ECON 524 Final Project

EFFECTS OF COLLEGE MAJOR, INSTITUTION, AND DEGREE ON POST-GRADUATE EARNINGS

Brittany Wheaton

Introduction

A common question that plagues students pursuing a college education, particularly in a climate where student loan debt burden is increasing, is "What value will I get from this education and how can I maximize it?" More and more young people pursuing college degrees end up in low-paying jobs after graduating or even unemployed. Often, they are not equipped with the knowledge to make the most rational choice for their future. This is the motivation for research questions such as the one that will be explored in this paper:

"How do college major, institution, and degree level affect graduate earnings?"

By understanding the impact of a chosen school, major, and level of final degree pursued, students can be equipped to make informed decisions regarding their future before they even graduate high school if they choose to do so. Parents can also use this information to help guide their students toward programs that have the highest return, given an individual's skill level and interest.

Data sources and background

The data used to perform the regression in this report come from the United States Census Bureau. The particular data set is an experimental data product called the Post-Secondary Employment Outcomes (PSEO). It contains earning outcomes and employment flows for recent graduates of partner colleges and universities. The universities represented in the dataset include several public universities in Colorado, the University of Texas network, the University of Michigan at Ann Arbor, and the University of Wisconsin at Madison. Graduates must meet the following criteria in order to be considered for the PSEO: 1) they must earn at least the annual equivalent of full-time work at the prevailing federal minimum wage, and 2) they must work three or more quarters in a calendar year.

The statistics are generated by matching university transcript data with a national database of jobs. Earning outcomes for graduates from a particular institution are available by degree field, degree level, and graduation cohort. The 25^{th}, 50^{th}, and 75^{th} percentiles are released for one, five, and 10 years after graduation.

Economic (theoretical) and Econometric (statistical) models

The question of interest in this research is grounded in Human Capital Theory. While there are many elements to this theory, a primary component of it explores the return on investment for education. A regression equation helps to explain the differences in earning outcomes based on customizable elements of an individual's education. An economic model that models earnings as a function of major, institution, and degree will be the base for this regression and is written as follows:

$$\textit{Earnings} = f(\textit{institution} + \textit{major} + \textit{degree level})$$

This can be converted to the following econometric model:

$$EARNINGS_i = \beta_0 + \beta_1 INSTITUTION_i + \beta_2 MAJOR_i + \beta_3 DEGREE_i + \epsilon_i$$

While not a primary variable of interest, the graduation cohort will also be considered in the regression to account for any differences in year and is modeled as follows:

$$EARNINGS_i = \beta_0 + \beta_1 INSTITUTION_i + \beta_2 MAJOR_i + \beta_3 DEGREE_i + \beta_4 COHORT + \epsilon_i$$

Independent Variables

The first independent variable considered in the regression is institution, or university. There are many institutions included in the dataset; however, most of them are Colorado schools. The only schools included for Texas are the University of Texas system schools. Michigan and Wisconsin each only have one school to represent them in this dataset. Therefore, for simplicity and even representation, four schools of similar type were chosen for the sample (the main campus of a 4-year public state university). The schools included in the selected sample are University of Colorado – Boulder, University of Michigan – Ann Arbor, University of Texas – Austin, and University of Wisconsin – Madison. It is likely that some of these universities may contribute more positively to an individual's earning potential due to prestige, though it is not immediately clear which schools provide the most benefit to graduates, if any. It is also possible that these effects may be more pronounced in certain geographic areas, though there is not data available to be able to explore this connection.

UCB	71
UMAA	77
UTA	80
UWM	74
Grand Total	**302**

Figure 1. Frequency table by university

The second independent variable, major, is somewhat more complex with over 50 different available majors. These were narrowed down to just seven majors representing several different areas, some of which were consolidated with other majors where appropriate. These majors include the following: Business Administration, Civil Engineering, Mathematics and Statistics, Fine and Studio Arts, English Language and Literature, Health and Physical Education/Fitness, and History. These categories were chosen on the basis of both popularity to ensure adequate representation and perceived potential differences in earnings. Below is a distribution of relative representation for each major in the sample used. Based on the chosen majors, it is assumed that each major will have significantly different effects on the dependent variable earnings. Projected positive majors are Business, Civil Engineering, and Mathematics. Those with less earning power are expected to be English, Fine and Studio Arts, Health and Physical Education, and History.

Business, Management, Marketing, andRelated Support Services (Consolidated52.01-52.99)	62
Civil Engineering	24
English Language and Literature/Letters(Consolidated 23.01-23.99)	59
Fine and Studio Arts	24
Health and Physical Education/Fitness	21
History (Consolidated 54.01-54.01)	56
Mathematics and Statistics(Consolidated 27.01-27.99)	56
Grand Total	**302**

Figure 2. Frequency table by major

The third independent variable included is degree level. The categories represented in the PSEO data include Baccalaureate, Masters, Doctoral – Research/Scholarship, and Doctoral – Professional Practice, as well as a Post-Baccalaureate Certificate category. The latter was removed from analysis due to an insignificant amount of observations, and no Doctoral –

Professional Practice were included due to the type of majors chosen. Since this is an ordinal scale, one would expect earnings to increase directly with more advanced degrees.

