early labor market outcomes of higher education and the importance of the vertical and horizontal dimensions of higher education. This study used the College Scorecard's field of study level and institution level data to estimate typical starting earnings associated with bachelor's and advanced degree programs. It also calculated advanced degree effects, and set precedence to systematically compare the effects of major, department, institution, and institutional characteristics across these degree levels. The Scorecard compared their earnings data, which were estimated based on federal loan and financial aid recipients, with earnings reported by the Census Bureau's Postsecondary Employment Outcomes (PSEO) program, which were estimated based on graduates not restricted to those received federal loan and financial aid. The earnings estimates from the two data sources were found to be generally in concordance with each other, though there were variations by broader categories of field of study (College Scorecard, 2019, pp. 9–11). Therefore, results of this study may be partially but not fully extended to graduates not supported by federal loan and financial aid.

Consistent with existing literature (Arcidiacono, 2004; Carnevale et al., 2015; Gerber & Cheung, 2008; Grogger & Eide, 1995; Grubb & Lazerson, 2007; Paulsen, 2001), this study found programs in health professions, engineering, computer sciences, and business are better rewarded than programs related to arts and humanities, though earnings vary not only across broad fields of study but also within broad fields across majors. Patterns that emerged from the ranked earnings and earnings differentials in Appendices E and F further revealed that programs with higher pay at the bachelor's degree level tend to have higher pay at the advanced degree

level, but large variations also exist in the additional earnings associated with advanced degrees across majors.

Results of this study confirmed the positive relation between earning and degree attainment at the top of the vertical dimension of higher education. Professional degrees were found to be the highest paid among all advanced degrees – which is in agreement with what Posselt and Grodsky (2017) reported based on the National Science Foundation's National Survey of College Graduates in 2013. Through a comparison of the random effects of institution, department, and major, this study also suggested that the choice of field of study is more important than the choice of institution in terms of their effects on the first-year earnings of bachelor's and master's degree graduates. Field of study is also more important for master's degree graduates than for bachelor's degree graduates, whereas institution is less important for master's degree graduates than for bachelor's degree graduates. Because the effects of institution and field of study vary with respect to degree levels, the importance of the vertical and horizontal dimensions of higher education should be discussed in relation to each other. Future research could take a more comprehensive approach by also including sub-baccalaureate credentials, such as undergraduate diplomas and associate's degrees, as well as post-baccalaureate certificates to better understand the dynamic roles of institution and field of study across all tertiary degree levels.

Because the data used in this study was based on first-year earnings upon degree completion, they were likely determined at the point of career entry before true productivity could be observed. The advanced degree effects estimated by this study thus likely reflect a "credential effect" or "sheep skin effect" (Frazis, 2002; Jaeger & Page, 1996) in the sense that employers reward advanced degrees more than bachelor's degrees because advanced degrees carry more signal values of productivity than bachelor's degrees. The growing major and department effects and diminishing institution effect from bachelor's to master's degree levels

further suggested that field of study and advanced degree attainment may be deemed as better proxies of productivity than institution. In addition to a credential effect, the larger premium associated with professional degrees may also be attributed to the effects of social closure (van de Werfhorst, 2011; Weber, 1978), because these degrees consist of programs primarily related to lucrative professions with licensure requirements.

The smaller effect of institution found in this study, relative to the effects of department and major, is in agreement with the findings of Borgen and Mastekaasa's (2018) study in Norway. The institution effect found in Norway was even smaller in magnitude, which was speculated by the authors due to fewer quality differences between Norwegian institutions as they are primarily financed by public funds. Though the institution effect found in this study is smaller than the effect of department and major, it does not imply institution is unimportant – especially since calculations were based on first-year earnings post graduation. Borgen and Mastekaasa showed the institution effect in Norway briefly decreased in the first two years of one's career before it rebounded and almost reached the level of the department effect by the eighth year. The effect of institution in the U.S. may also be higher later on, after the signal effect wanes and when true productivity can be better observed. In addition, the effect of institution in Norway was found mostly explained at the department level, but the effect of institution in the U.S. was found barely affected by department – thus the effect of institutions in the U.S. is more robust.

Indeed, most institution-level predictors included in the models were found to have small but significant effects at least at some degree levels. In particular, the effect of private non-profit institutions were found positive at all three academic degree levels, which is consistent with findings of prior studies that have found graduates from private universities earning more than graduates from public universities (Monks, 2000; Thomas, 2000). However, this study found private non-profit institutions a better predictor to master's and doctoral degree programs than to

bachelor's degree programs. The effect of private non-profit institutions to bachelor's degree programs was not significant ($p > .05$) and was largely explained by institutional finance. It is also worth noting that the private non-profit institution effect to bachelor's degree programs was found highly significant ($p < .001$) when a multiple linear regression model was tested instead of using a multilevel model. Hence, not taking into account of the nested institution and department effects could lead to biased private non-profit institution effect.

This study also found evidence suggesting institutions engaged in serving non-traditional and low SES students achieved favorable early labor market outcomes, since the shares of part-time and first-generation students consistently affected initial earnings of bachelor's and master's degree programs both significantly and positively. This finding could be particularly encouraging to institutions with higher shares of non-traditional and low SES students. These institutions should continue taking active measures to improve their students' educational experiences and to share their practices with other institutions. However, since the shares of Black, Hispanic, and female students were found negative at the bachelor's degree level, institutions with larger shares of minority and female students need to do more to improve their students' labor market outcomes.

Despite diversity and inclusion related variables being measured based on undergraduate student samples only, most of them had significant effects to both bachelor's and master's degree programs, though not to doctoral and professional degree programs. One possible explanation is that the composition of undergraduate students generally resembles the composition of Master's degree students. Diversity and inclusion related variables therefore not only have a significant effect to bachelor's degree programs, but also to master's degree programs – even though the strengths of their effects can vary between the two degree-levels. In contrast, the composition of undergraduate students may be too different from the composition of doctoral and professional

degree students. Diversity and inclusion related variables therefore cannot serve as significant predictors to doctoral and professional degree programs. Hence, a faint line of stratification may exist between bachelor's and master's degree levels, but a pronounced one exists above master's and below doctoral and professional degree levels. This study speculates, under the maximally maintained inequality hypothesis (Raftery & Hout, 1993), that the enrollment of high SES students have saturated at both bachelor's and master's degree levels. High SES students are therefore motivated to enter doctoral and professional degree programs to further distinguishing their privileged status. However, the high cost associated with doctoral and professional degree programs and their requirements of previous credentials have created barriers for low SES students. Thus, from a social closure perspective (Posselt & Grodsky, 2017; Pyne & Grodsky, 2018), doctoral and professional degrees could lead to social exclusion of low SES students. More research should therefore be geared towards pathways to doctoral and professional degree programs to improve access and equity for low SES students.

Significance and Limitations of the Study

This study revealed how the relative importance of institutions and field of study change from undergraduate to graduate degrees, and addressed how institutions' governance structure, finance, selectivity, and student body diversity and inclusion affect program level outcomes. With implications ranging from the signal values of advanced degrees, field of study, and institution, to stratification and social closure in higher education, and to how institutions of different characteristics serve students, this study may be of interest to university leaders and researchers in the fields of education, economy, and sociology. This study also estimated and ranked median starting earnings of a large spectrum of granularly categorized bachelor's and advanced degree programs, and calculated and ranked the associated advanced-to-bachelor's degree earnings differentials. These earnings information can be used to improve students' awareness on the varied labor market outcomes to different majors and degrees, and to facilitate

their makings of economically rational major choice and degree attainment decisions. For example, an academic or career advisor may utilize results of this study to help a prospective college student identifying best rewarded programs in the area of his or her interest, and to help a prospective college graduate assessing the additional benefit of continuing his or her current study in graduate school.

This study is subject to a few limitations. Though it took into account possible nested institution and department effects to improve accuracy in the results, model estimates are still vulnerable to omitted variable bias due to its controlled variable approach. Limitations in the data only allowed the inclusion of field-level employment rate as a job-related predictor, while other predictors known to affect labor market outcomes, such as occupation, labor market experiences, employment sector, and firm size (Gerber & Cheung, 2008; Grubb & Lazerson, 2007) were unaccounted for. Not factoring these job-related predictors may overestimate the effect of field of study. In addition, sampling bias could not be ruled out because some CIP codes included in the Scorecard data have small sample sizes, thus earnings estimates associated with these CIP codes may be skewed.

It must also be cautioned that graduates' first-year earnings only paint a partial picture of their financial situation upon degree completion. Graduates from a higher paying major do not necessarily live in a better financial situation than students who graduated from a lower paying major – at least initially, if the cost of the higher paying major is also high. Academic and career advisors should consider program level cost, such as tuition and fees, as well as cumulative student debt in addition to the earnings information provided by this study to help students assessing their financial outcomes associated with their major and degree attainment choices. It is especially important to discuss financial ramifications to students planning on entering into expensive programs with low post-graduation earnings to prevent them from falling into financial crisis after graduation. Though major-specific cost data are not yet available, the

Scorecard does provide major-level student debt data, which could be included in future studies to better assess graduates' financial health.

Furthermore, since the results of this study were calculated based on first-year earnings post degree completion, they should only infer to early labor market outcomes, which can differ from long-term labor market outcomes due to different wage growth across fields over time (Carnevale et al., 2015). The Scorecard has a plan to measure earnings at multiple points up to 10 years post-graduation, and has also recently begun to release the second-year earnings data. As more data becomes available, this study can be extended to assess long-term labor market consequences associated with vertical and horizontal dimensions of higher education.

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Appendices

Appendix A

Variance Inflation Factors

Variable		Model	Model1	Model2	Model3	Model4
Degree level						
	Master's	1.59				
	Doctoral	1.14				
	Professional	8.13				
CIP code						
	100	1.02	1.03	1		
	101	1.05	1.07	1		
	102	1	1			
	103	1.01	1.01			
	104	1	1			
	105	1	1.01			
	106	1.01	1.01			
	107	1	1			
	108	1	1			
	109	1.06	1.09			
	110	1.02	1.03	1		
	111	1.03	1.04	1		
	112	1	1.01			
	199	1	1			
	301	1.13	1.19	1.04		
	302	1.02	1.02	1.02		
	303	1	1.01			
	305	1.02	1.03	1.01		
	306	1.02	1.04			
	399	1	1			
	402	1.1	1.09	1.12		
	403	1.04	1.02	1.07		
	404	1	1			
	405	1.01	1.01	1.01		
	406	1.02	1.02	1.01		
	409	1.01	1.01	1.01		
	410	1.01		1.01		
	501	1.06	1.07	1.03		
	502	1.04	1.06	1.01		
	901	1.37	1.55	1.06		
	904	1.12	1.18	1.03		
	907	1.08	1.12	1.01		
	909	1.11	1.15	1.03		
	910	1		1.01		
	999	1.02	1.02	1.01		
	1001	1	1			
	1002	1.01	1.01	1		
	1003	1.03	1.04	1.01		
	1099	1	1			
	1101	1.2	1.3	1.05		
	1102	1	1.01			
	1103	1	1			
	1104	1.07	1.07	1.06	1.11	
	1105	1.01	1.01	1.01		

1107	1.17	1.25	1.03		
1108	1.02	1.02	1.01		
1109	1.01	1.02	1		
1110	1.02	1.03	1.02		
1199	1	1	1		
1203	1	1			
1205	1	1.01	1		
1301	1.13	1.03	1.2	1.35	
1302	1		1.01		
1303	1.09	1	1.17	1.19	
1304	1.3	1	1.43		1.04
1305	1.03		1.06		
1306	1		1.01	1.06	
1307	1	1	1.01		
1309	1		1.01		
1310	1.21	1.15	1.3		
1311	1.19		1.36	1.07	
1312	1.51	1.57	1.41	1.09	
1313	1.31	1.31	1.3	1.2	
1314	1.02	1.01	1.04		
1399	1.03	1.02	1.04	1.1	
1401	1.04	1.04	1.03		
1402	1.05	1.07	1.02	1.08	
1403	1.02	1.02			
1404	1.01	1.02	1.01		
1405	1.07	1.09	1.03	1.22	
1407	1.12	1.18	1.01		
1408	1.18	1.24	1.1	1.06	
1409	1.09	1.13	1.01		
1410	1.19	1.25	1.07	1.35	
1411	1	1			
1412	1	1.01			
1413	1.01	1.01	1.01		
1414	1.02	1.03	1.01		
1418	1.02	1.03			
1419	1.25	1.34	1.1	1.2	
1420	1	1			
1421	1.01	1.01			
1422	1.01	1.01			
1423	1.01	1.01			
1424	1	1			
1425	1.02	1.03	1		
1427	1.01	1.01	1.03		
1428	1	1			
1432	1	1			
1433	1	1.01			
1434	1	1			
1435	1.05	1.08	1.01		
1436	1.01	1.01			
1437	1.01	1.01	1.01		
1439	1	1	1.01		
1441	1	1			
1443	1	1			
1445	1	1			
1499	1.02	1.02	1.02		
1500	1.02	1.03			
1501	1	1.01			
1502	1.01	1.01			
1503	1.02	1.03			
1504	1	1.01			

1505	1	1.01	1	
1506	1.03	1.04	1	
1507	1.01	1.02	1.01	
1508	1.03	1.05		
1509	1	1		
1510	1.03	1.04	1.01	
1512	1.01	1.01		
1513	1	1.01		
1515	1.03	1.02	1.04	
1599	1.01	1.01	1.01	
1601	1.06	1.09	1.02	
1603	1.04	1.06		
1604	1	1		
1605	1	1.01		
1609	1.13	1.2	1.01	
1611	1	1		
1616	1.01	1.01	1.01	
1699	1	1.01		
1901	1.04	1.06	1.02	
1902	1.01	1.01		
1904	1.01	1.02	1.01	
1905	1.03	1.04	1.01	
1906	1.01	1.01		
1907	1.08	1.12	1.03	
1909	1.03	1.04	1.01	
2200	1.01	1.02	1	
2201	3.94			
2202	1.02	1	1.05	
2203	1.01	1.02	1	
2299	1.01	1.01	1.01	
2301	1.34	1.51	1.03	1.17
2313	1.09	1.1	1.08	
2314	1	1.01		
2399	1	1		
2401	1.23	1.34	1.04	
2501	1.04		1.09	
2599	1		1.01	
2601	1.47	1.7	1.03	1.24
2602	1.06	1.09	1.01	1.2
2604	1.03	1.04	1.01	1.19
2605	1.03	1.04	1.01	
2607	1.03	1.04	1.01	
2608	1.01	1.01		
2609	1.02	1.03	1.01	
2610	1	1	1	
2611	1.01	1	1.01	
2612	1.01	1.01	1.01	
2613	1.04	1.05	1.03	1.15
2615	1.05	1.07	1	
2699	1.01	1.01	1.02	1.5
2701	1.14	1.22	1.01	
2703	1.02	1.03	1.01	
2705	1.02	1.03	1.01	
2799	1	1		
2902	1	1		
3000	1.02	1.03	1.01	
3001	1.02	1.02	1.03	
3005	1.01	1.01	1.02	
3006	1	1.01	1	
3008	1	1		

3010	1	1			
3011	1	1	1.01		
3012	1	1	1.01		
3014	1.01		1.02		
3015	1.01	1.01	1		
3017	1	1.01			
3018	1	1.01			
3019	1.02	1.03	1.01		
3020	1.06	1.08	1.02		
3023	1	1			
3025	1.01	1.01	1.01		
3026	1	1.01			
3027	1.01	1.01			
3028	1.01		1.01	1.15	
3031	1		1.01		
3032	1	1			
3033	1.01	1.01	1.01		
3099	1.11	1.16	1.03		
3101	1.03	1.05	1.01		
3103	1.04	1.05	1.01		
3105	1.33	1.44	1.16		
3199	1	1			
3801	1.04	1.06	1		
3802	1.01	1.01	1.01	1.09	
3899	1	1	1.01		
3902	1.02	1.03	1.01		
3903	1	1			
3904	1.01	1.01	1.01		
3905	1.01	1	1.01		
3906	1.04	1.02	1.08		1.02
3907	1.01	1.02	1.02		
3999	1.01	1	1.02	1.1	
4001	1	1			
4002	1	1			
4004	1.01	1.01			
4005	1.11	1.14	1.01	1.82	
4006	1.05	1.07	1.01		
4008	1.03	1.04	1	1.18	
4010	1	1			
4099	1	1			
4199	1	1.01	1		
4201	1.57	1.86	1.04	1.16	
4227	1.02	1.04			
4228	1.15	1.03	1.24	1.41	
4299	1.01	1	1.01	1.19	
4301	1.34	1.48	1.11		
4302	1.01	1.01			
4303	1.01	1.01	1.01		
4399	1.01	1.01	1.01		
4400	1.03	1.05	1.01		
4402	1.01	1.01	1.01		
4404	1.13	1.04	1.23		
4405	1.04	1.02	1.06		
4407	1.33	1.31	1.37		
4499	1	1	1		
4501	1.04	1.06	1.01		
4502	1.11	1.17	1	1.07	
4503	1	1			
4504	1.06	1.09	1.01		
4506	1.22	1.34	1.02		

