Title Page

The Effect on Earnings of the Applied Baccalaureate Degree

Darby A. Kaikkonen
Policy Research Director, Washington State Board for Community and Technical Colleges
1300 Quince St., Olympia, WA, 98512
360-704-1019
dkaikkonen@sbctc.edu

Christopher L. Quarles
Mathematics Professor, Everett Community College
2000 Tower St, Everett, WA
425-388-9977
chrisquarles@gmail.com

Acknowledgements:

The authors would like to thank the anonymous reviewers for their helpful suggestions and Luke Miratrix for his suggestions regarding propensity scores.

Abstract

Objective/Research Questions: This study evaluates the post-graduate earnings of students with an applied baccalaureate (AB) degree as compared to the earnings of students with the same associate degree but no baccalaureate degree. The research questions include: For those students who earn an AB degree, does it result in higher earnings than the associate degree? Does the earnings difference vary by field of study? Which student characteristics account for variation in earnings beyond the effect of the applied baccalaureate degree?

Methods: This study used propensity score weighted regression to examine the difference in earnings of applied baccalaureate degree and associate degree graduates in three programs (health, technology, and social science) at three different community and technical colleges in Washington state.

Results: We find that the applied baccalaureate degree graduates have higher earnings than associate degree graduates in each of the three programs, although for certain programs the earnings increase is small enough to be explained by characteristics intrinsic to the student. We also find that higher earnings are also associated to other student characteristics such as age, gender, earnings prior to enrollment, and academic proficiency, indicating a difference in economic benefit for some students.

Contributions: The findings from this study contribute to the overall understanding of the complex relationship between level of education and earnings, specifically the impact on earnings of an applied baccalaureate above and beyond the associate degree. The analyses revealed evidence of a gender gap in earnings by program, which is an area that requires further study.

The Effect on Earnings of the Applied Baccalaureate Degree

Introduction

The concept of an applied baccalaureate (AB) degree in a community college was first established in the 1970's with New York's Fashion Institute of Technology offering the first one of its kind (Townsend, Bragg, and Ruud, 2008). Since that time, these degree programs have grown substantially with 80 community colleges in 17 states currently offering at least one AB program (Community College Baccalaureate Association, 2016). The policy drivers behind the development of these degrees initially began very student-focused. Compared to the traditional university student population, community college students are more likely to be working adults with families, low-income, students of color, and place-bound to their geographic area (American Association of Community Colleges, 2016; Bragg & Ruud, 2011; Lane, 2003; Walker, 2001). For many of these students, it is challenging to pursue a baccalaureate program without a four-year institution near home due to conflicting priorities of work and family. In this regard, having a baccalaureate degree program available at a local community college increases the educational attainment opportunity for students who might not be able to pursue one otherwise. In addition, the AB degree costs less than a baccalaureate program at a four-year institution since the first two years of coursework are at the community college tuition rate (State Board for Community and Technical Colleges, 2015). Consequently, the cost-effectiveness of the AB degree increases access particularly for low-income students (Walker, 2001).

The AB degree also provides another educational step for students who have completed workforce-specific professional-technical certificates and associates degrees. These programs are typically considered terminal in that the technical coursework is not designed to transfer into a traditional university baccalaureate degree program. The AB degree addresses this gap through

an inverted structure where the higher-order thinking skills traditionally found in a baccalaureate program are applied in the last two years of the degree program (Bragg & Ruud, 2011). Because they are designed to directly help students get jobs, professional-technical degree programs are also typically comprised of older, low-income, first generation, working adults (Association for Career and Technical Education, 2016). Consequently, the AB degree at the community college level fulfills a powerful role in increasing access to higher education for historically underserved populations.

In addition to the benefit of increased access and affordability for students, the AB degree plays an important role in filling gaps in the workforce. As national demand for a more highly educated workforce grows, states are challenged to meet the needs of their local economies with the existing baccalaureate degree capacity. AB degrees at community colleges are viewed as a cost-effective option to meeting this demand. In states such as Illinois, Kentucky, Oklahoma, and Washington where higher education attainment goals are part of overall workforce development, AB degrees at community colleges are a common element in state strategic plans to meet degree production goals (Bragg & Ruud, 2011; Illinois Council of Community College Presidents, 2015).

Fanelli (2007) cites a critical shortage of K-12 teachers as a major impetus for establishing AB programs at Florida's Miami Dade College, which is the largest community college in the state. In Arizona, the first state-level discussions about AB programs began with a shortage of personnel in fire service management and a perceived lack of responsiveness from the universities to address the need (Bragg & Ruud, 2011). Finally, the most common example of community college development of AB degrees in response to degree production and workforce demand is in the field of nursing. The Institute of Medicine (2010) consensus study, which calls

for increasing the proportion of nurses with a baccalaureate degree from current 50 percent to 80 percent by 2020, is consistently cited by community colleges as the impetus for offering the Bachelor of Science in Nursing (BSN) degree (Babbo, Fought, Holk, Mulligan, & Perrone, 2013; Illinois Council of Community College Presidents, 2015). To date, more than one-third of institutions that offer AB degrees offer the BSN, making it one of the most prevalent types of bachelor's degrees offered by community colleges (Community College Baccalaureate Association, 2016).

The foundation of AB degrees is rooted in increased opportunity for students and responsiveness to the needs of the local economy. However, the path to AB adoption has not been without controversy. One cited concern is mission creep (Illinois Council Community College Presidents, 2015; Lane, 2003). Some fear the AB degree opens the door for community colleges to operate as a four-year institution even though they may lack the structure and resources needed to offer high quality education. Others fear that offering a baccalaureate degree will cause the community college to lose its identity as a responsive institution designed to meet the needs of an emerging workforce (Walker, 2001).

Cost is also a significant factor in that, if new AB programs are created without new dedicated funding, then institutions would shift resources from the core mission areas of the college. These might include remedial education and student services (Lane, 2003). And while utilizing AB degrees to increase overall state baccalaureate degree production is a laudable policy goal, there is some debate about whether or not degree production is in fact affected. Porter, Cominole, and Jaquette (2014) studied AB degree implementation in nursing programs and found no appreciable increase in overall degree production. They suggest small number of graduates, limitations in faculty hiring at the baccalaureate nursing level, and "replacement" of students

who would have attended a bachelor's degree program anyway but chose the community college as a cheaper option instead as potential factors for their findings.