Baccalaureate	174
Doctoral -Research/Scholarship	64
Masters	64
Grand Total	**302**

Figure 3. Frequency table by degree attained

Graduation cohort was also included as a final independent variable when running the regression in order to account for any possible changes to programs or another time based anomalies. Time is accounted for in the measurements of earnings as data was recorded 1, 5, and 10 years postgrad.

2001-2003	30
2001-2005	32
2004-2006	30
2006-2010	32
2007-2009	28
2010-2012	28
2011-2015	32
2013-2015	28
All Cohorts	62
Grand Total	**302**

Figure 4. Frequency table by graduation cohort.

<u>Dependent variable</u>

The primary outcome of interest is the level of earnings of the graduates studied. The earnings are measured in 2016 U.S. dollars. Furthermore, the data is collected not by individual, but by school/major groupings and is reported by years postgrad (1, 5, and 10) combined with percentile (25^{th}, 50^{th}, and 75^{th}).

Earnings by years postgrad, percentile	Mean	Standard deviation
1 year, 25^{th} percentile	37545.62	23081.38
1 year, 50^{th} percentile	50883.48	29421.75
1 year, 75^{th} percentile	67638.01	37750.48
5 years, 25^{th} percentile	50824.33	23696.04
5 years, 50^{th} percentile	68625.39	30400.81
5 years, 75^{th} percentile	92666.78	41475.89
10 years, 25^{th} percentile	62504.24	25849.90
10 years, 50^{th} percentile	86191.27	35470.07
10 years, 75^{th} percentile	122615.6	54567.35

While earning reports 5-10 years post-graduation may be more stable indicators of true earning potential, there are progressively fewer observations as the number of years since graduation increases. This is because of missing data from some of the more recent graduation cohorts. For this reason, the regression analysis will focus will be on earnings one year after graduation. Additionally, 50^{th} percentile will be chosen as for the dependent variable in the regression as it is most representative corresponding to the mean. The mean earnings for a graduate one-year post-grad in the 50^{th} percentile in one of the 7 selected majors is $50,883.48 (in 2016 US dollars).

Results

Model 1: $\boldsymbol{EARNINGS_i = \beta_0 + \beta_1 INSTITUTION_i}$

To begin the model fitting process, a simple linear regression model was fit as a baseline comparison. The chosen independent variable is institution, coded as a dummy variable with 4 levels. The University of Colorado at Boulder was set as the dropped reference level. Institution 1 corresponds to the University of Michigan – Ann Arbor; 2 corresponds to the University of Texas – Austin; 3 corresponds to the University of Wisconsin – Madison. This model is found to have little explanatory power with an R-squared value of .049 and adjusted R-squared of .038; less than 5 percent of the variation in earnings can be explained by institution alone.

A few relationships between institutions are significant. A graduate of the University of Michigan – Ann Arbor could expect to earn a little over $15,000 more dollars on average 1-year postgrad than a graduate from the University of Colorado at Boulder ($\beta_1 = 15{,}268.98$, $p = .003$). Similarly, a graduate of the University of Texas at Austin could expect a similar advantage of $16,136.94 more in earnings one year after graduation (p-value = .001). There is no significant difference in earnings between the University of Colorado at Boulder and the University of Wisconsin at Madison.

Model 2: $\boldsymbol{EARNINGS_i = \beta_0 + \beta_1 INSTITUTION_i + \beta_2 MAJOR_i}$

The next model that includes major has significantly more explanatory power than the model with institution only as the R-squared increases to .55. The dynamics between institutions remain similar in that the same relationships are still significant and the estimates of coefficients remain close to those in the simple model; however, we see that the magnitude of effect shifts slightly in favor of the University of Michigan. In this model, a University of Michigan graduate could expect a $16,528.83 advantage over a University of Colorado graduate, while a University of Texas graduate would expect around $15,000 more that the University of Colorado graduate.

To examine the influence of major, the seven chosen majors correspond to the following cipcodes:

0 (reference) – Business, Management, Marketing
1 – Civil engineering
2 – English Language and Literature
3 – Fine and Studio Arts

4 – Health and Physical Education/Fitness
5 – History
6 – Math and Statistics

cipcode	coefficient estimate
1	-32468.79
2	-51118.95
3	-58529.16
4	-57072.92
5	-49715.35
6	-31452.13

According to this model, business graduates hold the highest earning potential, followed by civil engineers and math students. The lowest-earning majors one year after graduation are English Language and Literature, Fine and Studio Arts, and Health and Physical Education/Fitness. All of these relationships are significant with p-values of .000. The differences in earnings are also quite significant. The intercept for the model is $75,788.49 with the average difference in earnings between Business and the other 6 majors being around $45,000.

