Modeling the Returns to Education for High School and College Graduates

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October 1, 2024

We think students read the AER to make their college decisions?

Abstract

What determines college choice? Typically the literature examines the returns and costs to attending college where the return is measured as a college wage premium. However, there is another large difference: those with only a high school degree have an unemployment rate that is about twice as high as that of someone with a college degree. This changes the measured return to a college degree, and if people are basing their decision only on the wage differential then too few people are choosing to attend college. I examine how large this effect is using a standard labor search and matching model. I find that the reservation wage for attending college is lower by $\$7,000$. This means that 28.66% of people would change their decision and attend college when they consider the full impact of employment differences. This suggests policy should be aimed at encouraging this group to attend college.

1 Introduction

In June 2024 the unemployment rate for high school graduates with no college degree was 4.2% and the unemployment rate for those with a bachelor's degree or higher was 2.4% [1], and these trends are persistent over time. Proof?

When people make the decision whether or not to go to college they consider the impact their education will have on their earnings, or their average salary. However, taking into

1. United States Bureau of Labor Statistics. Unemployment rates for persons 25 years and older by educational attainment. 2024. Accessed July 12, 2024. https://www.bls.gov/charts/employment-situation/unemployment-rates-for-persons-25-years-and-older-by-educational-attainment.htm, Washington, DC.

This Q is just the abstract

consideration both ability level and the fact that college graduates are employed more of the time than high school graduates are, may actually change the decision for some people. When people consider the return to college, it is typically measured in terms of their wages. But, there is another large difference: those with only a high school degree have an unemployment rate that is roughly two times higher than that of someone with a college degree. This changes the measured return to a college degree. If people are basing their decision only on the wage differential, then this would lead to too few people choosing to attend college. This could lead to a significant amount of potential productivity that is lost due to the inefficient choice made by those not attending college. Using a standard labor search and matching model I will attempt to determine how large this effect is.

Are they?

The literature looks at the returns versus costs of attending college. Where the return is considered to be a college wage premium. The causal effect of education on earnings is well documented in the literature with the Mincer earnings regression being used to show how different levels of education affect earnings (Mincer (1974), Card (1999), Heckman, Lochner, and Todd (2003), and Bhuller, Mogstad, and Salvanes (2017)). The literature finds that the returns to schooling are around 8% per year of schooling (Patrinos (2016)). In these cases the return to college is measured by the benefit to their wages. In addition to the monetary returns to education, Oreopoulos and Salvanes (2011) show that there are significant non-monetary returns to ~~further~~ education such as enjoying working and more successful parenting and marriages. Heckman, Humphries, and Veramendi (2018) show that ability bias is a component of differences and document substantial positive effects of education on earnings. Furthermore, there are persistent positive effects of higher education on earnings over a lifetime (Tamborini, Kim, and Sakamoto (2015)). In this case considering how wages are higher over a lifetime. Braga (2018) shows that education provides benefits throughout a workers career. Generally in the literature the benefit to college is expressed as a college wage premium. I contribute to the literature on the returns to education by adding the mostly overlooked determinant of unemployment rates.

Incomplete sentence

Where? US?

Already said this

Incomplete sentence

What do these papers do in the case of a $0 wage? Drop the observation?

In this paper I study the decision workers make to go to college and how differing unemployment rates and ability level impact the reservation wage through a two state search model. Traditionally in school choice models only the wage differential is considered when making a decision about whether or not to go to college, but I will also show that the unemployment rate (and the fraction of time spent unemployed) and ability level is an

important factor in this decision.

The remainder of the paper is organized as follows: section 2 describes the data and empirical results, section 3 describes the model, section 4 presents the results, and section 5 concludes.

2 Data and Empirical Results

Whenever you want to use a dash to symbolize "through" like this, it's supposed to be an "en-dash." In LaTeX, you put two hyphens in a row.

Since I need individual worker data such as wages, ability level, and demographics, I use the NLSY79 dataset. I use the NLSY79 data to track individuals wages over time and their ability level as measured by the Armed Forced Qualifications Test (AFQT) score.

