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THE EVOLUTION OF COLLEGE EARNINGS AND COSTS:

ANALYZING THE FINANCIAL VALUE OF BACHELOR'S DEGREES BETWEEN 2019 AND 2021 AND PREDICTING THE FUTURE COST OF COLLEGE

A Thesis

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Table of Contents

List of Illustrations

Acknowledgements

I met Dr. Ardjmand when I started taking his class in January 2024. While I found the subject matter challenging (Predictive Analytics using Python code), I became skilled at problem-solving, and I felt I was gaining a vague understanding of coding in Python, which would become useful later. While this class was one of the most challenging parts of my college career, I also found it to be the most rewarding, especially when my code worked. Halfway through the semester, Dr. Ardjmand asked if I wanted to be a teaching assistant for his class the next school year. I accepted, and after thinking about how I wanted to approach my upcoming senior thesis, I asked if he would be my advisor. Dr. Ardjmand was initially very excited about my thesis topic, and he always seemed thrilled about this project as we met throughout my senior year. His enthusiasm and positivity toward my work, even when I felt I had accomplished nothing or had experienced a setback, encouraged me to keep pushing forward on this thesis.

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Finally, I must thank my parents, my fiancé, my friends, and my professors who supported me throughout my college career and my senior thesis.

Abstract

Utilizing data from the Department of Education's College Scorecard website, this study consists of two parts, which are calculating program-specific net present values (NPV) for 2019 and 2021 graduates and using linear regression to predict future college costs for each included institution. A paired t-test conducted on the differences in NPV between 2019 and 2021 shows that the majors with the most significant differences in values were in healthcare, engineering, and business fields, which supports broader trends in salary growth, hiring, and industry performance. The second part of the study, predicting future college costs, finds future annual academic year costs for each institution included through the 2027-28 academic year. These costs were analyzed by control type, geographic region, and urban versus rural designation. This data indicates an increasing gap between the costs of public and private universities. Additionally, the study shows that colleges in the Northeast are more expensive than in other regions, and schools in urban areas are more costly than those in rural areas. Overall, this study sets the stage for future research to be done on degree program values and the predictability of them once more data is available, which was the original intention of this undergraduate thesis.

Introduction

As the cost of higher education increases, students are faced with considering the long-term financial implications of earning a bachelor's degree, which is likely difficult for most 18-year-olds to put into perspective. These price increases are well-documented, as the Bureau of Labor Statistic reports that the annual price index of college has nearly tripled from 2000 to 2023 (BLS, n.d.). During that time frame, the cost of public in-state tuition, fees, room, and board combined rose from $13,938 to $23,063 for four-year public institutions (U.S. Department of Education, n.d.). From February 2020 to January 2023 alone, the cost of college tuition rose by 4.7% (BLS, 2024).

In fact, for parents with young children, these cost increases, and the uncertainty of future costs is likely more worrying than ever. A Charles Schwab college planning calculator estimates that Ohio parents or guardians with a kindergartener would need to begin with a $30,789 contribution today and then contribute $250 a month to a 529 plan to have enough funds to pay for just half of their child's public in-state education (Charles Schwab, n.d.). With this being such a pressing issue, prospective students and families are becoming increasingly concerned with how financing and achieving a college education will impact their financial health for years to come. Along with that, they also want to ensure that investing this much in a degree will be worthwhile.

This thesis will calculate the profitability of program-specific college degrees in the United States in terms of net present value (NPV) for 2019 and 2021 graduates. Using this data, this research will also forecast future college costs for students entering college in future years so decision makers and prospective college students have the most accurate information.

A study such as this is important to campus administrators, prospective students and their parents, high school guidance counselors, and anyone else who needs to make or help make decisions regarding the costs of a college education. Campus administrators need to determine how much tuition will be at their universities every year, and a factor in those decisions should be how much students will benefit financially from attending college. Administrators should be aware of the job market that they are sending students into post-graduation, and they should understand the earnings that are common for recent graduates. If more students do not see a positive return on their investment, they will be less likely to attend college and will find other career paths.

Prospective students and their parents need to understand how much benefit comes from attending each specific program, and students should understand what earnings typically look like for graduates of programs in which they are interested. This would help students make more informed decisions about their futures and select programs that would enable them to lead the lifestyles they desire. Likewise, guidance counselors need the best and most accurate information to advise prospective students on their post-secondary decisions.

This paper will answer two important questions surrounding the topic of return on investment for college students. Which bachelor's degrees provide the best return on investment, and which colleges are the most cost-effective? Obtaining higher education is an investment of both time and money, and understanding the potential costs and returns is important to making any investment decision.

The study will be segmented by individual college choice to account for differences in earnings between students who graduate from top private universities and public state schools, and it will be segmented by major to examine the NPV differences between students who graduate with different majors. For example, education and engineering majors are likely to earn very different salaries post-graduation. Ultimately, this study will determine the NPV for each program of study where data is available for every higher education program in the United States, and the results will be grouped by major for analysis.

Literature Review

Overall, previous literature on the topic of college degree values tends to be vague. Research tends to focus on broad major categories rather than specific majors, and there tend to be many assumptions made throughout the calculation process, which limits the accuracy of any interpretation of these values. However, assumptions such as a set number of years in college and a set number of years working may be unavoidable when making comparisons on such a large scale. This thesis, as shown later, will also make similar assumptions.

The recent publication of "Degrees of Return: Estimating Internal Rates of Return for College Majors Using Quantile Regression" by Liang Zhang, Xiangman Liu, and Yitong Hu (2024) finds the internal rate of return (IRR) of broader major categories, including business, computer science, education, engineering, health, humanities and liberal arts, math and sciences, social sciences, and the category of 'other majors.'

This study utilized data from the annual American Community Survey from 2009-2021, as it collects demographic and financial data on individuals and households. The study also collects data on undergraduate major choice. The data was limited to individuals who were born in the United States, were between the ages of 18 and 65, held a high school or bachelor's degree as the highest level of education attained, were not currently enrolled in school, and had positive earnings. Ultimately, this data covered 2.9 million high school graduates and 2.9 million undergraduate degree earners.

To calculate the IRR by major, the authors began with a log-linear equation that assumes a parallel age-earnings profile across majors. This equation is then adjusted to relax the assumption of parallel age-earnings, and the average characteristics of graduates are substituted to control for varying individual characteristics across each major group. From here, the earnings difference between high school and college graduates is calculated, and quantile regression is employed to address rank invariance. Rank invariance is the assumption that the median college graduate would have earned more than the median high school graduate if they had not attended a post-secondary institution. Finally, to further address this selection bias, a 25% adjustment was applied to the opportunity costs of attending college.

The college costs used in this study include an annual $20,000 for tuition expenses, $15,000 for non-tuition expenses, and an additional $1,000 for books and supplies. This is based on the average costs from the National Postsecondary Student Aid Study: 18 Administrative Collection (NPSAS). To be consistent with the ACS income data, these costs were adjusted to 2021 dollars. These costs were then adjusted to account for federal, state, institutional, and private financial aid sources, as well as adding income to account for the 40% of full-time students who are employed.

The results from this methodology create a concave earnings trajectory for all majors and high school graduates, with earnings being the highest between ages 50 and 60. The earnings curves for engineering and business majors are the highest for both men and women, and the curves for education majors and high school graduates are the lowest for both men and women.

Moreover, the study found that engineering and computer science majors yielded the highest IRRs, exceeding 13%. The next highest returns came from business, health, and math and science majors, which had IRRs between 10-13%. These returns are in line with the hypothesis of this paper, as the high-growth fields provided the highest IRRs. Biology, agriculture, social sciences, and the ‘other majors’ category presented IRRs between 8-9%. The lowest returns came from education and humanities and arts majors, at less than 8%.

While this study did break down how returns on a college education were segmented by major categories, it did not determine which programs were the highest-returning or how specific programs compared to each other. For prospective students, this is one of the most important factors in deciding on where to attend college, as graduates expect to capitalize on a wage-earning premium because of their degree-holding status. Furthermore, this study does not use the specific tuition rates for each university, but instead, it uses an average across the NPSAS.

Douglas A. Webber’s, “Are College Costs Worth It? How Ability, Major, and Debt Affect the Returns to Schooling,” (2016) finds that college returns by major category determine the expected value of a college degree and the age at which a graduate should break even on their investment. Webber’s study is different than previous literature because he takes the dropout rate of college entrants into account. He finds the value and earnings trajectory of STEM, Business, Social Science, Arts and Humanities, and high school degrees.

Webber used data from many sources to put his study together, including the National Longitudinal Survey of Youth (NLSY) data from 1979 and 1997, the 2014 American Community Survey (ACS), select March Current Population Surveys (CPS), and the National Survey of College Graduates (NSCG) from 1993 and 2003. The NLSY was chosen because it was designed to track the school-to-work transition, and it includes data such as Armed Forces

Qualification Test results, which are a measure of cognitive ability. The ACS data is utilized because it specifically asks about undergraduate majors, and it has such a large sample size that regression coefficients will be precisely estimated. The NSCG was selected because it surveys six educational outcomes including high school graduates with no college experience, some college but no four-year degree, and four-year degrees in science, technology, engineering, or math (STEM), business, social science, and arts/humanities, which is from where the major categories used in this study are derived. Finally, the CPS data is used to fill in data for high school graduates and those who only completed some college.

Webber used a lifecycle earnings simulation that takes explicit and implicit costs of obtaining a degree into account, along with the selection of majors based on both cognitive and non-cognitive factors. The overall goal of this study was to estimate the returns for each year an individual worked by major. To calculate returns, Webber uses a regression equation using variables such as age, degree, and ability level. He notes that he excludes industry and occupation from the equation, as they would bias the results by major. Finally, he states that since less than 60% of enrolled first-year students graduate within six years, he includes a college non-completion rate that is constant across all majors.

Another point that Webber makes in this study is that college has benefits beyond the return on investment for a degree. A particular point is that attending college gives students access to the 'college marriage market,' and earnings for a household with two college graduates are larger than individual earnings presented in the paper. Additionally, college opens more career opportunities to graduates, and individuals may be more satisfied with one of those jobs versus what could be attained with a high school diploma.

