Workforce outcomes of Washington high school graduates:

Measuring the long-term impacts of higher education, program choice and college costs

Education Research and Data Center
Forecasting and Research
Office of Financial Management

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About the ERDC

The research presented here uses data from the Education Research and Data Center, located in the Washington Office of Financial Management. ERDC works with partner agencies to conduct powerful analyses that can help inform the decision-making of Washington legislators, parents and education providers. ERDC's data system is a statewide longitudinal data system that includes data about people's preschool, educational and workforce experiences.

This study was completed as part of a larger program funded primarily by federal grant CFD #84.372A NCES 15-01 awarded by the Institute for Education science in the US Department of Education to the State of Washington's Office of the Superintendent of Public Instruction and carried out by the Office of Financial Management's Education Research and Data Center. The total program cost is $8,492,963.38. Eighty-four point eight percent (84.8 percent) ($7,203,021) of the total cost of the program is financed with this federal grant money, and 15.2 percent ($1,289,942.38) by the state of Washington.

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Executive summary

Students approaching high school graduation have a variety of post-graduation pathways they can take to enter the workforce. However, they generally have little information on the financial implications of these decisions.

This paper seeks to measure the impact of a high school graduate's education choices and how these choices affect future wages. In this study, we found relationships between different education credentials and programs that will help students and policymakers understand what today's students may earn after they enter Washington's workforce — whether directly after high school graduation or after they earn an education credential.

Here are the most important takeaways from this study:

1. Completing a bachelor's, graduate, or apprenticeship program leads to higher future wages.
2. Wages from post-secondary education credentials (apprenticeship, bachelor's degree, and graduate degree) increase over time.
3. Some programs offer a positive wage impact that is greater than the wage value of the credential.
4. Even if the program is popular, it doesn't mean it will result in higher wages.
5. Some programs, particularly computer science and engineering, have a notably higher impact on wages than other programs.
6. The impact of someone's program choice tends to accumulate over time, in both positive and negative directions.
7. This study couldn't determine the wage impact of earning an associate degree, certificate or completing some college.

Data analysis

We used a series of regression models to calculate how post-secondary credentials and program choice impacted future workforce earnings (for a more detailed explanation of the statistical models and to view the complete results, please see Appendix A.)

The regression models considered factors such as demographic characteristics, student ability and year. Each model used different reference characteristics to generate a different intercept for each year, also known as the "reference wage." The model produces "average annual dollars per hour" for each specific credential or program. This number represents the potential increase or decrease each year based on an individual's credentials and program choice.

While we included various demographic variables into our model, such as gender, race and OSPI program participation, we did not include any of these findings in this report. The existing literature suggests there may be an interaction between these measures and long-term wages, but our data was too generalized to draw any reliable conclusions.

The source data for this study is the 2018 High School Feedback report, which is published by the Education Research and Data Center (ERDC). ERDC compiles this report from information provided by the Office of Superintendent of Public Instruction, State Board of Community and Technical Colleges, and the Washington Employment Security Department. Additional data for this study came from the Washington Student Achievement Council and information submitted to ERDC by Washington's public four-year colleges and universities. Additional information from National Student Clearinghouse (NSC) is made available via contract. (For further explanation of the data we used, see Appendix B.)

What we found

We found there were a limited number of choices that a student can make to increase their expected wages later in life**.** What credential they seek, what program they choose, and how they pay for their education all impact their future wages. We also found that ways of paying for school other than loans and work study may provide benefits long after a student earns their credential.

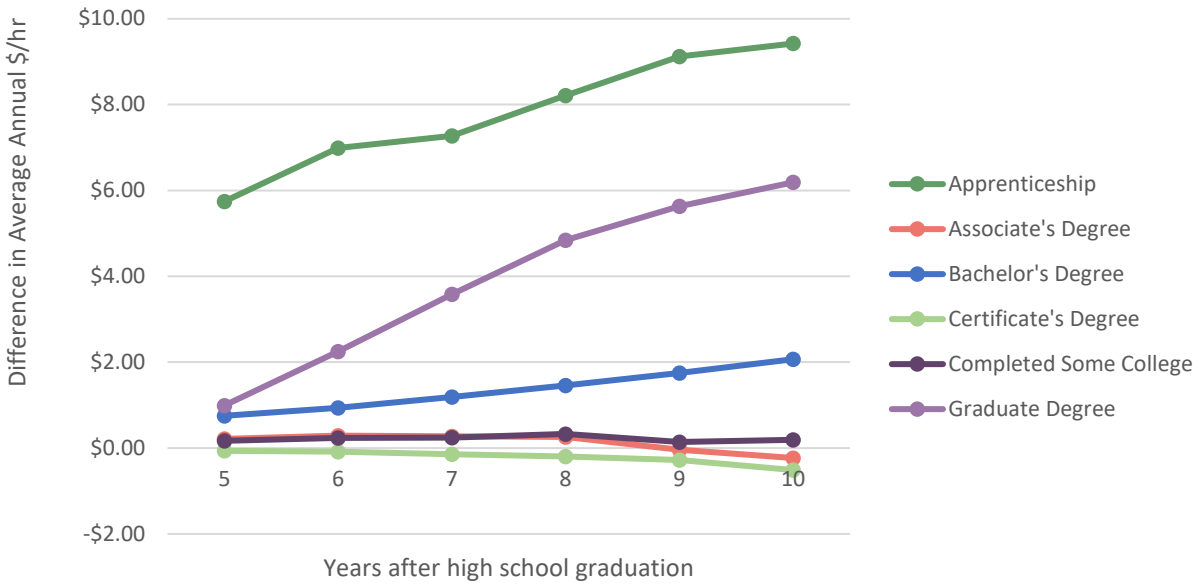
1. Completing a bachelor's, graduate, or apprenticeship program leads to higher future wages.

After we accounted for the impact of demographics, academic performance and groupings, we found that earning a bachelor's degree, graduate degree, or completing an apprenticeship produced a higher wage later in life than directly entering the workforce after high school graduation. This difference in wages persisted throughout the study and even grew over time. However, if someone only earned a certificate, associate degree or completed *some* college, their future wages weren't impacted as much.

Here's the most important takeaway from the graph below:

Apprenticeships, graduate degrees and bachelor's degrees increase future wages while associate, some college, and certificates have little to no impact on wages.

Figure 1: How much each "generic" credential is worth years after high school



The dollar values above (on the left-hand side of the graph) represent the difference in wages someone would earn based on what credential they earned. You can predict their hourly wage using the "intercept" value from Table 1 in the appendix and the wages in this chart. For example, a person who completes an apprenticeship will make $29.21 five years after graduation and will eventually earn $36.82 10 years after graduation. However, a person who pursues a certificate will make less, with $23.40 five years after graduation and earn $27.91 10 years after graduation.

In another example, a student who earns a bachelor's degree may earn an additional $2.07 based on that credential. However, they can earn an additional $6.19 on top of the $2.07 if they earn a graduate degree. to earn more overall.

We recommend that you take these results with caution because they don't include more specific variables such as program choice and the amount of financial aid someone will owe. When we control for these variables, then these values can change. The trends above seem to be stable across the models we looked at, but the size of the impact is heavily impacted by these key factors.

2. Wages from post-secondary education credentials (apprenticeship, bachelor's degree and graduate degree) increase over time.

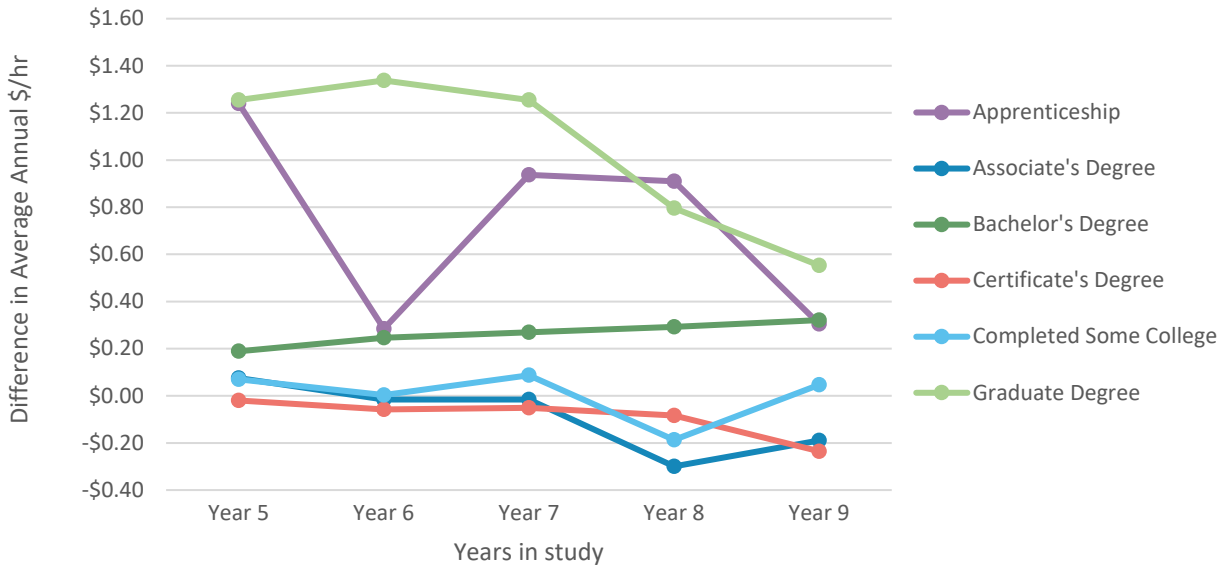
We found across all models that wages increased for students who completed apprenticeship, bachelor's and graduate credentials. The further these post-secondary students were removed from their high school graduation year, the bigger the difference in their wages compared to someone who entered the workforce right after high school. This result takes inflation (the buying power of a dollar) and the year when they earned the wages (the economic environment) into account.

The growth rate was highest for apprenticeship and graduate credentials with the growth rate only slightly slowing during the five to 10 years after graduation. The values in Figure 2 represent the difference in wage changes from the reference wage from one year to the next. Values in this chart represent the trend (either positive or negative) in the wage gap for these credentials.

Here's the most important takeaway from the graph below:

The rate that the wage gap among students with apprenticeships, graduate degrees and bachelor's degrees compared to students who entered the workforce directly after high school increases over time.

