HIGHER EDUCATION PRODUCT BASKETS:
DEGREE OFFERING DISTRIBUTIONS AND THE
FINANCIAL STRENGTH OF COLLEGES AND UNIVERSITIES

A Thesis
submitted to the Faculty of the
Graduate School of Arts and Sciences
of Georgetown University
in partial fulfillment of the requirements for the
degree of
Master of Public Policy

By

Patrick Stephen Matthew Nolan, B.A.

Washington, D.C.
April 29, 2018
Copyright 2018 by Patrick Stephen Matthew Nolan
All Rights Reserved
ABSTRACT

This thesis evaluates the relationship between the distributions of degrees offered by a college and the financial strength of that institution. While no causal relationship is established, the findings generally show that the more specialized an institution is, the more net wealth it is likely to hold. Additional evidence points to how this effect differs depending on the degrees themselves: High concentrations of STEM fields, for example, tend to benefit the home college's financial position.

This research highlights the importance of the considerations by which university systems balance the types of institutions in their network. It adds to the small but growing research into higher education finance. Finally, it advocates for an understanding of public institutions as policy platforms. By paying attention to the implementers of public policies, those policies might have more sustainable impacts.
TABLE OF CONTENTS

Introduction .................................................................................................................. 1
Literature Review ........................................................................................................ 4
Conceptual Framework ............................................................................................... 12
Data and Methods ..................................................................................................... 14
Results ....................................................................................................................... 22
Discussion .................................................................................................................. 29
Appendix: Figures and Tables .................................................................................. 35
References .................................................................................................................. 39
LIST OF FIGURES

Figure 1. Conceptual Framework .......................................................... 12
Figure 2. Gini Coefficients and Lorenz Curves ........................................... 26
Figure 3. Net Income by Percent STEM ....................................................... 35
Figure 4. Total Equity by Percent STEM ....................................................... 35
Figure 5. Total Equity by Degree Offering Distributions ......................... 36

LIST OF TABLES

Table 1. Regression Framework .............................................................. 20
Table 2. Degree Distributions and Total Equity Regression Results .......... 27
Table 3. Percent STEM and Net Income Regression Results ..................... 37
Table 4. Percent STEM and Total Equity Regression Results .................... 38
Introduction

Public and non-profit institutions of higher education are facing significant challenges in how they are funded. This thesis explores how college and university financial strength might be connected to the types and distributions of degrees offered by these institutions.

Public funding for colleges and universities has decreased significantly while tuition rates, particularly at private institutions, are increasing at remarkable rates. (IPEDS 2017) U.S. institutions of higher education are increasingly concerned with survivability while labor market forces demand increasingly specialized graduates. (The terms "college," "university," "school," and "institution" are used interchangeably except when regression analysis distinguishes between institutional types.) When colleges do not survive, students can be left with no degree at one of the most important times in their careers. (Puzzanghera and White 2016) In contrast to institutional weakening, a strong college or university provides employment to its local community. Further, universities serve as the primary engine of national research and development. From a civic perspective, they guard free speech and foster an informed voter base. Public and private colleges serve to transform young adults by enlightening their minds and encouraging their development. This thesis operates on the assumption that increased institutional strength of colleges and universities benefits society more broadly.

Without examining causal dynamics, this thesis examines the relationship between institutional financial strength and the types of degrees offered by institutions; it attempts to answer the question, "How does the distribution of academic disciplines (ex., English, Math, Engineering) correlate to a college or university's sustainability?" This thesis makes two broad assumptions: First, that the distribution of academic disciplines is relevant to a college's identity
and has consequences for the students and institutions that interact with that college; and second, that institutional strength can be measured by a college or university's financial position. This is more tenuous given the significant role of brand and tradition in U.S. higher education.

Regarding the former: Academic disciplinary distributions are measured here by degree offering distributions—the numbers of graduates in various academic fields. These distributions embody the degree to which society's labor market and intellectual culture will be either specialized or generalized. Highly concentrated distributions will tend to favor subject-specific labor market utility (neurosurgeons) while more broadly spread distributions will tend to graduate a more socially equitable and interdisciplinary cohort.

Regarding the latter: This thesis makes the assumption that university strength can be approximated by financial position. This is not a perfect proxy, and indeed several measures are not taken into account. University reputation, brand, and social position are very difficult to model. The Historically Black Colleges and Universities (HBCU's), Ivy League schools, and Jesuit colleges are all examples of groups whose institutional strength can arguably be derived from other factors. That said, the approach implemented here is designed to provide a generalizable structure for institutions that cannot rely on external reputations.

This investigation will rely on the U.S. Department of Education's Integrated Post-secondary Data Service (IPEDS) for panel data on 7,514 institutions of higher education collected over thirty years. The analytic methodology will investigate individual academic disciplines, the STEM grouping of disciplines, and a broader measure of relative distribution to differentiate broad-based institutions from those that are more highly concentrated. The thesis begins with a review of the literature and proceeds through discussions of the conceptual
framework, data and methods, and concludes with presenting findings and discussing their implications.
Literature Review

The relationship between degree offerings and a college or university's financial strength and opportunity touches on several fields of study in the social and management sciences. While the emergent and interdisciplinary field of higher education studies provides a certain amount of structure to integrating these disciplines, the independent fields remain significantly important. The following literature review examines three overlapping fields of progressively greater subject-matter specificity: the economic dynamics of the higher education market, the industry-accepted approaches to college and university finance, and the collected set of works touching on course- and degree-offering product portfolios. This approach to the literature is designed to deliver general background on the field under examination, advance an understanding of the principal agents involved, and discuss the current state of the field. Each subsection within the review surveys the available research and indicates the ways in which this thesis question would either advance novelty or evaluate existing analysis.

Because the subject at hand is academia itself, it should be little surprise that there has been significant study of the subject. There are two reasons why more research is not publicly available. First, the emergence of "higher education as a business" is a relatively recent phenomenon, largely coinciding with increased demand and evolving parent and student expectations. (Soares 2016) Second, little research on university finance is available because many institutions treat their approach to market strategy as proprietary--unlike corporate counterparts, universities do not hold earnings calls. (Hinrichs 2017) These challenges are surmountable in large part due to comparative analysis across different countries, the industry and professional associations incentivized to move the field forward, and the credit market
evaluation (bond-rating) that developed as a consequence of institutional borrowing.