The results of this study show that all majors have a significantly higher return than just a high school diploma, even after adjusting for degree completion uncertainty. Furthermore, the costs of college exhibit a great effect on the overall value of an undergraduate degree, and higher college expenses significantly drag down the value. Webber also found that those at the lower half of the ability distribution tend to take longer to attain a net positive return on their investment—and this usually happens between ages 40-50. Overall, the higher the cost of college and the lower an individual is on the ability distribution, the longer it takes to break even on a college degree.

Finally, Webber discounts the values of each degree back to present value at three percent, which he notes as consistent with the expected inflation rate. When he does that, the most valuable undergraduate major is Business, valued at $300,000, and the lowest returning major is Arts and Humanities at $85,000. Accounting for ability distribution, graduation rate, discounting back to present value, and the cost of college, he concludes that STEM and Business degrees are positive investments for about 73% of prospective students. Social Science and Arts and Humanities degrees do not fare nearly as well, as they are positive investments 63% and 50% of the time, respectively. He reiterates that this study is designed for high school seniors who are determining whether to attend college and what to major in, and non-traditional students who return to school later in adult life will not see these returns.

The big limitation of Webber's study is that it only focused on broad majors, even excluding some common majors such as education. He also only studied college costs as average or high, so the costs that he used are not going to be specific to a student's particular program. Furthermore, his study only captures the value of a college degree at one time, limiting the scope of his results. By not accounting for annual tuition increases, the study doesn't show how the value of a degree could fluctuate in the coming years.

Current research on college costs covers the possible causes of the massive increase experienced in the past several decades. It examines the additional costs universities have taken on, in addition to how the pricing of college tuition differs greatly between students. However, it does not offer many specific insights into what the future cost of college may hold.

Richard Vedder's book, *Going Broke by Degree: Why College Costs Too Much,* dives into how college costs have increased and the possible reasons for such increases between academic years 1979-80 and 2002-03. He notes that during this period, the tuition price for college increased at rates greater than the consumer price index (CPI) every single year, and for 20 of the 23 years, this increase exceeded the CPI by more than 2%. In fact, for nine of those years, the differential was more than 5% (Vedder, 2004).

Vedder points to several factors to account for the massive increase in college costs, including increases in government funding, slowing productivity from students and instructors, increasing amenities on campus, and lack of market influence. Furthermore, he discusses how university budgets are created compared to companies in the private sector also contribute to increases in tuition.

One of the first reasons Vedder cites as an explanation for the increase in college costs is the increase in funding from both the federal and state governments. On the federal level, overall borrowing to fund higher education more than doubled between 1992 and 1997, and Vedder notes that by 2000, more than 82% of students received support. As government assistance programs are expanded and there are more funding options for college students, overall demand increases, enabling universities to continue to raise costs.

Slowing productivity was another factor Vedder blames for the increase in the cost of college. Firstly, he writes about the increase in administrative costs, and how it takes 12.5% more staff to educate 100 students in the 1999-00 academic year than it did in the 1976-77 academic year. He suspects this increase in personnel has to do with increased pressure for research output from colleges rather than the ability to better educate students. Furthermore, he points to increases in administrative staff at several colleges. At Ohio University (where Vedder taught economics until his recent retirement), the number of associate provosts increased from two to seven in under ten years, and the University of Georgia has three senior vice presidents, four other vice presidents, and seven associate provosts. He believes that the bloating of university administration is another reason why college costs are continuing to grow so rapidly.

Something else that Vedder considers to be a major contributor to the rising cost of college is the increasing amenities and focus on student life, which oftentimes come with a hefty price tag that is reflected in students' bills. He cites Greg Winter's article, "Jacuzzi U.? A Battle of Perks to Lure Students," for examples of university spending on campus recreation. This article points to the University of Houston spending $53 million on a student wellness center, the University of Vermont's $70 million student center, the University of Rhode Island's $54 million sports center, and many other big-ticket student amenities (Winter, 2003). Vedder uses this article to demonstrate how these new amenities are contributing to the ever-increasing cost of college and how unnecessary they seem. While investments in these multimillion-dollar facilities were hitting the headlines in 2003, Vedder points out that the overall student experience is likely better than in previous years, as students now have access to air-conditioned lecture halls, computer labs, PowerPoint, email, and other innovations.

Another contributor to the rising cost of college Vedder considers is the lack of market influence on the pricing of tuition. With the exception of for-profit universities such as the University of Phoenix, higher learning institutions do not have their success measured in terms of profit and loss. Instead, universities are typically reviewed in terms of how they rank on certain lists at state and national levels. Vedder specifically points to the US News and World Reports rankings as measures of institutional success. On the same note, since there is no incentive for typical market measures of success, cutting costs is not a goal for administrators or department heads. Alternatively, there is an incentive for getting the biggest budget since it opens the most resources for getting things done and additional influence over university spending. Vedder argues that over time, this lack of cost-cutting adds to the overall burden of paying for a college education.

Likewise, Vedder explains how the budget strategy for a university differs from that of a company in the private sector, leading to more room to increase tuition. While most businesses determine their costs from the expected revenues, the opposite is true for universities. Universities get to determine (to some degree) what their costs will be for the year and then set the tuition price relative to how many students they believe will enroll and stay enrolled. Since at most universities, the tuition rate does not change throughout the academic year, administrators must plan accordingly so that the revenues are high enough to earn a profit if the costs are greater than expected. Alternatively, companies in the private sector can raise prices at any given time if their costs increase, and there are many more cost-cutting measures available. For instance, a private sector company can choose to lay off employees at any time to cut costs, but tenured professors cannot be as easily dismissed. Additionally, there usually isn't any incentive for an administrator to cut costs, but in the private sector, profit-sharing plans encourage employees to find more ways to cut costs.

While Vedder's book is over 20 years old, his logic on how a college education has gotten so expensive over the last 50 years still stands. Government investment in higher education has increased, with suggested bills on loan forgiveness and cancellation frequently being brought up in Congress. Some programs have started to take place, such as forgiveness programs for non-profit employees or K-12 teachers. Expensive and seemingly unnecessary amenities on college campuses are bountiful, and even the costs of small amenities add up over time. New offices have been created on probably every college campus in the last 20 years, leading to more administrative costs being passed through to students.

Vedder wrote his book from a very critical perspective of the overall collegiate institution and the then-current state of the student learning experience. However, it is warranted given the general expectation that if something is going to increase in price (especially beyond that of the CPI), it should also increase in quality. This critical point of view also enables different perspectives from which to blame the increase in costs, from the government, to the pricing structure, to student amenities, and much more. One single factor did not cause the price of a college education to increase so dramatically that most students now must borrow to attend and achieve their college-earnings premium. Private sector businesses do not just find one way to increase their profits, they take multiple steps, such as implementing more efficient processes, increasing prices, and laying off employees. Looking for all the factors that contribute to the explosion of costs provides a clearer picture of the best ways to slow tuition growth while still providing the amenities and services that college students now expect when they step onto campus.

Methodology

The Department of Education's College Scorecard website offers prospective college students and their families information on the estimated costs of college, the median annual earnings for graduates of specific college programs, the median monthly loan payments, graduation rates, and much more. College Scorecard makes the data used for this site downloadable, and the primary variables that will be used in the analysis of NPV of degree programs and the predictive model for future college costs include the average cost of attendance with and without aid and scholarships and the median earnings of working graduates one year after degree completion. Note that the average cost of attendance, both before- and after- financial aid, is for in-state students and includes on-campus housing. The complete list of relevant variables pulled from the College Scorecard database are outlined in Table 1, along with the simpler terms used to refer to these codes throughout the paper.

Table 1 – Glossary of Terms

Code	**Thesis Reference**	**College Scorecard Definition**
Year		
UNITID		Unit ID for institution
INSTNM	College, school, institution	Institution name
CITY		City
STABBR	State	State postcode
ZIP		ZIP code
CONTROL	Control will be either public, private, non-profit; or private for-profit	Control of institution
CIPCODE	Major code	Classification of Instructional Programs (CIP) code for the field of study
CIPDESC	Major	Text description of the field of study CIP Code
COSTT4_A	Sticker price/total cost	Average cost of attendance (academic year institutions)
NPT_4	After-aid cost	Average cost of attendance (academic year institutions) minus the average grant/scholarship aid
EARN_MDN_1YR	Earnings 1 year post-grad	Median earnings of graduates working and not enrolled 1 year after completing

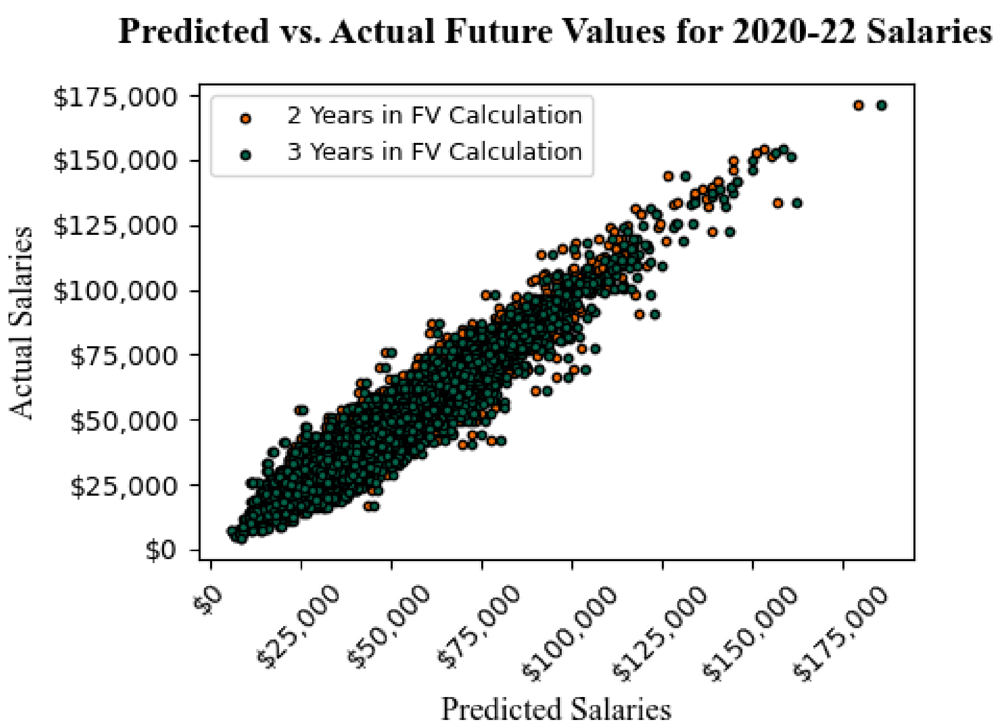
For the sake of simplicity in this undergraduate thesis, no data imputation was used on any missing values in this dataset. Instead, all rows with missing values were deleted, resulting in an estimated 80% of total data being lost. This will be discussed as a limitation of this thesis later.