4507	1.06	1.09	1.02		
4509	1.1	1.13	1.06		
4510	1.29	1.44	1.01		
4511	1.27	1.42	1		
4512	1.01	1.02	1.01		
4513	1	1.01			
4514	1	1			
4599	1.02	1.03	1.01		
4604	1	1			
4703	1	1			
4706	1.01	1.01			
4901	1.03	1.04	1.02		
4903	1.01	1.01			
5001	1.03	1.04	1.01		
5002	1	1			
5003	1.02	1.04	1		
5004	1.16	1.23	1.03		
5005	1.15	1.21	1.05		
5006	1.09	1.13	1.04		
5007	1.28	1.39	1.08		
5009	1.16	1.17	1.11	1.37	
5010	1.03	1.03	1.03		
5099	1.01	1.01	1.02		
5100	1.06	1.08	1.01		
5101	1.02				1.21
5102	1.19	1.08	1.32	1.08	
5104	1.86				1.46
5105	1.01		1.02		
5106	1.03	1.05	1		
5107	1.12	1.11	1.14		
5108	1.01	1.01	1.01		
5109	1.14	1.11	1.19		
5110	1.04	1.06	1.01		
5111	1.02	1.03			
5112	2.55				1.99
5114	1		1		
5115	1.09	1.03	1.15	1.11	
5117	1.21				1.17
5119	1.12				1.21
5120	2.21	1.01	1.01		1.32
5121	1.06				1.1
5122	1.15	1.12	1.19	1.3	
5123	1.28	1.04	1.22	1.34	1.61
5124	1.41				1.21
5125	1		1		
5127	1.01	1	1.01		
5131	1.04	1.06	1.02		
5132	1	1.01	1		
5133	1	1.75			
5138	1.66		1.49	1.26	1.12
5139	1	1			
5199	1.03	1.04	1.02		
5201	1.14	1.17	1.09		
5202				1.14	
5203	1.46	1.53	1.34		
5204	1	1			
5205	1.01	1.01	1		
5206	1.04	1.07	1.01		
5207	1.03	1.05	1.01		
5208	1.25	1.36	1.08		

5209	1.09	1.13	1.01		
5210	1.12	1.12	1.11	1.16	
5211	1.06	1.08	1.02		
5212	1.08	1.12	1.02		
5213	1.06	1.08	1.04		
5214	1.27	1.4	1.03		
5215	1.01	1.01	1.02		
5216	1.02		1.04		
5217	1.01	1.02	1.01		
5218	1.02	1.02	1.01		
5219	1.02	1.03	1		
5220	1.03	1.05	1.01		
5299	1.02	1.03	1.01		
5401	1.25	1.37	1.03	1.12	
Employment rate	1.44	1.45	1.43	2.26	2.35
Private non-profit institution	3.15	2.98	3.83	4.54	3.87
Natural log of net tuition revenue per full-time student	4.68	4.38	5.82	5.48	5.75
Expenditures per full-time student	3.77	3.49	4.46	7.73	3.88
Natural log of average faculty monthly salary	3.97	3.76	4.49	6.66	5.26
Admission rate	2.01	1.86	2.35	5.48	3.83
Percent of Black student	1.82	1.86	1.79	2.04	2.27
Percent of Hispanic student	1.89	1.94	1.87	2.03	1.77
Percent of Asian student	2.33	2.33	2.38	4.24	2.42
Percent of female student	1.43	1.41	1.52	2.32	1.9
Percent of part-time students	2.04	2.07	2.04	2.78	2.69
Percent of first-generation students	5.71	5.7	5.92	8.68	6.92
Natural log of students' median family income	6.33	6.75	5.66	6.89	5.88
Four-year completion rate	4.1	4.15	4.03	6.54	4.9
Mean VIF	**1.2**	**1.17**	**1.2**	**2.2**	**2.66**

Appendix B

Histograms of Standardized Residuals and Plots of Standardized Residuals vs. Fitted Values

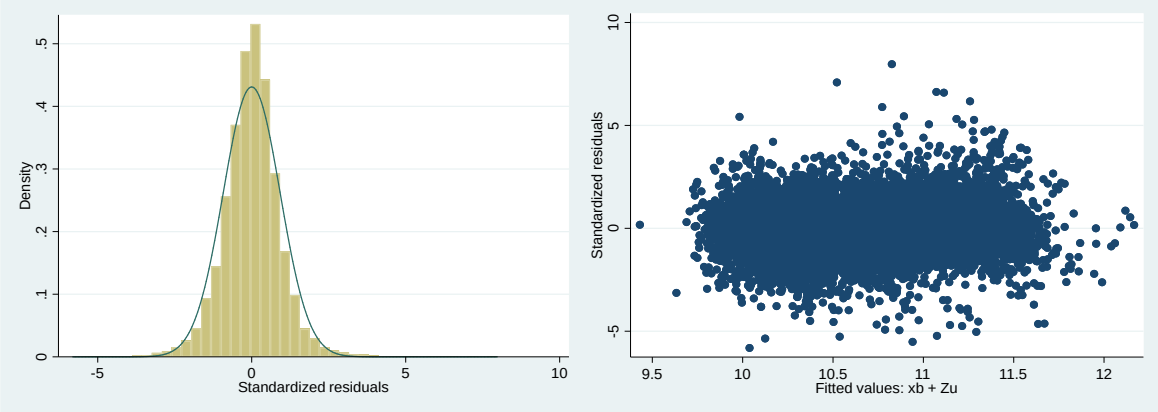


Figure B1: Model (All Degree)

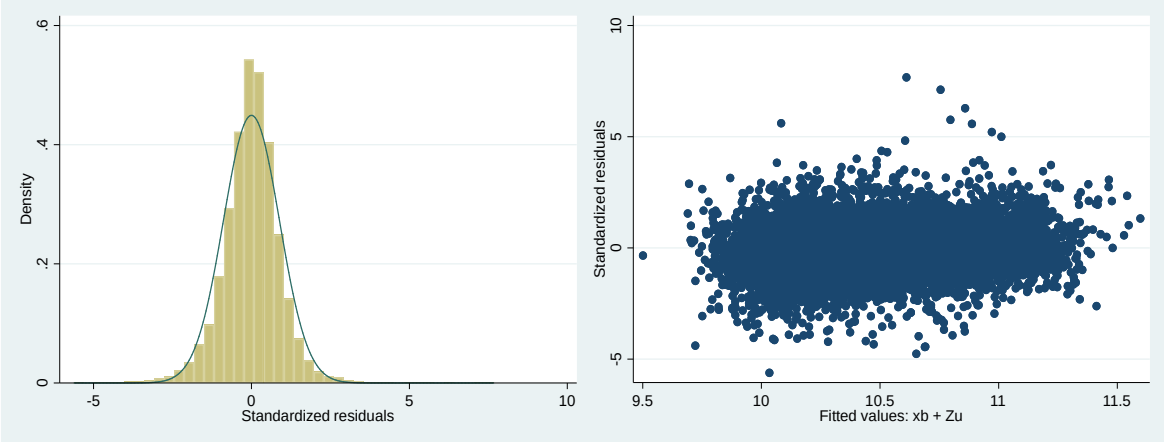


Figure B2: Model1 (Bachelor's Degree)

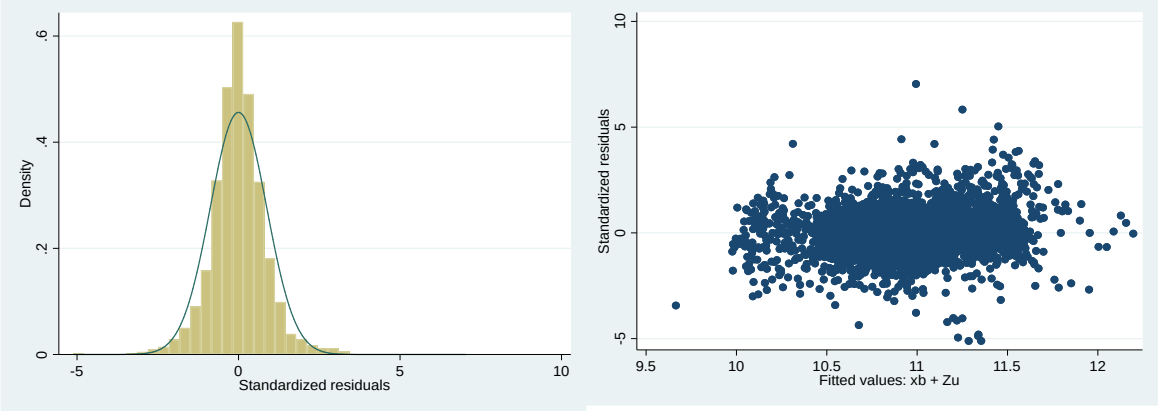
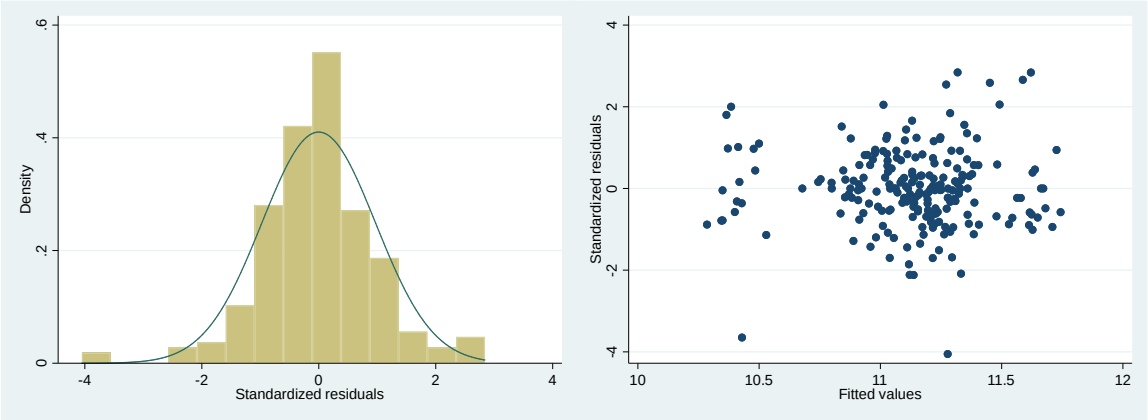


Figure B3: Model2 (Master's Degree)



1

Figure B4: Model3 (Doctoral Degree)

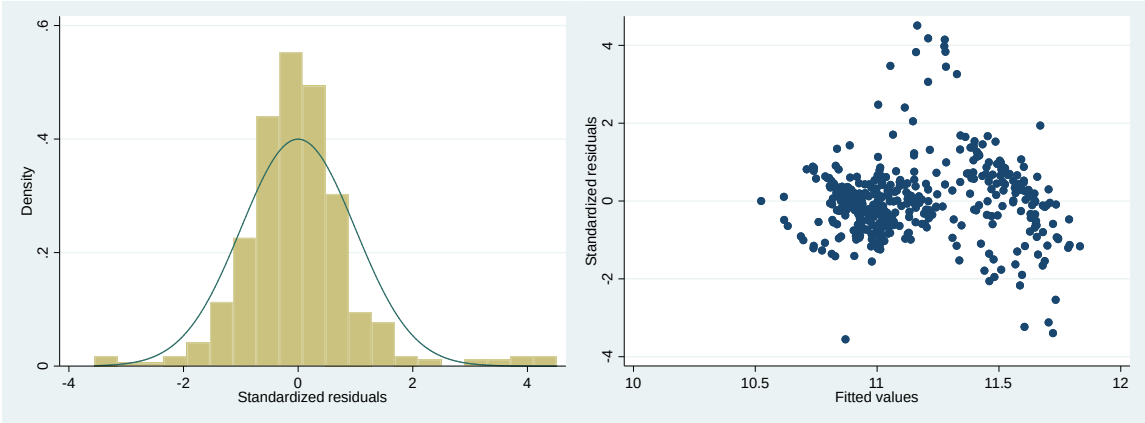


Figure B5: Mode4 (Professional Degree)

Appendix C

Estimates of Models with Different Sets of Control Variables

Table C1:

Estimates of Model1O (Bachelor's Degree Level) with Different Sets of Control Variables

Variable	Model1OA	Model1OB	Model1OC	Model1OD	Model1OE	Model1OF	Model1OG	Model1O
Employment rate	0.61***	0.61***	0.63***	0.64***	0.64***	0.66***	0.63***	0.63***
Private non-profit institution		0.02**	0.00	-0.01	0.00	0.01	0.01	0.01
Natural log of net tuition revenue per full-time student			0.05***	0.05***	0.04***	0.04***	0.02**	0.02**
Natural log of instructional expenditures per full-time student			0.01	0.00	-0.01	0.01	0.03**	0.03**
Natural log of average faculty monthly salary			0.25***	0.24***	0.20***	0.20***	0.17***	0.17***
Admission rate				-0.07***	-0.10***	-0.10***	-0.11***	-0.11***
Percent of Black students					-0.16***	-0.16***	-0.04*	-0.04
Percent of Hispanic students					-0.07**	-0.09***	-0.02	-0.02
Percent of Asian students					0.19**	0.13*	0.29***	0.29***
Percent of Female students					-0.09**	-0.14***	-0.14***	-0.14***
Percent of part-time status						0.28***	0.38***	0.39***
Percent of first-generation Students							0.17**	0.18**
Natural log of students' median family income							0.13***	0.13***
Four-year completion rate								0.01
Standard Deviation of Random Intercepts								
Institution	0.12	0.12	0.08	0.08	0.08	0.07	0.07	0.07
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Department	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Major	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Model Fitness								
Likelihood ratio test χ^2	5007.56	4738.21	2771.26	2699.13	2420.49	2262.03	2024.24	2021.68
Likelihood ratio test $p-$value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AIC	-15533.33	-15539.25	-16097.26	-16111.28	-16207.23	-16301.10	-16382.31	-16380.38
BIC	-13399.19	-13397.4	-13932.29	-13938.62	-14003.74	-14089.92	-14155.71	-14146.08

Notes: ***Significant at .001 level; **Significant at .01 level; *Significant at .05 level.

Table C2:

Estimates of Model2O (Master's Degree Level) with Different Sets of Control Variables

Variable	Model2OA	Model2OB	Model2OC	Model2OD	Model2OE	Model2OF	Model2OG	Model2O
Employment rate	0.76***	0.76***	0.77***	0.78***	0.82***	0.83***	0.80***	0.80***
Private non-profit institution		0.02*	0.06***	0.05***	0.04**	0.04**	0.04***	0.04***
Natural log of net tuition revenue per full-time student			-0.03*	-0.02	-0.01	0	-0.01	-0.01
Natural log of instructional expenditures per full-time student			0.02	0.01	0.01	0.01	0.02*	0.02*
Natural log of average faculty monthly salary			0.29***	0.28***	0.18***	0.18***	0.17***	0.18***
Admission rate				-0.05*	-0.03	-0.03	-0.04	-0.04
Percent of Black students					-0.07**	-0.07**	-0.01	-0.02
Percent of Hispanic students					0.12***	0.11***	0.13***	0.13***
Percent of Asian students					0.47***	0.46***	0.50***	0.50***
Percent of Female students					0.00	-0.01	-0.01	-0.01
Percent of part-time status						0.08*	0.12***	0.12**
Percent of first-generation Students							0.17*	0.16*
Natural log of students' median family income							0.07***	0.07***
Four-year completion rate								-0.02
Standard Deviation of Random Intercepts								
Institution	0.09	0.09	0.05	0.05	0.04	0.04	0.04	0.04
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Department	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Major	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Model Fitness								
Likelihood ratio test χ^2	856.31	810.43	417.20	401.28	303.58	307.01	299.04	299.14
Likelihood ratio test $p-$value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AIC	-3312.01	-3314.69	-3665.80	-3670.27	-3774.51	-3777.69	-3790.85	-3789.33
BIC	-1942.44	-1938.53	-2269.89	-2267.78	-2345.68	-2342.27	-2342.27	-2334.16

Notes: ***Significant at .001 level; **Significant at .01 level; *Significant at .05 level.

Table C3:

Estimates of Model3O (Doctoral Degree Level) with Different Sets of Control Variables

Variable	Model3OA	Model3OB	Model3OC	Model3OD	Model3OE	Model3OF	Model3OG	Model3O
Employment rate	0.25	0.32	0.33	0.32	0.2	0.2	0.27	0.31
Private non-profit institution		0.08**	0.06	0.07	0.1	0.1	0.10*	0.11*
Natural log of net tuition revenue per full-time student			0.05	0.04	0.02	0.02	0	0.01
Natural log of instructional expenditures per full-time student			-0.01	0	-0.01	-0.01	0	0
Natural log of average faculty monthly salary			0.1	0.11	0.08	0.08	0.1	0.13
Admission rate				0.03	0.08	0.08	0.01	-0.03
Percent of Black students					-0.07	-0.07	0.09	0.04
Percent of Hispanic students					-0.09	-0.09	-0.11	-0.13
Percent of Asian students					0.42	0.42	0.4	0.4
Percent of Female students					-0.13	-0.12	-0.14	-0.05
Percent of part-time status						-0.02	0.02	-0.04
Percent of first-generation Students							0.64	0.57
Natural log of students' median family income							0.19	0.20*
Four-year completion rate								-0.18
Model Fitness								
R^2	0.74	0.76	0.77	0.77	0.77	0.77	0.78	0.78
Adjusted R^2	0.69	0.71	0.71	0.71	0.71	0.71	0.71	0.71
AIC	-85.91	-94.43	-96.63	-94.72	-91.21	-89.23	-90.14	-89.93
BIC	35.77	30.63	38.57	43.86	60.88	66.25	72.09	75.69

Notes: ***Significant at .001 level; **Significant at .01 level; *Significant at .05 level.