**The Higher Education Market (Background):**

Due to data limitations and the fact that educational globalization is a relatively recent phenomenon, research in higher education is largely single-country focused. The exception to this are comparative studies that examine the impact of education on inequality and labor market outcomes. This subsection will briefly examine macro trends in higher education at the global and US levels before focusing strictly on specific domestic trends. These more local trends focus on two market-scale characteristics: stability and growth potential.

Internationally, higher education growth has rapidly accelerated in the last 40 years, largely due to public funding. In 1980, 3.5% of the OECD population completed tertiary education; in 2000, it was 15%. Unfortunately, the labor market has not kept pace, and many of these graduates wind up working blue-collar jobs. Another concern is that higher education is not bridging the income and wealth gaps. In Britain, for example, the proportion of low income students participating in higher education is roughly equal to what it was in the 1960s. A similar trend had been evident in developing countries, though the past ten years have seen the beginnings of increased access to higher education. (Holmes 2016)

The enrollment trends in the United States generally reflect those of OECD countries, despite the fact that our sector is structured with a greater emphasis on private funding. Public support for higher education has stayed relatively flat since 1985—roughly $5,000 per student—while costs of education have increased from $12,000 to almost $20,000 over the same period of time. (Hinrichs 2017) The remaining costs are being borne by students, resulting in changes to
Financial journalism about the US education market often emphasizes institutional wealth, particularly ballooning endowments and debt crunches. Still, the higher education credit market has been largely stable, with colleges borrowing for one of two reasons: to expand growth or to cover tuition discounting. While the overall credit ratings have declined across higher education, this is largely seen as the sector becoming comfortable with capital financing—a positive development so far. (Logue 2014) During the Great Recession, many university administrators feared their endowments' exposure to the stock market would lead to contagion and a restructuring of the sector. This focus on wealth, however, misunderstood a fundamental characteristic of university endowments: They are largely supplemental to university operating cash flow, precisely designed to absorb shocks. (Weisbrod 2016) Credit ratings agencies and endowment analysts continue to signal the US higher education market is a stable sector that is only likely to become more stable.

Given this stability, this literature review turned towards opportunities for growth in the higher education market. The first question was whether or not higher education meets market demand. Several studies have looked at this question, and most concur that streamlined curricula, IT training, and school-to-work pipelines are needed to enhance demand matching. (Hanson, 2016) Another area for exploration is on the institutional side: Simply, is there an overabundance of institutions of higher education in the U.S.? Recent working papers on higher education consolidation have examined this question and found that past mergers of institutions generated
no public or private benefits, except regarding of institutional market power. (Russell 2017)
Finally, the area of degree- and product-diversification—and its relationship to institutional
growth—remains relatively unexamined. The remainder of this review will look at the broad
categories of both university finance and product offering diversification (I view a degree in an
academic discipline as a product).

Institutional Finance in Higher Education:
In order to measure the impact of academic diversification on US college and university
institutional financial strength and growth, there needs to be a baseline understanding of how
strength and growth are best measured. To investigate this, my review examined traditional
standards as well as more heterodox methods. The traditional standards can be broken into those
established by trade groups, by credit rating agencies, and by public-sector entities. The novel
methods include both international approaches and the hybridization of traditional approaches.

The major higher education finance trade group in the U.S. is the National Association of
College and University Business Officers (NACUBO), a group which serves to advise higher
education CFOs on best practices. Their approach is to translate investment banking metrics to
the higher education field. For example, a "profit margin" is recoded as a "net income ratio" to
emphasise the non-profit nature of the business. Other metrics identified by NACUBO include
measures of liquidity (viability ratio), general operations (return on assets) and wealth (primary
reserve ratio). (Guastella 2013)

Many of these metrics are among those also used by credit rating agencies to assess
financial performance. Moody's, Fitch's, and Standard and Poor's all work in the higher
education space. While equipped to do sophisticated analysis, these firms only share their analyses with contracted universities, often when that school is looking to issue bonds. In addition to the metrics advanced by NACUBO, the ratings agencies also look at governance structures and market position. For example, the ratings agencies might look at the number of faculty who hold tenure; if it is high, they will consider that metric a liability. The one drawback to their approach is the issue of moral hazard: Because these firms are paid for by universities on a contracted basis, there is concern that they do not always use consistent standards. (Spainer 2010) Researchers looking for more unbiased set of metrics might turn toward the U.S. Department of Education’s partnership with the American Institutes of Research, a contracted project intended to perform objective analysis of publicly available university-based financial information. This initiative--the Delta Cost Project--examined the Integrated Postsecondary Education Data Service (IPEDS) data to arrive at a set of generally accepted metrics. (Hurlburt 2017) Many of these—in particular their tuition discount rate calculation—will be used in the analysis put forth later in this thesis.

In addition to trade group, rating agency, and public sector approaches, it is worth briefly mentioning two others. First, work done in the U.K. provides a source for comparative analysis. Recent research examines product pipeline approaches to measuring university operations, specifically through principal component analysis, multilevel modelling, and data envelopment analysis methodologies. (Johnes and Johnes 2014) While these approaches will surely be picked up by individual institutions, they are difficult to apply to institutions that do not make granular data public. Another novel approach, one that has potential to be adopted to U.S. public data, is a factor analysis system that combines the above-mentioned ratings-agency approach with new
variables and factor analysis. Research recently presented at the Association of Institutional Researchers by Henry Zheng, includes as a metrics "degree diversification" and could be used as a starting point for condensing multivariate approaches. (Zheng 2017) The next section will examine the concept of the degree-as-product, looking to both higher education and business literature.

Product and Degree Diversification:

Degree diversification refers to the number of degrees offered by an institution as segmented by the fields of degrees offered. It could refer to the number of Ph.D.'s relative to the number of bachelor's; or it could refer to the number of combined STEM degrees (associate's, bachelor's, master's, doctorate's) relative to the number of total combined degrees; finally, it might refer to the density of distributions within groupings. I approached this concept by examining three distinct fields: public policy, to understand whether the degree mix offered reflects the degree mix most beneficial to society; marketing, to understand whether degree mixes benefit universities; and through the higher education studies lens, to understand how the distributions affect campus cultures.