The NLSY79 dataset spans the years 1979-present. The original sample contains 12,686 men and women born during the years 1957 through 1964 and living in the United States when the survey began. The survey respondents were ages 14 to 22 when first interviewed in 1979, and they were interviewed annually from 1979-1994 and biannually from 1994-2020. It contains various data such as education level, income, demographics, employment history, ability measures, etc.

To measure the ability level of individuals, I use the Armed Forced Qualifications Test (AFQT) score in the NLSY. In 1980 the NLSY79 administered a series of 10 tests known as the Armed Forces Vocational Aptitude Battery (ASVAB). The AFQT is a composite score for each individual that is derived from different sections of the ASVAB. Many researchers use the AFQT score as a measure of IQ. In this dataset AFQT scores are percentile scores and range between 0 to 100.

I also use the AFQT scores as part of the cost of attending college. In particular, those with lower AFQT scores are assumed to have a higher "cost" of learning.

Table 1 shows summary statistics in the year 2020 organized by sex. Note that the AFQT score is from 1980. We can see that the average level of education is some college but no bachelor's degree, and the average income is higher for men than for women.

Table 1: Summary Statistics (2020)

	Avg Age	Avg Edu	Avg Income	Avg AFQT	Unemp (%)
Male	59.38	13.57	88719.49	48.98	5.18 %
Female	59.53	14.28	55035.16	50.53	3.84 %

Note: Edu = 14 means 2 years of college were attended but no degree was attained

Table 2: Unemployment Rates by Education Level

Education Level	Unemployment Rate
No Diploma	10.55%
High School	6.23%
Some College	4.37%
Bachelor's	2.46%
Master's	1.69%
Professional	1.14%
Doctorate	1.17%

Next I examine how unemployment rates differ for different levels of education. Table 2 shows unemployment rates in 2019 sorted by level of education.

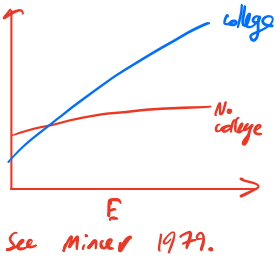
We can see that unemployment rates decrease significantly as the level of education increases, and these results are consistent over the time period. Show us?

Next I use an earnings regression to examine how different levels of education impact yearly earnings. I use the following earnings equation:

Is this standard?

$$log(w) = a + bE + cX + dQ + eX^2 + fX^3 + gX^4 + hS + i \quad (1)$$

Probably want to include some A×X interaction term. College is not a levels effect: it makes the returns to experience steeper. If you skip college and become a landscaper, you earn good money right away, but it'll be pretty flat over your life. If you go to college and work in tech, you might have some shitty internship for a few years, but then you'll slowly get a bunch of promotions. So the curve looks like this:



See Mincer 1974.

Where w is yearly earnings, A is age, E is level of education, X is potential experience, Q is AFQT score, S is a binary variable representing sex, where $S = 1$ is female, and i is the residual. As is standard in the literature, potential experience is calculated using: $X = A - E - 6$.

Table 3 reports the estimated coefficients.

We can see that being female is associated with lower earnings, and higher levels of education beyond a high school degree are associated with higher earnings.

We can see that the higher the level of education, the larger the estimated coefficient is, indicating that yearly earnings increase with education. These empirical results confirm the positive impact of education on earnings. There doesn't appear to be a significant affect of AFQT score on earnings.

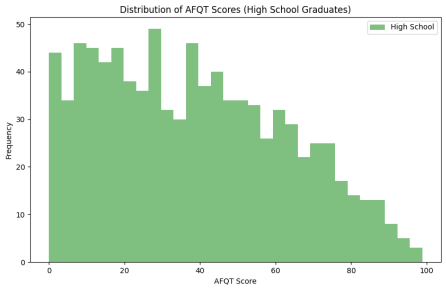
I examine the relationship between AFQT scores and education, and I find that there is a positive relationship between AFQT scores and education. Figure 1a shows the distribution