Figure 2: How much wages increase year over year for someone with specific credentials



Note: Wage values can be found in Appendix A, Table 1.

We don't know why the rate of increase of the wage gap slows over time, but it might be due to work experience. Slowing wage growth rates could mean that the model is picking up early career wage increases that don't continue later in someone's career. This is a good topic to study in the future.

3. Some programs offer a positive wage impact that is greater than the wage value of the credential.

Like credentials, values of programs vary over time. A program is the sequence of coursework someone must complete to earn a credential.

These programs are categorized by the Classification of Instructional Programs (CIP) code. We refer to these programs (CIP 1, CIP 2, CIP 3, etc.) in this report with numbers (See Appendix E for a full listing). Each number stands for a different program or credential name (such as engineering, biology, liberal arts).

While credentials may share some coursework, programs are much more focused on teaching the direct skills and information related to the field of study. This specialized training produces strong impacts on future wages.

This wage impact varies based on the program. At five years after high school graduation, only the value of completing a computer science degree is higher than completing an apprenticeship. On the other hand, earning a degree in biology and biomedical sciences reduces someone's future earnings more than the wage benefit they received from earning a generic bachelor's degree at any point between 5 and 10 years after high school graduation.

While individual programs represent large portions of future wages, the relationship between credentials and programs favors credentials over time. At 10 years after high school graduation, the wage value of completing an apprenticeship exceeds all other programs. The value of someone earning a graduate credential is also greater in all but three programs (CIP 11: computer science, CIP 14: engineering, CIP 51: health professions) 10 years after high school graduation.

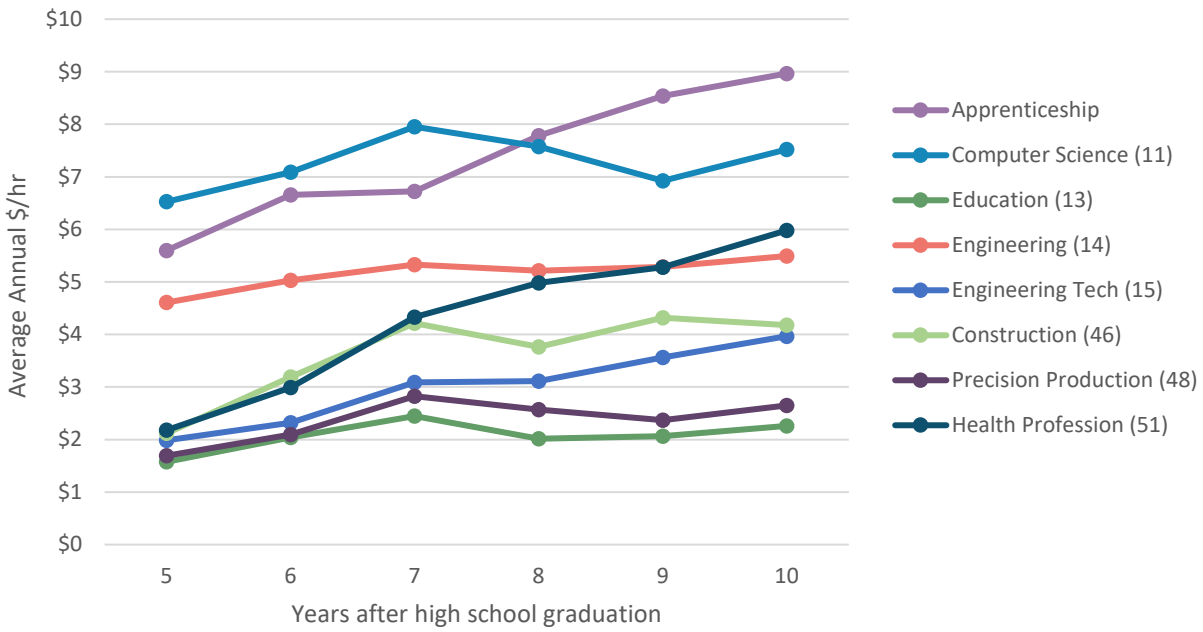
The exception to this trend is the bachelor's degrees credential. This credential produces a wage increase lower than 11 programs after 10 years. However, five of these program wage impacts are close to the value of the credential. (See Appendix A for a complete list of values for credentials and programs.)

In the chart below, we compare apprenticeship wages to wages someone could earn from college programs (not credentials).

Here's the most important takeaway from the graph below:

Earning a generic apprenticeship credential produces higher wages 10 years after graduation than completing any other program.

Figure 3: How future wages for apprenticeship earners compares to the future wages of someone who completed top earning programs



The values in Figure 3 represent the difference from the reference wage. See the "intercept" value in Appendix A, Table 2 for expected reference wages.

4. Even if the program is popular, it doesn't mean it will result in higher wages.

Just as there is great variation in the value of programs, there is also a substantial difference in how commonly students choose a program. While student interest, institutional offerings, and employment opportunities after graduation may impact the program choices students make, the *long-term value* of a program doesn't necessarily change due to its popularity.

Table 1: The eight most popular programs for those earning bachelor's degrees

CIP	Field of study
09	Communication, journalism and related programs
11	Computer and information sciences and support services
13	Education
24	Liberal Arts
42	Psychology
45	Social sciences
51	Health professions and related clinical sciences
52	Business, management, marketing and related support services

Bachelor's degrees are the most commonly earned credential in this dataset. While these are the most commonly chosen majors among students, Figure 5 displays the wage returns for these eight programs.

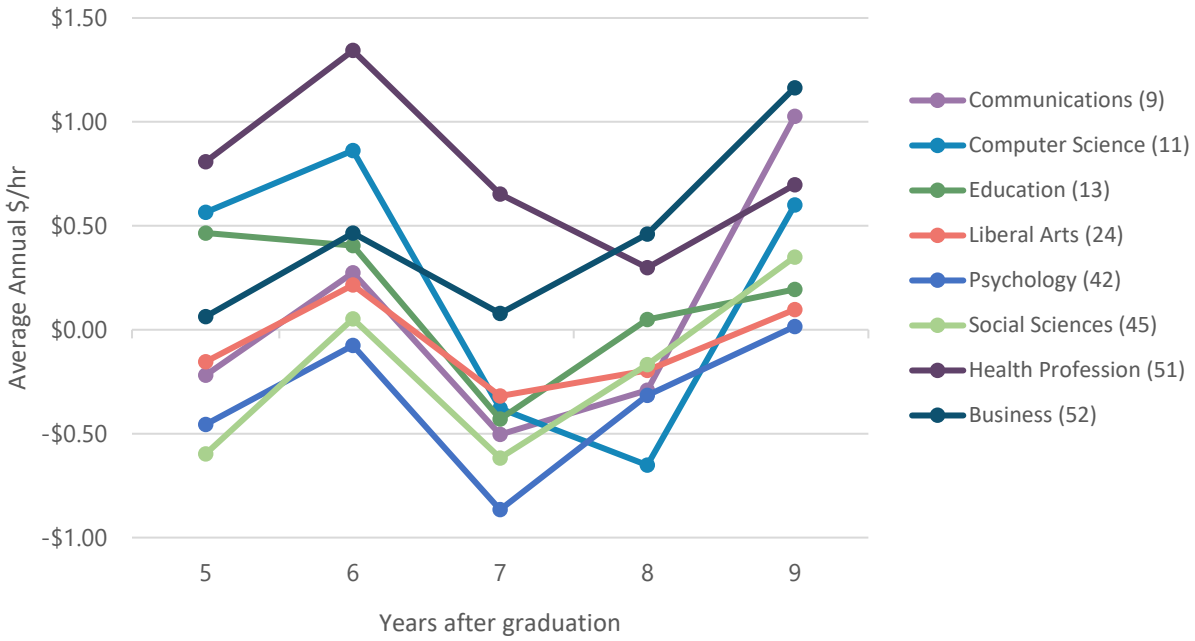
Common programs in this dataset tend toward higher long-term wage outcomes. Computer science, health professions, education, and business programs have the highest net (combination of credential and program) wages among all bachelor's degree programs.

On the other hand, psychology and social sciences produce a negative impact on wages. The most common major (CIP 24: Liberal Arts) is not represented on this chart because the program wage value was consistently insignificant. Said another way, the wage value of liberal arts degrees is effectively zero.

Here's the most important takeaway from the graph below:

Popular programs produce a wide range of future wage impacts.

Figure 5: Future wage returns for popular programs by CIP code



Note: The values in this graph represent the difference from the reference (low frequency program) wage. See the "intercept" value in Appendix A, Table 2 for expected reference wages.

However, the value of a program represented in this table is also independent of the credential. It is entirely possible that credentials other than bachelor's degrees are driving future wages. For example, majoring in construction trades (CIP 46) results in a higher wage value than majoring in communication, journalism, and related trades (CIP 9) but there are extremely few individuals who earned a bachelor's degree in a construction trade. That's why it's hard to say that choosing any individual program will result in something similar to the values represented above — even if it is a popular degree.

5. Some programs, particularly computer science and engineering, have a notably higher impact on wages than other programs.

While the wage value of completing a program varies, certain programs produce relatively large increases in wages. These high earning programs are generally STEM (Science, Technology, Engineering and Math) programs that experts consider pathways to highly productive careers. Computer science and engineering programs produce the highest increases in future wages and these STEM programs are particularly in demand in Washington's workforce.

There is also the potential for higher wages for students with multiple credentials in these programs. Many of the best paid, nonmanagement workers in the state are graduates of STEM programs who hold multiple credentials. A master's degree in computer science requires completing a bachelor's degree and a graduate credential. In combination, this credential is predicted to be worth $41.32 per hour just 10 years after high school graduation. That translates to nearly $86,000 per year. That's 221% of the average per capita income in Washington between 2015-2019 (Census, 2021). To look at the impact of a graduate degree in other STEM programs after 10 years, we compared a select group of programs in Figure 6. The red line is the net value of the two degrees (bachelor's + graduate) and the program (CIP Code).

That isn't to say all programs that require advanced education credentials produce significant wage gains. Both English (CIP 23) and History (CIP 54) programs produce strong negative effects on future wages. These impacts outweigh the benefits of a bachelor's degree and are not part of the program options for apprenticeship credentials. That's why earning a credential in these programs almost exclusively requires a graduate degree to outlearn someone who entered the workforce directly after high school graduation.