While the goals and challenges in implementation of AB degrees in community colleges have been heavily discussed in the literature, research on evaluation of the policy goals of the AB degrees has been limited. As Bragg and Soler (2016) note, the lack of information available about the outcomes of the programs make it difficult to answer questions about the challenges of the programs as well as report success. The goal of this paper is to focus the evaluation on one original policy goal behind AB programs, which is baccalaureate degree program opportunities for historically underserved students for the purpose of increased economic outcomes. Specifically, we seek to understand whether students who earn these degrees actually experience increased economic outcomes, above and beyond the 2-year professional-technical degree program. Does the tuition, time and effort spent for an additional two years pay off in terms of higher earnings? Are there differences in the effect on earnings between different types of AB programs, and what other factors might play a role in explaining earnings after program completion?

Literature and Theoretical Framework

There have been numerous studies on the impact or effect of a postsecondary education on earnings. According to the 2015 United States Department of Labor's Bureau of Labor Statistics (BLS) data shown in Figure 1, higher education levels are related to substantially larger earnings, with a significant increase occurring between an associate's and bachelor's degree. The most prevalent and widely reported studies show the value-added by all types of post-secondary education, from a certificate all the way to professional education at the doctorate level (Baum 2014; Carnevale, 2011; Crosby & Moncarz, 2006). Other studies that focus specifically on the

sub-baccalaureate sector compare the value-added by attending a community college versus not going at all (compared to high school only graduates) (Mullin & Phillipe 2013; Paterson & Weeks 2015a) and the value-added by different types of vocational training (certificate versus associate degree versus bachelor's degree) (Dadgar & Trimble, 2014; Grubb, 1999; Jepson, Troske, & Coomes, 2014; Xu & Trimble, 2016). While the overarching results of these comparisons show as education increases earnings increase, there is significant variation both within and across degree types. At the sub-baccalaureate level, Xu and Trimble (2016) studied the earnings outcomes of short and long term certificates in Virginia and North Carolina and found positive returns overall but variation within fields, such as health. Those programs with clear alignment between the labor market and skill set of the program yielded higher earnings than the more general fields. Bahr (2014) had similar findings from a California study of certificate programs where the technical fields showed positive strong economic returns while the non-technical fields showed insignificant and even negative returns.

Dadgar and Trimble (2014) found positive returns for the associate degree in all fields, but also found evidence that a long-term certificate in a health field shows a higher earnings premium as compared to a liberal arts associate degree. Similarly, Kerkhoff and Bell (1998) found vocational associate degrees returned higher earnings than a liberal arts associate degree, with the field of nursing assistant as the only exception. Liu, Belfield, and Trimble (2014) found substantial positive gains in earnings over a nine year time period for the associate degree as compared to individuals with some college and no degree. The gain was more significant for the associate in science degree than the general liberal arts. Bahr, Dynarski, Jacob, Kreisman, Sosa, and Weiderspan (2015) found higher earnings gains for students completing a credential as compared to those who did not complete at both the certificate and associate degree level. In

each of these studies on sub-baccalaureate credentials, women experienced a greater earnings gain than their comparison group than men, the exception being Bahr et al's (2015) study which found no earnings gain for females in certificates less than 15 credits.

At the bachelor's level, Baum (2014) found degree completers in elementary and middle school teaching had median earnings of $44,000 while fields such as registered nurses, accountants, and auditors showed earnings of $82,100. Similarly, Carnevale, Cheah, and Hanson (2015) found at the bachelor's level, health and business fields pay higher than teaching and STEM fields show the highest earnings of any bachelor degree. The STEM field earnings were at the top at both entry-level and mid-career as well as at the graduate level. Webber (2016) also found STEM and business majors as a whole had earnings above social/science and art/humanities; however, specific majors within the broad groups had different outcomes. Biology majors, while a STEM field, had earnings similar to those of art/humanities majors and economics majors (business field) had earnings second only to engineering.

These varied outcomes across degree types suggest there are a number of other factors that could also account for differences in earnings aside from education level and program. For example, prior academic history and proficiency have been identified as factors that can contribute to earnings above and beyond type of degree program (Kane & Rouse, 1995; Kerkhoff & Bell, 1998; Olitsky, 2014). Dadgar and Trimble (2014) note that the main unobservable factor that can impact future earnings (success) is ability, and therefore suggest that a proxy for academic proficiency is an important control for any model attempting to evaluate program impact. Gender is another factor for which differences have been observed. The differences are substantial enough that estimates for earnings value added are commonly done

separately for males and females (Dadgar & Trimble, 2014; Grubb, 1999; Jaggers & Xu, 2015; Kerkhoff & Bell, 1998; Paterson & Weeks 2015a; 2015b).

Aside from level of education, the program itself is probably the most significant factor related to earnings. Multiple studies have observed significant variation in earnings by field of study, both between and within level of education- so much so that it too should be estimated separately (Dadgar & Trimble 2014; Grubb, 1999; Olitsky, 2014). Kerkhoff and Bell (1998) found program to be the most powerful contributor to the differences in earnings of high school graduates versus those with a vocational credential. This was notated above and beyond gender. Carnevale, Strohl, and Melton (2011) found that, while college major appears to have the greatest impact on future earnings, prior work experience improves earnings in any major over time. Carnevale and others (Carnevale, Strohl & Melton, 2011; Carnevale, Jayasundera & Gulish 2015) also found that students who majored in science, technology, engineering or math (STEM) showed the highest earnings from a bachelor's degree. However, Paterson and Weeks (2015b) also conclude that simply comparing the post-program earnings of STEM and non-STEM majors may overstate the impact of the degree on the STEM majors. This is because it is likely that, given the characteristics of students within that field, those students may have done well in any other type of degree program as well. Arcidiacono (2004) partially supports this notion after finding math and verbal ability explains some of the earnings premium in the workforce but college major is the more significant factor.

These studies demonstrate a well-established link between education attainment level and earnings and how multiple factors unrelated to the degree program can also impact earnings and should be considered in studies of the effect of a degree program on earnings. To our knowledge, this kind of analysis has not previously been done with respect to applied baccalaureate degrees,

which is a significant gap in the study of these programs. As previously described, one of the primary drivers behind the first AB programs was to provide access to higher education for students who may not traditionally be able to earn a baccalaureate degree. The underlying assumption, based on what we know about the relationship between earnings and level of education, is that baccalaureate degrees result in higher earnings for the student. This is particularly germane to technical degree programs which are designed to go directly into the workforce because the applied baccalaureate builds on the technical skills of the applied associate degree with the goal of advancing a graduate directly into the workforce at a higher level of responsibility, and in theory, earnings. In addition, the workforce-specific nature of the applied baccalaureate degree makes the population who participate distinctly different than at a traditional four-year institution (American Association of Community Colleges, 2016; Bragg & Ruud, 2011; Lane, 2003; Walker, 2001). Comparing the earnings outcomes for graduates who are most alike will provide insight that has not yet been discovered regarding what kind of actual impact on earnings an applied baccalaureate degree has above and beyond the associate degree. We will investigate this gap in the study of AB programs through the following research questions:

Research Question 1: For those students who earn an applied baccalaureate degree, does it result in higher earnings than the associate degree?