The public policy analysis points to a method of understanding degree distributions within the context of labor market demand. Research by Anthony Carnevale at the Center for Education and the Workforce uses U.S. Census survey, employer survey, and proprietary online HR data to determine whether the types of degrees held by workers matches the types of skills required by employers. While it does not consider institution-level enrollment or graduation data, it does emphasize the importance of laborforce matching techniques beyond program and degree
alignment (the core focus of the paper and of this thesis). In particular, the paper discusses counseling, career services, and job placement requirements that must accompany program diversification. (Carnevale 2016)

While there is an abundance of public policy research on higher education, marketing research tends to operate at a strictly commercial level. One methodology that was particularly attractive was developed by marketing scientists at the Indian Institute of Technology. Using hierarchical regression and entropy measures, the researchers developed three core metrics for diversification, with the key insight being that product categories can be measured against product subcategories (i.e., the percent of students in STEM fields can be measured against the percent of STEM fields themselves). (Srinivasan 2016)

The interdisciplinary field of higher education studies refers to quantitative degree and program evaluation as "enrollment management," a term often employed to soften the news to a department that may be closing. While the field does not to my knowledge explicitly discuss degree diversification, it does provide a context for determining which variables should and should not be controlled for. Most notable are variables involving the size of the institutions (smaller can mean unmet enrollment targets) and the extent of financial aid provided. Regarding financial aid: While students may generally prefer degree offerings that grant them the best job prospects after graduation, an institution could distort the effect of those offerings by providing financial incentives to students who enroll in programs that reduce job prospects but increase institutional prestige or justify critical faculty hiring. (Kalsbeek 2013)

A survey of the available research reveals that the study of degree diversification fits neatly between the study of labor market demand and the study of university operations. It may
be that because this investigation is not squarely in one field or the other that it has not been researched to a greater extent. To further the current literature on the relationship between degree diversification and institutional strength will require adopting methods used in microeconomics, institutional finance, and higher education studies.
Conceptual Framework

This investigation seeks to develop an understanding of how a college's financial growth potential is related to the types and distributions of degrees offered by that institution. To understand the economic dynamics that would factor into this relationship, I separated the higher education market into two sets of forces impacting our dependent variable: on the left of the below chart are those demand-side forces; on the right, supply-side; in the middle column are those market effects that do not fall squarely into either supply or demand categories.

![Conceptual Framework Diagram](image-url)

*Figure 1: Conceptual Framework*
My operating hypothesis is that highly concentrated degree offering distributions are associated with lower university financial growth potential. The null hypothesis is that these relationships are positively related or not related at all. This hypothesis is based on the intuition that over-specialization creates systemic risk when certain disciplines fall out of favor with prospective student preferences or employer demands. This effect would likely be different for different types of institutions, with the possibility of sign change occurring for different institutional types. A full exploration of this relationship would require a longer, more historic time-series than is available.

The demand-side of this framework takes the student and their families as the consumers of the educational service and implies a sensitivity to price and the personal and career utility derived from its consumption. While the supply-side of the framework considers the ability of the school to meet student demand, it also reveals demand dynamics of faculty, administrators, and academia's interest in shaping intellectual culture.

Given these market dynamics, it is important to note that the relationship of distributions of degrees to financial growth is likely mitigated by the demand-side provision of education. The specific, impactful variables denoted by this framework include the availability of faculty, institutional reputation, local laborforce demands, social trends in automation and economic growth, and the operational (in)efficiencies of a given institution.
Data and Methods

The following sections will summarize the data source, variables, and types of analysis which could be deployed to determine whether and to what extent there might be a relationship between a college or university's fields of academic offerings and its overall financial strength.

Data Sources:

The data that analyzed here are principally sourced from the Integrated Post-secondary Education Data Service (IPEDS). The data set is comprised of survey information solicited by the U.S. Department of Education three times a year from all institutions of higher education with reporting obligations to the United States. While the results are not closely verified, the penalty of failure to report accurate information is so extensive that it could pose an existential risk to participating schools. If a school fails to report accurate information, its student may become ineligible for federal financial aid or loan support.

The data have been collected since 1986 and cover information on 7,514 colleges and universities (rough estimate dependent on definitions of "college" and "university"). The population examined here include all institutions within the United States that enroll students eligible for financial aid. (Fuller 2011) The total number of schools examined is 4,062, and the range of time examined includes the 2000-2001 academic year through 2016-2017 academic year. The repeated cross-sectional data are arranged in institution-year units with 64,992 observations.  

\[\text{\footnotesize a}\]

\[\text{\footnotesize a} \text{ The data are accessed and drawn-down through the IPEDS Data Center, an online tool that allows for limited tabular downloading. (IPEDS 2017) To effectively reproduce this data, the tables could be manually downloaded on a per-variable basis, pivoted from wide to tall, and merged by the IPEDS-designated institutional code or "UnitID" and year of analysis. Given that many schools have identical names, these should not be used as identifying characteristics.}\]
Additional data on local labor market demand was sourced from the American Community Survey's five-year estimates of median income. These data are collected at the county level and merged with institution's in those counties for the relevant years. The collection was limited to the 2011-2016 years in which a richer IPEDS iteration allowed for more sophisticated analysis of institutional finances.

Variables:

The variables included in this analysis fall broadly into four categories: financial strength, disciplinary strategy, enrollment, institution type; generally speaking, the relationship between the first two will be assessed by controlling for the last two.

Financial Strength (Dependent)

Institutional financial strength, the primary dependent variable, is measured using two separate techniques, each with multiple components. The techniques are respectively based on corporate finance and credit analysis. The corporate finance measures are adapted from the NACUBO approach and decompose return on equity net income. (NACUBO) These measures are defined using IPEDS variables as calculated by the Delta Cost Project. (Hurlburt 2017) The main purpose of this approach is to determine the effectiveness with which an institution grew its current equity, as measured by total revenue minus total expenses. Net-income is a public and non-profit accounting term synonymous with what for-profit entities refer to as "profit." Due to compounding effects, a natural log will be taken.
The second measure of financial strength is at the heart of the asset management approach developed by Dr. Henry Zheng using the IPEDS variables and based on Moody's credit ratings. (Zheng 2017) In this approach, fourteen different metrics are indexed into three categories: market position, operational performance, and asset usage. The approach used here takes the simplest metric available: The natural log of total equity, computed by subtracting total liabilities from total assets.