Similarly, not all STEM coursework results in higher long-term wages. A degree in the physical sciences (CIP 40) produces a negative wage impact for an individual who only earns a bachelor's degree. While a graduate degree in mathematics (CIP 27) produces a positive long-term wage value, we found that completing an apprenticeship in construction trades (CIP 46) results in higher long-term wages. This net (combination of credential and program) effect is partially the byproduct of extremely high wages for the limited number of people in the dataset who completed an apprenticeship. Approximately 55 times as many bachelor's degrees than apprenticeships are represented in the dataset. However, high wages for apprenticeship completers is a national phenomenon (Hanks, McGrew, & Zessoules, 2018) and is not likely the product of a small sample size.

6. The impact of someone's program choice tends to accumulate over time, in both positive and negative directions.

Program choice almost exclusively results in wage gaps that expand over time. While individual programs tend to result in positive or negative wage gaps five years after high school graduation, these gaps are almost always wider after 10 years – which means certain programs won't ever see a wage increase, despite how many years go by.

We can almost always see the direction of these gaps in the five years after graduation, and these gaps trend at a relatively stable rate, with some volatility year over year, until 10 years after graduation (the last year in our study). Values in this chart represent the trend (either positive or negative) in the wage gap for these credentials.

Here's the most important takeaway from the table below:

Across STEM programs, computer science and engineering programs produce the highest increases in future wages after 10 years.

Figure 6: Components of wages for a STEM graduate student 10 years after high school

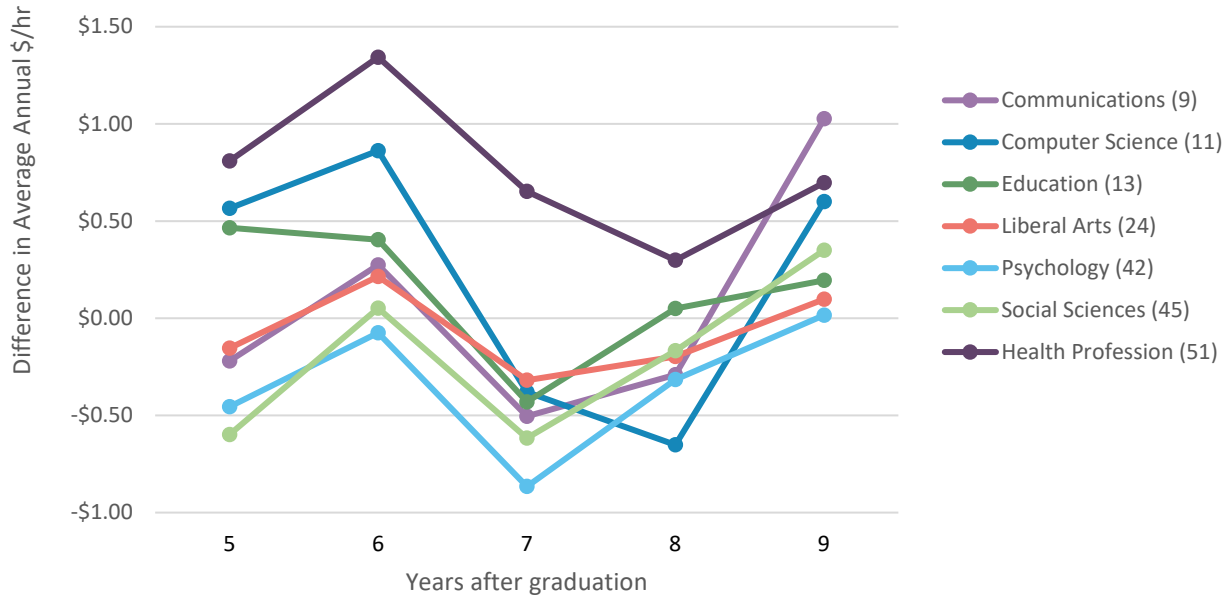
	Program	Bachelor's degree	Graduate degree	Total wages	Total wages + reference wage
Computer Science (11)	$ 7.52	$ 2.17	$ 4.87	$ 14.55	$ 41.32
Engineering (14)	$ 5.49	$ 2.17	$ 4.87	$ 12.52	$ 39.29
Engineering Tech (15)	$ 3.97	$ 2.17	$ 4.87	$ 11.00	$ 37.77
Biological/Biomedical (26)	$ - 4.13	$ 2.17	$ 4.87	$ 2.90	$ 29.67
Math & Statistics (27)	$ 2.57	$ 2.17	$ 4.87	$ 9.60	$ 36.37
Physical sciences (40)	$ -2.81	$ 2.17	$ 4.87	$ 4.22	$ 30.99
Health Profession (51)	$ 5.98	$ 2.17	$ 4.87	$ 13.01	$ 39.78

Note: The values represent the difference from the reference (low frequency program, no post-secondary education) wage. For 10 years after graduation, the reference value is equal to $26.77. See the "intercept" value in Appendix A, Table 2 for expected reference wages.

Here's the most important takeaway from the graph below:

The growth of the wage gaps from program choice is volatile year over year.

Figure 7: Annual wage changes for selected programs



Note: The values represent the difference in wage changes from the reference, one year to the next (Appendix A, Table 2)

There are, however, three exceptions to this trend. Legal professions (CIP 22) have a negative expected wage value five years after high school graduation but a positive value 10 years after high school graduation. Basically, someone will begin the legal profession with a negative wage value but will experience a positive wage accumulation over time. This is likely because legal studies offer low wages to someone who doesn't have a graduate degree. This trend makes sense because it's uncommon to be employed with a graduate degree five years after high school graduation and legal professions tend to reward higher levels of education.

The other two exceptions to this trend are personal and culinary services (CIP 12) and liberal arts (CIP 24) degrees. The wage impact for these programs is not significant; it's indistinguishable from zero. This means the wage impact is either minimal or can't be determined using this model.

7. This study couldn't determine the wage impact of earning an associate degree, certificate or completing some college

Not all post-secondary credentials produce a positive future wage. Shorter term credentials (those that can be typically completed in under two years) typically present lower future wage value than long term credentials (those that take more than two years to complete) (Oreopoulos, 2013). In this study, associate degrees, certificates or completing some college can be considered short-term degrees and we can expect them to bring lower future wage impacts than long-term credentials such as apprenticeships, bachelor's degrees and graduate degrees.

We found that the future wage value of an associate degree, certificate or some college (to an extent) was minimal to negative in this study. This does not mean these credentials are not valued in the workforce. Instead, credential's value seems to be directly tied to the program where someone earned the credential.

After we accounted for the specific program and the amount of financial aid, the wage benefit from earning an associate degree is small, positive and does not increase over time. The wage benefit seems to show up sometime between five and seven years after high school graduation. As program value tends to accumulate over time, this indicates again that someone's program choice drives future wages for their associate degree credentials.

This contrasts with the value of earning a certificate. We found that earning a certificate led to lower wages during the five to 10 years after graduation. This negative impact increased over time. This indicates there may be an opportunity cost (foregoing other opportunities) beyond the cost of tuition or could be related to the abilities of those who tend to earn certificates. In either case, earning a credential is tied to a negative impact on wages that increases over time. However, the program credential someone earned can have a large impact on wages and may serve to overcome the negative wage impact of the credential.

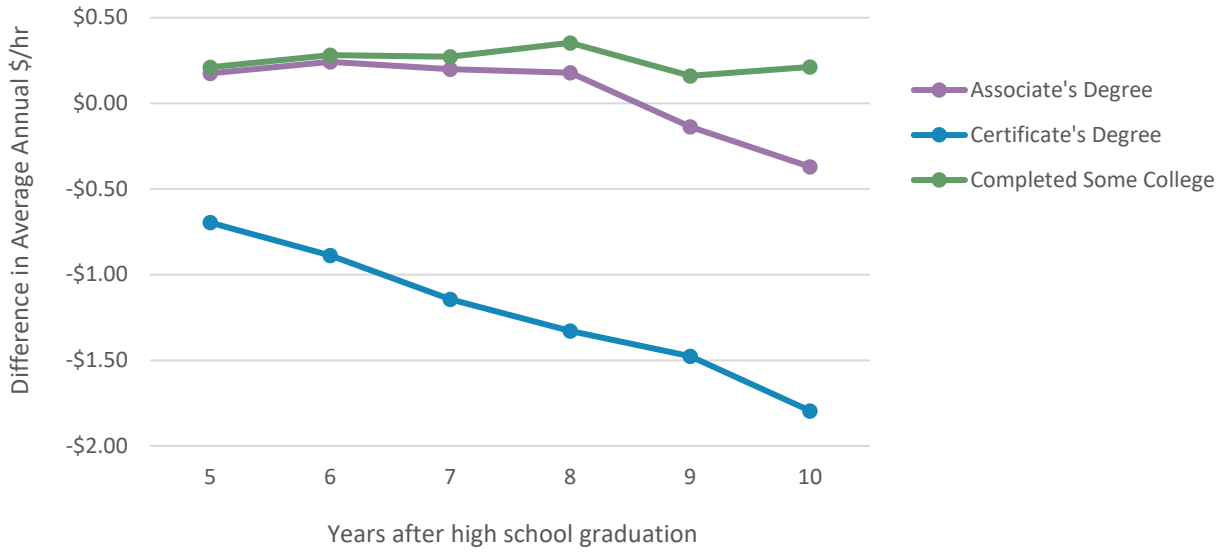
Completing some college but not earning a credential has a very uncertain impact on wages in the context of program and financial aid. Across multiple models, we found that the value of some college was slightly positive, slightly negative, and near zero at different points. This indicates that these individuals may earn similar wages to those who entered the workforce directly after high school but that we need more information to reach a conclusion.

The 'some college' group includes any individual who enrolled at one of the included institutions during the five to 10 years after graduation and who failed to earn a credential during that time. So, there are many possible variations for what 'some college' means. That's why we couldn't accurately capture the quantity of post-secondary education, level of credential someone sought and the program of study. And, the program of study wage premiums don't apply, making it difficult to argue that some college is more worthwhile than direct workforce entry from a wage perspective.

Here's the most important takeaway from the graph below:

Short-term credentials have minimal or negative impacts on long-term wages.