Research Question 2: Does the earnings difference vary by field of study?

Research Question: 3: Which student characteristics account for variation in earnings beyond the effect of the applied baccalaureate degree?

Methodology

To answer these questions, we study program and employment data from Washington state, whose community and technical college system has been offering AB degrees since 2007 and has seen tremendous growth over the past nine years of implementation. The programs were first piloted in six institutions, which included nursing, business management, interior design, and radiology. Each AB program was built upon an existing two-year, terminal technical program offered at the institution. The coursework for the AB degree is typically two years in length and is comprised of the third and fourth year requirements for a traditional baccalaureate degree. Consequently, enrollment in an AB degree program requires students to have previously completed an associate degree. As part of the approval process, colleges demonstrated that there was unmet demand for graduates in the program. This evaluation included a regional labor market assessment of the need from employers for a specific set of skills and a determination about a lack of graduates from the four-year institutions to fill that need. Earning level in the given industry are not a factor in determining appropriateness and subsequent state approval for the program. Rather, the primary goal for each of these degrees is to match local employer needs with skilled workers. Consequently, these AB degrees are prime choices for evaluating the effects of AB degrees at community colleges on earnings.

Sample

This study utilizes data from three AB programs (health, technology, and social sciences) at different community and technical colleges in Washington state. The colleges vary in geographic location, size, mission mix, and student demographics. A control group sample was identified to serve as the counterfactual for each type of AB program. Each control group included students who earned the same type of associate (AS) degree as their AB counterparts, but who had not

chosen to enroll in the AB program that builds upon the preceding two-year program. To generate a large enough sample for the study, the group included graduates between the years 2008-09 and 2013-14. The characteristics that could be a factor in the observed differences in earnings between AS and AB graduates were gathered from community and technical college records, which are housed at the Washington State Board for Community and Technical Colleges.

Variables

The resulting lists of paired AB and AS degree graduates were matched to unemployment insurance records through a data share agreement with the Washington state Employment Security department. All covered employers, defined as businesses who are required to file and pay unemployment-insurance taxes, are included in the records database (Washington State Employment Security Department, 2017). Some employees were excluded because their employers were not in the database. These employers included small non-profit preschools, self-employed independent contractors, the federal government, and out-of-state employers. Certain non-resident aliens were also excluded. Notably, if an individual had no employment record in the given time frame, we cannot know for certain if the person was unemployed or employed but without a record for one of the above reasons.

The dependent variable was the maximum earnings taken over the 3 quarters following degree completion. This value was adjusted for inflation and annualized. This selected time period for evaluating earnings is brief compared to other studies that assess longitudinal earnings gains following program completion. This research typically finds the earnings gains from more education becomes more pronounced over time (Baum, 2014; Crosby & Moncarz, 2006; Dadgar & Trimble, 2014; Liu, Belfield, & Trimble, 2015; Jepsen, Troske, & Combes, 2014). The

relatively small number of students who completed each degree prohibits this type of analysis in this study. We acknowledge this as a limitation for understanding the full benefit of the given degree on earnings over time, especially with respect to applied baccalaureate degrees as this has not been previously studied. However, there is a benefit to the shorter time period with respect to the potential bias that could be introduced by waiting multiple years to snapshot earnings, based on two main reasons. First, because the match only includes in-state wage records, the more time that passes increases the likelihood that a graduate may move out of state and thus not be included in the match. Second, the longer time period between graduation and the earnings match increases the likelihood that external factors (such as a new baby, death in the family, or enrollment in additional post-secondary education) may also impact earnings. Graduates with no social security number for employment matching were removed from the sample as well as a small number of graduates with annual earnings greater than $100,000 as their earnings are outliers from the normal distribution of the overall sample.

Other variables used include a student's age at graduation, final GPA at the completion of the AS program (for both treatment and control groups), whether the student had children at the time of program entry, whether they had any record of employment prior to enrollment, earnings prior to enrollment, gender, and race/ethnicity. Earnings values were set to zero if no employment records were found. The pre-enrollment variables are taken at the third quarter prior to enrollment. This time period is selected to account for the observed dip in earnings in the year prior to enrollment, also known as the "Ashenfelter Dip" (Jaggars & Xu, 2015; Jepson, Troske, & Coomes, 2014). As Dadgar and Trimble (2014) note, the selected time period to capture pre-enrollment employment records can have an impact on the findings, so for consistency sake, this is the agreed upon time period for most Washington state labor market analysis in the

community and technical college system (Washington State Board for Community and Technical Colleges, 2014). Due to small numbers of students in each racial group, students were grouped into two categories: *White/Asian* and *Student of Color* which included multiracial students. A small number of students (less than 5 percent) who declined to give their race/ethnicity were omitted from the results. The analysis was also run with those students and excluding race as a variable, and the results were similar as shown below. Also due to the small sample size, the estimates by program were not done separately for males and females as commonly notated in the literature.

Methodological Framework

As is often the case in social science research, this study was not a random, controlled experiment. Students at each college chose whether to work toward an AB degree, based on a variety of factors relating to their personal circumstances. For example, some students may have had economic circumstances which allowed them to spend more time in school. Other students may have been unaware of the program due to a general lack of familiarity with college policies. This creates challenges in answering the *causal* question of whether AB degrees positively impact student earnings. We find it likely that confounding variables have a significant impact on the relationship between a student's completion of an AB degree and their earnings. In other words, characteristics inherent in the student, such as a strong work ethic or supportive social network, might influence students to both earn a higher income and to be more likely to earn an AB degree. To control for these possible confounding characteristics, we use a weighted regression using propensity scores.

We assume a potential outcomes framework (Imbens & Rubin, 2015) where each individual has two hypothetical outcomes, only one of which is observed. In our case, each person has (a)

earnings assuming they were in the "treatment" group and earned an AB degree, and (b) earnings assuming they were in the "control" group and did not earn an AB degree. A key assumption of our framework is that the probability of assignment to treatment or control group is completely dependent on an appropriately specified set of covariates. In other words, if two individuals in our sample have the exact same values for each of these covariates, then they have the same probability (p_i) of earning an AB degree. More importantly for our analysis, if the treatment and control groups are "balanced" by having similar distributions of covariates, then we can compare the outcomes as in a randomized controlled trial.