The initial goal of this thesis was to create a predictive model that would estimate the NPV of a college program for a future graduate. Calculating the initial NPVs required several steps, and the analysis of this data was completed using Python code.

From the two 1-year post-graduation earnings datasets from the pooled years 2018-20 and 2020-22, the calculated annualized median salary growth rate across all program graduates is 3.58%. This growth rate is higher than the Social Security Administration's Average Wage Index's average growth rate over the same period – 3.17% (Social Security Administration, n.d.).

This growth rate (3.58%) was then used in a future value calculation to predict the 2020-22 salary data from the 2018-20 data. Since the variable is pooled by academic year, a test was needed to determine whether the future value calculation should use 2 or 3 years to predict the 2020-22 salaries. While there are visible differences in the two predictions, as shown in Figure 1, the correlations between the use of 2 years and 3 years both about 97.27%, with 2 years having a slightly higher correlation with the actual salaries. Based on these correlations, 2 years was determined to be the best fit in the future value function because it results in the NPV being slightly more correlated with the actual salaries. Figure 1 shows the relationship between the predicted salaries using 2 or 3 years in the future value calculation and the actual salaries for the pooled 2020-22 years.

Figure 1 – Comparison of Predicted and Actual Salaries for 2020-22 Pooled Years



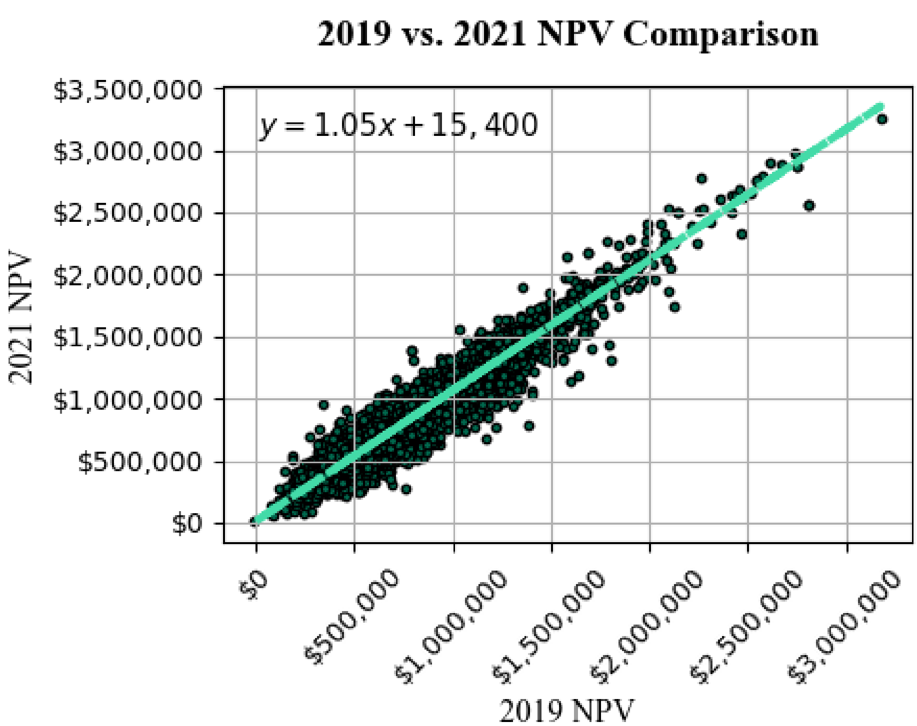
Next, a standard NPV calculation was used to determine the value of a 2019 degree, using after-aid college costs from the 2015-16 – 2018-19 academic years, represented in the equation below as C_t, and earnings from the 2018-20 pooled years indicated as S_0, as inputs. The equation assumes four years of college, indicated as T_c. The calculation assumes 40 years of employment (T_w) with a constant 3.58% annual salary growth rate (g_s). A 6% discount rate was used, represented as r in the equation below. The discount rate was not determined using any specific method, as the actual values of the degrees were not analyzed, just their relationships with each other.

$$NPV = \sum_{t=1}^{T_c} \frac{-C_t}{(1+r)^t} + \sum_{t=T_c+1}^{T_c+T_w} \frac{S_0(1+g_s)^{t-T_c-1}}{(1+r)^t}$$ *Equation 1 – NPV Equation*

This calculation was then applied to calculate NPVs for 2021 graduates, utilizing the respective years of academic costs and post-graduation earnings. Next, to see if the NPV of college programs grew between 2019 and 2021, the program NPVs were plotted against each other. It was anticipated that degree values would grow during this period since the Social Security Administration's average wage index grew by almost 11% between 2019 and 2021 (Social Security Administration, n.d.), and the cost of college remained constant in terms of 2022-23 dollars (National Center for Education Statistics, 2024).

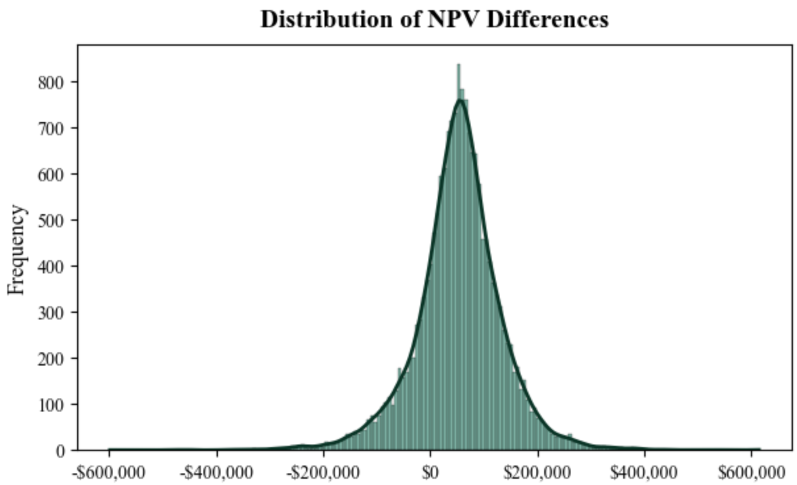
The scatterplot in Figure 2 supports the assumption that a college degree increased in value over this period. The slope of the line of best fit is greater than 1, indicating that there were overall increases in degree values during the period.

Figure 2 – Comparison of 2019 and 2021 Degree Values



To determine that the increase in NPV was statistically significant, a paired t-test was conducted on each program since the shape of the distribution between the differences in NPV between 2019 and 2021 is normal, as shown in Figure 3 below.

Figure 3 – Distribution of the Differences between 2021 and 2019 Degree Values



The null hypothesis of this t-test was that there is no significant difference between the 2019 and 2021 degree values, and the alternative hypothesis was that there was a significant difference between those values.

To calculate the t-stat, $\bar{d}$ represents the mean of the differences between the 2021 and 2019 degree values, s_d is the standard deviation of the differences, and n is the total number of pairs. The equation for the t-test is shown in Equation 2. The code used to calculate the t-test and the p-value is outlined in Appendix A. The calculated p-value shows the probability of observing the t-stat under the null hypothesis.

$$t = \frac{\bar{d}}{s_d/\sqrt{n}}$$

Equation 2 – T-Stat Equation

The multiple comparison correction, or Benjamini-Hochberg FDR, is used to adjust the calculated p-values for multiple comparisons, correcting for the false discovery rate or false positives. The code used to apply this correction is available in Appendix B.

The t-test automatically excluded any major that had only one occurrence. A p-value of 0.05 was used to determine significance, and, surprisingly, most majors had a p-value less than 0.05, indicating the null hypothesis should be rejected. The results of the paired t-test by major found 141 majors to have significant growth, or p-values below 0.05. These majors that saw the most significant growth between 2019 and 2021 will be analyzed in the discussion portion of this thesis.

The top ten majors, sorted by their adjusted p-value, or significance, are listed in Table 2. Those degrees include many healthcare, engineering, and business majors, which will be discussed in-depth. A larger t-stat indicates a stronger difference between the 2019 and 2021 degree values, and a lower p-value indicates that the difference in degree value is more significant. The mean difference represents the overall increase in NPV between 2019 and 2021. The factors that would contribute to larger differences are lower college costs and higher post-graduation earnings, which could be caused by several components explained later in this paper.

Table 2 – Top Ten Majors by Value Increase Significance (2019-2021)

Major	t-stat	Mean Difference	adjusted_p
Health-Related Knowledge and Skills.	inf	57,543.00	0.00e+00
Electromechanical Engineering.	inf	220,727.00	0.00e+00
Polymer/Plastics Engineering.	inf	90,022.00	0.00e+00
Registered Nursing, Nursing Administration, Nursing Research and Clinical Nursing.	67.88	154,061.82	1.30e-311
Teacher Education and Professional Development, Specific Levels and Methods.	32.88	67,447.93	2.51e-127
Business Administration, Management and Operations.	24.80	56,145.54	6.85e-104
Accounting and Related Services.	27.17	80,203.15	1.14e-100
Biology, General.	19.03	58,342.96	6.22e-63
Finance and Financial Management Services.	19.51	67,001.13	2.81e-56
Civil Engineering.	21.39	76,993.49	7.05e-52

While the initial goal of this thesis was originally to take the calculated NPVs and use linear regression to predict future NPVs of program-specific college degrees, there are simply not enough data points to create such a predictive model. The two data points per program that were calculated are a starting point to the potential future value of college studies, and this will be discussed toward the end of the paper.