Figure 11: Wage impact of earning a short-term credential (holding financial aid and program choice constant)



Note: The values in this graph represent the difference from the reference (no post-secondary education) wage. See the "intercept" value in Appendix A, Table 3 for expected reference wages.

Sufficient information about someone's socioeconomic status in our dataset may be the reason why we lack the clarity of how earning these credentials impacts someone's wages. The literature shows us that there is a correlation between family income and a student's decision to attend colleges, as well as correlations between someone's socioeconomic status and their access to college preparation opportunities (Walpole, 2003). Both factors impact the ability for a lower-income student to attend more selective programs and colleges. That's why we can't correctly represent what the baseline wages are for low-income students. Without that baseline, it's nearly impossible to tell if earning a credential will increase wages in the future.

What we learned

While the pathway a student follows through higher education matters, there are clearly a number of conditions that impact an individual's long-term earning potential.

Some of the less predictable results, such as grant aid and associate degrees, may reflect the missing family income/socio-economic status information that we mentioned earlier in this paper. Because students are impacted by their family's financial status, there may be a spillover later in life that's reflected in these pathways. Lower-income students may choose career pathways due to financial constraints, and a linear model (like the ones we used in this paper) isn't well suited for determining why these decisions happen without additional information.

Rather, this paper confirms much of what we already knew: More higher education results in higher wages. In-demand programs often result in higher wages.

Beyond these obvious conclusions, there is nuance that adds value for both policymakers and students alike. These nuances include:

- College program choice has a large influence on someone's long term wages. Choosing an in-demand program with a short-term credential can result in higher wages. An example of this might be an associate degree in health sciences/nursing. While the credential doesn't provide large wage impacts in this model, the program does.
- Credentials can be cumulative and that can result in some very high wages. While graduate school isn't for everyone, there are some programs where earning an advanced degree is necessary to earn a positive wage versus joining the workforce right out of high school. Substantially above-average wages are possible by combining stacked credentials with selective program choices.
- Apprenticeships are likely one of the best investments in higher education. With minimal investment in time and cost, nearly all common apprenticeships return higher wages between five and 10 years after high school than direct workforce entry.

While some programs do not produce the type of wage returns that make them desirable investments from a social benefit standpoint, there are a number of programs that we expect to return high economic benefits if more students could earn the credentials. By targeting grant aid and reducing loan burdens on students pursuing high-return graduate degrees and programs, then federal, state, and local governments can recoup at least a portion of their financial aid investment.

Similarly, investing more in apprenticeship programs would likely produce high returns. Students who enroll in these programs may not intend to pursue the higher education pathway. Investment in apprentice programs can help divert students from the direct workforce entry route and into higher wage outcome options.

Finally, we must note that heavy investment in individual pathways may result in unintended consequences. The reason wages are high for some occupations goes beyond someone's level of

education. For example, while engineers do earn high wages, their productivity does not fully account for the size of their wages. To some extent, the supply of engineers is below the demand for engineers and that results in higher wages. If a state were to invest heavily enough to create a surplus in engineers, there would likely be a drop in wages, which could offset the social benefits of the investment.

What comes next

While we used a substantial amount of data to estimate results in this study, there is still missing data. The source of information for this study was administrative data, which means it's not always possible to study important questions that we didn't include when we collected the data. In some cases, other datasets might contain the missing data, but for this research there were a few variables that might have helped improve the accuracy of our estimates that just weren't available.

One big issue with the data comes from *who wasn't* in the data. The administrative nature of the information that we collected systematically excluded certain workers from the data. This included individuals who worked in nonwage jobs, were self-employed, and who worked out of state. That made it difficult to take the lessons we learned from this research and apply them beyond waged workers in Washington. For example, while computer science and engineering is in demand for Washington's waged workforce, this may not be the case in other states.

There is also another key piece of data is missing in this research. We know that there is a relationship between socio-economic status and college attendance having an impact on someone's future wages (Walpole, 2003). However, Washington does not collect any of the traditional components of socio-economic status (family income, parent's educational attainment, parent's occupational status or neighborhood SES) so it's difficult to identify why students choose a pathway to workforce after high school graduation (Cowan, 2012).

Similarly, this data lacks sufficient detail to directly measure a student's academic ability. Just as socio-economic status is linked to college attendance, academic ability helps us determine which students are prepared to complete long term post-secondary credentials. When making admission decisions, selective colleges and universities consider factors such as standardized testing scores and the strength of someone's schedule and extracurricular activities (Clinedinst, 2020). However, these factors are not part of this study's dataset.

ERDC is now developing an understanding of how different high schools offer common coursework. This information is necessary to examine the rigor of a student's coursework. This, combined with a student's GPA, may serve as a more direct measure of academic ability and could help us predict college attendance.

To better understand the impacts of post-secondary education on workforce wages, we must incorporate more detailed data from these missing categories into our future research. For now, these study results should help lead policymakers toward the most productive credential/program/aid combinations to

support the future earnings of the state's high school graduates. However, given the issues with missing data, we advise policymakers to consider the direction and relative strength of our results rather than follow the exact values we estimated.

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Appendix A: Regression Results

The following tables are the regression results from the series of models used to generate the results. The coefficients (average annual $/hour) for each year after high school graduation (column) should be multiplied by the values for each variable (row) and then added together to produce an estimated wage for an individual. The confidence intervals for each coefficient are listed directly to their right. A key for confidence intervals is at the end of each table.

The general model utilized in this regression is a mixed effects model analyzed using the linear model estimation (LMER) method. Fixed effect variables were selected due to availability in the source data while random effect variables were purpose chosen to control for student choices beyond their control (cohort and school district) and choices within their control (college attended). Below is the general notation for the regression formula used in this paper.

$$y_i = X_i b_i + Z_i v_i + e_i$$

For i ϵ{1,...,n} where:

y is a known vector of observations representing the response vector
b is an unknown vector of fixed effects
v is an unknown vector of random effects
e is an unknown vector of random errors
X is the fixed effects design matrix relating the observations y to b
Z is the random effects design matrix relating the observations y to v

Table 1: Regression results in the absence of program and financial aid data

This model is a comparison of credentials to average annual wages. The design is simplistic but the relationships between variables is far more visible than with more complex implementations. It includes controls for the demographic and wage characteristics which methodologically make up a substantial amount of the variance expected in the modeling. Time dummies account for unobserved variation related to outside factors. To some extent, these extra variables absorb variance and are of little importance beyond this effect. Controls for grouping are added for high school, PSE institution, and Industry to produce more accurate coefficients than a standard linear model.

As a descriptive model, the mathematical equation is effectively:

$$\text{Outcome} = \sum \beta \cdot \text{Credentials} + \sum \beta \cdot \text{Demographics} + \sum \beta \cdot \text{Workforce Characteristics} + (1|\text{Industry}) + (1|\text{High School District}) + (1|\text{PSE Institution}) + \text{Error}$$

Results for this model are found below:

		5 Years after HS Grad	6 Years after HS Grad	7 Years after HS Grad	8 Years after HS Grad	9 Years after HS Grad	10 Years after HS Grad
n		350413	321165	284429	246079	207369	168754
(Intercept)		23.46352 ***	23.90155 ***	25.09849 ***	26.18585 ***	26.59304 ***	27.398 ***
Ability	Adult High School Diploma	0.531937 ***	0.334183	0.178049	-0.20253	-0.56472	-0.71985 ***
	Completion of Individualized Education Program	-1.3982 ***	-1.79132 ***	-2.17785 ***	-2.08819 ***	-1.69218 ***	-2.6293 ***
	Graduated High School with Associate' s Degree	1.611189 ***	2.456386 ***	4.09037 ***	4.252578 ***		
	HS GPA > 3.5	1.964037 ***	2.621667 ***	3.230943 ***	3.809638 ***	4.269155 ***	5.113291 ***
	HS GPA Between 2.0 and 3.5	0.349743 ***	0.485413 ***	0.593663 ***	0.726884 ***	0.898547 ***	1.165695 ***
	International Baccalaureate High School Diploma	3.980959 ***	6.349037 ***				

Credential	Apprenticeship	5.745978	***	6.986484	***	7.27112	***	8.208577	***	9.11934	***	9.423676	***
	Associate's Degree	0.21535	***	0.290688	***	0.274434	***	0.258727	***	-0.04075		-0.23095	***
	Bachelor's Degree	0.752419	***	0.941209	***	1.187379	***	1.456447	***	1.748478	***	2.06964	***
	Certificate's Degree	-0.06412	***	-0.08403	***	-0.14221	***	-0.19264	***	-0.27568	***	-0.51097	***
	Completed Some College	0.169578	***	0.239195	***	0.24256	***	0.329504	***	0.142369	***	0.188644	***
	Currently Enrolled in PSE	-0.55417	***	-0.96657	***	-1.24475	***	-1.51228	***	-0.92749	***	-0.69493	***
	Graduate Degree	0.993138	***	2.248341	***	3.586254	***	4.840579	***	5.63683	***	6.189865	***
	Unknown Degree	1.274334		-0.59672		-0.86192		-0.05799					
Demographics	American Indian or Alaska Native	-0.08624		-0.18319	***	-0.26598	***	-0.58048	***	-0.89647	***	-1.00839	***
	Asian	-0.11318	***	-0.13747	***	-0.33474	***	-0.44971	***	-0.28602	***	-0.30235	***
	Black/African American	-0.68382	***	-0.85145	***	-1.13888	***	-1.17423	***	-1.44146	***	-1.61311	***
	Female	-0.79098	***	-1.08333	***	-1.43781	***	-1.97207	***	-2.43685	***	-3.05371	***
	Free and Reduced Price Lunch	-0.58168	***	-0.69649	***	-0.86856	***	-0.99333	***	-1.15329	***	-1.23255	***