*Disciplinary Strategies (Independent)*

Disciplinary strategies—the primary independent variables investigated—are in many ways the defining characteristic of an institution's academic environment. At the university level, some schools might prefer a narrow, STEM-heavy research approach while others might prefer a well-rounded liberal arts curriculum. At the two-year level, some community colleges focus on completing general education requirements that would allow students to transfer into four-year programs as juniors; others might focus specifically on the disciplines preferred by a founding religious order.

This thesis defines disciplinary strategy in three ways: by the proportions of disciplines themselves, by the ratio of a specific subfield of degrees (STEM) granted to all other degrees, as well as by the overall distribution of degrees granted. I should also note here that a "degree" is defined by the discipline of study (i.e., Microbiology) rather than the level of the graduate's career (i.e., Associates degree). Further, disciplines of study would follow the National Center on Education Statistic's Classification of Instructional Program (CIP) system of categorizing
disciplines and sub-disciplines. (NCES 2010) The three types of disciplinary strategies are explored in greater length below.

First, the individual disciplines were examined, with the percentage share of students in each field being a measure of its relative weight within the institution. This approach allows for comparisons between English, Military Sciences, and fifteen others.

Second, disciplinary strategies will be analyzed through a series of subject-area degree analyses. Instead of asking how concentrated an institution is overall, this will simply analyze the proportion of students graduating with CIP codes in the STEM field. The "Percent STEM" variable examines the impact on financial strength of institutions based on the percent of students that graduate with degrees in the following CIP codes: Engineering (CIP code 14), Biological Sciences (CIP code 26), Mathematics (CIP code 27), and Physical Sciences (CIP code 40).

Finally, disciplinary strategies will be analyzed in terms of the overall distribution of degrees granted. That is, are equal numbers of students graduating from each degree offered, or are most students receiving one degree while just a few each complete many others? This variable will be calculated using the Gini statistic of a Lorenz curve, a common measurement of economic inequalities. In this application, the Gini coefficient measures the difference between a school where each discipline graduated an equal number of students and (Gini = 0) and a school where all students graduated with degrees in only one discipline (Gini = 1).

Enrollment (Control):

The enrollment variables are used to measure the size, selectivity, and demographic composition of the school. Institution size is measured by the full-time equivalent number of
students enrolled during a 12-month period (prior-year July through labelled-year June). To account for different credit-counting systems, a single full-time equivalent student is equal to three part-time students, with "part-time" being defined as those taking at least half the typical number of credits for a full-time degree program. While counterintuitive, the convention of valuing part-time students at one-third the rate of full-timers (despite them taking up to one half of the classes of full-timers) is designed to account for the wide variety of course loads taken by part-time students (some take as few as one fifth).

The selectivity or exclusivity of the student body enrollment is measured by dividing the admissions rate by the yield rate, with "yield rate" being the number of admitted students who actually enroll. The advantage of an approach including both admissions and yield rather than a simple admissions rate is that it accounts for some unrepresentative variation in application volumes, which are easily manipulated by colleges seeking to optimize rankings. Enrollment demographics are measured by gender and race. Gender remains a binary designation according to IPEDS and race is codified by legislation, specifically Title IX of the Higher Education Act. (HEA 2008) Because the racial categories have been incompatibly reorganized three times since the debut of IPEDS, this thesis would likely use a single derived metric: percent non-white. Demographic measures are used in exploratory analysis only.

As stated above, enrollment variables are included to mediate some of the variation between disciplinary strategy and institutional financial strength. By way of example, enrollment size may bias in favor of the economies of scale achieved by large universities; selectivity in favor of reputational advantages by highly ranked institutions; and demographics both for and
against schools that service specific sub-populations: elite women- or black-serving institutions on the one hand, and refugee- or oppressed-population serving institutions on the other.

*Institution Types (Control)*

In addition to variables measuring enrollment, this thesis makes use of institution-type variables for controlling the primary relationship. There are two principal elements to institution type: its surrounding labor market, its functional tradition, and its organizational control. Surrounding labor market-years can be analyzed as a fixed effect at several units of measurement, including zip code, commuting zone, city, county, state, or national region. Given the sample size and the fact that more granular levels of analysis absorb high numbers of degrees of freedom, this analysis may be limited to only controlling for statewide and annual fixed effects. To mitigate the breadth of variation within a state, county-level income controls from the American Community Survey are included.

The second institution-type control, an institution's functional tradition, can be described as a school's interpretation of and adherence to the purpose of higher education. While some institutions attempt to organize their efforts around educating students, others might instead emphasize research, or even civic service. The dominant approach to classifying institutions in this way is to account for their "Carnegie Classification", a taxonomy first developed by the Carnegie Commission on Higher Education in 1970 and refined frequently since then. (Carnegie 2015) The Carnegie approach is generally accepted as a classification schema by the literature, but is applied differently from year to year. To account for this, a simplified derivation takes into
account the three mid-level categories of baccalaureate colleges and both master's and research universities.

Beyond labor market location and functional tradition, an institution may be generally classifiable by its organizational ownership. This analysis will control for the three typical categories used by higher education researchers: public, non-profit, and private-for-profit. This differentiation accounts for the different responsibilities that might bias the relationship between discipline strategy and financial strength. For example, public institutions might focus on creating the highest return on taxpayer investment by producing a diversified workforce and thus a diversified discipline mix. In contrast, a for-profit might work on a contract basis for a specific corporate employer and thus develop very narrow disciplinary offerings.