However, the College Scorecard has data on the cost of college, both before and after aid is applied, dating back to the 2009-10 academic year. Given this, there is enough data to create a linear regression to predict future college costs, which is where this thesis pivots.

To create a linear regression model using the college cost data, the LinearRegression function available from Python's sklearn.linear_model library was utilized to predict the next five years of cost data. From this point throughout the rest of the methodology explanation in this paper, before- and after-aid cost prediction results will be shown side by side.

This concept was first tested by using the first nine years of both the historical before- and after-aid cost data to predict the last two. First, the cost data in both datasets were normalized so that they could easily be compared and analyzed. Train and test arrays were created to store the inputs, and a sliding window approach was utilized to sample the data. To create training samples, the previous three years of data were used to predict the next one, resulting in 9 predictions for each institution. The testing samples for the 2020-21 and 2021-22 academic years were then generated using the respective previous three years. From there, the mean squared error (MSE) and R^2 score were calculated to test the accuracy using the following formulas. The MSE is calculated where n is the number of observations, y_i is the actual cost, and $\hat{y}_i$ is the predicted cost.

$$MSE = \frac{1}{n}\sum_{i=1}^{n}(y_i - \hat{y}_i)^2$$

Equation 3 – MSE Equation

The MSEs for the before- and after-aid cost data were 0.001193 and 0.002802, respectively. These values indicate that the predicted values are very close to the actual costs, suggesting that the model is accurate.

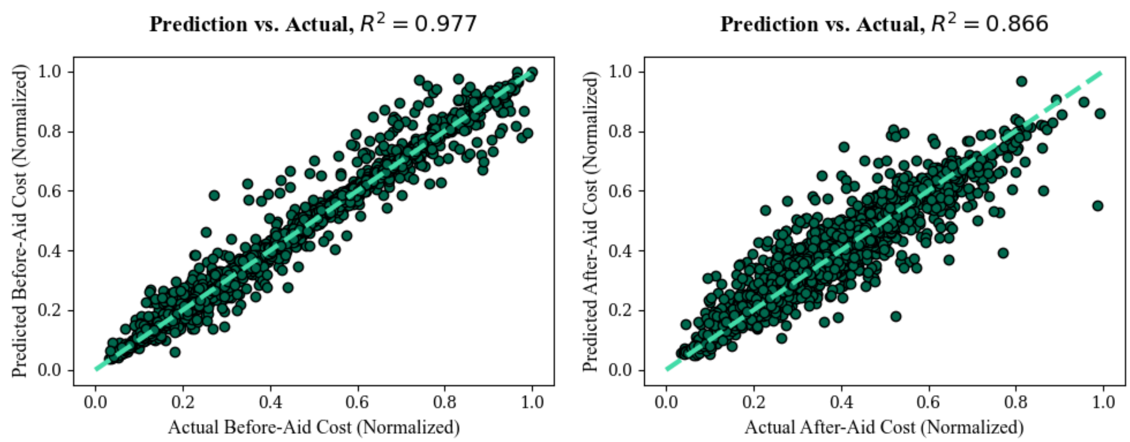
The R^2 formula is calculated from the residual sum of squared errors (SS_{res}), or the sum of squared errors between the actual and predicted cost values, the total sum of squares ($SStot$), which is the sum of squared differences from the mean.

$$R^2 = 1 - \frac{SS_{res}}{SS_{tot}}$$

Equation 4 – R^2 Equation

The R^2 scores for the before- and after-aid cost data were 97.70% and 86.60%, respectively, meaning that the model is fairly accurate. The reason why the after-aid cost data creates a slightly less accurate model is that the sticker price of college has a more linear pattern, and the average federal and scholarship aid provided to students fluctuates greatly from year to year. Regardless, these tests show that the linear regression model is appropriate for further predicting before- and after-aid college costs. This is visualized in Figure 4, which shows those relationships and the R^2 scores for each.

Figure 4 – Comparison of Predicted and Actual Before- and After-Aid Costs



To begin predicting beyond the known historical data, new columns for academic years 2023-23 to 2027-28 were created in the dataset to house the predicted cost values for each school. The three most recent costs for each school (2019-20 to 2021-22) were used as inputs for the linear regression model. When the model is run, each school has its row of predicted costs through 2027-28. The equations from the linear regression for both the before- and after-aid cost data are shown in Equations 5 and 6.

$$\hat{y} = -0.0007 - 0.07x_1 + 0.13x_2 + 0.97x_3 - 0.01x_4 + 0.003x_5 + 0.001x_6$$

Equation 5 – Linear Regression Equation for Before-Aid Costs

$$\hat{y} = 0.01 + 0.10x_1 + 0.17x_2 + 0.72x_3 - 0.01x_4 + 0.01x_5 + 0.01x_6$$

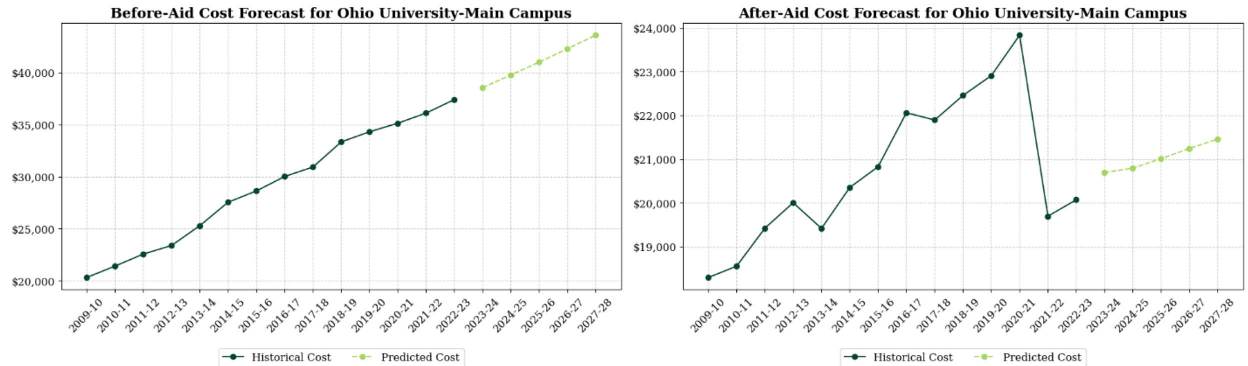
Equation 6 – Linear Regression Equation for After-Aid Costs

Table 3 – Glossary of Variables for Equations 5 and 6

Variable	Description
x_1, x_2, x_3	Normalized costs for academic years 2020-21, 2021-22, and 2022-23
x_4, x_5, x_6	Control variables for public, private, non-profit, and private, for-profit

In Figure 5, the historical and predicted before- and after-aid costs for Ohio University's main campus. Looking at these charts, it is evident that the sticker price to attend school has increased in an almost perfect linear fashion over the last thirteen years, and the model predicts that this will continue through the 2027-28 academic year. The after-aid costs have fluctuated greatly between the 2019-20 and 2020-21 school year, and this can be attributed due to Ohio University's participation in the CARES Act and the distribution of $1,384,283 in aid (Ohio University, n.d.). Overall, Ohio University's aid distribution appears to be choppy throughout the last thirteen academic years, with net costs peaking in the 2020-21 academic year.

Figure 5 – Plot of Before- and After-Aid Costs at Ohio University



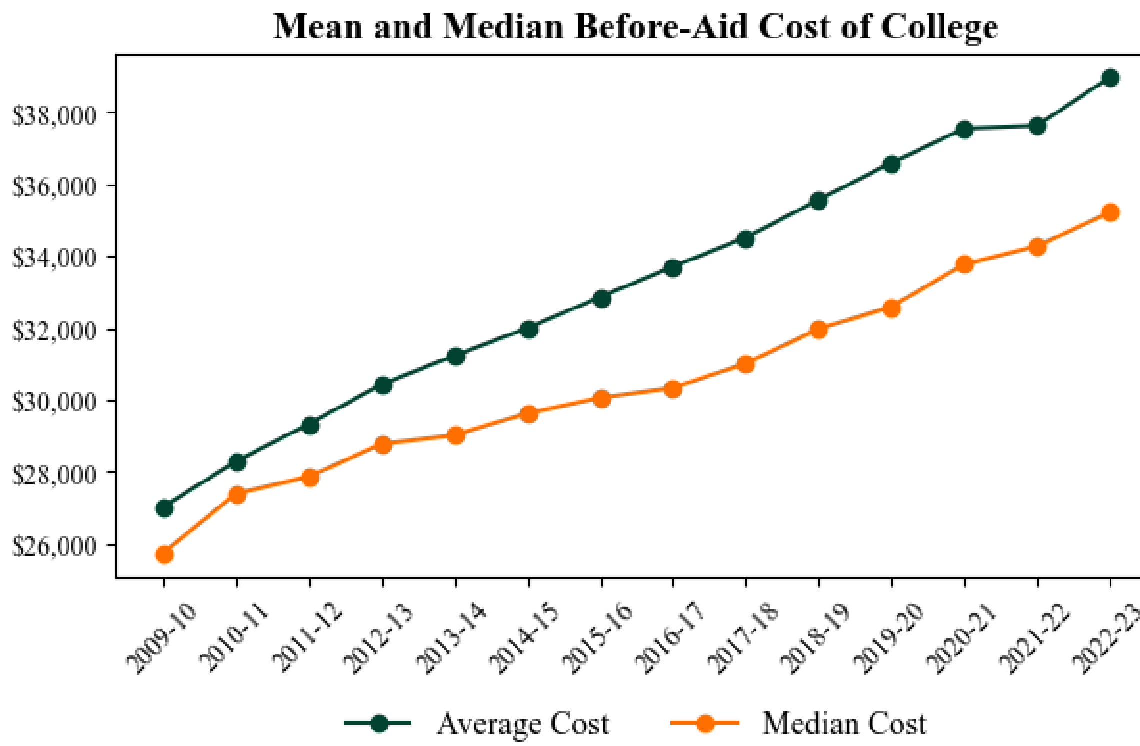
Much more analysis on what can be learned from the predicted data output will be conducted in the next section of this thesis.