Unfortunately, it is quite likely that there are important covariates which are not in our data set. Accordingly, the analysis comes in two steps: First, we analyze the data using the covariates in the data set to address our research questions. Second, we do a sensitivity analysis to understand how large of an impact an unmeasured covariate would need to have to affect the conclusions.

Propensity Score Weighted Regression

Our strategy for creating balance is to effectively simulate weighted control and treatment groups through a weighted regression using propensity scores. An individual's propensity score (p_i) is their probability of earning an AB degree, which is, by assumption completely dependent on the values of their covariates. If Z_i is a binary variable which indicates whether an individual actually received an AB degree, we estimate their propensity score using logistic regression.

$$logit(Z_i) = \alpha + \beta^T X_i + \epsilon_i$$

In the equation, X_i is a vector of the measured covariates for an individual and β^T is the vector of coefficients. The variables used in X_i to calculate the propensity score include age, GPA, whether the student had children, whether they were working prior to enrollment, earnings

prior to enrollment, gender, and race. We can then use the fitted values in the model as an estimate, $\hat{p}_i$, of the propensity score. There are a number of methods for creating weights from propensity scores (Lunceford & Davidian, 2014). Some methods are appropriate for estimating the effect of treatment assuming everyone received the treatment. However, an AB degree is not necessary or desirable for all students; therefore, it is inappropriate to attempt to estimate the effect of AB degrees on earnings for all students. Instead, we are interested in the effects of an AB degree on earnings for those types of students who would earn an AB degree. In the statistics literature, this is called the average treatment effect on the treated (ATT). We choose a weighting method designed to estimate ATT (Austin, 2011).

$$w_i = \begin{cases} \dfrac{\hat{p}_i}{1-\hat{p}_i} & if\ Z_i = 0 \quad \text{(no AB)} \\ 1 & if\ Z_i = 1 \text{ (earned AB)} \end{cases}$$

Since we are interested in understanding the effect of treatment on the types of students who would earn an AB, this effectively creates a *weighted* control group from those who did not earn an AB. Those who received treatment are not weighted in the analysis. Those who did not earn an AB have their membership in the control group weighted by the estimated odds of their earning an AB.

Balance

To analyze whether the choice of weights was well-specified, we examined balance by looking at differences in summary statistics between students who received AB degrees and those who didn't. Given a set of data $\{x_i\}$ with weights,$\{w_i\}$ the formulas $\bar{x} = \frac{\sum w_i x_i}{\sum w_i}$ and $s^2 = \frac{\sum w_i}{(\sum w_i)^2 - \sum w_i^2} \sum w_i (x_i - \bar{x})^2$ can be used to calculate the weighted sample mean and weighted sample standard deviation, respectively (Austin & Stuart, 2015). Since variables with larger

spreads may have larger differences between groups, we also calculated *standardized* differences between the groups. Standardized values are calculated using z-scores $z_i = \frac{x_i - \bar{x}}{\tilde{s}}$. Here $\bar{x}$ is the weighted mean over all samples. To calculate the pooled standard deviation, we use the formula $\tilde{s} = \sqrt{\frac{1}{2}(s_T^2 + s_C^2)}$, where s_T^2 and s_C^2 are the weighted standard deviations for the treatment and control samples, respectively. To calculate standardized differences, the mean and standard deviation of the z_i values are taken over each group, then differences in these values were calculated. For binary control variables, differences in means were compared. For quantitative control variables, we looked at differences in means and standard deviations to better compare the shape of each distribution.

Table 1 shows the unweighted and weighted means for each covariate. Table 2 gives the difference of means between the groups as well as the standardized differences between the means and standard deviations. The results of Table 2 show that the weighting achieved good balance. The weighted means of the treatment and control groups were within 0.1 standard deviations for every variable. Furthermore, the spread of the quantitative variables *age* and *GPA* were similar. For example, in the Health groups, the standard deviation of age among those who earned an AB degree was 14 percent smaller than the standard deviation of age among those who didn't earn an AB degree. A visual analysis of boxplots confirmed that the weighted distributions of quantitative covariates were similar.

After balance was analyzed, the main analysis was run. This was a weighted linear regression using the weights, w_i, calculated above.

$$earnings_i = \lambda + \tau \cdot AB_i + \rho^T \cdot X_i + \varepsilon_i$$

Here, AB_i is a variable which describes whether a student earned an applied baccalaureate degree and X_i is the vector of covariates used to calculate the weights.

Results

The results of the weighted regression analysis for all three programs is reported in Table 3. Earning an AB in the Health program was associated with an average increase in annual earnings of $23,848 ($p < .001$). In addition, GPA, race and ethnicity, parental status and gender were statistically significant predictors of earnings. In this cohort, male graduates, those with a higher GPA at the completion of the AS program, and graduates of color have higher earnings. Table 3 for the Technology program showed that having an AB had a significant effect on earnings (B = 11,878, $p < .001$), but so did several other factors. Higher earnings were also associated with higher GPA at the time of completion of the AS degree, higher earnings prior to enrollment in their associate degree program, male gender, and parental status. Similar to the Health and Technology programs, the results of the Social Science program analysis shown in Table 3 confirm that AB graduates have higher earnings than the associate degree alone graduates. In this program, other significant factors in addition to AB degree were younger age and higher income prior to enrollment.

Sensitivity Analysis

Numerous studies have studied traits which were correlated with earnings and with academic performance (Almlund, Duckworth, Heckman & Kautz, 2011; Heckman, Stixrud & Urzua, 2006; Komarraju & Ramsey, 2013; Reardon, 2011), and a number of those variables are not directly measured in our data set. While it is impossible to know the effects of unmeasured confounding variables (Imbens & Rubin, 2015), it is possible to estimate the necessary effect strength of an unmeasured confounder in order to change the conclusions of the study.

Following Rosenbaum (2010), we assume that an unmeasured confounding variable has an effect size that can affect the odds of earning an AB by at most Γ. Specifically, if individuals i

and *j* have the same *measured* covariates, then the relationship between their probabilities of earning an AB degree is given by the inequality:

$$\frac{1}{\Gamma} \leq \frac{p_i/(1-p_i)}{p_j/(1-p_j)} \leq \Gamma$$

Larger values of Γ imply a stronger effect of the unmeasured confounding variable. For example, a value of $\Gamma = 2$ assumes that the unmeasured confounder can double the odds of earning an AB degree. A sensitivity analysis finds the weakest possible result among all combinations of propensity scores which satisfy this inequality.