Table 3: Earnings Regression Results

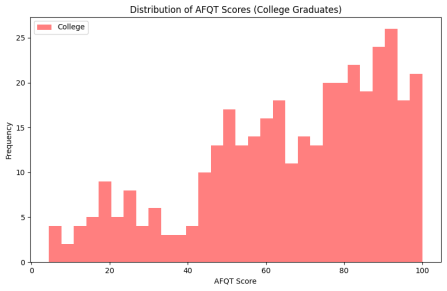
	Dependent variable: log(INC)	
	~~Model I~~	~~Model II~~
	(1)	(2)
Intercept	1.0069	1.3046
	(0.06)	(0.064)
Education	0.0569	0.0769
	(0.013)	(0.013)
Experience	0.7608	0.4586
	(0.07)	(0.08)
AFQT	6.327e-06	5.807e-06
	(0.0000)	(0.0000)
EXP^2	-0.0121	0.003
	(0.03)	(0.03)
EXP^3	-0.0001	-0.0004
	(0.006)	(0.005)
EXP^4	3.317e-06	5.481e-06
	(0.0000)	(0.0000)
Sex		-0.4703
		(0.038)
Observations	2280	2280
R-squared	0.164	0.108

Notes: All regression use OLS and standard errors are in parentheses.

If it's never exactly 0



(a) AFQT Scores for High School Graduates



(b) AFQT Scores for College Graduates

Figure 1: Distribution of AFQT Scores by Education Level

of AFQT scores for individuals with a high school degree. Figure 1b shows the distribution of AFQT scores for college graduates. We can see that in general, college graduates have higher AFQT scores than those with only a high school degree.

Next I further break down the AFQT scores for college graduates. In figure 2 we can see the percentage of college attendees in each AFQT score quartile.

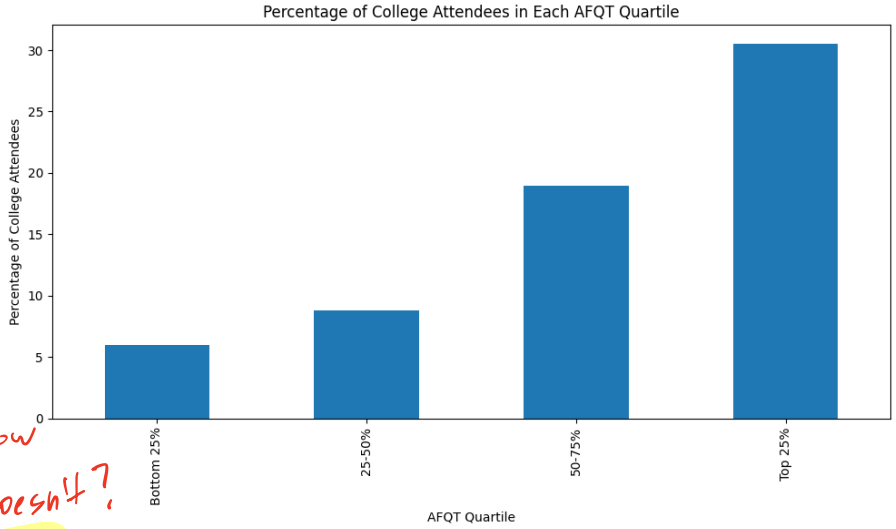


Figure 2: Percentage of College Graduates in each AFQT Quartile

The AFQT quartile boundaries are: $[0, 26.38, 49.71, 73.22, 100]$, meaning that the bottom 25% received a score between 0 and 26.38 and the top 25% received a score between 73.22 and 100. The percent of people who attended college in each AFQT quartile is:

$$\text{Bottom } 25\% : 5.96$$

$$25 - 50\% : 8.77$$

$$50 - 75\% : 18.95$$

$$\text{Top } 25\% : 30.53$$

To further motivate my model I examine how differences in unemployment rates affect expected wages. I calculate the present value of lifetime earnings for college and high school graduates while first considering only the wage differential, and next considering both the wage differentials and employment differences (college graduates are employed a higher fraction of their lives than high school graduates). I use the following formula to calculate lifetime earnings:

What is r? Don't we need to discount this?

$PVLE = \sum_{t=0}^{40} \beta^t \times$ (average annual wage) ← This should factor in unemployment as $0, so you don't need to also multiply by Prob(employed).