Discussion

Even before beginning to work on NPV or future college cost projections, analyzing data between college costs and earnings yielded many discoveries.

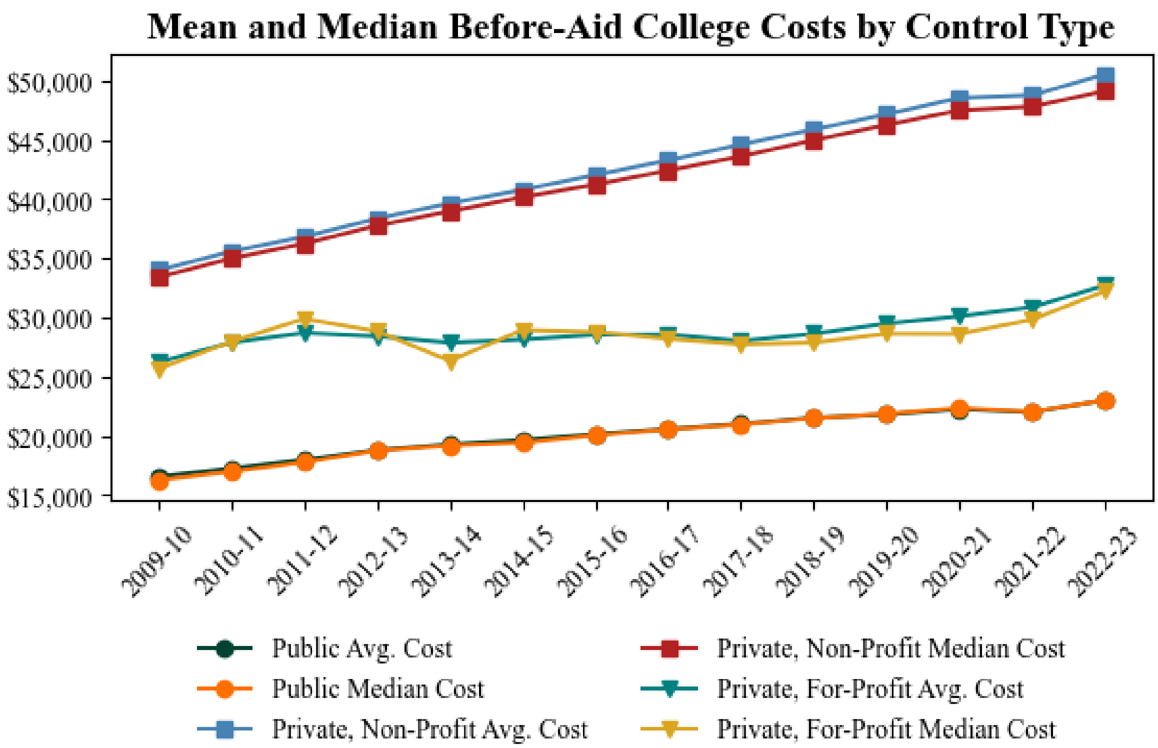
Firstly, in processing the data on college costs, it is evident that the difference between the average cost of college and the median cost of college across all schools grew significantly between the studied academic years of 2009-10 to 2022-23. This is visualized in Figure 6. Note that Figure 6 shows the average before-aid costs for an institution. As seen on the chart below, the average cost of college grew at a somewhat constant rate compared to the median, which tended to fluctuate slightly more. In addition, it is easy to see the effect that the COVID-19 pandemic had on the cost of higher education, as the average sticker price hardly grew between the 2019-20 and 2020-21 academic years.

Figure 6 – Plot of Mean and Median Before-Aid College Costs



The gap between the average and median costs are easily explained by the vast difference in costs between public universities and private, non-profit universities. Figure 7 separates the mean and average costs by control type, visualizing the differences in costs between these institutions. While there are many more public universities in the dataset, the costs from private universities are so great that they skew the mean annual cost much higher. The costs from private, for-profit universities are also higher than those of public universities, although not nearly as high. There are also far fewer private, for-profit institutions in the United States. a few notable names include the University of Phoenix, Strayer University, National American University, and Grand Canyon University – schools that are typically known for their nationally-available online degree programs.

Figure 7 – Plot of Mean and Median Before-Aid College Costs by Control Type



When this data is segmented by institution type, the differences between the mean and median are not very great. The costs of private, non-profit institutions are the most expensive, followed by the private, for-profit schools, and then the public universities. It is very clear, however, that private, non-profit universities have the fastest-growing costs. On the other hand, public universities boast a much more modest growth in cost since the 2009-10 academic year. Private universities are known to be more expensive, but the gap in average costs between public and private schools has grown by almost 58% in the last 13 years.

Note that the data in Figure 7 is not adjusted for inflation; the overall inflation rate between 2009 and 2023 is 33.15% (U.S. Bureau of Labor Statistics, n.d.), compared to the college costs rising by almost 50% (U.S. Bureau of Labor Statistics, n.d.). Table 4 outlines the growth of these costs.

Table 4 – Growth Rates of Before-Aid Costs by Control Type (2009-2023)

Institution Type	**Growth Rate of Average Sticker Costs (2009-2023)**
Public	38.89%
Private, For Profit	24.71%
Private, Non-Profit	48.64%

The most interesting thing about Table 4 is that while private, for-profit schools are more expensive than public institutions overall, the growth rate of their costs over the given period is much lower than that of public or private, non-profit institutions. This finding can be attributed to the market influence regarding for-profit institutions – they have a bottom line to meet that is publicly available. For-profit institutions have an incentive to not raise their costs as much because the alternatives, public and private non-profit schools, are implementing greater cost increases every year. Furthermore, for-profit institutions can cut costs where traditional universities cannot. For example, the University of Phoenix does not have any tenured faculty, and all faculty members teach adjunct (Dillon, 2007). Overall, this explains why costs for private, for-profit universities likely have not risen as much as traditional colleges during the 2009-10 to 2022-23 period.

Meanwhile, while the data prevented the ability to forecast future NPVs, there is a lot to be deducted from the program-specific NPVs calculated for 2019 and 2021 graduates. Analyzing the results of the NPV analysis (reference Table 2 on page 25) suggests a major in Health-Related Knowledge and Skills as having the most significant increase in value in the studied period.

The University Network reports that this major covers a broad spectrum of topics “such as nutrition, physical activity, disease prevention, health literacy, healthcare systems, and health legislation” (The University Network, n.d.) and that typical career trajectories include public health positions and health policy. This could also be a bachelor's degree that prospective doctors and other health professionals take on before their advanced degrees. However, since there is only data to compare 2019 and 2021 graduates, this data cannot take doctors into account. Despite that, it could be reasonable to assume that the healthcare professionals who majored in Health-Related Knowledge and Skills and perhaps work in public health and hospital administration saw compensation increases due to the COVID-19 pandemic.

The Bureau of Labor Statistics Occupational Outlook Handbook expects healthcare jobs overall to increase in demand faster than average through 2033, with about 1.9 million job openings projected each year (U.S. Bureau of Labor Statistics, n.d.). This supports the data analysis that the Health-Related Knowledge and Skills major had the most significant growth between 2019 and 2021.

The major with the second-most significant increase in value over the 2019-2021 period is electromechanical engineering. Electromechanical engineering is primarily focused on the automation and robotics industries (Pennsylvania State University, n.d.), so the expansion of these in recent years could be reasoning as to why this major has grown in value over the studied period. The automation and robotics industries are expected to grow at an 18.4% compounded annual growth rate (CAGR) between 2023 and 2030 (Melissa, 2024), so it seems rightly assumptive to say that the growth of this industry is driving the increase in the value of the major.

Another engineering major in the top ten is Polymer/Plastics Engineering. This could be in part caused by the growth in the plastics industry, which is projected to have a 7.72% CAGR through 2033 (Spherical Insights & Consulting, 2025). Furthermore, the plastics industry saw employment growth increases of 1.30% per year between 2012 through 2022 (Montoya, 2024), supporting the data that plastics engineering degrees are significantly increasing in value.

While the BLS Occupational Outlook Handbook does not have a section dedicated specifically to electromechanical, polymer, or plastics engineering, it estimates that architecture and engineering occupations (which is how the BLS groups the industries) will have overall above average growth compared to all occupations between 2023 and 2033 (U.S. Bureau of Labor Statistics, 2024). This supports the notion that those fields are growing and that the increase in NPV is supported by broader trends.

The third engineering major that saw the most significant growth between 2019 and 2021 was civil engineering. Like the other engineering majors discussed, the BLS reports that civil engineering employment is expected to grow by 6% between 2023 and 2033 (U.S. Bureau of Labor Statistics, 2024). This growth is caused in part by increases in eco-friendly infrastructure projects and new technologies that allow better planning early on in production (AtkinsRéalis, 2021). The increase in civil engineering degree values can be attributed to the growth in the overall engineering field.

Unsurprisingly, the analysis points toward nursing as having one of the biggest value increases between 2019 and 2021. This could be attributed to the travel nursing boom over the COVID-19 pandemic, when many nurses, attracted by high pay of sometimes more than $5,000 a week, began working for travel nursing agencies rather than just one hospital or hospital system. The number of nurses working for these agencies more than doubled during the pandemic (Lee, 2022). Nurses would travel around the country to the hospitals most overrun with COVID-19 patients, often for contracts between 7 and 13 weeks. Now that the pandemic has largely subsided, some nurses are seeing massive pay cuts, upwards of 50%, compared to their pay during the pandemic (Lee, 2022).