Table C4:

Estimates of Model4R (Professional Degree Level) with Different Sets of Control Variables

Variable	Model4RA	Model4RB	Model4RC	Model4RD	Model4RE	Model4RF	Model4RG	Model4R
Employment rate	2.93***	3.07***	2.21***	2.21***	2.48***	2.52***	2.47***	2.50***
Private non-profit institution		0.04	0	0	-0.01	-0.01	-0.02	-0.02
Natural log of net tuition revenue per full-time student			0	0	-0.01	0	0.01	0.01
Natural log of instructional expenditures per full-time student			0.03	0.02	0.03	0.03	0.02	0.02
Natural log of average faculty monthly salary			0.36***	0.35**	0.35**	0.36**	0.35**	0.34**
Admission rate				-0.01	-0.02	-0.02	-0.01	0.01
Percent of Black students					-0.1	-0.1	-0.13	-0.11
Percent of Hispanic students					0.1	0.07	0.11	0.1
Percent of Asian students					0.02	0.04	0.06	0.07
Percent of Female students					0.39**	0.36*	0.37*	0.33*
Percent of part-time status						0.16	0.14	0.18
Percent of first-generation Students							-0.3	-0.27
Natural log of students' median family income							-0.06	-0.06
Four-year completion rate								0.06
Model Fitness								
R^2	0.62	0.62	0.68	0.68	0.68	0.69	0.69	0.69
AIC	-64.06	-65.34	-127.74	-125.78	-125.09	-124.07	-121.26	-119.62
BIC	-19.67	-16.92	-67.21	-61.21	-44.38	-39.33	-28.44	-22.77

Notes: ***Significant at .001 level; **Significant at .01 level; *Significant at .05 level.

Appendix D

Formulas to Calculate Variable Impacts in Percentages

Based on the type and scale of both the outcome variable and the predictors, three different exponential transformations were used to convert the model estimates listed in Table 6 to variable impacts shown in Table 7. The most basic transformation, $(e^{x} - 1) \cdot 100\%$, was applied to all categorical predictors and random intercepts; a modified transformation, $(e^{.01x} - 1) \cdot 100\%$, was applied to all rates related predictors with values between 0 and 1; a slightly more complicated transformation, $[(1.01)^{x} - 1] \cdot 100\%$, was applied to predictors that were measured in a natural log scale. The derivations of the transformation formulas are explained as follows.

Calculating Impacts of Categorical Predictors and Random Intercepts

Let c_1 and c_2 be two different categories of a predictor, then the natural log transformed model outcomes at c_1 and c_2, can be written as $\ln\big(Y(c_1)\big)$ and $\ln\big(Y(c_2)\big)$. Thus, the equation below can be used to describe the difference of the model outcomes from c_1 to c_2, which is the effect of the predictor, x.

$$\ln\big(Y(c_2)\big) - \ln\big(Y(c_1)\big) = \ln\left(\frac{Y(c_2)}{Y(c_1)}\right) = x$$

The impact of the variable, x, in the original scale can therefore be calculated by exponentiating the above equation.

$$\left(\frac{Y(c_2)}{Y(c_1)}\right) = e^{x}$$

This equation is equivalent to:

$$\frac{Y(c_2) - Y(c_1)}{Y(c_1)} = e^x - 1 = (e^x - 1) \cdot 100\%$$

Therefore, if the effect of master's degree is .34 in the log scale, the impact of the variable would be 40.49% in the original scale, since $(e^{.34} - 1) = (1.4049 - 1) = .4049$. This means that on average, the starting earnings of majors at the master's degree level is 40.49% higher than the starting earnings of majors at the bachelor's degree level.

The same transformation formula can also be used to calculate the impact of a random intercept, which represents the percent change in the random intercept with respect to one standard deviation of change in its distribution. For instance, the random effect of institution at the bachelor's degree level is .07, moving up one standard deviation in the distribution of institutions would yield a 7.25% higher starting earning at the program level, since $(e^{.07} - 1) = (1.0725 - 1) = .0725$.

Calculating Impacts of Rates Related Predictors

Let r_1 and r_2 be two different rates of a predictor measured between 0 and 1, then the natural log transformed model outcomes at r_1 and r_2 can be written as $\ln\big(Y(r_1)\big)$ and $\ln\big(Y(r_2)\big)$. The effect of the predictor, x, can therefore be expressed by the difference quotient below.

$$\frac{\ln(Y(r_2)) - \ln(Y(r_1))}{r_2 - r_1} = x$$

If consider $r_2 - r_1 = .01$, that is a 1% difference between r_1 and r_2, the associated percent change in the original scale of the outcome can then be calculated using the steps below.

$$\ln(Y(r_2)) - \ln(Y(r_1)) = .01x$$

$$\ln\frac{Y(r_2)}{Y(r_1)} = .01x$$

$$\frac{Y(r_2)}{Y(r_1)} = e^{.01x}$$

$$\frac{Y(r_2) - Y(r_1)}{Y(r_1)} = e^{.01x} - 1 = (e^{.01x} - 1) \cdot 100\%$$

For example, if the estimated effect of major-specific employment rate at the professional degree level is 2.50, professional degree programs with a 1% higher employment rate would have a 2.53% higher median starting earning, since $(e^{.01 \cdot 2.50} - 1) = (1.0253 - 1) = .0253$.

Calculating Impacts of Natural Log Transformed Predictors

Just like the outcome variable, which was transformed by natural log to reduce skewness in the data, predictors measured in dollar amounts had undergone the same treatment. To convert the effects of these predictors to impacts in percentage terms required a slightly different process.

Let $\ln(d_1)$ and $\ln(d_2)$, be two different dollar amounts in the natural log scale associated with a predictor, such as the natural log of faculty monthly salaries. Then the model outcomes at d_1 and d_2, which are also measured in log scale, can be written as $\ln\big(Y(\ln(d_1))\big)$ and $\ln\big(Y(\ln(d_2))\big)$. Therefore, the effect of the predictor, x, which represents the change in the log transformed outputs respect to the change in the log transformed inputs, can be written in the form below.

$$\frac{\ln(Y(\ln(d_2))) - \ln(Y(\ln(d_1)))}{\ln(d_2) - \ln(d_1)} = x$$

Using rules of logarithms, this equation can be reformulated as follows.

$$\ln(Y(\ln(d_2))) - \ln(Y(\ln(d_1))) = x \cdot \ (\ln(d_2) - \ln(d_1))$$

$$\ln\left(\frac{Y(\ln(d_2))}{Y(\ln(d_1))}\right) = x \cdot \ln\left(\frac{d_2}{d_1}\right)$$

$$\ln\left(\frac{Y(\ln(d_2))}{Y(\ln(d_1))}\right) = \ln\left(\frac{d_2}{d_1}\right)^x$$

$$\frac{Y(\ln(d_2))}{Y(\ln(d_1))} = \left(\frac{d_2}{d_1}\right)^x$$

$$\frac{Y(\ln(d_2)) - Y(\ln(d_1))}{Y(\ln(d_1))} = \left(\frac{d_2}{d_1}\right)^x - 1 = \left[\left(\frac{d_2}{d_1}\right)^x - 1\right] \cdot 100\%$$

This formula reveals that the percent change of the outcome in the original scale from d_1 to d_2 is related to the ratio of d_1 and d_2. Suppose d_2 is 1% higher than d_1, the impact of the predictor is then $[(1.01)^x - 1] \cdot 100\%$. In the example where d represents faculty monthly salary, and the effect of the variable is $.34$ at the professional degree level, the impact of the variable is therefore .34%, since $(1.01)^{.34} - 1 = 1.0034 - 1 = .0034$. Thus institutions with a 1% higher faculty monthly salary is linked to a .34% higher starting earning at the program level.

Appendix E

Ranked Median Starting Earnings by Major and Degree Level

Table E1

Predicted Median Starting Earnings of Bachelor's Degree Programs by Four-Digit CIP Code (Based on Model1O)

Rank	2-Digit CIP Code	Department/Field Description	4-Digit CIP Code	Major Description	Margin	Std. Err.	z	P>z	Median Starting Earning in USD
1	51	Health Professions and Related Clinical Sciences	5139	Practical Nursing, Vocational Nursing and Nursing Assistants.	11.52	0.14	82.85	0.00	**100354.08**
2	26	Biological and Biomedical Sciences	2611	Biomathematics, Bioinformatics, and Computational Biology.	11.14	0.13	84.97	0.00	**68598.09**
3	49	Transportation and Materials Moving	4903	Marine Transportation.	11.12	0.07	165.24	0.00	**67434.36**
4	14	Engineering	1422	Naval Architecture and Marine Engineering.	11.09	0.06	182.74	0.00	**65465.59**
5	14	Engineering	1421	Mining and Mineral Engineering.	11.09	0.05	211.37	0.00	**65383.81**
6	14	Engineering	1409	Computer Engineering.	11.07	0.01	777.59	0.00	**64340.21**
7	14	Engineering	1427	Systems Engineering.	11.07	0.06	190.12	0.00	**64076.95**
8	14	Engineering	1410	Electrical, Electronics and Communications Engineering.	11.06	0.01	1059.43	0.00	**63573.37**
9	51	Health Professions and Related Clinical Sciences	5138	Registered Nursing, Nursing Administration, Nursing Research and Clinical Nursing.	11.05	0.01	1730.39	0.00	**63054.20**
10	14	Engineering	1425	Petroleum Engineering.	11.05	0.03	350.52	0.00	**62900.54**
11	14	Engineering	1420	Metallurgical Engineering.	11.04	0.09	122.76	0.00	**62433.67**
12	11	Computer and Information Sciences and Support Services	1107	Computer Science.	11.04	0.01	1057.32	0.00	**62224.87**
13	14	Engineering	1437	Operations Research.	11.02	0.08	144.00	0.00	**61343.84**
14	14	Engineering	1412	Engineering Physics.	11.02	0.07	149.25	0.00	**60851.39**
15	15	Engineering Technologies/Technicians	1510	Construction Engineering Technologies.	11.01	0.03	419.31	0.00	**60753.50**
16	14	Engineering	1433	Construction Engineering.	11.00	0.06	189.25	0.00	**60034.22**
17	14	Engineering	1435	Industrial Engineering.	11.00	0.02	605.86	0.00	**59633.33**
18	52	Business, Management, Marketing, and Related Support Services	5220	Construction Management.	10.99	0.02	517.06	0.00	**59464.81**
19	15	Engineering Technologies/Technicians	1509	Mining and Petroleum Technologies/Technicians.	10.99	0.15	75.08	0.00	**59449.95**
20	15	Engineering Technologies/Technicians	1504	Electromechanical Instrumentation and Maintenance Technologies/Technicians.	10.99	0.08	136.42	0.00	**59256.46**
21	14	Engineering	1419	Mechanical Engineering.	10.98	0.01	1195.01	0.00	**58811.34**
22	14	Engineering	1436	Manufacturing Engineering.	10.97	0.06	198.51	0.00	**58321.73**
23	14	Engineering	1411	Engineering Mechanics.	10.97	0.13	86.67	0.00	**58082.52**
24	14	Engineering	1401	Engineering, General.	10.96	0.02	448.21	0.00	**57436.77**
25	14	Engineering	1407	Chemical Engineering.	10.96	0.01	892.47	0.00	**57383.95**
26	14	Engineering	1432	Polymer/Plastics Engineering.	10.95	0.13	87.40	0.00	**57229.80**
27	14	Engineering	1404	Architectural Engineering.	10.95	0.04	280.04	0.00	**56715.34**

28	14	Engineering	1402	Aerospace, Aeronautical and Astronautical Engineering.	10.94	0.02	577.81	0.00	**56636.56**
29	15	Engineering Technologies/Technicians	1503	Electrical Engineering Technologies/Technicians.	10.94	0.03	369.95	0.00	**56628.63**
30	47	Mechanic and Repair Technologies/Technicians	4703	Heavy/Industrial Equipment Maintenance Technologies.	10.94	0.14	76.04	0.00	**56612.21**
31	15	Engineering Technologies/Technicians	1507	Quality Control and Safety Technologies/Technicians.	10.94	0.04	289.79	0.00	**56413.29**
32	14	Engineering	1499	Engineering, Other.	10.94	0.04	271.40	0.00	**56226.87**
33	14	Engineering	1443	Biochemical Engineering.	10.93	0.13	85.59	0.00	**55882.69**
34	14	Engineering	1441	Electromechanical Engineering.	10.93	0.13	83.06	0.00	**55615.65**
35	15	Engineering Technologies/Technicians	1501	Architectural Engineering Technologies/Technicians.	10.92	0.06	176.19	0.00	**55329.97**
36	14	Engineering	1418	Materials Engineering	10.92	0.03	382.92	0.00	**55271.35**
37	14	Engineering	1408	Civil Engineering.	10.92	0.01	1016.20	0.00	**55264.17**
38	11	Computer and Information Sciences and Support Services	1101	Computer and Information Sciences, General.	10.92	0.01	1166.39	0.00	**55071.63**
39	15	Engineering Technologies/Technicians	1515	Engineering-Related Fields.	10.92	0.04	298.53	0.00	**55045.75**
40	15	Engineering Technologies/Technicians	1508	Mechanical Engineering Related Technologies/Technicians.	10.91	0.02	468.93	0.00	**54644.84**
41	15	Engineering Technologies/Technicians	1500	Engineering Technology, General.	10.91	0.03	370.75	0.00	**54578.21**
42	15	Engineering Technologies/Technicians	1502	Civil Engineering Technologies/Technicians.	10.90	0.05	236.99	0.00	**54345.11**
43	14	Engineering	1423	Nuclear Engineering.	10.89	0.05	241.01	0.00	**53818.90**
44	46	Construction Trades	4604	Building/Construction Finishing, Management, and Inspection.	10.89	0.08	131.59	0.00	**53692.57**
45	15	Engineering Technologies/Technicians	1599	Engineering Technologies/Technicians, Other.	10.89	0.06	186.08	0.00	**53409.83**
46	14	Engineering	1424	Ocean Engineering.	10.88	0.13	86.23	0.00	**53361.78**
47	11	Computer and Information Sciences and Support Services	1105	Computer Systems Analysis.	10.88	0.06	192.87	0.00	**53091.39**
48	51	Health Professions and Related Clinical Sciences	5106	Dental Support Services and Allied Professions.	10.88	0.02	490.84	0.00	**53021.35**
49	30	Multi/Interdisciplinary Studies	3008	Mathematics and Computer Science.	10.87	0.10	107.09	0.00	**52722.10**
50	51	Health Professions and Related Clinical Sciences	5110	Clinical/Medical Laboratory Science/Research and Allied Professions.	10.87	0.02	551.16	0.00	**52652.03**
51	14	Engineering	1413	Engineering Science.	10.86	0.06	193.28	0.00	**51996.93**
52	15	Engineering Technologies/Technicians	1506	Industrial Production Technologies/Technicians.	10.85	0.03	431.38	0.00	**51688.99**
53	11	Computer and Information Sciences and Support Services	1109	Computer Systems Networking and Telecommunications.	10.85	0.04	280.48	0.00	**51503.24**
54	52	Business, Management, Marketing, and Related Support Services	5217	Insurance.	10.84	0.04	302.04	0.00	**51197.71**
55	11	Computer and Information Sciences and Support Services	1199	Computer and Information Sciences and Support Services, Other.	10.84	0.08	131.16	0.00	**50958.66**
56	11	Computer and Information Sciences and Support Services	1102	Computer Programming.	10.84	0.07	153.79	0.00	**50918.42**
57	14	Engineering	1405	Biomedical/Medical Engineering.	10.83	0.02	630.65	0.00	**50675.61**
58	52	Business, Management, Marketing, and Related Support Services	5212	Management Information Systems and Services.	10.83	0.01	805.34	0.00	**50558.68**
59	14	Engineering	1439	Geological/Geophysical Engineering.	10.83	0.09	120.31	0.00	**50412.78**
60	14	Engineering	1403	Agricultural Engineering.	10.83	0.03	323.36	0.00	**50288.41**
61	15	Engineering Technologies/Technicians	1512	Computer Engineering Technologies/Technicians.	10.82	0.05	205.95	0.00	**50081.15**
62	11	Computer and Information Sciences and Support Services	1104	Information Science/Studies.	10.82	0.02	589.47	0.00	**49987.59**
63	40	Physical Sciences	4010	Materials Sciences.	10.82	0.08	136.92	0.00	**49816.42**
64	11	Computer and Information Sciences and Support Services	1110	Computer/Information Technology Administration and Management.	10.82	0.03	354.30	0.00	**49806.46**