	In Learning Assistance Program	-0.52139	***	-0.65519	***	-0.89847	***	-0.89964	***	-1.07258	***	-1.29177	***
	Indicated as Homeless	-0.18802	***	-0.34472	***	-0.26725	***	-0.19549		-0.26519		0.011644	
	Multiple Races Details Unknown	-0.32834	***	-0.41473	***	-0.53957	***	-0.76774	***	-0.98212	***	-1.25865	***
	Native Hawaiian or Pacific Islander	-0.41603	***	-0.83943	***	-1.20618	***	-1.81134	***	-1.53684	***	-2.63196	***
	Not Provided	-0.02762		0.251818		0.453381	***	0.523775	***	0.687045	***	-0.35034	***
	Participated in Bilingual Coursework	-0.22107	***	-0.28511	***	-0.31157	***	-0.42225	***	-0.47333	***	-0.75142	***
	Section 504 Participant	-0.87912	***	-0.92482	***	-1.10572	***	-1.3122	***	-1.08914	***	-1.95913	***
	Spanish, Hispanic, or Latino	-0.45252	***	-0.47498	***	-0.60714	***	-0.70613	***	-0.70959	***	-0.87503	***
	Special Education Participant	-1.64161	***	-1.91711	***	-2.38451	***	-2.7846	***	-3.18018	***	-3.65957	***
	Title 1 Participant	0.025094		-0.20474	***	-0.32369	***	-0.45176	***	-0.37222	***	-0.57201	***
Time	2010	-9.53834	***										
	2011	-8.82158	***	-9.56057	***								

	2012	-8.30343	***	-8.89735	***	-9.31429	***					
	2013	-7.74834	***	-8.23969	***	-8.47912	***	-9.15396	***			
	2014	-7.12033	***	-7.47247	***	-7.4911	***	-7.95963	***	-8.57654	***	
	2015	-6.35558	***	-6.837	***	-6.76212	***	-7.05597	***	-7.4531	***	-8.00124	***
	2016	-5.12718	***	-5.54262	***	-5.70006	***	-5.88124	***	-6.1157	***	-6.34361	***
	2017	-3.49773	***	-3.81679	***	-3.79163	***	-4.31169	***	-4.32052	***	-4.47786	***
	2018	-1.70611	***	-2.0291	***	-1.88083	***	-1.97794	***	-2.26991	***	-2.15829	***
Workforce	Full Time Worker	-0.17068	***	0.050187		0.193722	***	0.157336	***	0.361523	***	0.562232	***
	Number of Hours Worked (Annual)	0.001577	***	0.001351	***	0.001102	***	0.000906	***	0.000883	***	0.00049	***
	Number of Quarters Worked (Annual)	-0.16412	***	0.136809	***	0.326367	***	0.528141	***	0.657603	***	0.840349	***

Confidence Intervals: . = 0.9, * = 0.95, ** = 0.975, *** = 0.99

Table 2: Regression results in the absence of financial aid data

This model builds on the mixed effect model by adding variables relating to program of study. There are a large number of additional variables which are effectively dummies which increases the specificity of the model without adding significant information.

As a descriptive model, the mathematical equation is effectively:

$$\text{Outcome} = \sum \beta \cdot \text{Credentials} + \sum \beta \cdot \text{Demographics} + \sum \beta \cdot \text{Workforce Characteristics} + \sum \beta \cdot \text{CIP Codes} + (1|\text{Industry}) + (1|\text{High School District}) + (1|\text{PSE Institution}) + \text{Error}$$

The results of this model are below:

		5 Years	6 Years	7 Years	8 Years	9 Years	10 Years
n		350413	321165	284429	246079	207369	168754
(Intercept)		23.08992 ***	23.7065 ***	24.43203 ***	25.70275 ***	26.28958 ***	26.76988 ***
Ability	Adult High School Diploma	0.486541 ***	0.265418	0.109997	-0.26348	-0.60399 ***	-0.73345 ***
	Completion of Individualized Education Program	-1.40438 ***	-1.80228 ***	-2.11726 ***	-2.00949 ***	-1.65151 ***	-2.52811 ***
	Graduated High School with Associate' s Degree	1.61472 ***	2.48881 ***	4.003749 ***	4.539076 ***		
	HS GPA > 3.5	1.828026 ***	2.438959 ***	3.009638 ***	3.541255 ***	3.979645 ***	4.810051 ***
	HS GPA Between 2.0 and 3.5	0.374431 ***	0.519833 ***	0.641757 ***	0.784897 ***	0.959744 ***	1.223301 ***
	International Baccalaureate High School Diploma	4.086966 ***	5.998335 ***				
CIP Code	0	0.520654 ***	0.593852 ***	1.22836 ***	1.012909 ***	1.038726 ***	1.44692 ***
	3	-2.45123 ***	-3.17314 ***	-3.65022 ***	-4.33562 ***	-4.65398 ***	-5.10627 ***
	4	-1.03324 ***	-1.64333 ***	-2.50325 ***	-3.46861 ***	-4.92707 ***	-5.29792 ***
	5	-2.4383 ***	-2.99359 ***	-3.3488 ***	-4.81093 ***	-5.65002 ***	-5.74504 ***
	9	-1.53014 ***	-1.74952 ***	-1.47619 ***	-1.98044 ***	-2.27172 ***	-1.24554 ***

	11	6.525426	***	7.090617	***	7.952853	***	7.573777	***	6.922123	***	7.522086	***
	12	-0.22089		-0.22394		0.288072		-0.22436		-0.18158		0.023879	
	13	1.576293	***	2.041821	***	2.446311	***	2.016216	***	2.066056	***	2.260364	***
	14	4.607335	***	5.029535	***	5.327157	***	5.211538	***	5.283361	***	5.492099	***
	15	1.985672	***	2.322953	***	3.087107	***	3.110872	***	3.564166	***	3.966416	***
	16	-2.37564	***	-3.18524	***	-3.39283	***	-4.49103	***	-5.1373	***	-5.6934	***
	19	-1.48592	***	-2.20777	***	-2.35016	***	-2.99309	***	-2.99315	***	-2.64226	***
	22	-1.05749	***	-0.48064	***	1.15408	***	1.474118	***	1.058545	***	1.414235	***
	23	-2.99778	***	-3.6891	***	-3.96701	***	-5.08879	***	-5.82621	***	-5.61152	***
	24	-0.10269		-0.25625		-0.04111		-0.36011		-0.55633		-0.4592	
	26	-3.11666	***	-3.65618	***	-3.81385	***	-4.63443	***	-4.43989	***	-4.13088	***
	27	1.312636	***	1.221443	***	2.070572	***	1.170309	***	2.050427	***	2.56587	***
	30	-1.60515	***	-2.06729	***	-2.29734	***	-3.30761	***	-3.46864	***	-3.1756	***
	31	-1.73835	***	-2.29629	***	-2.63589	***	-3.49965	***	-3.69806	***	-3.36411	***
	38	-2.16752	***	-2.82852	***	-3.20888	***	-4.47633	***	-4.49386	***	-4.40763	***
	40	-1.6622	***	-1.98844	***	-2.04492	***	-2.74578	***	-2.36795	***	-2.81116	***
	42	-2.17339	***	-2.62877	***	-2.70432	***	-3.57026	***	-3.88636	***	-3.87068	***
	43	-0.56684	***	-0.55142	***	-0.14446		-0.47539		-0.83395	***	-0.53361	
	44	-1.12592	***	-1.90084	***	-2.23968	***	-3.13785	***	-3.67076	***	-3.7326	***
	45	-1.66553	***	-2.26343	***	-2.21104	***	-2.82792	***	-2.99528	***	-2.64528	***
	46	2.116887	***	3.190532	***	4.216189	***	3.765394	***	4.31794	***	4.175308	***
	47	1.34294	***	1.656096	***	2.220965	***	2.105504	***	2.393991	***	2.51609	***
	48	1.691889	***	2.093621	***	2.824598	***	2.570829	***	2.367362	***	2.650886	***
	49	1.787554	***	1.728784	***	2.86247	***	3.168498	***	3.265597	***	4.294407	***
	50	-1.94721	***	-2.49295	***	-2.70951	***	-3.62875	***	-4.12605	***	-4.58417	***
	51	2.178505	***	2.987422	***	4.330819	***	4.98412	***	5.282451	***	5.98021	***
	52	0.305687	***	0.368926	***	0.834558	***	0.913676	***	1.373753	***	2.538347	***
	54	-2.95745	***	-3.27265	***	-3.30173	***	-4.37142	***	-5.0395	***	-4.47823	***
Credential	Apprenticeship	5.599385	***	6.653935	***	6.721028	***	7.781445	***	8.53834	***	8.966355	***

	Associate's Degree	0.180701	***	0.24904	***	0.204777	***	0.181724	***	-0.13518	***	-0.36869	***
	Bachelor's Degree	0.919573	***	1.146944	***	1.426341	***	1.672913	***	1.966751	***	2.165101	***
	Certificate's Degree	-0.69208	***	-0.88356	***	-1.13943	***	-1.32448	***	-1.47355	***	-1.79216	***
	Completed Some College	0.173999	***	0.244615	***	0.242122	***	0.329527	***	0.13273	***	0.191034	***
	Currently Enrolled in PSE	-0.63901	***	-1.07189	***	-1.31599	***	-1.53487	***	-0.73053	***	-0.59778	***
	Graduate Degree	0.239673	***	1.287396	***	2.523203	***	3.597337	***	4.30376	***	4.867779	***
	Unknown Degree	0.641935		0.168136		-0.75712		-2.50518					
Demographics	American Indian or Alaska Native	-0.08576		-0.1965	***	-0.26528	***	-0.58032	***	-0.89959	***	-0.98689	***
	Asian	-0.22049	***	-0.264	***	-0.4692	***	-0.60289	***	-0.43709	***	-0.45911	***
	Black/African American	-0.68765	***	-0.83907	***	-1.12309	***	-1.16243	***	-1.41163	***	-1.59452	***
	Female	-0.58783	***	-0.85648	***	-1.19523	***	-1.7104	***	-2.15609	***	-2.75959	***
	Free and Reduced Price Lunch	-0.59723	***	-0.7148	***	-0.8976	***	-1.0242	***	-1.17402	***	-1.26158	***
	In Learning Assistance Program	-0.53399	***	-0.6803	***	-0.92573	***	-0.91549	***	-1.11857	***	-1.33782	***
	Indicated as Homeless	-0.22964	***	-0.39203	***	-0.30216	***	-0.24377		-0.38297		-0.17501	
	Multiple Races Details Unknown	-0.33353	***	-0.4101	***	-0.53968	***	-0.73555	***	-0.94063	***	-1.24314	***
	Native Hawiian or Pacific Islander	-0.39683	***	-0.80887	***	-1.16701	***	-1.76214	***	-1.36673	***	-2.44303	***
	Not Provided	-0.01182		0.184755		0.376636	***	0.413796	***	0.618753	***	-0.44021	
	Participated in Bilingual Coursework	-0.29833	***	-0.40373	***	-0.46476	***	-0.6062	***	-0.67489	***	-0.93945	***
	Secion 504 Participant	-0.84534	***	-0.87365	***	-1.06951	***	-1.24879	***	-1.07353	***	-1.87452	***
	Spanish, Hispanic, or Latino	-0.42069	***	-0.42988	***	-0.54545	***	-0.63232	***	-0.62482	***	-0.76834	***
	Special Education Participant	-1.64382	***	-1.92585	***	-2.39917	***	-2.79759	***	-3.19265	***	-3.67582	***