**Analysis:**

The primary relationship that examined in this thesis is that between disciplinary strategies and institutional financial strength. Due to the multiple approaches to defining both sides of this relationship discussed in the Variables subsection, the below matrix would be used to isolate effects each type of independent-dependent pairing:

*Table 1: Regression Framework*

<table>
<thead>
<tr>
<th>Independent</th>
<th>Dependent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Net Income</td>
</tr>
<tr>
<td>Total Enrollees in Each CIP Classification</td>
<td></td>
</tr>
<tr>
<td>Percent CIP Code in STEM vs. Overall</td>
<td></td>
</tr>
<tr>
<td>Gini Coefficient of Overall CIP Distribution</td>
<td></td>
</tr>
</tbody>
</table>

Each empty cell at the intersection of a dependent and independent variable would represent a discrete model and contain both key coefficients and key statistics representing the
model fit. Each of the six models will utilize the same controlling variables and fixed effects for each of the Carnegie-ownership institutional categories:

\[ Y_{Financial\ Strength} = \alpha + \beta_{Disciplinary\ Distribution} + \beta_{Enrollment\ Controls} + \beta_{State-time\ F.E.} + \upsilon \]

These models are estimated based on the hypothesized linear relationship between the independent and dependent variables. For this reason, OLS is seen as the optimal methodology. Linearity was explored through descriptive analysis between dependent and primary independent variables (Figures 1, 2, and 4) as well as all variables used to control for this relationship.
Results

The initial phase of this investigation explored whether certain disciplines are associated with a college or university's financial standing. The analysis then proceeded to explore a specific grouping of disciplines (those in the STEM fields) and their relationship with both operating performance and overall financial standing, finding a positive relationship in both cases. Finally, I tested the overall distribution within institutions in an effort to determine whether highly specialized institutions tend to perform better than institutions with more equal densities across fields.

At each stage in the process, the effects were evaluated within six types of institutions based first on the "control" of the institution (public or private) and then on the type of institution (baccalaureate, master's, and research). Each of the three phases relied on exploratory visualization and correlation testing to determine the best-suited control variables. As discussed in the Data & Methods section, the regressions reported here used a fixed-effects analysis, holding time and state as constants. Natural logs of the primary dependent financial metrics (net income and total equity) were taken to account for financial compounding and economies of scale. When a variable is referred to as "statistically significant" is evaluated as having a less than 5% likelihood of having occurred by random chance when all else is equal.

Individual Disciplines (ex., History or Engineering):

Many individual disciplines were shown to be associated with changes in total equity—the total assets of an institution less its total liabilities. Net income measures were not statistically significant. Given that the discipline variables were measured as percentages of total degrees
granted (i.e., 12% of degrees were granted to students studying Education) and that total equity was logged, all results are interpreted in terms of percentage point changes being associated with percent increases. This model contained 6,545 institution-year observations covering the years 2011-2015 and including all types of schools. It controlled for the distributions of disciplines, student body size, net income, and selectivity (via admit rate alone). This regression accounted for 82% of the variation in the dependent variable (adjusted R-squared).

The disciplines associated with increases in total equity include Biology, Ethnic Studies, Humanities, Languages and Linguistics, Law, Mathematics, Mechanical-Technical, Personal Health, Physical Sciences, Social Sciences, and Visual and Performing Arts. The strongest positive relationship was between Languages and Linguistics and total equity, with a 1 percentage point increase in the number of students graduating with these degrees being associated with a 1.1% increase in the home institution's total equity.

The disciplines negatively associated with institutional equity include Engineering Technology trades (distinct from pure Engineering), English, Family Studies, History, Law Enforcement, Library Sciences, Psychology, Public Administration, and Recreation Studies, with the strongest negative correlation belonging to Engineering Technology trades.

**Groups of Disciplines, STEM as Case-study:**

The preceding investigation served largely to frame further structural analysis into how degree offering distributions are related to institutional net income and net wealth. This intermediary phase looks at a STEM-centered case-study of intermediate aggregation, one situated between a study of specific disciplines and one studying total measures of institutional
degree offering distribution. Unlike the previous regressions which controlled for institutional type and control but did not separate the regression accordingly, this study examines the relationship independently for each institutional category.

The first dependent variable examined was net income. It should be noted here that all zero-based income and equity values were dropped as if they were reporting errors (about 25), this was done largely in accordance to the accounting heuristic that revenues will never equal expenses. The percent STEM variable includes the following majors, selected based on a taxonomy that excludes vocational work as STEM-classified: Agricultural Science, Architecture, Engineering, Mathematics, Natural Resource Sciences, and Physical Sciences.

A graphic examination of the relationship between percent STEM and net income by institutional category reveals significant non-linear clustering for Public Research and Master's universities, followed by high variance for the others when the percent STEM exceeds 25%. (See Figure 3 in Appendix.) Due to the low levels of linearity for each category, further linear regression would not provide an accurate account of the relationship between percent STEM and net income. (See Table 3 in Appendix.) There appears to be no statistically significant relationship between Percent STEM and net income.

The results for the relationship between percent STEM and total equity were more correlated and more linear. The significant deviation from linearity of a significant minority of schools at the 25%-and-greater-STEM levels resulted in skewed regression statistics. For this reason, the analysis only examines those 91% of institutions with less than 25% of their graduates receiving degrees in the STEM fields. (See Figure 4 in Appendix.) The five institution-types evaluated (Private Master's colleges showed no significant relationship) accounted for
between 69% and 91% of the variation in the respective total equity metrics. Again, the fixed
effects controlled for included the state in which the institution is located and the year of the
reporting.

The most significant relationships between equity and STEM-graduating were for
Research universities, both Public and Private, with Private Research institutions with less than
25% graduates in STEM having a marginal effect of 1 percentage point increase STEM degrees
granted being associated with a 1.84% increase in total equity. (See Table 4 in Appendix.) While
the impact on total equity for STEM is largely positive, the benefits may indeed diminish after
the 25% limit. Spline analysis was inconclusive and extensive variation occurred after that limit,
despite the relatively few cases.

**Total Distribution of Higher Education Degree Baskets:**

The final level of analysis focuses on more summary concentrations of degrees within
certain subjects in a given institution, and the impact that has on the two dependent variables.
Determining a strong summary statistic for degree dispersion involves using a measure without a
central tendency (given that disciplines are not ordered).