↑ annual discount rate, so maybe 0.95? 0.98? Check the literature

$$PVLE = \sum_{40 \text{ years}} \text{wage} \times \text{weeks worked} \times (1+r)$$

This would be if people invested their earnings, right?

Lifetime earnings not considering unemployment differences for high school and college graduates, respectively:

$$PVLE_{\text{High School}} = 1,503,800$$

$$PVLE_{\text{College}} = 2,467,080$$

$$\text{returns} : 1.64$$

Lifetime earnings when considering unemployment differences for high school and college graduates, respectively (fraction of time employed = 74% for high school graduates, = 87% for college (BLS):

$$PVLE_{\text{High School}} = 1,112,811$$

$$PVLE_{\text{College}} = 2,147,055$$

$$\text{returns} : 1.93$$

We can see that the returns to education are around 30% higher when also considering the employment differences between high school and college graduates (fraction of time spent employed). These further amplify the effect of education on earnings. As a result it is likely that many workers would have chosen not to go to college believing that the returns to college are lower than they truly are. Some people may have benefited more from obtaining a college degree, especially higher ability individuals, and I will use my model to pin down this mass of people.

These empirical results confirm the positive effect of education on earnings, and the lifetime earnings calculation shows that these results understate the benefit of college, providing motivation for the following model.

3 Model

I construct a model of college choice based on the standard approach looking only at the wage differential. I use a standard labor search and matching model to determine a reservation wage such that a wage draw above it means the individual should college. I then change the job destruction rate and arrival rates to match the unemployment rates of college versus high school graduates in the data, and I recalculate the reservation wages to see how many more people will choose to attend college.

How does this differ from standard models? E.g., Diamond Mortensen Pissarides?

3.1 Environment

The basic environment is discrete time and agents discount the future at rate β. There are two states: employed and unemployed. Once you become employed you can't go back to school. Individuals who did not go to college receive job offers at rate α_h and have a wage distribution $F(w_h)$, and lose jobs at a rate δ_h. Workers with a college degree receive job offers at rate α_c from a higher average wage distribution $F(w_c)$, and lose their jobs at a rate of δ_c. Note that the mean of $F(w_c)$ is above the mean of $F(w_h)$. To deal with the difference between the actual wage distribution and the offer distribution, I use the Heckman Correction (Heckman 1979). To do this I first model the selection process using a Probit model (to find the probability that the individual accepted the job offer). Then I incorporate the inverse Mills ratio into the the wage equation to correct for selection bias.

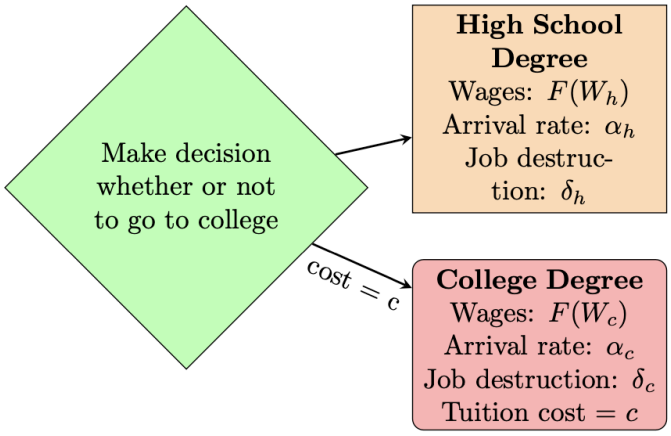
Workers with a high school degree start working in year 0 and stop working in year T and college degree individuals start working in year 4 and stop working in year $T + 4$.[2] The flows are unemployed to employed, employed to unemployed for both college and high school graduates. Figure 3 shows the decision a high school graduate faces.

The high school graduate will choose to go to college if the costs are not too high relative to the returns, or they will choose to go straight into the work force if the costs of college are too high. The flow from unemployed to employed would happen if you receive some offer above your reservation wage, this will yield different reservation wages for college and high school graduates.

Agents differ in their ability levels such that agents with higher ability levels have a lower cost of attending college. Ability level is measured by the individuals AFQT score from the

2. Workers work 40 years regardless of educational level (despite them losing out on the 4 years during college, they tend to work 4 years longer, and high school graduates will retire earlier).