	Title 1 Participant	0.039264		-0.16012		-0.27397	***	-0.3885	***	-0.29146		-0.50466	***
Time	2010	-9.53993	***										
	2011	-8.82271	***	-9.55729	***								
	2012	-8.29629	***	-8.879	***	-9.28184	***						
	2013	-7.72587	***	-8.21576	***	-8.42053	***	-9.12101	***				
	2014	-7.10448	***	-7.43288	***	-7.43025	***	-7.89872	***	-8.57092	***		
	2015	-6.3597	***	-6.8007	***	-6.68334	***	-6.98348	***	-7.41752	***	-8.04928	***
	2016	-5.14563	***	-5.53471	***	-5.62886	***	-5.79478	***	-6.07855	***	-6.35413	***
	2017	-3.51212	***	-3.8306	***	-3.76263	***	-4.24406	***	-4.26704	***	-4.48839	***
	2018	-1.69469	***	-2.04322	***	-1.86963	***	-1.94703	***	-2.23919	***	-2.13087	***
Workforce	Full Time Worker	-0.15654	***	0.053367		0.182895	***	0.113553		0.285103	***	0.444851	***
	Number of Hours Worked (Annual)	0.001574	***	0.001345	***	0.001126	***	0.00093	***	0.00091	***	0.000522	***
	Number of Quarters Worked (Annual)	-0.15958	***	0.108768	***	0.287098	***	0.484271	***	0.600105	***	0.775866	***

Confidence Intervals: . = 0.9, * = 0.95, ** = 0.975, *** = 0.99

Table 3: Regression results with all categories included

This model has two different implementations within the paper. First, student cost burden is represented by the types of aid awarded and the cost of attendance. Then the model is re-run with only a calculated field representing percentage of school cost covered by loans and percentage covered by direct funding.

As a descriptive model, the mathematical equation is effectively:

Outcome = ∑ β·Credentials + ∑ β·Demographics + ∑ β·Workforce Characteristics + ∑ β· CIP Codes + ∑ β· School Finance + (1|Industry) + (1|High School District) + (1|PSE Institution) + Error

For the model with various types of aid represented, the results are below:

		5 Years	6 Years	7 Years	8 Years	9 Years	10 Years
	n	350413	321165	284429	246079	207369	168754
	(Intercept)	23.04045 ***	23.664838 ***	24.415823 ***	25.729174 ***	26.344241 ***	26.888229 ***
Ability	Adult High School Diploma	0.5294364 ***	0.3100134	0.1554437	-0.2077139	-0.5555179	-0.6677309
	Completion of Individualized Education Program	-1.4131035 ***	-1.8051113 ***	-2.1143587 ***	-2.0010329 ***	-1.6356118 ***	-2.489267 ***
	Graduated High School with Associate's Degree	1.5984984 ***	2.4648651 ***	3.9840682 ***	4.4942925 ***		
	HS GPA > 3.5	1.8070624 ***	2.4073767 ***	2.976584 ***	3.5103764 ***	3.9461489 ***	4.7756007 ***
	HS GPA Between 2.0 and 3.5	0.3822541 ***	0.5259315 ***	0.6452747 ***	0.7829069 ***	0.9555145 ***	1.2159344 ***
	International Baccalaureate High School Diploma	4.0984087 ***	5.9741637 ***				
CIP Code	0	0.5505851 ***	0.6361053 ***	1.2598809 ***	1.0347542 ***	1.077113 ***	1.4410837 ***
	3	-2.4417715 ***	-3.1513679 ***	-3.6154582 ***	-4.2965112 ***	-4.5671512 ***	-5.0403 ***

4	-1.0053884 ***	-1.5847875 ***	-2.4466756 ***	-3.4171581 ***	-4.8600662 ***	-5.2397206 ***
5	-2.4137175 ***	-2.9538259 ***	-3.3230715 ***	-4.7788996 ***	-5.5540058 ***	-5.6615617 ***
9	-1.5250078 ***	-1.7276098 ***	-1.4655226 ***	-1.9816845 ***	-2.2770638 ***	-1.2814136 ***
11	6.538993 ***	7.1100268 ***	7.9758505 ***	7.6101214 ***	7.0051736 ***	7.5872573 ***
12	-0.2094266	-0.1947584	0.302333	-0.2290357	-0.2144982	-0.0887387
13	1.5865033 ***	2.0588043 ***	2.464818 ***	2.0313044 ***	2.1096649 ***	2.3026538 ***
14	4.5958497 ***	5.0294916 ***	5.3348595 ***	5.2460977 ***	5.3747562 ***	5.5946546 ***
15	1.9922723 ***	2.3429653 ***	3.0975475 ***	3.1155138 ***	3.5590923 ***	3.9275509 ***
16	-2.3408722 ***	-3.1264646 ***	-3.360191 ***	-4.469649 ***	-5.1062076 ***	-5.6602236 ***
19	-1.4460762 ***	-2.1438974 ***	-2.3032755 ***	-2.9629727 ***	-2.9573852 ***	-2.6343238 ***
22	-0.9370181 ***	-0.3485216	1.2705957 ***	1.5599652 ***	1.1113713 ***	1.3838653 ***
23	-2.9910777 ***	-3.6686479 ***	-3.9543585 ***	-5.0865244 ***	-5.8046148 ***	-5.6145178 ***
24	-0.0611053	-0.1982495	-0.0035637	-0.3395235	-0.5417717	-0.5011413
26	-3.020902 ***	-3.558371 ***	-3.7509452 ***	-4.5979513 ***	-4.3789984 ***	-4.1038631 ***
27	1.3235049 ***	1.2439802 ***	2.0980188 ***	1.1954874 ***	2.1167026 ***	2.6267202 ***
30	-1.5490481 ***	-2.0026999 ***	-2.2394372 ***	-3.2702805 ***	-3.4180447 ***	-3.1696139 ***
31	-1.7133383 ***	-2.2559273 ***	-2.6103443 ***	-3.499694 ***	-3.6910256 ***	-3.3746221 ***
38	-2.114788 ***	-2.757907 ***	-3.1633008 ***	-4.452269 ***	-4.4612159 ***	-4.4222596 ***
40	-1.6180756 ***	-1.9329377 ***	-1.9981704 ***	-2.7056311 ***	-2.2853286 ***	-2.7574435 ***
42	-2.1300899 ***	-2.578889 ***	-2.6698214 ***	-3.5546517 ***	-3.8607834 ***	-3.8658608 ***
43	-0.5359764 ***	-0.504183 ***	-0.1148215	-0.4639197	-0.8273845 ***	-0.5548972
44	-1.0552727 ***	-1.8139921 ***	-2.1610153 ***	-3.0729088 ***	-3.5705209 ***	-3.6728928 ***
45	-1.6395064 ***	-2.2223987 ***	-2.1867323 ***	-2.8176726 ***	-2.9683501 ***	-2.6415795 ***
46	2.1079873 ***	3.1921255 ***	4.2101663 ***	3.7396574 ***	4.2529534 ***	4.0193651 ***
47	1.3352512 ***	1.6628786 ***	2.2186018 ***	2.0918339 ***	2.3397683 ***	2.386683 ***
48	1.6900439 ***	2.1000513 ***	2.8157331 ***	2.5569174 ***	2.3334838 ***	2.5547518 ***
49	1.8077525 ***	1.781874 ***	2.8885056 ***	3.1338825 ***	3.163766 ***	4.0958215 ***
50	-1.9334055 ***	-2.4710066 ***	-2.6964903 ***	-3.6283447 ***	-4.1153025 ***	-4.6025968 ***
51	2.2455971 ***	3.0587397 ***	4.3855086 ***	5.0259053 ***	5.3057377 ***	5.9132791 ***
52	0.3106925 ***	0.3912435 ***	0.8557626 ***	0.9382768 ***	1.4208439 ***	2.561082 ***

	54	-2.9471951	***	-3.2389614	***	-3.284059	***	-4.3728672	***	-5.0258156	***	-4.4983212	***
Credential	Apprenticeship	5.5675182	***	6.6220119	***	6.7021009	***	7.7738537	***	8.5247555	***	8.9490082	***
	Associate's Degree	0.1957585	***	0.2573208	***	0.2272714	***	0.2274068	***	-0.0334968		-0.2464952	***
	Bachelor's Degree	0.9264347	***	1.1572526	***	1.4266117	***	1.6673749	***	1.9640886	***	2.169495	***
	Certificate's Degree	-0.6886751	***	-0.8821719	***	-1.1344649	***	-1.3079799	***	-1.4243516	***	-1.725745	***
	Completed Some College	0.260435	***	0.3218546	***	0.3175093	***	0.4098042	***	0.2777741	***	0.3374992	***
	Currently Enrolled in PSE	-0.5618771	***	-0.9714859	***	-1.203513	***	-1.422148	***	-0.7343807	***	-0.6140647	***
	Graduate Degree	0.3421143	***	1.3756701	***	2.5876248	***	3.6173326	***	4.2795501	***	4.7595859	***
	Unknown Degree	0.6691919		0.2159877		-0.8055286		-2.6224231					
Demographics	American Indian or Alaska Native	-0.0895825		-0.2016618	***	-0.2679576	***	-0.5761011	***	-0.8796515	***	-0.9635959	***
	Asian	-0.1967742	***	-0.241749	***	-0.4382921	***	-0.5563899	***	-0.3458108	***	-0.3512205	***
	Black/African American	-0.6199654	***	-0.7709129	***	-1.0551431	***	-1.0942891	***	-1.3084046	***	-1.4841669	***
	Female	-0.5749409	***	-0.8445022	***	-1.1812372	***	-1.6957115	***	-2.1295156	***	-2.7270309	***
	Free and Reduced Price Lunch	-0.5097055	***	-0.6250891	***	-0.7956226	***	-0.908992	***	-0.9935133	***	-1.0636259	***
	In Learning Assistance Program	-0.5481647	***	-0.691259	***	-0.9336436	***	-0.9271553	***	-1.1438605	***	-1.3660277	***
	Indicated as Homeless	-0.2123085	***	-0.3686881	***	-0.2834226	***	-0.2307341		-0.3671411		-0.1728689	
	Multiple Races Details Unknown	-0.3186564	***	-0.393098	***	-0.5269379	***	-0.7235906	***	-0.9083067	***	-1.1996804	***
	Native Hawaiian or Pacific Islander	-0.3901666	***	-0.805477	***	-1.1667722	***	-1.7591474	***	-1.3575161	***	-2.4064558	***
	Not Provided	-0.0256792		0.1790981		0.3792892	***	0.4182597	***	0.6371122	***	-0.3551863	