In our analysis, this assumption affects the weighting of the individuals who did not earn an AB since the weights for those who did earn an AB were equal to one regardless of propensity score. To create a sensitivity table, for each individual we randomly chose whether the unmeasured confounder had either no effect or its maximum effect. The allowable weights were either the original weight $w_i = \frac{\hat{p}_i}{1-\hat{p}_i}$ or the product $w_i\ \Gamma$. Consequently, rerunning the main analysis with the new weights gives a new regression coefficient. Starting with w_1, we then checked whether a weight of w_1 or $w_1 \cdot \Gamma$ gave a smaller coefficient and kept that as the new weight. We repeated this for each individual in turn until one complete pass of all individuals yielded no smaller coefficients. This process converged to the same value for different random initializations. The results are shown in Table 4.

Taking a value of $p = 0.05$ as a cutoff for statistical significance, it is clear that the earnings benefits of the Health degree are very robust to unmeasured variables. The results for this degree were statistically significant at the $p = 0.05$ level up to $\Gamma = 17$. The Technology and Social Science degree were not as robust to unmeasured variables. The effects of the Technology degree on earnings was statistically significant, as long as unmeasured variables do not affect the

odds of someone earning an AB by a factor of 2.5 or more. The effects of the Social Science degree on earnings was statistically significant for unmeasured variables that affected the odds of earning an AB by less than a factor of 2.

To put this analysis in perspective, we compare the effects of the *measured* variables, such as race and gender, on a students' likelihood of earning an AB degree with the maximum effects listed above. For students in the Technology cohort, the trait most related to earning an AB degree was being a student of color, which corresponded to an adjusted odds ratio of $\Gamma = 2.27$. This is approximately the Γ value where an *unmeasured* confounding variable would make the earnings difference between AB and non-AB students statistically insignificant. Put simply, if there are unmeasured confounding variables which are as strongly related to earning an AB degree as being a student of color, then we cannot conclude that the Technology AB degree increases short-term student earnings. For students in the Social Science degree, the trait most related to earning an AB degree was having a job prior to enrollment, which corresponded to $\Gamma = 1.9$. If there are unmeasured confounding variables which are as strongly related to earning an AB as pre-enrollment employment, then we cannot conclude that the Social Science degree increases short-term earnings.

Discussion

This paper began with a discussion about the goals of the community college applied baccalaureate degree, some ongoing challenges with implementation of the concept, and how a lack of research on outcomes of the degree keep those challenges somewhat misunderstood. Our research questions in this study focused on one policy goal of applied baccalaureate degree programs: increased baccalaureate degree access for historically underserved populations for the purpose of better economic outcomes. We sought to learn if the applied baccalaureate degree

increases earnings above and beyond the technical associate degree and if there were differences of that impact based on field of study. Previous studies on the relationship between educational attainment and earnings have also revealed a series of factors that can also explain the differences that are unrelated to the degree program. These include demographic characteristics, academic and work history, and unobservable characteristics such as motivation or interfering life events. Consequently, we also investigated if there were any other characteristics that can be associated to higher earnings, observed and unobserved, aside from the applied baccalaureate degree.

This study was conducted on three different programs (health, technology, and social science) in Washington state. The AB program approval process in the Washington state community and technical college system includes demonstrated evidence of unmet demand at the baccalaureate degree level in the given field. This employer-demand requirement for the programs is intended to provide a level of assurance for students that they have a reasonable chance of finding a job within the industry upon graduation. However, there is no minimum earnings requirement within the application and approval process for new AB programs. Thus, it remains unknown for the student if they can expect higher earnings within a given industry above and beyond those of an associate degree graduate. As colleges continue to propose new programs based in part on employment demand, understanding the economic impact to the student adds something to the process which could be shared with students so they fully understand their options. For the average applied baccalaureate degree, students can expect to pay $15,000 for two years of tuition and fees (State Board for Community and Technical Colleges, 2015). Therefore, if the types of jobs that require a baccalaureate degree do not appear to return earnings at a significantly higher

level than an associate degree, students can make better informed choices about what will work best for them.

The results of the analysis in our study showed that, in each of the three programs, applied baccalaureate degree graduates earn more than associate degree graduates. However, when we consider the possibility that students self-selected into the AB programs based on unmeasured personal traits, the earnings difference is highly dependent on program. The sensitivity analysis showed that the Technology and Social Science degrees were not robust to this self-selection. For example, Ishitani (2006) found that a number of factors, including parental education, high school class rank, and educational expectations, were related to degree completion at a level which might explain the higher incomes for these two degrees. Heckman, Stixrud & Urzua (2006) showed that non-cognitive factors such as locus of control and self-esteem were significantly related to income and educational attainment. Given these results, it seems quite possible that the increased earnings of students who received the Technology and Social Science AB degrees was due to unmeasured traits that were also associated with higher earnings and not the program itself.

In the Health program the average difference in earnings between AB and AS was approximately $24,000 per year. Based on this difference it would take less than a year for a student's increased earnings to make up for the extra tuition and fees for the AB degree. The sensitivity analysis revealed this effect to be particularly robust to the effect of any unmeasured potentially confounding variables. In other words, there is strong evidence that this Health degree improves earnings within nine months.

In the Technology program, the earnings difference between AS and AB graduates was approximately $12,000, which is only $2,000 less than the extra tuition and fees that an AB

degree costs. In this program, it is possible that the types of associate degrees that were included in the study could have an effect on the difference. The baccalaureate degree graduates in the Technology program came from a variety of six different types of associate degrees as their starting program as compared to just one type of associate degree program for both the Health and Social Science programs. Recent studies by Carnevale, Jayasundera, & Gulish (2015) as well as Baum (2014) argue that analyzing earnings by occupation rather than industry is a more comprehensive way to understand patterns of growth over time. This study assumes one "industry" for all six types of associate degree only graduates by comparing their earnings outcomes to the baccalaureate graduates. In reality, those associate degree programs may serve fundamentally different occupations, thus the relevance of an applied baccalaureate degree may differ based on the occupation more so than in a more unidimensional field, such as nursing or automotive for example.

In the Social Science program, the overall average earnings was lower than the other two programs and the difference in earnings between AS and AB graduates was only about $7,000. Further, as with the Technology degree, the sensitivity analysis showed that the effect of the AB degree on earnings could be explained using personal traits correlated with both measures. However, our measure of earnings only measured nine months after graduation. It is unclear whether it may take more years in the workforce or further education before the full benefit is realized and the tuition and fees is made up by way of increased earnings. This significant difference between a highly technical (Health) and a more liberal arts (Social Science) degree aligns with Xu and Trimble's (2016) and Bahr's (2014) findings on certificate research regarding strong skill alignment to the labor market resulting in higher earnings. It also suggests an area for

future research which would include the impact of additional graduate level education over the course of time.