To accomplish this, a variation on the relative mean absolute difference was used. A
common statistic in studies of consumer finance and inequality, this can be expressed in the form
of a Gini coefficient or graphically in the form of a Lorenz curve. See below for illustrative
examples from the University of Houston and the California Institute of Technology reflecting
the relationship between distributions of degrees (histogram) and the corresponding below
Lorenz curves from which Gini coefficients are derived (Figure 2 on the following page):

25
The Gini coefficient was the primary dependent variable used to evaluate institutional net wealth and net income. The narrowed hypothesis in this case is that specialization is beneficially related to Master's universities and negatively related to 4-year institutions that are more conventionally considered "liberal arts" institutions. Research institutions that are often responsible for covering several fields of inquiry. Once again, initial analysis showed that net income was not linearly correlated with the extent of disciplinary specialization. Total equity (net wealth) did have a linear relationship with degree distribution, particularly for Private research institutions and Public Master's universities. (See Figure 5 in Appendix.)
A cursory look at the graphical representation shows that for all institutional types examined here—community colleges and for-profit schools were not addressed—the more specialized a school is (or the more concentrated its offerings are), the more likely it is to have lower total wealth. It is worth noting that for several institutional types, particularly research, the trends seem less directional at the tail ends. That is, there seems to still be a penalty for overly-equal distributions of degree offerings. The fixed-effects regression reveals a statistically significant and negative relationship between high disciplinary concentration and high total equity. (See Table 2 below.) The most pronounced of these relationships is within Private research institutions where a one-unit Gini increase is associated with a 1.6% decrease in equity.

Table 2: Degree Distribution and Total Equity Regression Results

<table>
<thead>
<tr>
<th>Types of Institutions:</th>
<th>Private 4-Year (1)</th>
<th>Private Master's (2)</th>
<th>Private Research (3)</th>
<th>Public 4-Year (4)</th>
<th>Public Master's (5)</th>
<th>Public Research (9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gini Dispersion</td>
<td>-0.441***</td>
<td>-0.202***</td>
<td>-1.572***</td>
<td>-0.084***</td>
<td>-0.122***</td>
<td>-0.577***</td>
</tr>
<tr>
<td>Enrollment (FTE)</td>
<td>0.0000***</td>
<td>0.0000***</td>
<td>0.0000***</td>
<td>0.0000***</td>
<td>0.0000***</td>
<td>0.0000***</td>
</tr>
<tr>
<td>Net Income (Ln)</td>
<td>5.058***</td>
<td>6.891***</td>
<td>0.969***</td>
<td>2.024***</td>
<td>2.872***</td>
<td>2.501***</td>
</tr>
<tr>
<td>Admit Rate</td>
<td>0.002***</td>
<td>0.0002***</td>
<td>0.007***</td>
<td>0.0001***</td>
<td>-0.0003***</td>
<td>-0.003***</td>
</tr>
<tr>
<td>Yield Rate</td>
<td>0.001***</td>
<td>0.001***</td>
<td>0.005***</td>
<td>0.00002</td>
<td>-0.0001</td>
<td>-0.0002</td>
</tr>
<tr>
<td>Local Med. Income</td>
<td>0.080***</td>
<td>-0.003</td>
<td>0.214*</td>
<td>-0.008</td>
<td>-0.013</td>
<td>0.153*</td>
</tr>
<tr>
<td>STEM-Enroll Interaction</td>
<td>0.0001***</td>
<td>0.00003***</td>
<td>0.0001***</td>
<td>0.00001***</td>
<td>0.00000***</td>
<td>0.0001***</td>
</tr>
</tbody>
</table>

Fixed effects? | State/Year | State/Year | State/Year | State/Year | State/Year | State/Year |
----------------|------------|------------|------------|------------|------------|------------|
Observations    | 2,125      | 1,603      | 479        | 342        | 1,194      | 802        |
R²              | 0.705      | 0.644      | 0.922      | 0.847      | 0.700      | 0.820      |
Adjusted R²     | 0.697      | 0.631      | 0.916      | 0.826      | 0.686      | 0.806      |
While net income does not appear directly correlated with the types and densities of degrees granted, the total equity of an institution does. Further, the extent of these variations is easily detectable among different types of institutions. For example, Private Research institutions have the highest adjusted equities associated with corresponding increases in the percent of STEM majors and decreases in the concentration of degrees overall. It is hardly surprising that universities offering different types of degrees find themselves in different types of financial positions. The findings laid out in the previous section generally conform to the hypothesis offered at the beginning of this inquiry. Certain patterns that emerged in the results—similarities across types of institutions—suggests that there might be more to the results than a straightforward assessment of the hypothesis.
Discussion

This section will proceed by evaluating the findings against the hypothesis, examining potential practical implications, denoting the limitations of the study, and finally suggesting new avenues for research. It should be noted again for clarity that all findings only pointed to correlations, with causal inference being unexamined.

Evaluating Findings:

The hypothesis laid out in the Conceptual Framework was that higher distributions of degree offerings is positively associated with higher net income and wealth. In my analysis of the aggregate distribution of all degrees, I found that colleges and universities that offer more equal distributions of several disciplines tend to have more wealth than institutions that tend to graduate most students in fewer disciplines. This evaluation only holds up for wealth—there was not sufficient evidence to support that either wide or narrow distributions are associated with institutional net income. That said, the pattern of high distribution-high wealth breaks down when individual disciplines are aggregated at different levels. For example, the analysis of STEM degrees shows that, as a group, a denser distribution is better.

That these results take on different magnitudes for different types of institutions is also notable. While many schools aspire to be research powerhouses with high specializations in very narrow fields, few are able to obtain it. Similarly, many small rural colleges aspire to the broad curricula of the top liberal arts programs. The reality is that the fiscal sustainability of high academic distribution for small private colleges looks very different than that of large public
research institutions. The data and coefficients reviewed show significant difference between institutional types, but identifying specific trends would be premature.

The most significant surprise came from an evaluation of the individual degrees that were associated with high institutional wealth. It was striking to discover that even though a profession is associated with high pay (Lawyers, for example), the education of that profession might be associated with weaker institutional finance (law school dependent colleges, in this case). The inverse appeared to be true, with languages and linguistics—as well as visual and performing arts—being associated with superior institutional wealth.

Whether these surprising results have their roots in elite education as a social marker or in the nature of the disciplines themselves, it is clear that the effects are real. Whether private non-profit or public, the leaders of these institutions and the policy makers that govern them must grapple with the tradeoffs implied by this research.