	Participated in Bilingual Coursework	-0.3124672	***	-0.4214434	***	-0.471089	***	-0.606876	***	-0.6511583	***	-0.89571	***
	Section 504 Participant	-0.861877	***	-0.8872054	***	-1.0836655	***	-1.260274	***	-1.0670712	***	-1.843718	***
	Spanish, Hispanic, or Latino	-0.4085895	***	-0.4188667	***	-0.5298808	***	-0.60866	***	-0.5806595	***	-0.7192394	***
	Special Education Participant	-1.6707124	***	-1.9529017	***	-2.4238276	***	-2.8202572	***	-3.2302267	***	-3.7176375	***
	Title 1 Participant	0.0373986		-0.162574		-0.2726381	***	-0.3740645	***	-0.2672542		-0.4905387	***
FinAid	All Aid (Total)	-0.0286672	***	-0.0396501	***	0.0375482	***	0.1519681	***	0.3433519	***	0.4608753	***
	Cost of Attendance	0.0453933	***	0.1020599	***	0.0835047	***	0.0204232		-0.1371022	***	-0.274159	***
	Grant Aid (Total)	0.1917902	***	0.2335889	***	0.1551825	***	-0.0171428		-0.2767843	***	-0.4752627	***
	Need Amount (Total)	-0.2000933	***	-0.271771	***	-0.2628039	***	-0.1985962	***	-0.0752798	***	0.0792238	***
	Work Aid (Total)	-0.0366506		-0.0742101		-0.3977402	***	-0.1140983		-0.4912031	***	-0.9038202	***
Time	2010	-9.585031	***										
	2011	-8.8489279	***	-9.6048555	***								
	2012	-8.2983761	***	-8.9057076	***	-9.3457616	***						
	2013	-7.6917506	***	-8.218786	***	-8.4628327	***	-9.2263024	***				
	2014	-7.064986	***	-7.4028643	***	-7.4456425	***	-7.9775339	***	-8.7424706	***		
	2015	-6.3206338	***	-6.7637482	***	-6.6642588	***	-7.029737	***	-7.5440373	***	-8.2529793	***
	2016	-5.1110471	***	-5.5024324	***	-5.603936	***	-5.8030704	***	-6.1515576	***	-6.5064019	***
	2017	-3.4954452	***	-3.8024313	***	-3.7429736	***	-4.2409431	***	-4.2826417	***	-4.5782723	***
	2018	-1.6852919	***	-2.0373662	***	-1.8510225	***	-1.948457	***	-2.2333185	***	-2.1576124	***
Workforce	Full Time Worker	-0.1704409	***	0.031342		0.1618886	***	0.096312		0.2659844	***	0.43354	***
	Number of Hours Worked (Annual)	0.001554	***	0.0013237	***	0.0011036	***	0.0009092	***	0.0008705	***	0.0004789	***
	Number of Quarters Worked (Annual)	-0.1533353	***	0.1138412	***	0.2913089	***	0.4871836	***	0.6090891	***	0.792222	***

Confidence Intervals: . = 0.9, * = 0.95, ** = 0.975, *** = 0.99

Table 4: Regression results with all categories included, financial aid represented as "percent borrowed"

This model is identical in implementation to the previous model with the exception that financial aid variables are adjusted for cost of attendance.

		5 Years	6Years	7 Years	8 Years	9 Years	10 Years
n		350413	321165	284429	246079	207369	168754
(Intercept)		23.0733382 ***	23.693967 ***	24.4254416 ***	25.70077143 ***	26.29484551 ***	26.77655997 ***
Ability	Adult High School Diploma	0.48113065 ***	0.2629051	0.10658393	-0.26384876	-0.60419418 ***	-0.7325525 ***
	Completion of Individualized Education Program	-1.41039975 ***	-1.8090559 ***	-2.12100465 ***	-2.01152514 ***	-1.65416148 ***	-2.53168098 ***
	Graduated High School with Associate' s Degree	1.61398029 ***	2.4865882 ***	4.00549915 ***	4.53700619 ***		
	HS GPA > 3.5	1.8312275 ***	2.440924 ***	3.01124089 ***	3.54194741 ***	3.97842241 ***	4.80856987 ***
	HS GPA Between 2.0 and 3.5	0.381261 ***	0.5269953 ***	0.64803949 ***	0.78956938 ***	0.9632725 ***	1.22586447 ***
	International Baccalaureate High School Diploma	4.08683443 ***	5.9792394 ***				
CIP Code	0	0.53886434 ***	0.6056572 ***	1.24155367 ***	1.02291225 ***	1.05061174 ***	1.4554666 ***
	3	-2.44505912 ***	-3.1705797 ***	-3.64508137 ***	-4.3365021 ***	-4.64944862 ***	-5.10321522 ***
	4	-1.02389676 ***	-1.6364121 ***	-2.48624448 ***	-3.45555726 ***	-4.90581516 ***	-5.28260391 ***
	5	-2.40316848 ***	-2.9623255 ***	-3.32223705 ***	-4.79110509 ***	-5.62917541 ***	-5.72584032 ***
	9	-1.51119769 ***	-1.7347965 ***	-1.46370866 ***	-1.97100936 ***	-2.26022091 ***	-1.23696017 ***
	11	6.52166624 ***	7.0814043 ***	7.94932342 ***	7.56929092 ***	6.92024832 ***	7.52059079 ***
	12	-0.20134749	-0.2093628	0.30139721	-0.21175781	-0.16670467	0.03662372

13	1.59241221 ***	2.0537065 ***	2.46028048 ***	2.0268106 ***	2.07968736 ***	2.26761255 ***
14	4.59704963 ***	5.0163621 ***	5.32036686 ***	5.20221782 ***	5.27305995 ***	5.4852528 ***
15	1.99717155 ***	2.3343658 ***	3.10027631 ***	3.11965167 ***	3.57473956 ***	3.97753534 ***
16	-2.35837881 ***	-3.1705923 ***	-3.37698707 ***	-4.47808314 ***	-5.12138627 ***	-5.68435513 ***
19	-1.45720464 ***	-2.1890441 ***	-2.33222118 ***	-2.97870765 ***	-2.97422982 ***	-2.62382165 ***
22	-1.02094737 ***	-0.4336841	1.19299791 ***	1.5005737 ***	1.09788953 ***	1.4435305 ***
23	-2.97659874 ***	-3.6728119 ***	-3.95201521 ***	-5.08090875 ***	-5.81670827 ***	-5.60429987 ***
24	-0.08038217	-0.2395306	-0.02549313	-0.34865219	-0.54159164	-0.44560093
26	-3.0978944 ***	-3.6429113 ***	-3.80103809 ***	-4.62562854 ***	-4.42627505 ***	-4.122737 ***
27	1.3103891 ***	1.2101989 ***	2.06853852 ***	1.16970996 ***	2.04958888 ***	2.56293169 ***
30	-1.59433229 ***	-2.0613317 ***	-2.29022356 ***	-3.30454179 ***	-3.46272531 ***	-3.16948849 ***
31	-1.70877455 ***	-2.2736805 ***	-2.61263466 ***	-3.4816983 ***	-3.67867366 ***	-3.34983655 ***
38	-2.1331823 ***	-2.8069478 ***	-3.19024632 ***	-4.46318672 ***	-4.47354647 ***	-4.38790356 ***
40	-1.6409572 ***	-1.9738372 ***	-2.03111511 ***	-2.73609958 ***	-2.35579557 ***	-2.79743711 ***
42	-2.14857778 ***	-2.6093155 ***	-2.68839829 ***	-3.5574372 ***	-3.87057762 ***	-3.85817834 ***
43	-0.54641856 ***	-0.5363525 ***	-0.13000949	-0.46747367	-0.82240083 ***	-0.52630155
44	-1.10003149 ***	-1.8809578 ***	-2.22224856 ***	-3.12422943 ***	-3.65124608 ***	-3.71605222 ***
45	-1.63853139 ***	-2.2434682 ***	-2.19096737 ***	-2.81344928 ***	-2.97881317 ***	-2.6330271 ***
46	2.12876967 ***	3.1941177 ***	4.22090319 ***	3.76952368 ***	4.32398393 ***	4.18112209 ***
47	1.35169154 ***	1.6586859 ***	2.22451892 ***	2.10902619 ***	2.39937341 ***	2.52231951 ***
48	1.70029622 ***	2.096631 ***	2.82938499 ***	2.57249658 ***	2.36932608 ***	2.65492281 ***
49	1.81350881 ***	1.7548255 ***	2.89114038 ***	3.19119682 ***	3.28780559 ***	4.31537077 ***
50	-1.92618171 ***	-2.4803528 ***	-2.69465722 ***	-3.6167429 ***	-4.11288 ***	-4.57294007 ***