The impact of different AB degrees on earnings is important information not only for students but for colleges to understand as well. As mentioned in the introduction of this paper, one of the goals of applied baccalaureate degree programs in community colleges is to expand the opportunities to help meet state goals for overall baccalaureate degree production. While this question is out of the scope of this study, the implications of our findings about the earnings benefit of AB degrees for students can have an impact. If a college is going to invest the time and resources to establish a new AB program, then understanding potential future student enrollment is a critical component. If students are unlikely to see significant increased economic outcomes beyond their associate degree, it might mean low enrollment and degree production, and ultimately an unsustainable program.

The last element of this study was the impact of characteristics other than degree type and student demographics on earnings as related to the degree program. Our analysis revealed that there were other characteristics that also explained higher earnings within both types of degrees. Similar to the wide ranging differences in earnings, the impact of these characteristics differed depending on the college and program. In the Technology and Social Science programs, higher income prior to enrollment was associated with improved earnings after graduation. This finding aligns with other research that link earnings potential with experience (Carnevale, 2011), but interestingly enough it did not make a difference in the Health program. For student demographics there was no discernable difference in earnings for students of color in the Social Science program. In the Technology program, students of color earnings were lower and in the Health program students of color earnings were significantly more than white and Asian

students. Alternatively, all three programs showed a significant disparity in earnings for women as compared to men, regardless of the type of degree. The revelation of an earnings gap despite separate and balanced program analyses is cause for further study to better understand why women with the same credential earn less than men.

In conclusion, the findings from this study contribute to the overall understanding of the complex relationship between level of education and earnings. The takeaways are especially meaningful for community and technical colleges as they expand their student-focused mission of serving historically underrepresented students through baccalaureate degree attainment. This information gives colleges specific information to help them think about whether the goals of their programs, to include those of the larger system of community and technical colleges in Washington state, are being met.

References

Almlund, M., Duckworth, A., Heckman, J., & Kautz, T. (2011). *Personality psychology and economics* (NBER Working Paper No. 16822). Retrieved from http://www.nber.org/papers/w16822

American Association of Community Colleges. 2016. *Fast Facts.* Accessed http://www.aacc.nche.edu/AboutCC/Documents/FastfactsR2.pdf

Arcidiacono, P. (2004). Ability sorting and the returns to college major. *Journal of Econometrics*, 121(1), 343-375.

Association for Career and Technical Education. 2016. Accessed https://www.acteonline.org/aboutcte/#college

Austin, P. C. (2011). An introduction to propensity score methods for reducing the effects of confounding in observational studies. *Multivariate Behavioral Research, 46*(3), 399–424. http://doi.org/10.1080/00273171.2011.568786

Austin, P.C. & Stuart, E.A. (2015) Moving towards best practice when using inverse probability of treatment weighting (IPTW) using the propensity score to estimate causal treatment effects in observational studies. *Statistics in Medicine, 34*(12), 3661-3679. http://doi.org/10.1002/sim.6607

Babbo, G., Fought, S., Holk, M., Milligan, A.M., & Perrone, C. (2013). RN-to-BSN programs in the community college setting: Challenges and successes. *Journal of Nursing Education, 52*(2), 85-91.

Bahr, P. R. (2014). *The labor market return in earnings to community college credits and credentials in California*. Ann Arbor, Michigan: Center for the Study of Higher and Postsecondary Education, School of Education, University of Michigan. Retrieved from http://www.soe.umich.edu/people/profile/peter_riley_bahr/

Bahr, P. R., Dynarski, S., Jacob, B., Kreisman, D., Sosa, A., & Wiederspan, M. (2015). Labor market returns to community college awards: Evidence from Michigan (CAPSEE working paper). Retrieved from http://capseecenter.org/wp-content/uploads/2015/03/labor-market-returns-michigan.pdf

Baum, Sandy. (2014). Higher education earnings premium: value, variation, and trends. The Urban Institute. Retrieved from http://www.urban.org/research/publication/higher-education-earnings-premium-value-variation-and-trends/view/full_report.

Bragg, D.D. & Ruud, C. (2011). The adult learner and the applied baccalaureate: Lessons learned from six states. Office of Community College Research and Leadership. University of Illinois at Urbana-Champaign. Retrieved from http://occrl.illinois.edu/docs/librariesprovider4/ab/six-lessons.

Bragg, D.D. & Soler, M.C. (2015). Outcomes evaluation of applied baccalaureate degree programs in STEM and technician education. Office of Community College Research and Leadership. University of Illinois at Urbana-Champaign. Retrieved from http://occrl.illinois.edu/docs/librariesprovider4/ab/ab-degrees.pdf?sfvrsn=8.

Carnevale, A.P., Strohl, J., & Michelle Melton. (2011). What's it worth? The economic value of college majors. Georgetown University Center on Education and the Workforce. Washington, DC. Retrieved from cew.georgetown.edu/whatsitworth.

Carnevale, A.P., Cheah, B., and Andrew R. Hanson. (2015). The economic value of college majors. Georgetown University Center on Education and the Workforce. Washington, DC. Retrieved from https://cew.georgetown.edu/wp-content/uploads/The-Economic-Value-of-College-Majors-Full-Report-web-FINAL.pdf

Carnevale, A.P., Jayasundera, T., & Gulish, A. (2015). Good jobs are back: College graduates are first in line. Georgetown University Center on Education and the Workforce. Washington, DC. Retrived from https://cew.georgetown.edu/.

Community College Baccalaureate Association. (2016). Retrieved from http://www.accbd.org/resources/baccalaureate-conferring-locations/.

Crosby, O., & Moncarz, R. (2006). The 2004-14 job outlook for college graduates. *Occupational Outlook Quarterly, Fall 2006.* Retrived from http://www.bls.gov/careeroutlook/2006/fall/art03.pdf

Dadgar, M. & Trimble, M. J. (2014). Labor market returns to sub-baccalaureate credentials: How much does a community college degree or certificate pay? *Educational Evaluation and Policy Analysis, 37*(4), *399-418.* doi:10.3102/0162373714553814.

Fanelli, S.A. (2007). Bringing the community college baccalaureate into focus. *The Presidency*, v10 n1 p20-25 Winter 2007.