**Practical Implications:**

The practical extensions of this research might fall into two categories: a contribution to the growing literature on the organizational theory of public institutions, and a set of recommendations for policy makers.

Regarding the first practical extension—to organizational theory of public institutions—this analysis adapts the perspective of colleges and universities as public institutions—this definition applies to private non-profit colleges in addition to traditional public colleges on the grounds that they take as their mission a further contribution to social welfare.
By examining the impact of a college's service-provision on institutional strength, policy researchers and decision makers are able to better manage the durations of a given intervention's impact. Because these institutions often outlast specific public policies (ex., financial aid programs and research grants), ensuring their persistence and sustainability means reducing the up-front outlays for tomorrow's intervention. Put another way, strengthening colleges and universities means strengthening a policy platform.

The specific contribution of this thesis to the field of public institution analysis is in understanding what I refer to as "product baskets" or the distribution of types of degrees offered. A similar approach in other fields might look to some of the following: the types of medical services offered by hospitals, where the over-concentration of certain types of surgeries might generate institutional risk; the portfolio distributions of housing units available for subsidization by neighborhood development banks; or the concentration of job training programs by local governments and trade organizations.

Regarding the second practical extension—of specific recommendations—this analysis can point to two specific governmental actions: Public university structuring and higher education consolidation. Public university systems could leverage this analysis in their allocation of academic departments and programs. A hypothetical state system looking to open new data science program might consider locating it at a school with a low number of humanities-focused majors. Similarly, a new anthropology program might be best suited within an institution with dense concentrations in STEM fields. New programs might be less suited for schools with broad program distributions.
In the area of higher education consolidation, this research contributes to a better understanding of which universities should work together, and which might weaken their general financial position. The analysis suggests that schools with similar offerings might actually worsen their financial strength if they were to consolidate. This supplements current research which suggests that the improved market power of mergers between similar schools can result in increased market power and thus detrimental increases in student costs. (Russell, 2017)

**Study Limitations:**

This thesis is limited by the reliability of its underlying data, its classification of degree types, and its simplification of financial measurement.

The Department of Education did not begin collecting in-depth financial data until 2011 and even then the reporting did not stabilize until the following year. In addition, the lag in data collection and processing times means that this analysis was managing only four years of financial data. Due to covariance between the dependent variables and fluctuations in the financial markets (particularly in a post-recession climate), there is reason to believe that additional data would be illuminative.

This analysis also relied on segmenting degree types by their CIP categories (Engineering, Philosophy, History), but the construction of this taxonomy raises questions: should English and History be placed under Humanities or Architecture under Engineering? Should Biological Sciences be split into Medical and Non-Medical? Should Public Administration be abolished? Theorists from Hegel to Dewey have tackled the question of
knowledge-area categorization and the CIP code system is among the best available. Still, the questions are valid.

Finally, this research takes a very simple approach to measuring financial strength, on the one hand examining an operational metric, net income (revenue minus expense), and on the other evaluating a wealth metric, total equity (assets minus liabilities). But on their own, these measurements fail to capture several important dynamics, including strategic borrowing, debt consolidation, deferred revenue, and amortized expenses. Further, they do not delve into the nature of the assets beyond those which are property and those that aren't. Endowments with heavy restrictions on how their money is spent were evaluated in the same way as those that allow their managers free reign.

This analysis was also limited by the inability of the researcher to infer any possible causal dynamics at play. If stronger time series or quasi-experimental designs would have allowed for a stronger understanding of the mechanics at play. If dependent variables had been subject to factor or principal component analysis, there is a good chance that risks for overfitting could have been narrowed.

Future Research Opportunities and Conclusion:

This research maintained a narrow focus on the disciplines of degrees offered, but future research might look to the level of degrees offered: what is the "right" mix of two-year, four-year, and doctoral degrees? While public panel data is unavailable on the intersection of the discipline and level (i.e., an institution's number of two-year degrees in engineering), there is ample information on how many students complete which levels of degrees.
To aid in an analysis of degree-level distributions, the discipline density measures outlined in this research could serve to normalize some of the variation that comes from different disciplinary densities. If future research had the cooperation of institutions, this analysis could be done at a much more granular level. One opportunity to explore in this regard would be in examining student-level data within public university systems.

This thesis explores the interplay between education and institutional strength. While no university should exist for its own sake, it is important to develop organizations that can weather storms, develop cultures of inquiry, and stand ready to implement future interventions in higher education policy.
Appendix: Figures and Tables

Figure 3: Net Income by Percent STEM

Figure 4: Total Equity by Percent STEM
Figure 5: Total Equity by Degree Offering Distributions
Table 3: Percent STEM and Net Income Regression Results