While the data from the Department of Education between 2019 and 2021 shows that nursing degrees saw some of the most significant value growth, this could just be a spike attributable to an outside event. However, an argument could be made that with an aging population and overall advances in healthcare, nursing could have had very significant growth without the effects of the COVID-19 pandemic. As such, the Bureau of Labor Statistics estimates that there will be a 6% increase in the employment of registered nurses between 2023 and 2033, which is considered “faster than average” (Bureau of Labor Statistics, U.S. Department of Labor, 2025).

Teacher Education, Professional Development, Specific Levels and Methods is another major with significant growth in value between 2019 and 2021. The average difference between 2019 and 2021 NPV calculations was over $62,000. However, there does not appear to be much information on the major and why it might have had such an increase in value in those two years. The universities that offer it, according to the Department of Education data, include Arizona State University, Alabama A&M University, Purdue University, and San Diego State University, but this major does not appear on any of their websites (Arizona State University, 2025; Alabama A&M University, 2025; Purdue University, 2025; San Diego State University, 2025). Additionally, US News and World Report lists the major as a master’s program rather than an undergraduate major (U.S. News & World Report, n.d.).

It is hard to determine the reasoning as to why this major had such a great increase in value over the studied period. Since it is easy to assume that the vast majority of teachers were some form of education major (i.e., early elementary or secondary), it is not clear where teacher education, etc. majors were employed after graduation, especially since there doesn't seem to be any information about the major itself. Even if it is assumed that these graduates did become teachers, by most (if not all) accounts, teachers' salaries are not growing that greatly. The first couple points on the Nation Education Association's webpage on Educator Pay Data are that "even with record-level increases in some states, average teacher pay has failed to keep up with inflation over the past decade" and "adjusted for inflation, on average, teachers are making 5% less than they did 10 years ago" (National Education Association, n.d.), so it is doubtful that this increase in value on the major had to do with graduates working in K-12 public schools. Ultimately, there does not seem to be any sound reasoning as to why this major had such significant growth between 2019-2021.

On this list, three majors with the most significant growth between 2019 and 2021 are very similar: Business Administration, Management, and Operations, Accounting and Related Services, and Finance and Financial Management Services. Because of the similarities between these majors, they were grouped for the analysis of their value growth. Back in 2021, the Bureau of Labor Statistics estimated that business, management, and sales professions would not only have the highest number of annual job openings between 2020 and 2030 but also the highest average of median wages across different career paths (Torpey, 2021). The BLS's Occupational Outlook Handbook attributes a lot of these openings to the number of people leaving such professions, either to leave the industry or retire (Bureau of Labor Statistics, 2025). Regardless, the combination of a strong outlook for open jobs in the field coupled with the highest salaries certainly contributes to the reasoning why there was both the most data from these majors as opposed to the others, and as to why the value of those business degrees had some of the greatest growth between 2019 and 2021.

This outlook continues to be accurate, and the BLS estimates that 10% of jobs are business careers, and for many business-related careers, employment demand “is expected to increase four times faster than the average for all occupations” (Ice & Laycock, 2025). Furthermore, most of the occupations in business fields had wages higher than the overall median wage for 2023 (Ice & Laycock, 2025). It is probably accurate to assume many business students pursued such a major at least in part because of the higher expected earnings, and the BLS data shows that such earnings are a reality that seems to be sustainable over the next ten years (University of New Hampshire College of Professional Studies, 2022; BLS, 2025). Additionally, for most careers in this field, a bachelor’s degree is required, so there is no other way for prospective business-function-related employees to get a foot in the door. Business degrees have become so popular that a vast majority of awarded bachelor’s degrees are for business, and the next awarded degree, with over 100,000 fewer conferred for the 2021-22 academic year, is under the health professions and related programs umbrella (Ice & Laycock, 2025). The other advantage of a business degree is that they are flexible, simply because, one way or another, almost everything is a business.

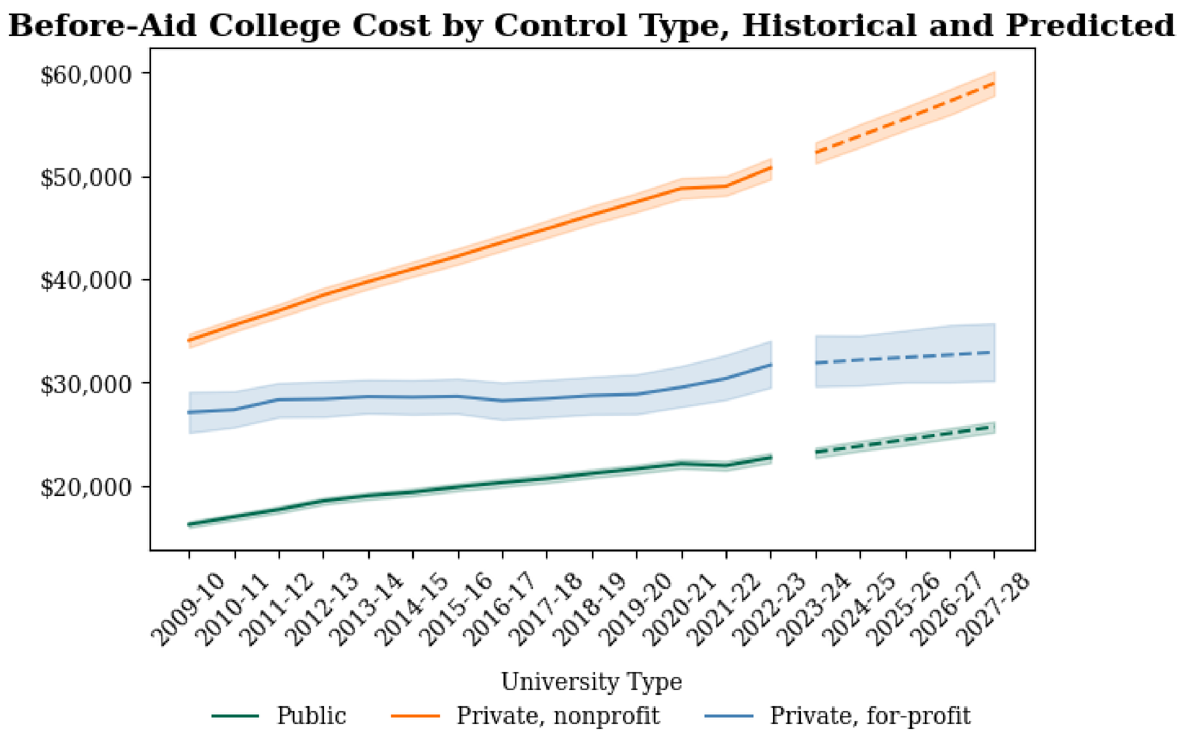
Overall, this growth of the value of business degrees showcases how much employers value college degrees in general, as well as how much the financial and accounting fields are growing. Specifically, accounting and financial analyst jobs are expected to grow by 6% and 9% between 2023-33, respectively (BLS, 2025).

Finally, biology is the major with the eighth-most significant degree value growth between 2019 and 2021. The analysis for this major is a little more complicated, as 59% of bachelor's degree earners in biology obtain a more advanced degree (U.S. Bureau of Labor Statistics, 2024). So while the Department of Education does have data on those undergraduates that are working 1 year post-graduation, the earnings data is representative of those with only a bachelor's degree at that point and not of those with more advanced degrees. However, the BLS notes that there are some fields within biology where most employees only have a bachelor's degree, including laboratory technicians and registered nurses. Since there are so many applications for bachelor's degrees in biology, there is not a specific occupation category that can be studied for job and salary growth. Despite that, the BLS's Occupational Outlook Handbook notes that "overall employment in life, physical, and social science occupations is projected to grow faster than the average for all occupations from 2023 to 2033" (U.S. Bureau of Labor Statistics, 2024), so it stands to reason that there could be more job openings for undergraduates majoring in biology. This increase in employment leads to higher earnings numbers for graduates, increasing the NPV of these degrees.

As for predictive cost data, trends regarding how college costs may change based on institution control, location, aid received, and other factors were analyzed. While these predictions are limited to the cost inputs and exclude external factors such as changes in legislation, pandemics, and other events that may affect college costs, they do show the overall trajectory of the annual average cost of attendance at institutions by certain variables.

Figure 8 shows the actual average sticker costs for academic years 2009-10 through 2021-22 and the predicted sticker costs for academic years 2023-24 through 2027-28. The term "sticker cost" being used to designate that these costs include "The average annual total cost of attendance, including tuition and fees, books and supplies, and living expenses for all full-time, first-time, degree/certificate-seeking undergraduates who receive Title IV aid," but it does not take any aid into account, and it only contains data on in-state students (U.S. Department of Education, n.d.). Those living expenses mentioned in the explanation are for on-campus room and board, and it does not include any off-campus expenses.