Grubb, W.N. (1999). Learning and earning in the middle: The economic benefits of sub-baccalaureate education. Retrieved from http://ccrc.tc.columbia.edu/publications/learning-and-earning.html.

Heckman, J., Stixrud, J., & Urzua, S. (2006). The effects of cognitive and noncognitive abilities on labor market outcomes and social behavior. *Journal of Labor Economics, 24*(3), 411-482. https://doi.org/10.1086/504455 Retrieved from http://www.nber.org/papers/w12006

Illinois Council of Community College Presidents. (2015). The bachelor of science in nursing and the applied baccalaureate degree. Retrieved from http://www.communitycolleges.org/baccalaureatedegreebackground.html

Imbens, G. W., & Rubin, D. B. (2015). *Causal inference for statistics, social, and biomedical sciences: An introduction*. New York: Cambridge University Press.

Institute of Medicine. (2010). The future of nursing: Focus on education. Retrieved from http://www.nationalacademies.org/hmd/Reports/2010/The-Future-of-Nursing-Leading-Change-Advancing-Health.aspx.

Ishitani, T. T. (2006). Studying attrition and degree completion behavior among first-generation college students in the United States. *The Journal of Higher Education, 77*(5), 861-885. https://doi.org/10.1353/jhe.2006.0042

Jaggars, S.S. & Xu, D. (2015). Examining the earnings trajectories of community college students using a piecewise growth curve modeling approach. A CAPSEE Working Paper. New York, NY: Teachers College, Center for Analysis of Postsecondary Education and Employment. Retrieved from

http://ccrc.tc.columbia.edu/media/k2/attachments/earnings-growth-curve-modeling-approach.pdf.

Jepsen, Troske, and Coomes. 2014. The labor-market returns to community college degrees, diplomas, and certificates. *The Journal of Labor Economics, 32(1),* 95-121.

Kane, T. J., & Rouse, C. E. (1995). Labor market returns to two-year and four-year schools. *American Economic Review, 85*(3), 600–614.

Kerckhoff, A. C., & Bell, L. (1998). Hidden capital: Vocational credentials and attainment in the United States. *Sociology of Education, 71*(2), 152-174. Retrieved from http://search.proquest.com/docview/216479558?accountid=1611.

Komarraju, M., Ramsey, A., & Rinella, V. (2013). Cognitive and non-cognitive predictors of college readiness and performance: Role of academic discipline. *Learning and Individual Differences, 24,* 103–109. http://dx.doi.org/10.1016/j.lindif.2012.12.007

Lane, K. (2003). Community colleges' new foray. *Black Issues in Higher Education;* May 22, 2003; 20,7; ProQuest Research Library pg. 30.

Liu, V., Belfield, C., & Trimble, M. (2015). The medium-term labor market returns to community college awards: Evidence from North Carolina. *Economics of Education Review*, 44, 42-55.

Lunceford, J., & Davidian, M. (2004). Stratification and weighting via the propensity score in estimation of causal treatment effects: A comparative study. *Statistics in Medicine, 23*(19), 2937–60. http://doi.org/10.1002/sim.1903

Mullin, C. M., & Phillippe, K. (2013). Community college contributions (Policy Brief 2013-01PB). Washington, DC: American Association of Community Colleges. Retrieved from http://www.aacc.nche.edu/Publications/Briefs/Documents/2013PB_01.pdf

Olitsky, N.H. (2014). How do academic achievement and gender affect the earnings of STEM Majors? A propensity score matching approach. *Research in Higher Education*, *55* (3):245–271. DOI 10.1007/s11162-013-9310-y

Paterson, T. & Weeks, G. (2015a). Project Postsecondary Education Assessment in Washington State: Earnings Premium Estimates for Associate Degrees. Retrieved from Education and Research Data Center website: http://www.erdc.wa.gov/briefs/pdf/201501.pdf.

Paterson, T. & Weeks, G. (2015b). Earnings Premium Estimates by Gender and Race Category for STEM Baccalaureate Degrees in Washington State. Retrieved from Education and Research Data Center website: http://www.erdc.wa.gov/briefs/pdf/201503.pdf.

Porter, S.R., Cominole, M.B., & Jaquette, O. (2014). Do community college baccalaureate degree policies increase degree production? Paper presented at the meeting of the Association for Education Finance and Policy, San Antonio, TX. Retrieved from http://stephenporter.org/papers/CCBA_paper_AEFP.pdfhere

Reardon, S. (2011). The widening academic achievement gap between the rich and the poor: New evidence and possible explanations. In R. Murnane & G. Duncan (Eds.), *Whither Opportunity? Rising Inequality and the Uncertain Life Chances of Low-Income Children*. New York: Russell Sage Foundation Press.

Rosenbaum, P. R. (2010). *Design of observational studies*. New York: Springer-Verlag. http://doi.org/10.1007/978-1-4419-1213-8.

State Board for Community (SBCTC) (2015). *Academic Year Report 2014-15: Appendix A Tuition and Fees.* Retrieved from https://www.sbctc.edu/colleges-staff/research/annual-reports/academic-year.aspx

State Board for Community (SBCTC) (2014). *Data Linking for Outcomes Assessment*. Retrieved from https://www.sbctc.edu/colleges-staff/data-services/data-warehouse-documentation.aspx

Townsend, B.K, Bragg, D.D., & Ruud, C.M. (2008). The adult learner and the applied baccalaureate: national and state-by-state inventory. Retrieved from http://files.eric.ed.gov/fulltext/ED504474.pdf.

United States Department of Labor; Bureau of Labor Statistics. http://www.bls.gov/emp/ep_chart_001.htm

Walker, K.P. (2001). Opening the door to the baccalaureate degree. *Community College Review;* Fall 2001; 29, 2; ProQuest Research Library pg. 18.

Washington State Employment Security Department. (2017). Unemployment insurance tax information: A handbook for Washington state employees. Retrieved from https://esd.wa.gov/employer-taxes

Webber, D. (2016). Are college costs worth it? How ability, major, and debt affect the returns to schooling. *Economics of Education Review*, 53, 296-310.Xu, D. & Trimble, M. (2016).