<table>
<thead>
<tr>
<th>Types of Institutions:</th>
<th>Private 4-Year</th>
<th>Private Master's</th>
<th>Private Research</th>
<th>Public 4-Year</th>
<th>Public Master's</th>
<th>Public Research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent STEM</td>
<td>-0.006**</td>
<td>0.005***</td>
<td>-0.056**</td>
<td>-0.006***</td>
<td>-0.003</td>
<td>-0.005</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.002)</td>
<td>(0.026)</td>
<td>(0.001)</td>
<td>(0.003)</td>
<td>(0.012)</td>
</tr>
<tr>
<td>Enrollment (FTE)</td>
<td>0.00000</td>
<td>0.00000***</td>
<td>-0.00000**</td>
<td>-0.00000*</td>
<td>0.000</td>
<td>-0.00000***</td>
</tr>
<tr>
<td></td>
<td>(0.00000)</td>
<td>(0.00000)</td>
<td>(0.00000)</td>
<td>(0.00000)</td>
<td>(0.00000)</td>
<td>(0.00000)</td>
</tr>
<tr>
<td>Total Equity (ln)</td>
<td>0.063***</td>
<td>0.044***</td>
<td>0.203***</td>
<td>0.044***</td>
<td>0.028***</td>
<td>0.122***</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.002)</td>
<td>(0.017)</td>
<td>(0.008)</td>
<td>(0.003)</td>
<td>(0.007)</td>
</tr>
<tr>
<td>Admit Rate</td>
<td>0.00000</td>
<td>-0.00002**</td>
<td>0.001***</td>
<td>-0.00002*</td>
<td>0.00000</td>
<td>-0.0001</td>
</tr>
<tr>
<td></td>
<td>(0.00001)</td>
<td>(0.00001)</td>
<td>(0.0003)</td>
<td>(0.00001)</td>
<td>(0.00001)</td>
<td>(0.00001)</td>
</tr>
<tr>
<td>Yield Rate</td>
<td>0.00003***</td>
<td>0.00000</td>
<td>0.001***</td>
<td>-0.00001</td>
<td>0.00001</td>
<td>0.00004</td>
</tr>
<tr>
<td></td>
<td>(0.00001)</td>
<td>(0.00001)</td>
<td>(0.0003)</td>
<td>(0.00001)</td>
<td>(0.00001)</td>
<td>(0.00001)</td>
</tr>
<tr>
<td>Local Med. Income</td>
<td>-0.004</td>
<td>-0.001</td>
<td>-0.013</td>
<td>-0.009***</td>
<td>0.005***</td>
<td>-0.016</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.002)</td>
<td>(0.053)</td>
<td>(0.003)</td>
<td>(0.002)</td>
<td>(0.015)</td>
</tr>
<tr>
<td>STEM-Enroll Interaction</td>
<td>-0.00000</td>
<td>-0.00000***</td>
<td>0.00000*</td>
<td>0.00000***</td>
<td>0.00000**</td>
<td>0.00000*</td>
</tr>
<tr>
<td></td>
<td>(0.00000)</td>
<td>(0.00000)</td>
<td>(0.00000)</td>
<td>(0.00000)</td>
<td>(0.00000)</td>
<td>(0.00000)</td>
</tr>
</tbody>
</table>

Fixed effects?  | State/Year | State/Year | State/Year | State/Year | State/Year | State/Year |
Observations   | 2,125       | 1,603       | 479         | 342         | 1,194       | 802         |
R²             | 0.520       | 0.655       | 0.722       | 0.473       | 0.347       | 0.606       |
Adjusted R²    | 0.507       | 0.643       | 0.698       | 0.401       | 0.315       | 0.574       |
### Table 4: Percent STEM and Total Equity Regression Results

<table>
<thead>
<tr>
<th>Types of Institutions</th>
<th>Private 4-Year</th>
<th>Private Master's</th>
<th>Private Research</th>
<th>Public 4-Year</th>
<th>Public Master's</th>
<th>Public Research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent STEM</td>
<td>0.409***</td>
<td>0.058</td>
<td>1.839***</td>
<td>0.108**</td>
<td>0.225***</td>
<td>0.831***</td>
</tr>
<tr>
<td></td>
<td>(0.034)</td>
<td>(0.040)</td>
<td>(0.224)</td>
<td>(0.043)</td>
<td>(0.055)</td>
<td>(0.309)</td>
</tr>
<tr>
<td>Enrollment (FTE)</td>
<td>-0.00000*</td>
<td>-0.00000</td>
<td>0.00001***</td>
<td>0.00000</td>
<td>0.00001***</td>
<td>0.00001***</td>
</tr>
<tr>
<td></td>
<td>(0.00000)</td>
<td>(0.00000)</td>
<td>(0.00000)</td>
<td>(0.00000)</td>
<td>(0.00000)</td>
<td>(0.00000)</td>
</tr>
<tr>
<td>Net Income (ln)</td>
<td>5.275***</td>
<td>7.165***</td>
<td>1.068***</td>
<td>2.150***</td>
<td>3.126***</td>
<td>3.830***</td>
</tr>
<tr>
<td></td>
<td>(0.169)</td>
<td>(0.277)</td>
<td>(0.107)</td>
<td>(0.546)</td>
<td>(0.304)</td>
<td>(0.204)</td>
</tr>
<tr>
<td>Admit Rate</td>
<td>-0.001***</td>
<td>-0.0002**</td>
<td>-0.006***</td>
<td>-0.0004</td>
<td>-0.0002***</td>
<td>-0.001***</td>
</tr>
<tr>
<td></td>
<td>(0.0001)</td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.0001)</td>
<td>(0.0001)</td>
<td>(0.001)</td>
</tr>
<tr>
<td>Yield Rate</td>
<td>0.0004***</td>
<td>-0.001***</td>
<td>0.004***</td>
<td>-0.0001</td>
<td>-0.0002</td>
<td>-0.00005</td>
</tr>
<tr>
<td></td>
<td>(0.0001)</td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.0001)</td>
<td>(0.0001)</td>
<td>(0.001)</td>
</tr>
<tr>
<td>Local Med. Income</td>
<td>0.085***</td>
<td>0.004</td>
<td>0.208</td>
<td>-0.017</td>
<td>-0.010</td>
<td>0.093</td>
</tr>
<tr>
<td></td>
<td>(0.026)</td>
<td>(0.022)</td>
<td>(0.135)</td>
<td>(0.026)</td>
<td>(0.021)</td>
<td>(0.099)</td>
</tr>
<tr>
<td>STEM-Enroll Interaction</td>
<td>0.0001***</td>
<td>0.00005***</td>
<td>-0.00003***</td>
<td>-0.00002**</td>
<td>-0.00001***</td>
<td>-0.000000</td>
</tr>
<tr>
<td></td>
<td>(0.00001)</td>
<td>(0.00001)</td>
<td>(0.00001)</td>
<td>(0.00001)</td>
<td>(0.00001)</td>
<td>(0.00000)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fixed effects?</th>
<th>State/Year</th>
<th>State/Year</th>
<th>State/Year</th>
<th>State/Year</th>
<th>State/Year</th>
<th>State/Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observations</td>
<td>1.866</td>
<td>1.553</td>
<td>354</td>
<td>264</td>
<td>1.122</td>
<td>553</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.685</td>
<td>0.613</td>
<td>0.905</td>
<td>0.815</td>
<td>0.718</td>
<td>0.794</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.676</td>
<td>0.599</td>
<td>0.895</td>
<td>0.783</td>
<td>0.703</td>
<td>0.770</td>
</tr>
</tbody>
</table>
References