65	47	Mechanic and Repair Technologies/Technicians	4706	Vehicle Maintenance and Repair Technologies.	10.80	0.07	163.47	0.00	**49255.19**
66	51	Health Professions and Related Clinical Sciences	5109	Allied Health Diagnostic, Intervention, and Treatment Professions.	10.80	0.01	726.97	0.00	**48791.43**
67	52	Business, Management, Marketing, and Related Support Services	5213	Management Sciences and Quantitative Methods.	10.77	0.02	646.72	0.00	**47378.79**
68	15	Engineering Technologies/Technicians	1513	Drafting/Design Engineering Technologies/Technicians.	10.76	0.07	157.10	0.00	**47140.60**
69	27	Mathematics and Statistics	2705	Statistics.	10.76	0.03	353.30	0.00	**46967.92**
70	52	Business, Management, Marketing, and Related Support Services	5203	Accounting and Related Services.	10.76	0.01	1545.23	0.00	**46891.89**
71	14	Engineering	1414	Environmental/Environmental Health Engineering.	10.74	0.03	391.41	0.00	**46373.80**
72	52	Business, Management, Marketing, and Related Support Services	5208	Finance and Financial Management Services.	10.74	0.01	1293.98	0.00	**46224.72**
73	1	Agriculture, Agriculture Operations, and Related Sciences	104	Agricultural and Food Products Processing.	10.74	0.09	115.88	0.00	**46077.96**
74	14	Engineering	1434	Forest Engineering.	10.73	0.13	83.98	0.00	**45703.04**
75	1	Agriculture, Agriculture Operations, and Related Sciences	199	Agriculture, Agriculture Operations, and Related Sciences, Other.	10.73	0.08	131.78	0.00	**45596.67**
76	27	Mathematics and Statistics	2703	Applied Mathematics.	10.71	0.03	346.88	0.00	**45006.85**
77	41	Science Technologies/Technicians	4199	Science Technologies/Technicians, Other.	10.70	0.07	148.86	0.00	**44321.27**
78	27	Mathematics and Statistics	2799	Mathematics and Statistics, Other.	10.70	0.08	131.90	0.00	**44275.64**
79	4	Architecture and Related Services	409	Architectural Sciences and Technology.	10.69	0.06	168.90	0.00	**43745.32**
80	52	Business, Management, Marketing, and Related Support Services	5215	Real Estate.	10.68	0.04	275.57	0.00	**43672.33**
81	1	Agriculture, Agriculture Operations, and Related Sciences	102	Agricultural Mechanization.	10.68	0.08	140.84	0.00	**43648.32**
82	15	Engineering Technologies/Technicians	1505	Environmental Control Technologies/Technicians.	10.68	0.07	153.20	0.00	**43584.20**
83	52	Business, Management, Marketing, and Related Support Services	5206	Business/Managerial Economics.	10.68	0.02	588.58	0.00	**43445.39**
84	14	Engineering	1445	Biological/Biosystems Engineering.	10.67	0.07	143.59	0.00	**42943.48**
85	45	Social Sciences	4506	Economics.	10.66	0.01	1185.86	0.00	**42503.00**
86	52	Business, Management, Marketing, and Related Support Services	5218	General Sales, Merchandising and Related Marketing Operations.	10.65	0.03	332.92	0.00	**42307.51**
87	30	Multi/Interdisciplinary Studies	3015	Science, Technology and Society.	10.65	0.05	197.65	0.00	**42102.82**
88	4	Architecture and Related Services	406	Landscape Architecture.	10.64	0.04	303.86	0.00	**41766.51**
89	43	Security and Protective Services	4302	Fire Protection.	10.64	0.06	172.33	0.00	**41642.23**
90	52	Business, Management, Marketing, and Related Support Services	5299	Business, Management, Marketing, and Related Support Services, Other.	10.63	0.03	357.36	0.00	**41236.13**
91	19	Family and Consumer Sciences/Human Sciences	1906	Housing and Human Environments.	10.63	0.06	191.53	0.00	**41201.09**
92	27	Mathematics and Statistics	2701	Mathematics.	10.63	0.01	943.59	0.00	**41190.79**
93	4	Architecture and Related Services	402	Architecture.	10.62	0.02	598.03	0.00	**40978.38**
94	52	Business, Management, Marketing, and Related Support Services	5202	Business Administration, Management and Operations.	10.62	0.01	1877.35	0.00	**40925.15**
95	13	Education	1303	Curriculum and Instruction.	10.62	0.14	76.67	0.00	**40851.96**
96	52	Business, Management, Marketing, and Related Support Services	5201	Business/Commerce, General.	10.62	0.01	898.06	0.00	**40793.58**
97	52	Business, Management, Marketing, and Related Support Services	5210	Human Resources Management and Services.	10.62	0.01	779.51	0.00	**40781.34**
98	52	Business, Management, Marketing, and Related Support Services	5204	Business Operations Support and Assistant Services.	10.62	0.09	115.48	0.00	**40778.08**

99	4	Architecture and Related Services	404	Environmental Design.	10.61	0.10	104.46	0.00	**40631.54**
100	52	Business, Management, Marketing, and Related Support Services	5211	International Business.	10.61	0.02	625.16	0.00	**40470.15**
101	30	Multi/Interdisciplinary Studies	3006	Systems Science and Theory.	10.60	0.08	128.80	0.00	**40121.60**
102	1	Agriculture, Agriculture Operations, and Related Sciences	101	Agricultural Business and Management.	10.59	0.02	552.21	0.00	**39907.52**
103	49	Transportation and Materials Moving	4901	Air Transportation.	10.59	0.03	383.76	0.00	**39899.14**
104	44	Public Administration and Social Service Professions	4499	Public Administration and Social Service Professions, Other.	10.59	0.08	132.30	0.00	**39745.03**
105	51	Health Professions and Related Clinical Sciences	5107	Health and Medical Administrative Services.	10.58	0.01	724.32	0.00	**39260.73**
106	52	Business, Management, Marketing, and Related Support Services	5214	Marketing.	10.58	0.01	1349.27	0.00	**39151.34**
107	43	Security and Protective Services	4303	Homeland Security.	10.57	0.04	249.38	0.00	**38982.57**
108	14	Engineering	1428	Textile Sciences and Engineering.	10.57	0.13	82.77	0.00	**38958.41**
109	11	Computer and Information Sciences and Support Services	1103	Data Processing.	10.57	0.14	76.38	0.00	**38880.18**
110	1	Agriculture, Agriculture Operations, and Related Sciences	112	Soil Sciences.	10.56	0.06	175.73	0.00	**38656.11**
111	1	Agriculture, Agriculture Operations, and Related Sciences	110	Food Science and Technology.	10.56	0.03	329.84	0.00	**38577.71**
112	39	Theology and Religious Vocations	3999	Theology and Religious Vocations, Other.	10.54	0.15	68.07	0.00	**37651.95**
113	43	Security and Protective Services	4399	Homeland Security, Law Enforcement, Firefighting and Related Protective Services, Other.	10.52	0.06	165.75	0.00	**36938.14**
114	13	Education	1310	Special Education and Teaching.	10.52	0.01	825.31	0.00	**36916.73**
115	26	Biological and Biomedical Sciences	2612	Biotechnology.	10.51	0.06	174.29	0.00	**36795.84**
116	44	Public Administration and Social Service Professions	4404	Public Administration.	10.51	0.03	405.06	0.00	**36736.64**
117	4	Architecture and Related Services	405	Interior Architecture.	10.51	0.06	167.15	0.00	**36611.22**
118	29	Military Technologies	2902	Intelligence, Command Control and Information Operations.	10.51	0.10	101.59	0.00	**36601.34**
119	52	Business, Management, Marketing, and Related Support Services	5207	Entrepreneurial and Small Business Operations.	10.49	0.02	471.37	0.00	**36022.54**
120	22	Legal Professions and Studies	2203	Legal Support Services.	10.49	0.04	260.10	0.00	**35845.38**
121	44	Public Administration and Social Service Professions	4405	Public Policy Analysis.	10.47	0.04	271.37	0.00	**35414.27**
122	44	Public Administration and Social Service Professions	4402	Community Organization and Advocacy.	10.47	0.05	190.67	0.00	**35312.42**
123	52	Business, Management, Marketing, and Related Support Services	5205	Business/Corporate Communications.	10.47	0.04	250.86	0.00	**35276.07**
124	3	Natural Resources and Conservation	305	Forestry.	10.47	0.03	318.68	0.00	**35244.68**
125	13	Education	1313	Teacher Education and Professional Development, Specific Subject Areas.	10.47	0.01	1156.80	0.00	**35102.23**
126	12	Personal and Culinary Services	1203	Funeral Service and Mortuary Science.	10.47	0.08	126.33	0.00	**35101.53**
127	13	Education	1312	Teacher Education and Professional Development, Specific Levels and Methods.	10.46	0.01	1495.76	0.00	**34985.19**
128	22	Legal Professions and Studies	2299	Legal Professions and Studies, Other.	10.46	0.06	161.52	0.00	**34962.80**
129	11	Computer and Information Sciences and Support Services	1108	Computer Software and Media Applications.	10.46	0.04	294.37	0.00	**34790.16**
130	19	Family and Consumer Sciences/Human Sciences	1902	Family and Consumer Sciences/Human Sciences Business Services.	10.46	0.06	173.60	0.00	**34785.99**
131	9	Communication, Journalism, and Related Programs	909	Public Relations, Advertising, and Applied Communication.	10.45	0.01	829.27	0.00	**34470.18**
132	1	Agriculture, Agriculture Operations, and Related Sciences	100	Agriculture, General.	10.45	0.03	362.04	0.00	**34412.67**

133	40	Physical Sciences	4008	Physics.	10.44	0.03	380.46	0.00	**34329.49**
134	52	Business, Management, Marketing, and Related Support Services	5209	Hospitality Administration/Management.	10.44	0.01	802.19	0.00	**34327.43**
135	51	Health Professions and Related Clinical Sciences	5199	Health Professions and Related Clinical Sciences, Other.	10.44	0.02	443.19	0.00	**34263.30**
136	22	Legal Professions and Studies	2200	Non-Professional General Legal Studies (Undergraduate).	10.44	0.04	278.96	0.00	**34178.77**
137	40	Physical Sciences	4005	Chemistry.	10.43	0.01	750.43	0.00	**33962.42**
138	45	Social Sciences	4512	Urban Studies/Affairs.	10.42	0.04	262.78	0.00	**33608.02**
139	19	Family and Consumer Sciences/Human Sciences	1904	Family and Consumer Economics and Related Studies.	10.42	0.04	293.28	0.00	**33548.25**
140	30	Multi/Interdisciplinary Studies	3005	Peace Studies and Conflict Resolution.	10.42	0.07	147.72	0.00	**33366.24**
141	30	Multi/Interdisciplinary Studies	3011	Gerontology.	10.42	0.08	125.40	0.00	**33359.57**
142	52	Business, Management, Marketing, and Related Support Services	5219	Specialized Sales, Merchandising and Marketing Operations.	10.41	0.03	406.10	0.00	**33325.56**
143	43	Security and Protective Services	4301	Criminal Justice and Corrections.	10.41	0.01	1374.24	0.00	**33263.97**
144	1	Agriculture, Agriculture Operations, and Related Sciences	111	Plant Sciences.	10.41	0.03	410.82	0.00	**33176.93**
145	30	Multi/Interdisciplinary Studies	3033	Sustainability Studies.	10.41	0.08	131.41	0.00	**33053.41**
146	30	Multi/Interdisciplinary Studies	3099	Multi/Interdisciplinary Studies, Other.	10.40	0.01	798.46	0.00	**33010.14**
147	13	Education	1307	International and Comparative Education.	10.40	0.15	71.71	0.00	**33000.24**
148	50	Visual and Performing Arts	5004	Design and Applied Arts.	10.40	0.01	988.88	0.00	**32998.59**
149	30	Multi/Interdisciplinary Studies	3018	Natural Sciences.	10.40	0.07	142.08	0.00	**32993.64**
150	40	Physical Sciences	4006	Geological and Earth Sciences/Geosciences.	10.40	0.02	551.71	0.00	**32736.31**
151	1	Agriculture, Agriculture Operations, and Related Sciences	106	Applied Horticulture and Horticultural Business Services.	10.40	0.05	205.18	0.00	**32735.00**
152	40	Physical Sciences	4001	Physical Sciences.	10.39	0.13	77.30	0.00	**32615.08**
153	51	Health Professions and Related Clinical Sciences	5120	Pharmacy, Pharmaceutical Sciences, and Administration.	10.39	0.05	211.36	0.00	**32493.33**
154	22	Legal Professions and Studies	2202	Legal Research and Advanced Professional Studies.	10.39	0.10	101.97	0.00	**32483.25**
155	16	Foreign Languages, Literatures, and Linguistics	1699	Foreign Languages, Literatures, and Linguistics, Other.	10.38	0.08	125.22	0.00	**32293.78**
156	30	Multi/Interdisciplinary Studies	3025	Cognitive Science.	10.38	0.06	183.29	0.00	**32223.46**
157	19	Family and Consumer Sciences/Human Sciences	1909	Apparel and Textiles.	10.38	0.02	426.96	0.00	**32109.91**
158	13	Education	1304	Educational Administration and Supervision.	10.38	0.08	133.03	0.00	**32060.50**
159	4	Architecture and Related Services	403	City/Urban, Community and Regional Planning.	10.37	0.04	248.81	0.00	**32039.99**
160	44	Public Administration and Social Service Professions	4407	Social Work.	10.37	0.01	1118.71	0.00	**32033.58**
161	45	Social Sciences	4510	Political Science and Government.	10.37	0.01	1307.96	0.00	**32029.74**
162	45	Social Sciences	4504	Criminology.	10.37	0.02	629.02	0.00	**32023.01**
163	9	Communication, Journalism, and Related Programs	999	Communication, Journalism, and Related Programs, Other.	10.37	0.03	302.65	0.00	**32015.65**
164	16	Foreign Languages, Literatures, and Linguistics	1605	Germanic Languages, Literatures, and Linguistics.	10.37	0.08	132.28	0.00	**31954.55**
165	51	Health Professions and Related Clinical Sciences	5115	Mental and Social Health Services and Allied Professions.	10.37	0.03	387.76	0.00	**31909.21**
166	45	Social Sciences	4501	Social Sciences, General.	10.37	0.02	515.95	0.00	**31850.87**
167	51	Health Professions and Related Clinical Sciences	5122	Public Health.	10.36	0.01	717.64	0.00	**31595.82**
168	1	Agriculture, Agriculture Operations, and Related Sciences	103	Agricultural Production Operations.	10.35	0.04	236.61	0.00	**31394.25**
169	13	Education	1301	Education, General.	10.35	0.03	360.90	0.00	**31375.42**
170	51	Health Professions and Related Clinical Sciences	5108	Allied Health and Medical Assisting Services.	10.35	0.05	222.68	0.00	**31336.22**
171	30	Multi/Interdisciplinary Studies	3010	Biopsychology.	10.35	0.15	71.01	0.00	**31298.96**
172	45	Social Sciences	4507	Geography and Cartography.	10.35	0.02	621.07	0.00	**31257.67**
173	26	Biological and Biomedical Sciences	2605	Microbiological Sciences and Immunology.	10.35	0.03	382.88	0.00	**31238.29**
174	44	Public Administration and Social Service Professions	4400	Human Services, General.	10.35	0.02	446.03	0.00	**31141.92**