What about certificates? Evidence on the labor market returns to nondegree community college awards in two states. *Educational Evaluation and Policy Analysis* 38 (2), 272-292

Tables

Table 1. Unweighted and weighted sample means by degree type

Variables	Health			Technology			Social Science		
	Baccalaureate	Associate Unweighted	Associate Weighted	Baccalaureate	Associate Unweighted	Associate Weighted	Baccalaureate	Associate Unweighted	Associate Weighted
Age	33.9	32.7	34.2	32.0	30.3	32.0	41.6	41.9	41.6
GPA at graduation	3.55	3.61	3.57	3.70	3.60	3.70	3.53	3.42	3.53
Has children	0.28	0.27\6	0.26	0.28	0.22	0.28	0.48	0.42	0.49
Pre-enrollment employment	0.84	0.69	0.84	0.58	0.49	0.58	0.72	0.56	0.72
Pre-enrollment earnings	30,646	18,707	33,602	13,954	11,306	13,996	16,828	12,086	16,988
Female	0.76	0.64	0.75	0.33	0.33	0.32	0.80	0.70	0.79
Student of Color	0.08	0.07	0.08	0.19	0.11	0.17	0.52	0.56	0.52
Average of highest earnings within 3 quarters after graduation	72,605	47,906		34,395	21,516		24,709	15,700	
Sample size	25	182		43	383		60	151	

Table 2: Differences of weighted means and standard deviations between students who receive AB degrees and those who didn't

	Health			Technology			Social Science		
Variables	Difference of Means	Standardized Difference of Means	Standardized Difference of SD	Difference of Means	Standardized Difference of Means	Standardized Difference of SD	Difference of Means	Standardized Difference of Means	Standardized Difference of SD
Age	-0.28	-0.04	-0.14	0.05	0.01	-0.12	0.02	0.00	-0.08
GPA at graduation	-0.02	-0.07	0.06	0.00	0.01	-0.159	0.00	0.01	0.03
Has children	0.00	0.05		0.00	0.00		-0.01	-0.02	
Pre-enrollment employment	0.00	0.01		0.00	0.00		0.00	0.00	
Pre-enrollment earnings	-2,956	-0.10	-0.313	-43	0.00	-.034	-160	-0.01	0.12
Female	0.01	0.02		-0.01	0.00		0.01	0.02	
Student of Color	0.00	-0.01		0.02	0.03		0.00	-0.01	

Table 3: OLS regression results predicting earnings

	Health				Technology				Social Science			
	B		SE	p	B		SE	p	B		SE	p
Intercept	15464		20221	0.445	-33631		17721	0.058	10443		13440	0.438
Earned AB	23848	***	2947	0.000	11878	***	2301	0.000	7419	***	2183	0.001
Age	-410	**	214	0.057	-410	**	134	0.002	-401	***	106	0.000
GPA at graduation	14921	**	4971	0.003	16997	***	4888	0.001	5715		3281	0.083
Has children	8641	*	3503	0.014	7528	**	2776	0.007	4008		2354	0.090
Pre-enrollment employment	-2738		4764	0.566	1207		3330	0.717	636		3023	0.834
Pre-enrollment earnings	0.005		0.065	0.941	0.337	***	0.091	0.000	0.242	**	0.073	0.001
Female	-9289	*	3636	0.011	-5598	*	2633	0.034	-5408		2907	0.064
Student of Color	11987	*	5676	0.036	3949		3025	0.192	2311		2464	0.349
R^2			0.34				0.17				0.19	

*p < .05, **p < .01, ***p < .001

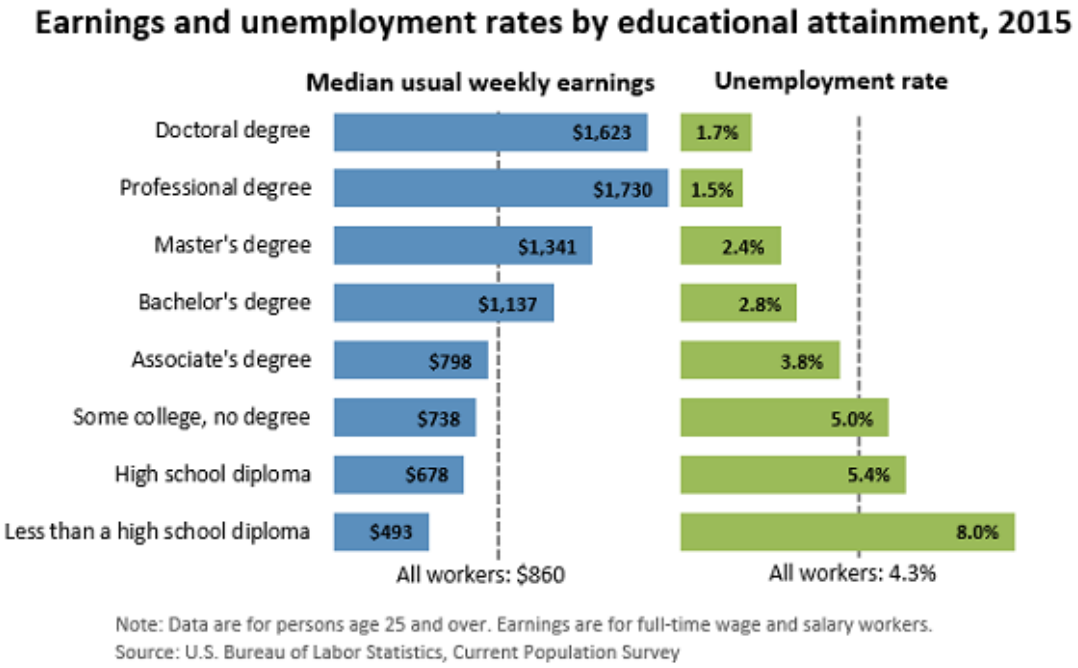
Excludes non-responders for race

Table 4: Sensitivity analysis: smallest possible coefficient of “Earned AB: for a given Γ

	Health		Technology		Social Science	
Γ	**B**	**p**	**B**	**p**	**B**	**p**
1	**23848**	**0.000**	**11878**	**0.000**	**7419**	**0.001**
1.5	**20711**	**0.000**	**8563**	**0.000**	**5269**	**0.016**
2	**18694**	**0.000**	**6172**	**0.008**	**3778**	**0.082**
2.5	**17190**	**0.000**	**4309**	**0.065**	**2649**	**0.222**
3	**15976**	**0.000**	**2788**	**0.236**	**1746**	**0.421**
3.5	**14976**	**0.000**	**1470**	**0.536**	**1003**	**0.644**
4	**14129**	**0.000**	**320**	**0.893**	**383**	**0.860**
4.5	**13396**	**0.000**	**0**	**1.000**	**0**	**1.000**
5	**12758**	**0.000**	**0**	**1.000**	**0**	**1.000**

Figures

Figure 1.



Source: https://www.bls.gov/emp/ep_chart_001.htm