Model 3: **$EARNINGS_i = \beta_0 + \beta_1 INSTITUTION_i + \beta_2 MAJOR_i + \beta_3 DEGREE$**

Model three, containing variables for institution, major, and degree level, is again another improvement with an R-squared of .7732 and adjusted R-squared of .7637. The relationships between institutions remain similar, though the effect of school is diminished in the larger model, with differences in earnings being closer to $12,000 for the aforementioned schools (University of Michigan and University of Texas). The effect of institution is not statistically significant for the University of Wisconsin (p=.07)

Variable	Coefficient estimate	Significant@.05(Y/N)	P-value
Institution			
UM-AA	12708.76	Y	0
UT-A	12394.35	Y	0
UW-M	4755.76	N	0.07
Major			
Civil Eng.	-20602.49	Y	0
English	-52495.95	Y	0
Fine Arts	-46662.86	Y	0
Health/PE	-44845.77	Y	0
History	-50582.6	Y	0
Math	-34344.9	Y	0
Degree			
Master's	12274.811	Y	0
Doctorate	39163.93	Y	0

There also remains significant differences between all 7 majors in the sample (p-value = 0.000), though coefficient estimates change after accounting for degree level. One of the most noticeable shifts is for civil engineering. In the previous model, a civil engineer might expect to make over 30,000 fewer dollars in earnings than a business graduate (holding institution fixed). In model 3, this gap closes to about 20,000 fewer dollars after accounting for degree level in addition to institution. Other decreases include the discrepancies between business and fine arts and business and health/fitness, which is logical since there are generally going to be more business majors who attain an MBA than arts or health graduates who pursue a Master's degree in their respective fields. The greatest difference is between Business and English, as an English graduate can expect to earn $52,452.88 less on average than a Business graduate one year postgraduation, after accounting of differences in institution and degree level. History majors can also expect to earn just over $50,000 less on average than business graduates one year after graduation, holding other variables constant. Math graduates earn $34,256.31 less on average than Business graduates one year post-grad after accounting for university and degree attained.

The effects of degree level are also significant, as expected based on human capital theory, which suggests that more education results in more economic return. This is evidenced by a coefficient estimate of $12,274.81 for a degree level of Master's, meaning that a graduate with a Master's degree can expect to earn $12,274.81 more on average than a baccalaureate, holding institution and major fixed. Similarly, a graduate with a Doctorate (scholarship/research) can anticipate nearly $40,000 more in earnings than comparable graduate with a baccalaureate only.

Model 4: $\mathbf{EARNINGS_i = \beta_0 + \beta_1 INSTITUTION_i + \beta_2 MAJOR_i + \beta_3 DEGREE + \beta_4 COHORT}$

The addition of cohort year to the regression model provides no beneficial explanatory power, as evidenced by a reduced adjusted R-squared value of .7595 compared with the previous model's R-squared value of .7637. Additionally, if we examine the relationship between the seven different cohorts with the combined reference group, there is no significant difference between any of the groups.

Cohort	Coefficient estimates	Significant@.05(Y/N)	P-value
2001	-2382.93	N	0.385
2004	-936.01	N	0.793
2006	206.34	N	0.955
2007	97.95	N	0.978
2010	-1702.55	N	0.636
2011	2188.27	N	0.566
2013	1388.13	N	0.7

An F-test was performed to further confirm Model 3 as the preferred model. The F-test tested the null hypothesis that $\beta_4 = 0$ against the alternative hypothesis that $\beta_4 \neq 0$. This test resulted in a failure to reject the null hypothesis, leading to the conclusion that model 3 is the preferred regression model, given the data available (F-test, F=2.395).

Discussion

There are many areas for possible extension from the research given. One obvious limitation to the regression as performed above was the choice to include only 7 majors. Clearly, most major universities offer many more than this; there were over 50 represented in the original dataset. For the scope of this project, a representative few were chosen for ease of interpretation. Because of the choice to omit certain majors, this also led to the exclusion of any observations with "Doctorate – Professional Practice" degrees. While the relationship between Baccalaureate, Master's, and Doctorate are fairly intuitive, a comparison between types of Doctorate degrees may have added another level of insight.

The PSEO data has already been released by the Longitudinal Employer-Household Dynamics (LEHD) program in the form of a PSEO Explorer visualization tool, which allows individuals to interactively manipulate the variables presented in this research to visualize earning outcomes. It provides a more comprehensive predictive tool as it utilizes more complex algorithms to incorporate all levels of the given variables. It also is able to account for differences in time since graduation, which the regression results do not, as changing the dependent variable would very likely change coefficient estimates and significance.

One potential area of growth for both this research and the PSEO Explorer is a wider range of schools. Only 4 states represented in the dataset: Colorado, Michigan, Wisconsin, and Texas. These bounds fail to extend to either coastline, making the sample quite limited. Another major shortcoming in terms of population representation is the type of school represented. Colorado is the only state in the sample with any depth of school type as there are public 4-year universities, community colleges, and private institutions in the original data as collected. Data for Texas includes only schools part of the University of Texas system, and the other two states have only information from one school. Deciding whether to attend a public or private university is a major component of choosing a college for many young students, and this research would be improved greatly by the addition of a more diverse sampling of U.S. educational institutions.

Citations:

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