175	9	Communication, Journalism, and Related Programs	901	Communication and Media Studies.	10.34	0.01	1474.89	0.00	**31089.95**
176	45	Social Sciences	4509	International Relations and National Security Studies.	10.34	0.01	701.70	0.00	**30961.20**
177	26	Biological and Biomedical Sciences	2602	Biochemistry, Biophysics and Molecular Biology.	10.34	0.02	593.85	0.00	**30950.36**
178	51	Health Professions and Related Clinical Sciences	5123	Rehabilitation and Therapeutic Professions.	10.34	0.02	439.88	0.00	**30875.24**
179	45	Social Sciences	4599	Social Sciences, Other.	10.34	0.03	385.44	0.00	**30866.60**
180	24	Liberal Arts and Sciences, General Studies and Humanities	2401	Liberal Arts and Sciences, General Studies and Humanities.	10.34	0.01	1151.04	0.00	**30863.21**
181	16	Foreign Languages, Literatures, and Linguistics	1616	American Sign Language.	10.33	0.06	184.22	0.00	**30646.08**
182	39	Theology and Religious Vocations	3902	Bible/Biblical Studies.	10.33	0.03	302.94	0.00	**30503.30**
183	30	Multi/Interdisciplinary Studies	3000	Multi-/Interdisciplinary Studies, General.	10.32	0.03	372.51	0.00	**30483.17**
184	51	Health Professions and Related Clinical Sciences	5100	Health Services/Allied Health/Health Sciences, General.	10.32	0.02	604.27	0.00	**30481.04**
185	3	Natural Resources and Conservation	302	Natural Resources Management and Policy.	10.32	0.03	309.86	0.00	**30464.58**
186	30	Multi/Interdisciplinary Studies	3017	Behavioral Sciences.	10.32	0.06	163.16	0.00	**30395.81**
187	42	Psychology	4228	Clinical, Counseling and Applied Psychology.	10.32	0.03	367.90	0.00	**30349.64**
188	26	Biological and Biomedical Sciences	2610	Pharmacology and Toxicology.	10.32	0.13	81.00	0.00	**30346.30**
189	13	Education	1399	Education, Other.	10.32	0.03	295.66	0.00	**30273.56**
190	39	Theology and Religious Vocations	3905	Religious/Sacred Music.	10.30	0.14	74.47	0.00	**29746.00**
191	26	Biological and Biomedical Sciences	2608	Genetics.	10.30	0.05	192.96	0.00	**29735.00**
192	31	Parks, Recreation, Leisure, and Fitness Studies	3103	Parks, Recreation and Leisure Facilities Management.	10.29	0.02	466.39	0.00	**29550.32**
193	45	Social Sciences	4511	Sociology.	10.29	0.01	1303.14	0.00	**29455.91**
194	40	Physical Sciences	4004	Atmospheric Sciences and Meteorology.	10.28	0.06	182.53	0.00	**29236.70**
195	5	Area, Ethnic, Cultural, and Gender Studies	501	Area Studies.	10.28	0.02	474.09	0.00	**29223.84**
196	19	Family and Consumer Sciences/Human Sciences	1901	Family and Consumer Sciences/Human Sciences, General.	10.28	0.02	474.43	0.00	**29166.32**
197	9	Communication, Journalism, and Related Programs	904	Journalism.	10.28	0.01	868.03	0.00	**29133.97**
198	19	Family and Consumer Sciences/Human Sciences	1905	Foods, Nutrition, and Related Services.	10.28	0.03	411.15	0.00	**29130.18**
199	31	Parks, Recreation, Leisure, and Fitness Studies	3101	Parks, Recreation and Leisure Studies.	10.28	0.02	444.21	0.00	**29074.01**
200	16	Foreign Languages, Literatures, and Linguistics	1609	Romance Languages, Literatures, and Linguistics.	10.28	0.01	852.09	0.00	**29056.86**
201	10	Communications Technologies/Technicians and Support Services	1003	Graphic Communications.	10.27	0.03	378.56	0.00	**28964.32**
202	51	Health Professions and Related Clinical Sciences	5131	Dietetics and Clinical Nutrition Services.	10.27	0.02	492.85	0.00	**28957.37**
203	1	Agriculture, Agriculture Operations, and Related Sciences	108	Agricultural Public Services.	10.27	0.08	134.81	0.00	**28823.03**
204	42	Psychology	4227	Research and Experimental Psychology.	10.27	0.03	388.73	0.00	**28711.13**
205	13	Education	1314	Teaching English or French as a Second or Foreign Language.	10.26	0.08	132.51	0.00	**28565.64**
206	1	Agriculture, Agriculture Operations, and Related Sciences	109	Animal Sciences.	10.26	0.02	578.53	0.00	**28548.79**
207	26	Biological and Biomedical Sciences	2615	Neurobiology and Neurosciences.	10.26	0.02	499.43	0.00	**28506.29**
208	12	Personal and Culinary Services	1205	Culinary Arts and Related Services.	10.26	0.07	137.91	0.00	**28500.59**
209	42	Psychology	4299	Psychology, Other.	10.26	0.08	123.74	0.00	**28456.16**
210	26	Biological and Biomedical Sciences	2604	Cell/Cellular Biology and Anatomical Sciences.	10.26	0.03	362.65	0.00	**28441.37**
211	31	Parks, Recreation, Leisure, and Fitness Studies	3105	Health and Physical Education/Fitness.	10.25	0.01	1310.14	0.00	**28382.84**
212	42	Psychology	4201	Psychology, General.	10.25	0.01	1770.89	0.00	**28335.20**
213	26	Biological and Biomedical Sciences	2699	Biological and Biomedical Sciences, Other.	10.25	0.05	196.92	0.00	**28326.41**
214	10	Communications Technologies/Technicians and Support Services	1001	Communications Technology/Technician.	10.25	0.14	71.06	0.00	**28311.40**
215	30	Multi/Interdisciplinary Studies	3020	International/Global Studies.	10.25	0.02	545.41	0.00	**28278.02**

216	16	Foreign Languages, Literatures, and Linguistics	1604	Slavic, Baltic and Albanian Languages, Literatures, and Linguistics.	10.25	0.10	107.33	0.00	**28275.47**
217	30	Multi/Interdisciplinary Studies	3001	Biological and Physical Sciences.	10.25	0.04	287.83	0.00	**28266.43**
218	54	History	5401	History.	10.25	0.01	1182.48	0.00	**28244.39**
219	30	Multi/Interdisciplinary Studies	3032	Marine Sciences.	10.25	0.15	70.42	0.00	**28210.80**
220	26	Biological and Biomedical Sciences	2601	Biology, General.	10.25	0.01	1595.13	0.00	**28169.07**
221	39	Theology and Religious Vocations	3907	Pastoral Counseling and Specialized Ministries.	10.24	0.04	229.00	0.00	**27989.09**
222	51	Health Professions and Related Clinical Sciences	5111	Health/Medical Preparatory Programs.	10.24	0.03	364.64	0.00	**27960.55**
223	30	Multi/Interdisciplinary Studies	3019	Nutrition Sciences.	10.23	0.03	358.70	0.00	**27853.11**
224	19	Family and Consumer Sciences/Human Sciences	1907	Human Development, Family Studies, and Related Services.	10.23	0.01	695.03	0.00	**27819.71**
225	3	Natural Resources and Conservation	301	Natural Resources Conservation and Research.	10.23	0.01	861.10	0.00	**27813.87**
226	39	Theology and Religious Vocations	3906	Theological and Ministerial Studies.	10.22	0.05	216.00	0.00	**27495.84**
227	10	Communications Technologies/Technicians and Support Services	1099	Communications Technologies/Technicians and Support Services, Other.	10.21	0.08	121.45	0.00	**27291.48**
228	31	Parks, Recreation, Leisure, and Fitness Studies	3199	Parks, Recreation, Leisure, and Fitness Studies, Other.	10.20	0.15	70.19	0.00	**26970.26**
229	38	Philosophy and Religious Studies	3801	Philosophy.	10.20	0.02	434.85	0.00	**26851.58**
230	16	Foreign Languages, Literatures, and Linguistics	1603	East Asian Languages, Literatures, and Linguistics.	10.20	0.03	292.96	0.00	**26773.02**
231	9	Communication, Journalism, and Related Programs	907	Radio, Television, and Digital Communication.	10.19	0.01	706.29	0.00	**26758.84**
232	23	English Language and Literatures/Letters	2301	English Language and Literature, General.	10.19	0.01	1368.90	0.00	**26616.86**
233	51	Health Professions and Related Clinical Sciences	5133	Alternative and Complementary Medicine and Medical Systems.	10.19	0.10	101.07	0.00	**26528.37**
234	39	Theology and Religious Vocations	3904	Religious Education.	10.19	0.05	209.86	0.00	**26504.51**
235	45	Social Sciences	4513	Sociology and Anthropology.	10.18	0.07	148.27	0.00	**26300.94**
236	5	Area, Ethnic, Cultural, and Gender Studies	502	Ethnic, Cultural Minority, Gender, and Group Studies.	10.17	0.02	448.09	0.00	**26097.37**
237	50	Visual and Performing Arts	5010	Arts, Entertainment, and Media Management.	10.17	0.03	339.71	0.00	**26051.48**
238	51	Health Professions and Related Clinical Sciences	5102	Communication Disorders Sciences and Services.	10.16	0.02	585.50	0.00	**25909.63**
239	40	Physical Sciences	4002	Astronomy and Astrophysics.	10.16	0.14	73.57	0.00	**25877.26**
240	3	Natural Resources and Conservation	303	Fishing and Fisheries Sciences and Management.	10.16	0.07	147.89	0.00	**25846.49**
241	23	English Language and Literatures/Letters	2313	Rhetoric and Composition/Writing Studies.	10.16	0.02	626.95	0.00	**25826.85**
242	38	Philosophy and Religious Studies	3802	Religion/Religious Studies.	10.16	0.05	212.86	0.00	**25808.78**
243	30	Multi/Interdisciplinary Studies	3012	Historic Preservation and Conservation.	10.15	0.10	101.19	0.00	**25655.42**
244	51	Health Professions and Related Clinical Sciences	5127	Medical Illustration and Informatics.	10.14	0.14	73.25	0.00	**25368.92**
245	26	Biological and Biomedical Sciences	2609	Physiology, Pathology and Related Sciences.	10.14	0.03	343.78	0.00	**25360.29**
246	16	Foreign Languages, Literatures, and Linguistics	1601	Linguistic, Comparative, and Related Language Studies and Services.	10.14	0.02	524.85	0.00	**25331.91**
247	30	Multi/Interdisciplinary Studies	3027	Human Biology.	10.13	0.06	176.70	0.00	**25160.74**
248	30	Multi/Interdisciplinary Studies	3023	Intercultural/Multicultural and Diversity Studies.	10.13	0.11	95.97	0.00	**25040.00**
249	45	Social Sciences	4514	Rural Sociology.	10.12	0.13	78.02	0.00	**24753.45**
250	1	Agriculture, Agriculture Operations, and Related Sciences	107	International Agriculture.	10.12	0.13	77.64	0.00	**24735.88**
251	3	Natural Resources and Conservation	306	Wildlife and Wildlands Science and Management.	10.10	0.03	370.23	0.00	**24351.77**
252	38	Philosophy and Religious Studies	3899	Philosophy and Religious Studies, Other.	10.09	0.14	70.11	0.00	**24027.64**
253	50	Visual and Performing Arts	5007	Fine and Studio Arts.	10.08	0.01	1196.77	0.00	**23976.03**
254	50	Visual and Performing Arts	5001	Visual and Performing Arts, General.	10.08	0.02	403.77	0.00	**23953.03**
255	45	Social Sciences	4502	Anthropology.	10.08	0.01	803.28	0.00	**23864.80**
256	10	Communications Technologies/Technicians and Support Services	1002	Audiovisual Communications Technologies/Technicians.	10.08	0.04	241.79	0.00	**23818.79**

257	23	English Language and Literatures/Letters	2314	Literature.	10.07	0.06	155.50	0.00	**23530.20**
258	50	Visual and Performing Arts	5009	Music.	10.06	0.01	817.41	0.00	**23406.76**
259	26	Biological and Biomedical Sciences	2613	Ecology, Evolution, Systematics, and Population Biology.	10.04	0.02	454.68	0.00	**22812.87**
260	50	Visual and Performing Arts	5099	Visual and Performing Arts, Other.	10.03	0.08	130.01	0.00	**22615.26**
261	23	English Language and Literatures/Letters	2399	English Language and Literature/Letters, Other.	10.02	0.10	97.81	0.00	**22568.72**
262	50	Visual and Performing Arts	5006	Film/Video and Photographic Arts.	10.02	0.01	725.94	0.00	**22552.70**
263	50	Visual and Performing Arts	5002	Crafts/Craft Design, Folk Art and Artisanry.	10.02	0.08	130.98	0.00	**22389.78**
264	26	Biological and Biomedical Sciences	2607	Zoology/Animal Biology.	10.01	0.02	403.99	0.00	**22341.47**
265	30	Multi/Interdisciplinary Studies	3026	Cultural Studies/Critical Theory and Analysis.	10.01	0.15	65.35	0.00	**22226.04**
266	1	Agriculture, Agriculture Operations, and Related Sciences	105	Agricultural and Domestic Animal Services.	9.99	0.06	171.73	0.00	**21788.12**
267	16	Foreign Languages, Literatures, and Linguistics	1611	Middle/Near Eastern and Semitic Languages, Literatures, and Linguistics.	9.96	0.13	75.56	0.00	**21091.87**
268	45	Social Sciences	4503	Archeology.	9.94	0.13	75.89	0.00	**20839.74**
269	39	Theology and Religious Vocations	3903	Missions/Missionary Studies and Missiology.	9.93	0.14	72.96	0.00	**20555.77**
270	3	Natural Resources and Conservation	399	Natural Resources and Conservation, Other.	9.92	0.10	101.86	0.00	**20416.51**
271	50	Visual and Performing Arts	5005	Drama/Theatre Arts and Stagecraft.	9.90	0.01	899.47	0.00	**19882.93**
272	50	Visual and Performing Arts	5003	Dance.	9.86	0.03	379.94	0.00	**19092.77**
273	40	Physical Sciences	4099	Physical Sciences, Other.	9.82	0.15	67.53	0.00	**18446.54**

Table E2

Predicted Median Starting Earnings of Master's Degree Programs by Four-Digit CIP Code (Based on Model2O)

Rank	2-Digit CIP Code	Department/Field Description	4-Digit CIP Code	Major Description	Margin	Std. Err.	z	P>z	Median Starting Earning in USD
1	51	Health Professions and Related Clinical Sciences	5105	Advanced/Graduate Dentistry and Oral Sciences.	12.06	0.06	198.95	0.00	**172154.91**
2	51	Health Professions and Related Clinical Sciences	5114	Medical Clinical Sciences/Graduate Medical Studies.	12.00	0.15	79.34	0.00	**162350.04**
3	51	Health Professions and Related Clinical Sciences	5108	Allied Health and Medical Assisting Services.	11.76	0.07	172.55	0.00	**128297.88**
4	52	Business, Management, Marketing, and Related Support Services	5219	Specialized Sales, Merchandising and Marketing Operations.	11.69	0.15	77.31	0.00	**119511.75**
5	51	Health Professions and Related Clinical Sciences	5138	Registered Nursing, Nursing Administration, Nursing Research and Clinical Nursing.	11.46	0.01	1143.80	0.00	**95022.60**
6	51	Health Professions and Related Clinical Sciences	5109	Allied Health Diagnostic, Intervention, and Treatment Professions.	11.44	0.02	736.21	0.00	**92971.66**
7	15	Engineering Technologies/Technicians	1505	Environmental Control Technologies/Technicians.	11.44	0.12	96.29	0.00	**92882.45**
8	14	Engineering	1437	Operations Research.	11.41	0.11	107.96	0.00	**89897.01**
9	11	Computer and Information Sciences and Support Services	1107	Computer Science.	11.40	0.04	261.04	0.00	**89666.27**
10	14	Engineering	1427	Systems Engineering.	11.37	0.05	240.54	0.00	**86677.53**
11	30	Multi/Interdisciplinary Studies	3031	Human Computer Interaction.	11.36	0.12	96.05	0.00	**86028.16**
12	14	Engineering	1499	Engineering, Other.	11.35	0.06	192.39	0.00	**84661.82**
13	14	Engineering	1410	Electrical, Electronics and Communications Engineering.	11.35	0.03	405.82	0.00	**84583.12**
14	14	Engineering	1409	Computer Engineering.	11.33	0.06	176.18	0.00	**83191.46**
15	52	Business, Management, Marketing, and Related Support Services	5220	Construction Management.	11.33	0.15	73.51	0.00	**83146.55**
16	14	Engineering	1401	Engineering, General.	11.31	0.04	263.49	0.00	**81462.66**
17	11	Computer and Information Sciences and Support Services	1110	Computer/Information Technology Administration and Management.	11.31	0.06	198.10	0.00	**81387.75**
18	15	Engineering Technologies/Technicians	1515	Engineering-Related Fields.	11.29	0.04	293.77	0.00	**80358.25**
19	11	Computer and Information Sciences and Support Services	1101	Computer and Information Sciences, General.	11.28	0.03	323.46	0.00	**79584.13**
20	51	Health Professions and Related Clinical Sciences	5127	Medical Illustration and Informatics.	11.28	0.07	168.88	0.00	**79172.16**
21	1	Agriculture, Agriculture Operations, and Related Sciences	110	Food Science and Technology.	11.27	0.17	67.75	0.00	**78780.44**
22	14	Engineering	1402	Aerospace, Aeronautical and Astronautical Engineering.	11.27	0.05	208.19	0.00	**78623.03**
23	4	Architecture and Related Services	410	Real Estate Development.	11.26	0.08	142.23	0.00	**77799.48**
24	52	Business, Management, Marketing, and Related Support Services	5213	Management Sciences and Quantitative Methods.	11.26	0.04	308.24	0.00	**77715.50**
25	27	Mathematics and Statistics	2705	Statistics.	11.25	0.07	165.49	0.00	**76921.45**