Figure 8 – Plot of Before-Aid Costs by Control Type with Predictions



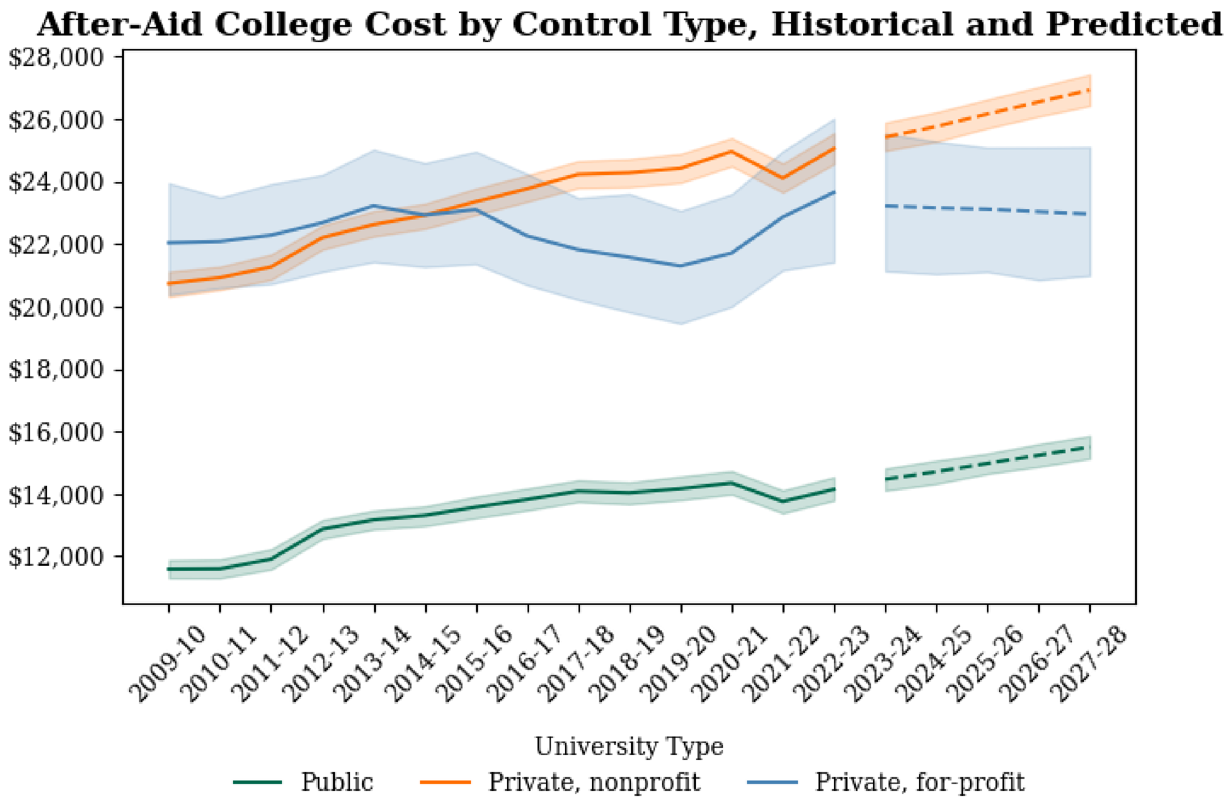
In Figure 8, costs are segmented by control type, and the hue surrounding the center line is the 95% confidence interval for these predictions. This plot shows that private, non-profit institution costs have risen at a much faster rate than private, for-profit, and public schools. This trend is expected to continue, with average sticker prices at private colleges quickly approaching $60,000 per year. Meanwhile, private, for-profit college costs are expected to remain somewhat stagnant through the 2027-28 academic year. Public institutions have historically had a much slower growth rate of their sticker prices, but they are expected to have slight increases in cost over the prediction period.

Note once again that these costs are only for in-state students, and those students attending public colleges out of state are likely responsible for higher costs. The Department of Education does not include data for those out-of-state students. In general, it is widely known that for many states, such as California or New York, out-of-state students pay a much higher premium to attend public colleges. The inclusion of those costs may make private, for-profit college costs much more comparable to out-of-state costs for some public schools. Unfortunately, for prospective students looking to attend public colleges out of state, the College Scorecard website does not include data on the out-of-state difference.

Alternatively, this data can also be analyzed on a "net cost" basis, or the total cost as described before minus any scholarship and grant aid received. This is the total cost of college for which a student is responsible, whether it is paid by themselves, student loans, family members, or another method. Figure 9 is a visualization of the net costs by control type.

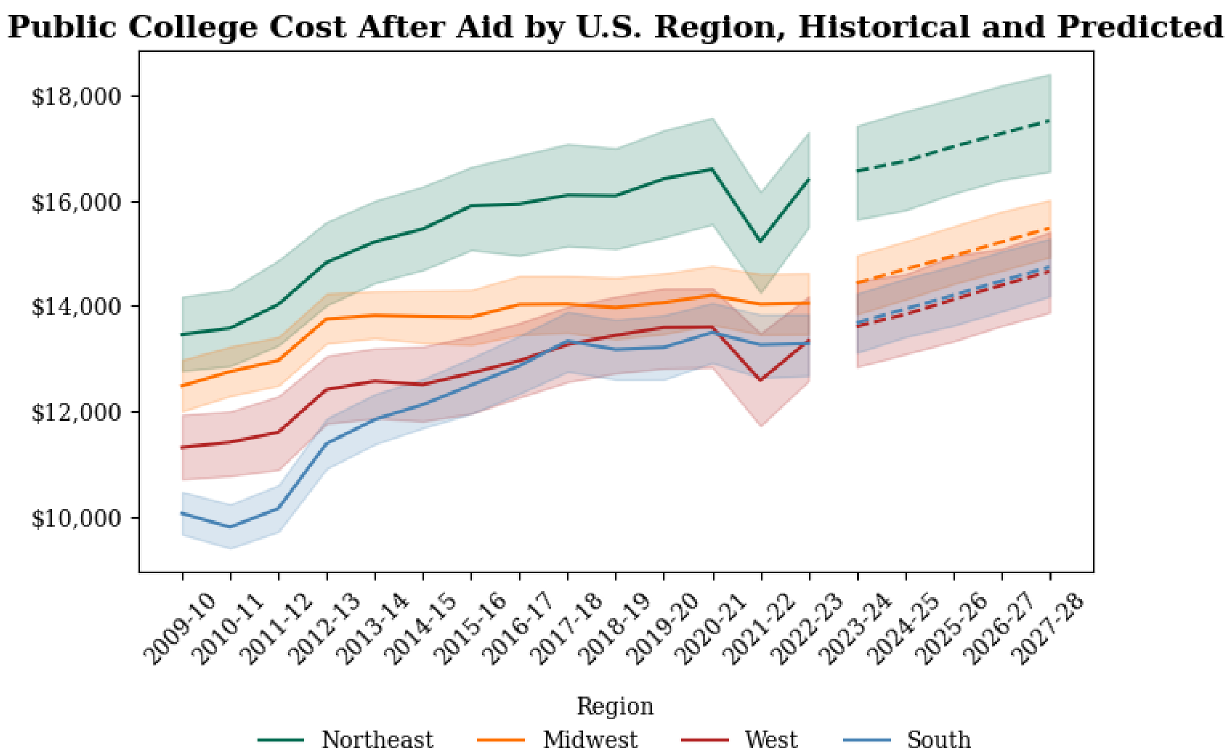
When analyzing the net cost data, it is evident that private, non-profit universities are still the most expensive, but there is a nearly $40,000 gap between the posted sticker price and the cost for which students are responsible. Public universities once again have the lowest costs, but the model suggests that they are expected to rise at about the same rate as private, non-profit universities in the coming years, perhaps suggesting that the amount of financial aid that is received is awarded at the same rate. Meanwhile, due to the volatility in federal and scholarship aid offered year to year, the confidence intervals for the after-aid costs are wider than the sticker prices, leaving prospective students and families a more unclear picture of what college could cost. Furthermore, the 95% confidence interval for private, for-profit universities is much wider, suggesting more uncertainty in the future costs of these schools.

Figure 9 – Plot of After-Aid Costs by Control Type with Predictions



For a regional examination of the data, shown in Figure 10, the schools were separated into the regions recognized on the US Census: Northeast, Midwest, South, and West. The graph below shows the historical and predicted costs of public institutions by region, with the 95% confidence interval represented by the hue around the lines. While an analysis of all schools unsurprisingly shows the Northeast as the most expensive (as many private schools, including most of the Ivy League and MIT, are in the region), the public-school only data also shows the Northeast as the most expensive region to attend college. There is a significant gap between the costs (and predicted costs) of the northeast schools compared to the other regions. The data also shows that the cost of attending a public college in the South and the West regions are about the same, and are predicted to remain that way.