	51	2.2018969	***	3.0047411	***	4.34921268	***	4.99994828	***	5.30412295	***	5.9995905	***
	52	0.30559136	***	0.36348	***	0.83205321	***	0.90964305	***	1.37094438	***	2.53700142	***
	54	-2.92224448	***	-3.2456785	***	-3.27493669	***	-4.35331807	***	-5.01924669	***	-4.46116407	***
Credential	Apprenticeship	5.55899551	***	6.6200618	***	6.69409922	***	7.75752688	***	8.51070096	***	8.94457995	***
	Associate's Degree	0.17579131	***	0.2423718	***	0.19978615	***	0.17851535	***	-0.13767933	***	-0.3706478	***
	Bachelor's Degree	0.93309823	***	1.1655045	***	1.44230052	***	1.6865666	***	1.98196721	***	2.1779256	***
	Certificate's Degree	-0.69621969	***	-0.8870772	***	-1.14333646	***	-1.32875015	***	-1.47671331	***	-1.79499796	***
	Completed Some College	0.21119071	***	0.2823187	***	0.27241647	***	0.35353178	***	0.16073538	***	0.21171949	***
	Currently Enrolled in PSE	-0.61527028	***	-1.0509196	***	-1.29761807	***	-1.51818902	***	-0.72444736	***	-0.59119422	***
	Graduate Degree	0.29348263	***	1.3316359	***	2.55784874	***	3.62855999	***	4.34171356	***	4.89873578	***
	Unknown Degree	0.67152331		0.2506165		-0.7102547		-2.5240999					
Demographics	American Indian or Alaska Native	-0.08847202		-0.1991019	***	-0.26587147	***	-0.58152007	***	-0.90116142	***	-0.98865918	***
	Asian	-0.22617378	***	-0.2687633	***	-0.47336495	***	-0.60587303	***	-0.44003413	***	-0.46127685	***
	Black/African American	-0.66909314	***	-0.8185419	***	-1.10400456	***	-1.14644505	***	-1.39318557	***	-1.58017738	***
	Female	-0.58521047	***	-0.854539	***	-1.19410583	***	-1.70872487	***	-2.15465514	***	-2.75813326	***
	Free and Reduced Price Lunch	-0.60103551	***	-0.7182253	***	-0.89951886	***	-1.02535029	***	-1.17473324	***	-1.26174317	***
	In Learning Assistance Program	-0.53815806	***	-0.6843406	***	-0.92895891	***	-0.91831432	***	-1.12224048	***	-1.34012841	***
	Indicated as Homeless	-0.22490513	***	-0.3874742	***	-0.29800399	***	-0.24016239		-0.37816984		-0.17027993	
	Multiple Races Details Unknown	-0.32742467	***	-0.4023407	***	-0.5339143	***	-0.73203665	***	-0.94093745	***	-1.24294302	***
	Native Hawiian or Pacific Islander	-0.38924712	***	-0.8028576	***	-1.16149071	***	-1.75501339	***	-1.35626562	***	-2.43529786	***
	Not Provided	-0.02806492		0.1711777		0.37115522	***	0.40937865		0.61349733	***	-0.43937147	
	Participated in Bilingual Coursework	-0.31481383	***	-0.4214425	***	-0.47917525	***	-0.6184871	***	-0.68938616	***	-0.95067674	***

	Secion 504 Participant	-0.851106	***	-0.8796301	***	-1.07444461	***	-1.25401692	***	-1.07852534	***	-1.87801348	***
	Spanish, Hispanic, or Latino	-0.42463162	***	-0.4339903	***	-0.54928362	***	-0.6358298	***	-0.62826083	***	-0.77065362	***
	Special Education Participant	-1.65229773	***	-1.934375	***	-2.40657576	***	-2.80320446	***	-3.19861322	***	-3.67959687	***
	Title 1 Participant	0.02929646		-0.1706404		-0.28219635	***	-0.39542216	***	-0.29755585		-0.508156	***
FinAid	Percent Covered	-0.00027555		-0.0002564		-0.0003253		0.00012593		0.00018372		0.00087653	
	Percent Borrowed	-0.86817277	***	-0.8351749	***	-0.67012057	***	-0.54379822	***	-0.57435877	***	-0.43688123	***
Time	2010	-9.50876807	***										
	2011	-8.80145664	***	-9.5275083	***								
	2012	-8.28398763	***	-8.8583843	***	-9.25832819	***						
	2013	-7.7148365	***	-8.2027517	***	-8.40508064	***	-9.10497302	***				
	2014	-7.09456687	***	-7.4233051	***	-7.42121678	***	-7.88827684	***	-8.55542308	***		
	2015	-6.35019444	***	-6.7910967	***	-6.67740223	***	-6.97852709	***	-7.40856536	***	-8.0378162	***
	2016	-5.13893091	***	-5.5262223	***	-5.62312548	***	-5.79249731	***	-6.07571382	***	-6.34795799	***
	2017	-3.50932985	***	-3.8254507	***	-3.75741848	***	-4.24171409	***	-4.26636705	***	-4.4866411	***
	2018	-1.69387159	***	-2.0412918	***	-1.86702659	***	-1.94516421	***	-2.23888991	***	-2.13069491	***
Workforce	Full Time Worker	-0.15579381	***	0.0527092		0.18005475	***	0.11321864		0.28415464	***	0.44378224	***
	Number of Hours Worked (Annual)	0.00157228	***	0.0013454	***	0.00112623	***	0.00093029	***	0.00090855	***	0.00052243	***
	Number of Quarters Worked (Annual)	-0.15870864	***	0.1091325	***	0.28670344	***	0.48435083	***	0.60018544	***	0.77500279	***

Confidence Intervals: . = 0.9, * = 0.95, ** = 0.975, *** = 0.99

Appendix B: Data

All datasets are cleaned and checked for completeness before being added to the ERDC data warehouse. To generate the research dataset, ERDC merged multiple datasets based on a procedure that can be found here. The information contained within the database encompasses students who graduate from Washington public high schools and subsequently work in an unemployment covered waged position within Washington State. The dataset for this study is a subset of this database selected for completeness and timeframe (see appendix D for an explanation of data cleaning procedures). Individuals who graduated from high school between 2005 and 2013 and that were employed in a waged position in Washington for at least one quarter compose the population for this analysis. The study period includes quarters, aggregated to calendar years, at a minimum five years after high school graduation and no more than 10 years after graduation during the calendar years 2010-2018.

The variables of interest (degree completion indicators) are derived from program completion data compiled from institutional reporting and NSC data and represent awarded credentials for each student. Students who complete multiple credentials will be indicated for each credential earned. Awarded credentials are included across all years of workforce participation even if the credential was earned subsequent to the earnings year. A student who enrolls in an included college program but fails to graduate is assigned to the "some college" category no matter which institution they enrolled in or for how long. Grouping variables (institution, school district and industry) are determined by the group they were most recently associated with for the earnings year. Students identified as bilingual participated in a dual language program their last year in high school.

A selection from the overall dataset was retained for analysis with outlying individuals excluded as explained in Appendix D. These individuals fall outside the scope of this research and likely have unobserved characteristics which could distort the model. These cases also generally represented outliers in the dataset which could have prevented an accurate estimation of the model. After removing these individuals, the resulting dataset includes over 1.1 million person-years (one individual's annual earnings, with replacement) which represents over 369,000 unique individuals. After selection, the data used in this study was adjusted to represent real wages (2010 base year) using CPI data obtained from the Minneapolis Federal Reserve (2019).

CIP codes are not evenly distributed across cohorts. A number of programs were found to be rare (less than 100 student years) and others were clustered in just a few cohorts. In deference to model fit, these variables are combined into an "all other CIP" variable which had a number of observations in line with the more common CIPs. Similarly, all students who did not receive a diploma, including those with some college experience, were assigned to a single group (CIP 0). This category may also capture a limited number of individuals who earned degrees from out-of-country which were not included in NSC data, at nonreporting private schools, or who have no assigned CIP to their program of choice.

Appendix C: CIP Codes

Although no two different post-secondary institutions offer the exact same curriculum, the US Department of Education (ED) began creating a taxonomy of programs in the 1970s to help translate the plethora of different program names and curricula. ED's research resulted in the Classification of Instructional Programs (CIP), which was implemented for the 1980-81 school year. The program was developed to:

- Map programs to a shared understanding of what a given program of study includes, based on a designated code.
- Collect data from schools on programs of study offered.
- Create reports on educational trends for use by government and the public.

(Department of Homeland Security, 2021)

CIP codes are broken into more than 1,800 subcategories under 47 general categories. These categories are represented by a six-digit code with each two-digit pair representing the general category, subcategory, and specific program code respectively. An example for the classification of a program that teaches students how to create video game graphics is shown below:

2-digit	11	Computer and Information Sciences and Support Services
4-digit	11.10	Computer Software and Media Applications
6-digit	11.1004	Computer Graphics

General categories are delineated by two digits and represent higher level groupings of related programs (11, Computer and Information Sciences and Support Services). Subcategories are represented by the larger category number plus a two-digit subcategory code. This four-digit code represents groupings of programs with similar content and objectives (11.10, Computer Software and Media Applications). The full CIP code as reported to the National Center of Education Statistics' Integrated Postsecondary Education Data System (IPEDS) survey by institutions is six digits and represents a relationship between specific programs as defined by ED (11.1004 Computer Graphics) (US Department of Education, 2021).

For this research we utilize two digit CIP codes. A list of the included CIP codes can be found below.

2-Digit CIP Codes and the fields they represent

CIP	Field of study[1]
01	Agriculture, agriculture operations, and related sciences
03	Natural resources and conservation
04	Architecture and related services
05	Area, ethnic, cultural, and gender studies
09	Communication, journalism, and related programs
10	Communications technologies/ technicians and support services
11	Computer and information sciences and support services
12	Personal and culinary services
13	Education
14	Engineering
15	Engineering technologies/ technicians
16	Foreign languages, literatures, and linguistics
19	Family and consumer sciences/ human sciences
22	Legal professions and studies
23	English language and literature/ letters
24	Liberal Arts
25	Library science
26	Biological and biomedical sciences
27	Mathematics and statistics
29	Military technologies
30	Multi/interdisciplinary studies
31	Parks, recreation, leisure and fitness studies
34	Liberal arts and sciences, general studies, and humanities
38	Philosophy and religious studies
39	Theology and religious vocations
40	Physical sciences
41	Science technologies/technicians
42	Psychology
43	Security and protective services
44	Public administration and social service professions
45	Social sciences
46	Construction trades
47	Mechanic and repair technologies/ technicians
48	Precision production
49	Transportation and materials moving
50	Visual and performing arts
51	Health professions and related clinical sciences
52	Business, management, marketing, and related support services
54	History

**Note*: Some uncommon 2-digit CIP codes are excluded from this list.