26	44	Public Administration and Social Service Professions	4499	Public Administration and Social Service Professions, Other.	11.24	0.11	102.95	0.00	**76458.24**
27	51	Health Professions and Related Clinical Sciences	5120	Pharmacy, Pharmaceutical Sciences, and Administration.	11.24	0.07	170.36	0.00	**76181.20**
28	15	Engineering Technologies/Technicians	1507	Quality Control and Safety Technologies/Technicians.	11.24	0.08	134.54	0.00	**76163.68**
29	52	Business, Management, Marketing, and Related Support Services	5212	Management Information Systems and Services.	11.24	0.05	220.10	0.00	**75936.29**
30	11	Computer and Information Sciences and Support Services	1105	Computer Systems Analysis.	11.22	0.08	136.53	0.00	**74473.60**
31	11	Computer and Information Sciences and Support Services	1199	Computer and Information Sciences and Support Services, Other.	11.21	0.11	99.83	0.00	**74054.01**
32	52	Business, Management, Marketing, and Related Support Services	5217	Insurance.	11.20	0.11	100.36	0.00	**72977.03**
33	14	Engineering	1435	Industrial Engineering.	11.19	0.06	174.55	0.00	**72262.46**
34	11	Computer and Information Sciences and Support Services	1104	Information Science/Studies.	11.19	0.03	390.09	0.00	**72164.97**
35	52	Business, Management, Marketing, and Related Support Services	5201	Business/Commerce, General.	11.19	0.02	521.88	0.00	**72148.37**
36	11	Computer and Information Sciences and Support Services	1108	Computer Software and Media Applications.	11.19	0.07	157.31	0.00	**72143.32**
37	14	Engineering	1419	Mechanical Engineering.	11.18	0.03	444.50	0.00	**71979.74**
38	11	Computer and Information Sciences and Support Services	1109	Computer Systems Networking and Telecommunications.	11.18	0.17	67.11	0.00	**71651.55**
39	40	Physical Sciences	4008	Physics.	11.17	0.16	68.70	0.00	**70850.69**
40	52	Business, Management, Marketing, and Related Support Services	5207	Entrepreneurial and Small Business Operations.	11.16	0.08	148.65	0.00	**70401.51**
41	41	Science Technologies/Technicians	4199	Science Technologies/Technicians, Other.	11.15	0.17	67.10	0.00	**69855.21**
42	14	Engineering	1407	Chemical Engineering.	11.15	0.10	106.97	0.00	**69719.83**
43	52	Business, Management, Marketing, and Related Support Services	5208	Finance and Financial Management Services.	11.14	0.02	466.49	0.00	**68737.49**
44	52	Business, Management, Marketing, and Related Support Services	5202	Business Administration, Management and Operations.	11.13	0.01	1524.55	0.00	**68425.44**
45	26	Biological and Biomedical Sciences	2610	Pharmacology and Toxicology.	11.13	0.17	66.90	0.00	**68313.32**
46	52	Business, Management, Marketing, and Related Support Services	5211	International Business.	11.13	0.05	208.34	0.00	**68065.79**
47	52	Business, Management, Marketing, and Related Support Services	5215	Real Estate.	11.13	0.06	181.91	0.00	**68065.79**
48	49	Transportation and Materials Moving	4901	Air Transportation.	11.13	0.10	113.39	0.00	**67939.98**
49	27	Mathematics and Statistics	2703	Applied Mathematics.	11.12	0.08	133.75	0.00	**67745.28**
50	14	Engineering	1439	Geological/Geophysical Engineering.	11.12	0.16	69.81	0.00	**67638.32**
51	52	Business, Management, Marketing, and Related Support Services	5216	Taxation.	11.11	0.03	333.91	0.00	**66757.37**
52	43	Security and Protective Services	4399	Homeland Security, Law Enforcement, Firefighting and Related Protective Services, Other.	11.10	0.08	138.31	0.00	**66186.38**
53	26	Biological and Biomedical Sciences	2611	Biomathematics, Bioinformatics, and Computational Biology.	11.10	0.07	155.25	0.00	**66160.57**
54	14	Engineering	1425	Petroleum Engineering.	11.09	0.15	75.52	0.00	**65610.43**
55	15	Engineering Technologies/Technicians	1510	Construction Engineering Technologies.	11.09	0.12	94.38	0.00	**65574.36**
56	14	Engineering	1404	Architectural Engineering.	11.08	0.11	97.55	0.00	**64914.74**
57	40	Physical Sciences	4005	Chemistry.	11.08	0.12	93.88	0.00	**64754.60**

58	1	Agriculture, Agriculture Operations, and Related Sciences	111	Plant Sciences.	11.07	0.17	66.06	0.00	**64349.21**
59	22	Legal Professions and Studies	2202	Legal Research and Advanced Professional Studies.	11.07	0.04	310.15	0.00	**63966.19**
60	43	Security and Protective Services	4303	Homeland Security.	11.07	0.07	168.10	0.00	**63959.80**
61	14	Engineering	1408	Civil Engineering.	11.06	0.02	472.39	0.00	**63587.36**
62	14	Engineering	1414	Environmental/Environmental Health Engineering.	11.06	0.09	126.78	0.00	**63398.79**
63	14	Engineering	1413	Engineering Science.	11.04	0.17	65.51	0.00	**62219.89**
64	52	Business, Management, Marketing, and Related Support Services	5299	Business, Management, Marketing, and Related Support Services, Other.	11.03	0.06	189.82	0.00	**61885.43**
65	51	Health Professions and Related Clinical Sciences	5107	Health and Medical Administrative Services.	11.03	0.02	637.43	0.00	**61864.39**
66	14	Engineering	1405	Biomedical/Medical Engineering.	11.03	0.04	247.38	0.00	**61794.52**
67	26	Biological and Biomedical Sciences	2612	Biotechnology.	11.03	0.08	134.53	0.00	**61692.65**
68	51	Health Professions and Related Clinical Sciences	5125	Veterinary Biomedical and Clinical Sciences.	11.01	0.10	107.60	0.00	**60653.95**
69	52	Business, Management, Marketing, and Related Support Services	5210	Human Resources Management and Services.	11.00	0.02	572.69	0.00	**60140.57**
70	52	Business, Management, Marketing, and Related Support Services	5214	Marketing.	11.00	0.05	240.91	0.00	**59921.46**
71	52	Business, Management, Marketing, and Related Support Services	5218	General Sales, Merchandising and Related Marketing Operations.	11.00	0.10	106.03	0.00	**59907.68**
72	51	Health Professions and Related Clinical Sciences	5106	Dental Support Services and Allied Professions.	11.00	0.16	69.20	0.00	**59658.39**
73	15	Engineering Technologies/Technicians	1506	Industrial Production Technologies/Technicians.	10.96	0.17	65.54	0.00	**57665.83**
74	30	Multi/Interdisciplinary Studies	3028	Dispute Resolution.	10.96	0.09	118.08	0.00	**57276.75**
75	52	Business, Management, Marketing, and Related Support Services	5206	Business/Managerial Economics.	10.95	0.17	64.99	0.00	**56818.09**
76	52	Business, Management, Marketing, and Related Support Services	5203	Accounting and Related Services.	10.94	0.01	959.77	0.00	**56573.16**
77	30	Multi/Interdisciplinary Studies	3015	Science, Technology and Society.	10.94	0.16	68.85	0.00	**56525.10**
78	40	Physical Sciences	4006	Geological and Earth Sciences/Geosciences.	10.93	0.07	146.54	0.00	**56094.33**
79	51	Health Professions and Related Clinical Sciences	5123	Rehabilitation and Therapeutic Professions.	10.93	0.01	768.88	0.00	**55735.91**
80	45	Social Sciences	4507	Geography and Cartography.	10.92	0.06	176.70	0.00	**55385.33**
81	51	Health Professions and Related Clinical Sciences	5102	Communication Disorders Sciences and Services.	10.92	0.01	894.13	0.00	**55016.04**
82	22	Legal Professions and Studies	2299	Legal Professions and Studies, Other.	10.89	0.12	92.07	0.00	**53873.82**
83	16	Foreign Languages, Literatures, and Linguistics	1616	American Sign Language.	10.89	0.17	64.53	0.00	**53660.91**
84	51	Health Professions and Related Clinical Sciences	5100	Health Services/Allied Health/Health Sciences, General.	10.89	0.08	140.47	0.00	**53601.38**
85	13	Education	1305	Educational/Instructional Media Design.	10.89	0.03	416.20	0.00	**53599.77**
86	1	Agriculture, Agriculture Operations, and Related Sciences	101	Agricultural Business and Management.	10.88	0.17	65.52	0.00	**53261.02**
87	13	Education	1304	Educational Administration and Supervision.	10.88	0.01	1063.68	0.00	**52935.00**
88	9	Communication, Journalism, and Related Programs	999	Communication, Journalism, and Related Programs, Other.	10.88	0.07	150.66	0.00	**52840.33**
89	44	Public Administration and Social Service Professions	4405	Public Policy Analysis.	10.87	0.03	328.61	0.00	**52461.77**

90	51	Health Professions and Related Clinical Sciences	5199	Health Professions and Related Clinical Sciences, Other.	10.87	0.05	208.08	0.00	**52418.25**
91	38	Philosophy and Religious Studies	3899	Philosophy and Religious Studies, Other.	10.85	0.17	64.49	0.00	**51455.36**
92	45	Social Sciences	4506	Economics.	10.85	0.06	189.29	0.00	**51360.26**
93	4	Architecture and Related Services	409	Architectural Sciences and Technology.	10.84	0.09	118.55	0.00	**51120.46**
94	13	Education	1309	Social and Philosophical Foundations of Education.	10.84	0.09	119.82	0.00	**51024.44**
95	51	Health Professions and Related Clinical Sciences	5122	Public Health.	10.84	0.02	695.71	0.00	**50767.92**
96	44	Public Administration and Social Service Professions	4404	Public Administration.	10.83	0.01	772.55	0.00	**50658.38**
97	15	Engineering Technologies/Technicians	1599	Engineering Technologies/Technicians, Other.	10.83	0.17	65.37	0.00	**50605.73**
98	13	Education	1306	Educational Assessment, Evaluation, and Research.	10.83	0.11	95.34	0.00	**50472.81**
99	13	Education	1302	Bilingual, Multilingual, and Multicultural Education.	10.82	0.09	125.11	0.00	**49972.09**
100	45	Social Sciences	4509	International Relations and National Security Studies.	10.81	0.03	320.48	0.00	**49492.18**
101	19	Family and Consumer Sciences/Human Sciences	1905	Foods, Nutrition, and Related Services.	10.80	0.07	160.01	0.00	**49177.43**
102	51	Health Professions and Related Clinical Sciences	5131	Dietetics and Clinical Nutrition Services.	10.80	0.05	219.97	0.00	**49069.85**
103	27	Mathematics and Statistics	2701	Mathematics.	10.79	0.10	111.68	0.00	**48766.55**
104	13	Education	1303	Curriculum and Instruction.	10.79	0.02	690.23	0.00	**48710.02**
105	30	Multi/Interdisciplinary Studies	3099	Multi/Interdisciplinary Studies, Other.	10.79	0.04	251.94	0.00	**48637.01**
106	13	Education	1310	Special Education and Teaching.	10.79	0.01	889.49	0.00	**48611.72**
107	30	Multi/Interdisciplinary Studies	3033	Sustainability Studies.	10.79	0.09	113.62	0.00	**48564.59**
108	43	Security and Protective Services	4301	Criminal Justice and Corrections.	10.79	0.02	510.75	0.00	**48431.22**
109	45	Social Sciences	4510	Political Science and Government.	10.79	0.06	176.68	0.00	**48387.17**
110	4	Architecture and Related Services	402	Architecture.	10.79	0.02	517.37	0.00	**48293.39**
111	13	Education	1314	Teaching English or French as a Second or Foreign Language.	10.78	0.04	284.85	0.00	**48270.70**
112	13	Education	1301	Education, General.	10.78	0.01	731.31	0.00	**48139.10**
113	13	Education	1313	Teacher Education and Professional Development, Specific Subject Areas.	10.78	0.01	904.58	0.00	**48047.72**
114	4	Architecture and Related Services	403	City/Urban, Community and Regional Planning.	10.78	0.03	349.89	0.00	**47904.75**
115	19	Family and Consumer Sciences/Human Sciences	1909	Apparel and Textiles.	10.77	0.17	64.28	0.00	**47675.84**
116	30	Multi/Interdisciplinary Studies	3000	Multi-/Interdisciplinary Studies, General.	10.77	0.17	64.91	0.00	**47392.53**
117	9	Communication, Journalism, and Related Programs	909	Public Relations, Advertising, and Applied Communication.	10.75	0.04	265.07	0.00	**46850.64**
118	3	Natural Resources and Conservation	305	Forestry.	10.75	0.10	112.17	0.00	**46786.50**
119	42	Psychology	4299	Psychology, Other.	10.75	0.07	160.36	0.00	**46671.55**
120	26	Biological and Biomedical Sciences	2613	Ecology, Evolution, Systematics, and Population Biology.	10.75	0.05	226.93	0.00	**46629.10**
121	13	Education	1307	International and Comparative Education.	10.75	0.09	122.24	0.00	**46602.06**
122	13	Education	1399	Education, Other.	10.75	0.04	304.30	0.00	**46533.14**
123	3	Natural Resources and Conservation	301	Natural Resources Conservation and Research.	10.75	0.04	280.72	0.00	**46457.82**
124	30	Multi/Interdisciplinary Studies	3011	Gerontology.	10.74	0.12	93.18	0.00	**46367.78**
125	4	Architecture and Related Services	405	Interior Architecture.	10.74	0.16	67.89	0.00	**46246.45**
126	9	Communication, Journalism, and Related Programs	901	Communication and Media Studies.	10.74	0.03	384.89	0.00	**46125.44**
127	13	Education	1312	Teacher Education and Professional Development, Specific Levels and Methods.	10.74	0.01	1054.37	0.00	**46065.52**

128	30	Multi/Interdisciplinary Studies	3006	Systems Science and Theory.	10.74	0.17	64.33	0.00	**45942.69**
129	51	Health Professions and Related Clinical Sciences	5132	Bioethics/Medical Ethics.	10.74	0.15	70.85	0.00	**45937.64**
130	45	Social Sciences	4504	Criminology.	10.73	0.07	157.24	0.00	**45778.97**
131	42	Psychology	4201	Psychology, General.	10.71	0.03	316.99	0.00	**44956.02**
132	50	Visual and Performing Arts	5004	Design and Applied Arts.	10.71	0.04	251.61	0.00	**44903.90**
133	24	Liberal Arts and Sciences, General Studies and Humanities	2401	Liberal Arts and Sciences, General Studies and Humanities.	10.71	0.04	263.73	0.00	**44769.84**
134	52	Business, Management, Marketing, and Related Support Services	5209	Hospitality Administration/Management.	10.71	0.06	173.87	0.00	**44731.80**
135	52	Business, Management, Marketing, and Related Support Services	5205	Business/Corporate Communications.	10.71	0.15	70.92	0.00	**44669.22**
136	51	Health Professions and Related Clinical Sciences	5110	Clinical/Medical Laboratory Science/Research and Allied Professions.	10.70	0.08	141.82	0.00	**44568.83**
137	3	Natural Resources and Conservation	302	Natural Resources Management and Policy.	10.70	0.06	193.24	0.00	**44420.22**
138	1	Agriculture, Agriculture Operations, and Related Sciences	100	Agriculture, General.	10.70	0.17	64.23	0.00	**44288.93**
139	44	Public Administration and Social Service Professions	4407	Social Work.	10.70	0.01	945.47	0.00	**44247.76**
140	19	Family and Consumer Sciences/Human Sciences	1904	Family and Consumer Economics and Related Studies.	10.70	0.11	95.63	0.00	**44199.55**
141	44	Public Administration and Social Service Professions	4400	Human Services, General.	10.70	0.07	161.26	0.00	**44185.41**
142	30	Multi/Interdisciplinary Studies	3005	Peace Studies and Conflict Resolution.	10.70	0.05	204.82	0.00	**44159.79**
143	39	Theology and Religious Vocations	3902	Bible/Biblical Studies.	10.69	0.11	93.13	0.00	**44067.16**
144	42	Psychology	4228	Clinical, Counseling and Applied Psychology.	10.69	0.01	785.02	0.00	**44022.67**
145	22	Legal Professions and Studies	2203	Legal Support Services.	10.69	0.11	93.24	0.00	**43948.33**
146	39	Theology and Religious Vocations	3999	Theology and Religious Vocations, Other.	10.69	0.08	128.73	0.00	**43816.25**
147	25	Library Science	2599	Library Science, Other.	10.68	0.12	90.48	0.00	**43656.17**
148	13	Education	1311	Student Counseling and Personnel Services.	10.68	0.01	986.35	0.00	**43329.54**
149	45	Social Sciences	4511	Sociology.	10.68	0.17	64.13	0.00	**43289.70**
150	26	Biological and Biomedical Sciences	2602	Biochemistry, Biophysics and Molecular Biology.	10.67	0.11	95.40	0.00	**43121.63**
151	4	Architecture and Related Services	406	Landscape Architecture.	10.67	0.09	119.49	0.00	**43009.66**
152	45	Social Sciences	4512	Urban Studies/Affairs.	10.67	0.08	129.46	0.00	**42921.15**
153	50	Visual and Performing Arts	5001	Visual and Performing Arts, General.	10.64	0.15	71.98	0.00	**41868.12**
154	25	Library Science	2501	Library Science and Administration.	10.63	0.02	435.92	0.00	**41518.73**
155	19	Family and Consumer Sciences/Human Sciences	1901	Family and Consumer Sciences/Human Sciences, General.	10.63	0.07	155.57	0.00	**41506.28**
156	9	Communication, Journalism, and Related Programs	907	Radio, Television, and Digital Communication.	10.63	0.08	128.99	0.00	**41498.39**
157	5	Area, Ethnic, Cultural, and Gender Studies	502	Ethnic, Cultural Minority, Gender, and Group Studies.	10.63	0.17	63.10	0.00	**41322.40**
158	39	Theology and Religious Vocations	3905	Religious/Sacred Music.	10.63	0.16	68.03	0.00	**41315.79**
159	31	Parks, Recreation, Leisure, and Fitness Studies	3103	Parks, Recreation and Leisure Facilities Management.	10.63	0.08	127.34	0.00	**41215.10**
160	50	Visual and Performing Arts	5010	Arts, Entertainment, and Media Management.	10.62	0.04	241.07	0.00	**41110.14**
161	16	Foreign Languages, Literatures, and Linguistics	1601	Linguistic, Comparative, and Related Language Studies and Services.	10.62	0.08	126.50	0.00	**41014.46**
162	26	Biological and Biomedical Sciences	2699	Biological and Biomedical Sciences, Other.	10.62	0.07	143.67	0.00	**40915.33**