Figure 10 – Plot of After-Aid Costs by Region with Predictions

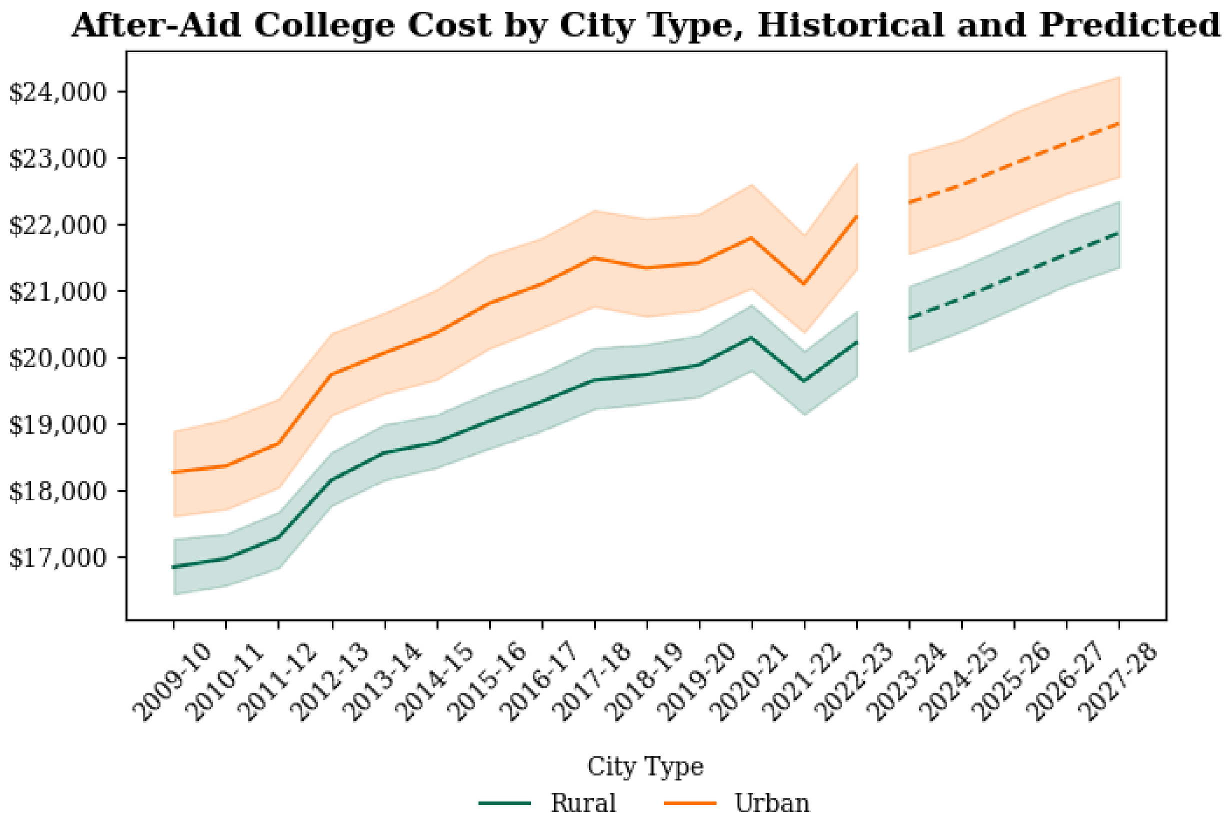


Another noticeable point in this data is the difference in the effects of the COVID-19 pandemic on college costs by region. Colleges in the Northeastern and Western regions experienced a greater dip in after-aid college costs than those in the Midwest or Southern regions. This is likely attributable to the differences in pandemic safety policies by state during the 2021-22 academic year and university participation in the CARES Act. For example, the University of Washington in the West region determined that its winter quarter classes for the 2021-22 academic year would be held remotely, and it had spent nearly $117.8 million of its CARES Act funding as of January 1, 2022 (Sabes & Singman, 2022). It stands to reason that students at these universities may have received more aid from their colleges, perhaps along with reduced housing costs, causing the dip.

It could also be assumed that state policy could be another factor behind the dip in after-aid college costs, since states in the South and West are typically more conservative, despite a few outliers. There does not appear to be much analysis of the college cost trend differences post-pandemic between regions. However, many of those conservative states, such as Florida, Mississippi, Montana, Idaho, Utah and others placed a ban on public schools requiring vaccines for students (National Academy for State Health Policy, 2025), suggesting that likely fewer colleges in those states participated in remote off-campus learning for the 2021-22 academic year, which would not impact on-campus housing costs.

There also appears to be a net cost gap between institutions located in large cities and those in rural areas, which is visualized in Figure 11. Colleges in cities with populations greater than 100,000 in 2023 were considered "urban" for this analysis, and all other schools were considered "rural" (Wikipedia contributors, n.d.). Schools in both categories followed the same trajectory in net costs between the 2009-10 and 2022-23 academic years, and the gap between them seems to have remained consistent over the past 13 years. However, colleges in urban areas saw a sharper increase in net costs in recent years compared to rural schools, perhaps due to increasing housing costs in more populated areas (remember that these net costs take on-campus housing into account). As universities have expanded and have needed to increase the availability of on-campus housing, costs for new residence halls have also increased. Looking forward, there appears to be much more variability in what future costs for colleges in urban areas could look like compared to rural areas, as the 95% confidence interval around the predicted line is wider.

Figure 11 – Plot of After-Aid Costs by City Type with Predictions



Limitations

The initial limitation with this thesis is that most of the data from College Scorecard was incomplete. By the time all the rows of data with missing cost or earnings values were eliminated, less than 20% of the original data still existed. However, it seems reasonable to assume that a lot of the data lost was irrelevant to some degree. For example, there was not sufficient data on Hobe Sound Bible College, which, according to Niche, only enrolls 78 undergraduate students (Niche, 2024). Most data from obscure institutions like this were omitted, and there are numerous small institutions around the country.

To expand on that, the biggest limitation of this study on the value of college is the lack of historical earnings data. The Department of Education recently started recording the earnings of college graduates in 2018, and there is no data on the individual graduating classes. Instead, the earnings data is in pooled years, leaving only two data points. For this undergraduate thesis, the midpoint of the 2018-20 data pool was assumed, and the correlations shown in Figure 1 on Page 21 were used to select the year used for the 2020-22 data pool. This severely limited the ability to create the predictive model as initially intended to find the NPV of a future college graduate. As this limitation came to light, the study pivoted to analyzing the differences in NPV over the two selected years and determining which programs saw significant increases in value and the possible causes. An additional result of this pivot was the analysis of the cost of college between the 2009-10 and 2022-23 academic years and eventually using this data to forecast the cost of college for the coming years.

Another limitation of this study is the assumption that both wage and college cost growth will be both linear and uniform in the NPV analysis, which simply isn't realistic. Salaries can fluctuate beyond a normal growth rate through promotions, employer performance, job changes, and inflationary pressures. Additionally, wage growth does not always continue to grow toward the end of an individual's career, and many degree value models assume that wages decline as one retires. In terms of average wages for graduates, this makes sense, as many people retire or move to part-time work at different ages, which would pull the average earnings awarded to a cohort down. While these models may be taking individual decisions such as working fewer hours or retiring early into their calculations, it is a typical assumption, nonetheless. Two examples of this type of model include that used by the Hamilton Project (The Hamilton Project, 2020), and the findings from Zhang et al. in their 2024 study discussed earlier in this thesis.

For the NPV calculations, there was no accounting for the implications that student loans would have on cash flow. This decision was made largely for the sake of simplicity in the calculations, which assume the tuition was paid in full each semester. Although, income data from College Scorecard represents the "median annual earnings of individuals who received federal financial aid during their studies and completed an award at the indicated field of study" (U.S. Department of Education, 2024), so the data assumes that either graduates will have some amount of federal student loan debt, or they attended college on a federal grant, such as the Pell grant. This decision impacts the projected cash flows and the time value of money in such an analysis. However, it would likely be difficult to implement such implications of student loans on a large scale, even though 92.4% of all student loan debt is with the federal government rather than with private corporations – meaning data is accessible (Hanson, 2025).

One reason for the exclusion of student loans in the calculation is that graduates are likely to pay down their loans at different rates depending on their personal cash flow situations. Some may make minimum payments for several years to qualify for existing loan forgiveness programs such as the Income-Driven Repayment forgiveness or Teacher Loan forgiveness programs (Haverstock, Helhoski, & Lowe, 2025), and others, presumably those entering high-paying careers post-graduation, may make additional payments to wipe out the debt faster than scheduled.

Furthermore, college costs have not increased at a constant rate. While the overall median annualized growth rate was 2.9%, this exact growth rate does not occur every year at every institution. This assumption would have had a massive impact on the study if there had been enough data to forecast future degree NPVs. Since there was data on the cost of a four-year degree for 2019 and 2021 graduates, this prediction was not needed.

An additional factor is that for some schools, there is limited information and reporting. For example, the Department of Education just started receiving data from Pennsylvania State

University, from which more than 40,000 undergraduate students attend (U.S. News & World Report, 2025), so those points were excluded from the overall analysis. Other notable missing schools include Princeton University, American University, Howard University, and Georgetown University, among many others.

The lack of data here impacts the overall accuracy of the cost findings as it relates to most students. Many of the institutions that were not included in the cost analysis graduate thousands of students every year, and these larger schools tend to come with higher price tags, which would impact the measures of central tendency that were used to compare costs over time.

Finally, a limitation in the comparison of before and after-aid college costs is observed in that the data was not matched against each other. Because of this, the two datasets may not completely represent the same schools, so the comparison of trends between the costs may be flawed.

Conclusion

While the initial purpose of this study could not be carried out, analyzing college cost and earnings data has still provided material findings about the state of higher education in the United States. The majors with the most significant increases in value are in healthcare, education-related, electromechanical and plastics engineering, and business fields.

On the other hand, the sticker price for the cost of college is suggested to continue rising, with a widening gap between the cost of public and private universities that will continue. The average net price that students pay is also suggested to increase, but with slightly less certainty as federal and scholarship aid fluctuates every year. Colleges in the Northeastern United States are expected to continue to be the most expensive, likely because of the large presence of elite private schools in the region. When omitting the private colleges, Northeastern colleges are still the most expensive, but the gap between this and the other four regions is not nearly as wide. Meanwhile, public colleges in the Midwest, South, and West have fairly even pricing predicted for the coming years. The gap in price between colleges in urban and rural areas has remained consistent over the past 13 years, and the model suggests that it should remain the same in the next five years.

Overall, a student looking for the least expensive college experience should consider public schools in the Southern or Western regions that are in rural areas.

This study did not accomplish its initial goal of forecasting NPVs of individual degree programs, but it did begin the framework for conducting such research. As the Department of Education continues to collect data in the coming years (provided any legislation does not dismantle the collection of such data), there will eventually be enough data to forecast future values of bachelor's degrees.

Using this method to value a college degree would help prospective college students make informed decisions about their career paths and their standard of living after graduation. It will also help them compare the advantages and disadvantages of different degree programs between schools. While the College Scorecard does give prospective students and their families real data as to typical earnings and debt repayments for each program, it does not account for future earnings potential and recovering the cost of education. As the website evolves, it could begin to provide more earnings data for graduates ten, fifteen, or twenty years post-graduation, which would provide prospective students with an idea of career progression, and it would permit more accurate calculations for degree valuation.

Appendix A

Equation 2 Supporting Code

```
t_stat, p_value = stats.ttest_rel(data["2021_npv"], data["2019_npv"], nan_policy='omit')
```

The code above was used to calculate the t-stat and p-value to determine the significance of the differences between the 2019 and 2021 NPVs. The t-test function is from the Python SciPy library, and it is set to omit null values.

Appendix B

Benjamini-Hochberg FDR

```
major_results["adjusted_p"] = smm.multipletests(major_results["p-value"], method="fdr_bh")[1]
```

The multiple comparison correction, or Benjamini-Hochberg FDR, is used to adjust the calculated p-values for multiple comparisons, correcting for the false discovery rate or false positives. The “fdr_bh” segment of the code is used to apply this method, and the results are inputted into the new column in the major_results dataframe titled “adjusted_p,” which is the adjusted p-value.

Appendix C

A note on the use of generative AI:

Generative AI, namely ChatGPT, was utilized in this thesis as a tool to debug and adjust Python code, format charts and graphs, and format citations. All AI responses were checked for accuracy.

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