163	51	Health Professions and Related Clinical Sciences	5115	Mental and Social Health Services and Allied Professions.	10.61	0.02	631.87	0.00	**40677.89**
164	45	Social Sciences	4501	Social Sciences, General.	10.61	0.08	130.20	0.00	**40646.58**
165	45	Social Sciences	4599	Social Sciences, Other.	10.61	0.09	112.08	0.00	**40627.08**
166	9	Communication, Journalism, and Related Programs	910	Publishing.	10.60	0.08	133.90	0.00	**40308.59**
167	19	Family and Consumer Sciences/Human Sciences	1907	Human Development, Family Studies, and Related Services.	10.60	0.04	238.49	0.00	**40156.52**
168	31	Parks, Recreation, Leisure, and Fitness Studies	3105	Health and Physical Education/Fitness.	10.60	0.02	615.60	0.00	**40109.16**
169	26	Biological and Biomedical Sciences	2605	Microbiological Sciences and Immunology.	10.59	0.08	130.07	0.00	**39763.71**
170	44	Public Administration and Social Service Professions	4402	Community Organization and Advocacy.	10.59	0.07	148.48	0.00	**39575.28**
171	39	Theology and Religious Vocations	3904	Religious Education.	10.58	0.11	93.67	0.00	**39525.84**
172	39	Theology and Religious Vocations	3906	Theological and Ministerial Studies.	10.58	0.03	380.07	0.00	**39505.30**
173	9	Communication, Journalism, and Related Programs	904	Journalism.	10.58	0.04	252.06	0.00	**39408.63**
174	38	Philosophy and Religious Studies	3801	Philosophy.	10.57	0.17	63.60	0.00	**39129.82**
175	5	Area, Ethnic, Cultural, and Gender Studies	501	Area Studies.	10.57	0.06	178.52	0.00	**39098.52**
176	30	Multi/Interdisciplinary Studies	3019	Nutrition Sciences.	10.56	0.07	141.77	0.00	**38624.42**
177	23	English Language and Literatures/Letters	2301	English Language and Literature, General.	10.56	0.05	229.19	0.00	**38524.90**
178	16	Foreign Languages, Literatures, and Linguistics	1609	Romance Languages, Literatures, and Linguistics.	10.56	0.16	65.38	0.00	**38481.77**
179	30	Multi/Interdisciplinary Studies	3012	Historic Preservation and Conservation.	10.56	0.12	89.27	0.00	**38462.15**
180	45	Social Sciences	4502	Anthropology.	10.56	0.12	89.64	0.00	**38460.23**
181	54	History	5401	History.	10.56	0.04	236.35	0.00	**38412.57**
182	30	Multi/Interdisciplinary Studies	3025	Cognitive Science.	10.55	0.17	63.08	0.00	**38213.34**
183	26	Biological and Biomedical Sciences	2609	Physiology, Pathology and Related Sciences.	10.55	0.07	143.82	0.00	**38105.73**
184	26	Biological and Biomedical Sciences	2607	Zoology/Animal Biology.	10.54	0.12	91.04	0.00	**37911.89**
185	30	Multi/Interdisciplinary Studies	3020	International/Global Studies.	10.54	0.07	155.42	0.00	**37780.94**
186	22	Legal Professions and Studies	2200	Non-Professional General Legal Studies (Undergraduate).	10.54	0.17	63.32	0.00	**37757.14**
187	12	Personal and Culinary Services	1205	Culinary Arts and Related Services.	10.53	0.17	63.61	0.00	**37521.15**
188	26	Biological and Biomedical Sciences	2601	Biology, General.	10.52	0.05	229.28	0.00	**37221.06**
189	31	Parks, Recreation, Leisure, and Fitness Studies	3101	Parks, Recreation and Leisure Studies.	10.52	0.12	89.18	0.00	**36976.58**
190	39	Theology and Religious Vocations	3907	Pastoral Counseling and Specialized Ministries.	10.50	0.08	129.00	0.00	**36289.00**
191	10	Communications Technologies/Technicians and Support Services	1003	Graphic Communications.	10.48	0.10	108.71	0.00	**35737.65**
192	26	Biological and Biomedical Sciences	2604	Cell/Cellular Biology and Anatomical Sciences.	10.44	0.16	65.54	0.00	**34353.53**
193	23	English Language and Literatures/Letters	2313	Rhetoric and Composition/Writing Studies.	10.43	0.03	365.34	0.00	**33809.26**
194	38	Philosophy and Religious Studies	3802	Religion/Religious Studies.	10.36	0.17	62.11	0.00	**31562.97**
195	30	Multi/Interdisciplinary Studies	3014	Museology/Museum Studies.	10.34	0.06	163.99	0.00	**31015.74**
196	30	Multi/Interdisciplinary Studies	3001	Biological and Physical Sciences.	10.34	0.10	106.08	0.00	**31010.46**
197	50	Visual and Performing Arts	5006	Film/Video and Photographic Arts.	10.30	0.05	225.51	0.00	**29858.06**
198	50	Visual and Performing Arts	5003	Dance.	10.26	0.15	69.78	0.00	**28536.52**
199	50	Visual and Performing Arts	5099	Visual and Performing Arts, Other.	10.25	0.09	113.17	0.00	**28211.36**
200	26	Biological and Biomedical Sciences	2615	Neurobiology and Neurosciences.	10.24	0.16	64.35	0.00	**28047.37**
201	10	Communications Technologies/Technicians and Support Services	1002	Audiovisual Communications Technologies/Technicians.	10.24	0.16	63.32	0.00	**27915.02**
202	50	Visual and Performing Arts	5005	Drama/Theatre Arts and Stagecraft.	10.19	0.03	312.01	0.00	**26675.21**

203	50	Visual and Performing Arts	5007	Fine and Studio Arts.	10.17	0.03	384.20	0.00	**26085.37**	
204	50	Visual and Performing Arts	5009	Music.	10.09	0.02	461.99	0.00	**23989.46**	

Table E3

Predicted Median Starting Earnings of Doctoral Degree Programs by Four-Digit CIP Code (Based on Model3O)

Rank	2-Digit CIP Code	Department/Field Description	4-Digit CIP Code	Major Description	Margin	Std. Err.	z	P>z	Median Starting Earning in USD
1	40	Physical Sciences	4008	Physics.	11.78	0.19	61.96	0.00	**130642.52**
2	11	Computer and Information Sciences and Support Services	1104	Information Science/Studies.	11.65	0.19	62.34	0.00	**115096.94**
3	51	Health Professions and Related Clinical Sciences	5138	Registered Nursing, Nursing Administration, Nursing Research and Clinical Nursing.	11.64	0.05	233.59	0.00	**113332.36**
4	14	Engineering	1410	Electrical, Electronics and Communications Engineering.	11.53	0.14	80.05	0.00	**101516.84**
5	14	Engineering	1419	Mechanical Engineering.	11.45	0.13	85.49	0.00	**93816.87**
6	13	Education	1306	Educational Assessment, Evaluation, and Research.	11.40	0.18	62.27	0.00	**89623.25**
7	52	Business, Management, Marketing, and Related Support Services	5202	Business Administration, Management and Operations.	11.32	0.11	104.19	0.00	**82066.08**
8	52	Business, Management, Marketing, and Related Support Services	5210	Human Resources Management and Services.	11.31	0.19	59.14	0.00	**82007.83**
9	13	Education	1304	Educational Administration and Supervision.	11.31	0.03	428.62	0.00	**81666.57**
10	14	Engineering	1408	Civil Engineering.	11.20	0.18	61.71	0.00	**73061.00**
11	13	Education	1399	Education, Other.	11.19	0.11	103.80	0.00	**72656.64**
12	13	Education	1301	Education, General.	11.19	0.05	214.04	0.00	**72560.79**
13	51	Health Professions and Related Clinical Sciences	5102	Communication Disorders Sciences and Services.	11.19	0.13	86.94	0.00	**72425.95**
14	13	Education	1312	Teacher Education and Professional Development, Specific Levels and Methods.	11.18	0.18	60.61	0.00	**71547.01**
15	51	Health Professions and Related Clinical Sciences	5122	Public Health.	11.15	0.11	100.02	0.00	**69628.55**
16	13	Education	1303	Curriculum and Instruction.	11.15	0.06	182.21	0.00	**69458.17**
17	13	Education	1313	Teacher Education and Professional Development, Specific Subject Areas.	11.12	0.08	132.88	0.00	**67756.12**
18	51	Health Professions and Related Clinical Sciences	5123	Rehabilitation and Therapeutic Professions.	11.12	0.04	257.83	0.00	**67721.57**
19	13	Education	1311	Student Counseling and Personnel Services.	11.10	0.18	60.43	0.00	**66454.32**
20	51	Health Professions and Related Clinical Sciences	5115	Mental and Social Health Services and Allied Professions.	11.06	0.19	59.14	0.00	**63287.30**
21	42	Psychology	4201	Psychology, General.	11.05	0.09	120.73	0.00	**62986.14**
22	40	Physical Sciences	4005	Chemistry.	11.04	0.06	198.13	0.00	**62424.93**
23	14	Engineering	1405	Biomedical/Medical Engineering.	11.01	0.14	81.10	0.00	**60204.36**
24	26	Biological and Biomedical Sciences	2699	Biological and Biomedical Sciences, Other.	10.98	0.21	51.49	0.00	**58894.91**
25	42	Psychology	4228	Clinical, Counseling and Applied Psychology.	10.96	0.05	232.95	0.00	**57435.05**
26	26	Biological and Biomedical Sciences	2613	Ecology, Evolution, Systematics, and Population Biology.	10.96	0.13	83.63	0.00	**57390.27**
27	30	Multi/Interdisciplinary Studies	3028	Dispute Resolution.	10.93	0.19	57.84	0.00	**55929.65**
28	23	English Language and Literatures/Letters	2301	English Language and Literature, General.	10.87	0.08	130.93	0.00	**52530.02**

29	26	Biological and Biomedical Sciences	2604	Cell/Cellular Biology and Anatomical Sciences.	10.84	0.11	100.50	0.00	**50975.99**
30	42	Psychology	4299	Psychology, Other.	10.83	0.14	79.67	0.00	**50649.77**
31	26	Biological and Biomedical Sciences	2601	Biology, General.	10.83	0.11	99.10	0.00	**50266.29**
32	39	Theology and Religious Vocations	3999	Theology and Religious Vocations, Other.	10.81	0.19	58.13	0.00	**49682.60**
33	45	Social Sciences	4502	Anthropology.	10.78	0.18	58.81	0.00	**48160.29**
34	26	Biological and Biomedical Sciences	2602	Biochemistry, Biophysics and Molecular Biology.	10.76	0.13	80.44	0.00	**47303.52**
35	50	Visual and Performing Arts	5009	Music.	10.41	0.04	232.78	0.00	**33207.80**

Table E4

Predicted Median Starting Earnings of Professional Degree Programs by Four-Digit CIP Code (Based on Model4R)

Rank	2-Digit CIP Code	Department/Field Description	4-Digit CIP Code	Major Description	Margin	Std. Err.	z	P>z	Median Starting Earning in USD
1	51	Health Professions and Related Clinical Sciences	5120	Pharmacy, Pharmaceutical Sciences, and Administration.	11.67	0.02	507.41	0.00	**117018.81**
2	51	Health Professions and Related Clinical Sciences	5138	Registered Nursing, Nursing Administration, Nursing Research and Clinical Nursing.	11.62	0.08	146.66	0.00	**111370.75**
3	51	Health Professions and Related Clinical Sciences	5104	Dentistry.	11.40	0.05	248.28	0.00	**89506.81**
4	51	Health Professions and Related Clinical Sciences	5117	Optometry.	11.33	0.05	219.30	0.00	**83151.54**
5	51	Health Professions and Related Clinical Sciences	5124	Veterinary Medicine.	11.18	0.03	364.96	0.00	**71764.13**
6	51	Health Professions and Related Clinical Sciences	5123	Rehabilitation and Therapeutic Professions.	11.11	0.03	427.03	0.00	**66595.35**
7	13	Education	1304	Educational Administration and Supervision.	11.10	0.04	288.87	0.00	**66058.76**
8	22	Legal Professions and Studies	2201	Law.	11.01	0.03	377.73	0.00	**60373.17**
9	51	Health Professions and Related Clinical Sciences	5119	Osteopathic Medicine/Osteopathy.	10.92	0.05	215.31	0.00	**55112.95**
10	51	Health Professions and Related Clinical Sciences	5121	Podiatric Medicine/Podiatry.	10.86	0.03	383.84	0.00	**51892.52**
11	51	Health Professions and Related Clinical Sciences	5112	Medicine.	10.84	0.02	519.99	0.00	**50825.83**
12	51	Health Professions and Related Clinical Sciences	5101	Chiropractic.	10.76	0.12	93.36	0.00	**47300.21**
13	39	Theology and Religious Vocations	3906	Theological and Ministerial Studies.	10.40	0.02	422.28	0.00	**32954.07**

Appendix F

Ranked Advanced-to-Bachelor's Degree Earnings Differentials

Table F1

Master's-to-Bachelor's Degree Earnings Differentials by Major

2-digit CIP code	Department/Field Description	4-digit CIP code	Major Description	Median earning (Bachelor's)	Median earning (Master's)	Earnings Differential
1	Agriculture, Agriculture Operations, and Related Sciences	110	Food Science and Technology.	38577.71	78780.44	40202.73
		111	Plant Sciences.	33176.93	64349.21	31172.29
		101	Agricultural Business and Management.	39907.52	53261.02	13353.50
		100	Agriculture, General.	34412.67	44288.93	9876.26
3	Natural Resources and Conservation	301	Natural Resources Conservation and Research.	27813.87	46457.82	18643.95
		302	Natural Resources Management and Policy.	30464.58	44420.22	13955.64
		305	Forestry.	35244.68	46786.50	11541.82
4	Architecture and Related Services	403	City/Urban, Community and Regional Planning.	32039.99	47904.75	15864.77
		405	Interior Architecture.	36611.22	46246.45	9635.23
		409	Architectural Sciences and Technology.	43745.32	51120.46	7375.13
		402	Architecture.	40978.38	48293.39	7315.01
		406	Landscape Architecture.	41766.51	43009.66	1243.15
5	Area, Ethnic, Cultural, and Gender Studies	502	Ethnic, Cultural Minority, Gender, and Group Studies.	26097.37	41322.40	15225.03
		501	Area Studies.	29223.84	39098.52	9874.69
9	Communication, Journalism, and Related Programs	999	Communication, Journalism, and Related Programs, Other.	32015.65	52840.33	20824.68
		901	Communication and Media Studies.	31089.95	46125.44	15035.49
		907	Radio, Television, and Digital Communication.	26758.84	41498.39	14739.56
		909	Public Relations, Advertising, and Applied Communication.	34470.18	46850.64	12380.46
		904	Journalism.	29133.97	39408.63	10274.66
10	Communications Technologies/Technicians and Support Services	1003	Graphic Communications.	28964.32	35737.65	6773.33
		1002	Audiovisual Communications Technologies/Technicians.	23818.79	27915.02	4096.23
11	Computer and Information Sciences and Support Services	1108	Computer Software and Media Applications.	34790.16	72143.32	37353.16
		1110	Computer/Information Technology Administration and Management.	49806.46	81387.75	31581.28
		1107	Computer Science.	62224.87	89666.27	27441.41
		1101	Computer and Information Sciences, General.	55071.63	79584.13	24512.50
		1199	Computer and Information Sciences and Support Services, Other.	50958.66	74054.01	23095.35
		1104	Information Science/Studies.	49987.59	72164.97	22177.38
		1105	Computer Systems Analysis.	53091.39	74473.60	21382.21
		1109	Computer Systems Networking and Telecommunications.	51503.24	71651.55	20148.31

12	Personal and Culinary Services	1205	Culinary Arts and Related Services.	28500.59	37521.15	9020.56
13	Education	1304	Educational Administration and Supervision.	32060.50	52935.00	20874.50
		1314	Teaching English or French as a Second or Foreign Language.	28565.64	48270.70	19705.05
		1301	Education, General.	31375.42	48139.10	16763.68
		1399	Education, Other.	30273.56	46533.14	16259.58
		1307	International and Comparative Education.	33000.24	46602.06	13601.82
		1313	Teacher Education and Professional Development, Specific Subject Areas.	35102.23	48047.72	12945.49
		1310	Special Education and Teaching.	36916.73	48611.72	11695.00
		1312	Teacher Education and Professional Development, Specific Levels and Methods.	34985.19	46065.52	11080.33
		1303	Curriculum and Instruction.	40851.96	48710.02	7858.06
14	Engineering	1437	Operations Research.	61343.84	89897.01	28553.18
		1499	Engineering, Other.	56226.87	84661.82	28434.95
		1401	Engineering, General.	57436.77	81462.66	24025.89
		1427	Systems Engineering.	64076.95	86677.53	22600.58
		1402	Aerospace, Aeronautical and Astronautical Engineering.	56636.56	78623.03	21986.47
		1410	Electrical, Electronics and Communications Engineering.	63573.37	84583.12	21009.75
		1409	Computer Engineering.	64340.21	83191.46	18851.26
		1439	Geological/Geophysical Engineering.	50412.78	67638.32	17225.54
		1414	Environmental/Environmental Health Engineering.	46373.80	63398.79	17024.98
		1419	Mechanical Engineering.	58811.34	71979.74	13168.40
		1435	Industrial Engineering.	59633.33	72262.46	12629.12
		1407	Chemical Engineering.	57383.95	69719.83	12335.87
		1405	Biomedical/Medical Engineering.	50675.61	61794.52	11118.91
		1413	Engineering Science.	51996.93	62219.89	10222.96
		1408	Civil Engineering.	55264.17	63587.36	8323.19
		1404	Architectural Engineering.	56715.34	64914.74	8199.40
		1425	Petroleum Engineering.	62900.54	65610.43	2709.89
15	Engineering Technologies/Technicians	1505	Environmental Control Technologies/Technicians.	43584.20	92882.45	49298.25
		1515	Engineering-Related Fields.	55045.75	80358.25	25312.49
		1507	Quality Control and Safety Technologies/Technicians.	56413.29	76163.68	19750.39
		1506	Industrial Production Technologies/Technicians.	51688.99	57665.83	5976.84
		1510	Construction Engineering Technologies.	60753.50	65574.36	4820.86
		1599	Engineering Technologies/Technicians, Other.	53409.83	50605.73	-2804.10
16	Foreign Languages, Literatures, and Linguistics	1616	American Sign Language.	30646.08	53660.91	23014.83
		1601	Linguistic, Comparative, and Related Language Studies and Services.	25331.91	41014.46	15682.56
		1609	Romance Languages, Literatures, and Linguistics.	29056.86	38481.77	9424.91
19	Family and Consumer Sciences/Human Sciences	1905	Foods, Nutrition, and Related Services.	29130.18	49177.43	20047.25
		1909	Apparel and Textiles.	32109.91	47675.84	15565.93
		1901	Family and Consumer Sciences/Human Sciences, General.	29166.32	41506.28	12339.96

		1907	Human Development, Family Studies, and Related Services.	27819.71	40156.52	12336.81
		1904	Family and Consumer Economics and Related Studies.	33548.25	44199.55	10651.30
22	Legal Professions and Studies	2202	Legal Research and Advanced Professional Studies.	32483.25	63966.19	31482.94
		2299	Legal Professions and Studies, Other.	34962.80	53873.82	18911.02
		2203	Legal Support Services.	35845.38	43948.33	8102.95
		2200	Non-Professional General Legal Studies (Undergraduate).	34178.77	37757.14	3578.37
23	English Language and Literatures/Letters	2301	English Language and Literature, General.	26616.86	38524.90	11908.04
		2313	Rhetoric and Composition/Writing Studies.	25826.85	33809.26	7982.41
24	Liberal Arts and Sciences, General Studies and Humanities	2401	Liberal Arts and Sciences, General Studies and Humanities.	30863.21	44769.84	13906.64
26	Biological and Biomedical Sciences	2610	Pharmacology and Toxicology.	30346.30	68313.32	37967.01
		2612	Biotechnology.	36795.84	61692.65	24896.81
		2613	Ecology, Evolution, Systematics, and Population Biology.	22812.87	46629.10	23816.23
		2607	Zoology/Animal Biology.	22341.47	37911.89	15570.41
		2609	Physiology, Pathology and Related Sciences.	25360.29	38105.73	12745.44
		2699	Biological and Biomedical Sciences, Other.	28326.41	40915.33	12588.91
		2602	Biochemistry, Biophysics and Molecular Biology.	30950.36	43121.63	12171.27
		2601	Biology, General.	28169.07	37221.06	9051.99
		2605	Microbiological Sciences and Immunology.	31238.29	39763.71	8525.42
		2604	Cell/Cellular Biology and Anatomical Sciences.	28441.37	34353.53	5912.16
		2615	Neurobiology and Neurosciences.	28506.29	28047.37	-458.92
		2611	Biomathematics, Bioinformatics, and Computational Biology.	68598.09	66160.57	-2437.52
27	Mathematics and Statistics	2705	Statistics.	46967.92	76921.45	29953.53
		2703	Applied Mathematics.	45006.85	67745.28	22738.42
		2701	Mathematics.	41190.79	48766.55	7575.76
30	Multi/Interdisciplinary Studies	3000	Multi-/Interdisciplinary Studies, General.	30483.17	47392.53	16909.36
		3099	Multi/Interdisciplinary Studies, Other.	33010.14	48637.01	15626.87
		3033	Sustainability Studies.	33053.41	48564.59	15511.18
		3015	Science, Technology and Society.	42102.82	56525.10	14422.28
		3011	Gerontology.	33359.57	46367.78	13008.20
		3012	Historic Preservation and Conservation.	25655.42	38462.15	12806.74
		3005	Peace Studies and Conflict Resolution.	33366.24	44159.79	10793.55
		3019	Nutrition Sciences.	27853.11	38624.42	10771.31
		3020	International/Global Studies.	28278.02	37780.94	9502.92
		3025	Cognitive Science.	32223.46	38213.34	5989.88
		3006	Systems Science and Theory.	40121.60	45942.69	5821.09
		3001	Biological and Physical Sciences.	28266.43	31010.46	2744.04
31	Parks, Recreation, Leisure, and Fitness Studies	3105	Health and Physical Education/Fitness.	28382.84	40109.16	11726.32
		3103	Parks, Recreation and Leisure Facilities Management.	29550.32	41215.10	11664.78
		3101	Parks, Recreation and Leisure Studies.	29074.01	36976.58	7902.57

38	Philosophy and Religious Studies	3899	Philosophy and Religious Studies, Other.	24027.64	51455.36	27427.73
		3801	Philosophy.	26851.58	39129.82	12278.23
		3802	Religion/Religious Studies.	25808.78	31562.97	5754.19
39	Theology and Religious Vocations	3902	Bible/Biblical Studies.	30503.30	44067.16	13563.86
		3904	Religious Education.	26504.51	39525.84	13021.34
		3906	Theological and Ministerial Studies.	27495.84	39505.30	12009.46
		3905	Religious/Sacred Music.	29746.00	41315.79	11569.79
		3907	Pastoral Counseling and Specialized Ministries.	27989.09	36289.00	8299.91
		3999	Theology and Religious Vocations, Other.	37651.95	43816.25	6164.30
40	Physical Sciences	4008	Physics.	34329.49	70850.69	36521.20
		4005	Chemistry.	33962.42	64754.60	30792.18
		4006	Geological and Earth Sciences/Geosciences.	32736.31	56094.33	23358.02
41	Science Technologies/Technicians	4199	Science Technologies/Technicians, Other.	44321.27	69855.21	25533.94
42	Psychology	4299	Psychology, Other.	28456.16	46671.55	18215.39
		4201	Psychology, General.	28335.20	44956.02	16620.83
		4228	Clinical, Counseling and Applied Psychology.	30349.64	44022.67	13673.03
43	Security and Protective Services	4399	Homeland Security, Law Enforcement, Firefighting and Related Protective Services, Other.	36938.14	66186.38	29248.24
		4303	Homeland Security.	38982.57	63959.80	24977.22
		4301	Criminal Justice and Corrections.	33263.97	48431.22	15167.26
44	Public Administration and Social Service Professions	4499	Public Administration and Social Service Professions, Other.	39745.03	76458.24	36713.21
		4405	Public Policy Analysis.	35414.27	52461.77	17047.50
		4404	Public Administration.	36736.64	50658.38	13921.74
		4400	Human Services, General.	31141.92	44185.41	13043.50
		4407	Social Work.	32033.58	44247.76	12214.18
		4402	Community Organization and Advocacy.	35312.42	39575.28	4262.86
45	Social Sciences	4507	Geography and Cartography.	31257.67	55385.33	24127.66
		4509	International Relations and National Security Studies.	30961.20	49492.18	18530.98
		4510	Political Science and Government.	32029.74	48387.17	16357.44
		4502	Anthropology.	23864.80	38460.23	14595.43
		4511	Sociology.	29455.91	43289.70	13833.79
		4504	Criminology.	32023.01	45778.97	13755.96
		4599	Social Sciences, Other.	30866.60	40627.08	9760.47
		4512	Urban Studies/Affairs.	33608.02	42921.15	9313.13
		4506	Economics.	42503.00	51360.26	8857.26
		4501	Social Sciences, General.	31850.87	40646.58	8795.71
49	Transportation and Materials Moving	4901	Air Transportation.	39899.14	67939.98	28040.85
50	Visual and Performing Arts	5001	Visual and Performing Arts, General.	23953.03	41868.12	17915.09
		5010	Arts, Entertainment, and Media Management.	26051.48	41110.14	15058.65

		5004	Design and Applied Arts.	32998.59	44903.90	11905.32
		5003	Dance.	19092.77	28536.52	9443.75
		5006	Film/Video and Photographic Arts.	22552.70	29858.06	7305.36
		5005	Drama/Theatre Arts and Stagecraft.	19882.93	26675.21	6792.28
		5099	Visual and Performing Arts, Other.	22615.26	28211.36	5596.10
		5007	Fine and Studio Arts.	23976.03	26085.37	2109.34
		5009	Music.	23406.76	23989.46	582.71
51	Heath Professions and Related Clinical Sciences	5108	Allied Health and Medical Assisting Services.	31336.22	128297.88	96961.65
		5127	Medical Illustration and Informatics.	25368.92	79172.16	53803.24
		5109	Allied Health Diagnostic, Intervention, and Treatment Professions.	48791.43	92971.66	44180.23
		5120	Pharmacy, Pharmaceutical Sciences, and Administration.	32493.33	76181.20	43687.87
		5138	Registered Nursing, Nursing Administration, Nursing Research and Clinical Nursing.	63054.20	95022.60	31968.39
		5102	Communication Disorders Sciences and Services.	25909.63	55016.04	29106.41
		5123	Rehabilitation and Therapeutic Professions.	30875.24	55735.91	24860.67
		5100	Health Services/Allied Health/Health Sciences, General.	30481.04	53601.38	23120.34
		5107	Health and Medical Administrative Services.	39260.73	61864.39	22603.66
		5131	Dietetics and Clinical Nutrition Services.	28957.37	49069.85	20112.48
		5122	Public Health.	31595.82	50767.92	19172.11
		5115	Mental and Social Health Services and Allied Professions.	31909.21	40677.89	8768.68
		5106	Dental Support Services and Allied Professions.	53021.35	59658.39	6637.03
		5110	Clinical/Medical Laboratory Science/Research and Allied Professions.	52652.03	44568.83	-8083.20
		5139	Practical Nursing, Vocational Nursing and Nursing Assistants.	100354.08	52418.25	-47935.83
52	Business, Management, Marketing, and Related Support Services	5219	Specialized Sales, Merchandising and Marketing Operations.	33325.56	119511.75	86186.19
		5207	Entrepreneurial and Small Business Operations.	36022.54	70401.51	34378.98
		5201	Business/Commerce, General.	40793.58	72148.37	31354.79
		5213	Management Sciences and Quantitative Methods.	47378.79	77715.50	30336.71
		5211	International Business.	40470.15	68065.79	27595.64
		5202	Business Administration, Management and Operations.	40925.15	68425.44	27500.30
		5212	Management Information Systems and Services.	50558.68	75936.29	25377.61
		5215	Real Estate.	43672.33	68065.79	24393.46
		5220	Construction Management.	59464.81	83146.55	23681.74
		5208	Finance and Financial Management Services.	46224.72	68737.49	22512.77
		5217	Insurance.	51197.71	72977.03	21779.32
		5214	Marketing.	39151.34	59921.46	20770.12
		5299	Business, Management, Marketing, and Related Support Services, Other.	41236.13	61885.43	20649.30
		5210	Human Resources Management and Services.	40781.34	60140.57	19359.23
		5218	General Sales, Merchandising and Related Marketing Operations.	42307.51	59907.68	17600.17
		5206	Business/Managerial Economics.	43445.39	56818.09	13372.70
		5209	Hospitality Administration/Management.	34327.43	44731.80	10404.37
		5203	Accounting and Related Services.	46891.89	56573.16	9681.27

		5205	Business/Corporate Communications.	35276.07	44669.22	9393.16
54	History	5401	History.	28244.39	38412.57	10168.18

Table F2

Doctoral-to-Bachelor's Degree Earnings Differentials by Major

2-digit CIP code	Department/Field Description	4-digit CIP code	Major Description	Media Earning (Bachelor's)	Median Earning (Doctoral)	Earnings Differential
11	Computer and Information Sciences and Support Services	1104	Information Science/Studies.	49987.59	115096.94	65109.35
13	Education	1304	Educational Administration and Supervision.	32060.50	81666.57	49606.07
		1399	Education, Other.	30273.56	72656.64	42383.08
		1301	Education, General.	31375.42	72560.79	41185.37
		1312	Teacher Education and Professional Development, Specific Levels and Methods.	34985.19	71547.01	36561.82
		1313	Teacher Education and Professional Development, Specific Subject Areas.	35102.23	67756.12	32653.88
		1303	Curriculum and Instruction.	40851.96	69458.17	28606.21
14	Engineering	1410	Electrical, Electronics and Communications Engineering.	63573.37	101516.84	37943.47
		1419	Mechanical Engineering.	58811.34	93816.87	35005.53
		1408	Civil Engineering.	55264.17	73061.00	17796.83
		1405	Biomedical/Medical Engineering.	50675.61	60204.36	9528.75
23	English Language and Literatures/Letters	2301	English Language and Literature, General.	26616.86	52530.02	25913.16
26	Biological and Biomedical Sciences	2613	Ecology, Evolution, Systematics, and Population Biology.	22812.87	57390.27	34577.40
		2699	Biological and Biomedical Sciences, Other.	28326.41	58894.91	30568.50
		2604	Cell/Cellular Biology and Anatomical Sciences.	28441.37	50975.99	22534.62
		2601	Biology, General.	28169.07	50266.29	22097.22
		2602	Biochemistry, Biophysics and Molecular Biology.	30950.36	47303.52	16353.16
30	Multi/Interdisciplinary Studies	3099	Multi/Interdisciplinary Studies, Other.	33010.14	49682.60	16672.46
40	Physical Sciences	4008	Physics.	34329.49	130642.52	96313.03
		4005	Chemistry.	33962.42	62424.93	28462.51
42	Psychology	4201	Psychology, General.	28335.20	62986.14	34650.94
		4228	Clinical, Counseling and Applied Psychology.	30349.64	57435.05	27085.41
		4299	Psychology, Other.	28456.16	50649.77	22193.61
45	Social Sciences	4502	Anthropology.	23864.80	48160.29	24295.48
50	Visual and Performing Arts	5009	Music.	23406.76	33207.80	9801.04
51	Heath Professions and Related Clinical Sciences	5138	Registered Nursing, Nursing Administration, Nursing Research and Clinical Nursing.	63054.20	113332.36	50278.15
		5102	Communication Disorders Sciences and Services.	25909.63	72425.95	46516.32
		5122	Public Health.	31595.82	69628.55	38032.74
		5123	Rehabilitation and Therapeutic Professions.	30875.24	67721.57	36846.32
		5115	Mental and Social Health Services and Allied Professions.	31909.21	63287.30	31378.09
52		5210	Human Resources Management and Services.	40781.34	82007.83	41226.49

Business, Management, Marketing, and Related Support Services	5202	Business Administration, Management and Operations.	40925.15	82066.08	41140.93