Is this true in the data?



Where $\alpha_c > \alpha_h$, $\delta_c < \delta_h$ and the mean of $F(W_c)$ is above the mean of $F(W_h)$

Figure 3: Decision of a High School Graduate

NLSY. Let y = ability level of an individual and let $\bar{y}$ = the threshold ability level. Then if $y = \bar{y}$ the individual has the threshold ability level for attending college. If $y > \bar{y}$ then the individual has a higher ability level than the threshold and would thus derive greater benefit from college. If $y < \bar{y}$ then the individual has a lower ability level than the threshold and would thus derive less benefit from college.

3.2 Value Functions

There are two types of value functions for employed and unemployed agents depending on if they went to college or not. V^h is the value function for employed agents with a high school degree, V^c is the value function for employed agents with a college degree, U^h is the value function for unemployed agents with a high school degree, and U^c is the value function for unemployed agents with a college degree.

An employed agent, receives wage w, they receive job offers at rate α, and are separated

from their job at rate δ. The worker will either continue working at the current wage or they will lose their job with some probability δ and move to the unemployed state. Individuals with a college degree also pay the cost of college (c), where c includes both an explicit tuition cost (C), and a "cost of learning" determined by their AFQT score. I use an inverse function for the AFQT score such that the cost of college is higher for individuals with a lower AFQT score. In the model, c is treated as an annual payment which is found by calculating the total cost of college and then divide by the lifetime years worked (40 years). The value functions for employed agents are:

$$V^h = w_h + \beta[\delta_h U^h + (1-\delta_h)V^h] \tag{2}$$

$$V^c = w_c - c + \beta[\delta_c U^c + (1-\delta_c)V^c] \tag{3}$$

An unemployed agent will receive unemployment benefit b and will receive job offers with probability α, they have a choice to accept the job offer and move to the employed state, or they can reject the offer and continue being unemployed, there is also a probability $1-\alpha$ that they will not receive a job offer and will stay unemployed. The value functions for unemployed agents are:

$$U^h = b + \beta\alpha_h \int max\{U^h, V^h\} dF(w_h) + \beta(1-\alpha_h)U^h \tag{4}$$

$$U^c = b + \beta\alpha_c \int max\{U^c, V^c\} dF(w_c) + \beta(1-\alpha_c)U^c \tag{5}$$

3.3 Calibration

I calibrate the model to find reservation wages and value functions for high school and college graduates and to determine how many workers who only received a high school degree would have benefited from receiving a college degree. The model is calibrated at a yearly frequency. The discount rate is set at 0.98 to match the literature. The job arrival rates and destruction rates are calibrated to match the data. The remaining parameters are calibrated to match the NLSY79 1979-2020 data. The wage distributions $F(w_c)$ and $F(w_h)$ are assumed log-normal with their means and variances calibrated to match the sample

mean and variance from the data. The explicit college tuition cost (C) is set at $24,482 to match the average college tuition in the US[3]. The parameters are displayed in Table 4. I determine the reservation wage such that a wage draw above it will mean the individual should attend college. I then change the job losing probability to match the unemployment rates of college versus high school graduates. I then recalculate the reservation wages to see how many more people will choose to attend college.

Parameters			
Parameter	Value	Description	Source
β	0.98	Discount rate	literature
α_{hs}	0.30	Job arrival rate for individuals with a high school degree	NLSY79
δ_{hs}	0.20	Job separation rate for individuals with a high school degree	
α_c	0.53	Job arrival rate for individuals with a college degree	
δ_c	0.12	Job separation rate for individuals with a college degree	
μ_{hs}	10.91	mean of wage distribution for individuals with a high school degree	NLSY79
σ_{hs}	0.73	st. dev of wage distribution for individuals with a high school degree	
μ_c	11.63	mean of wage distribution for individuals with a college degree	
σ_c	0.64	st. dev of wage distribution for individuals with a college degree	
b	10,662	Unemployment benefit	Shimer (2005)
C	24,482	Explicit cost of college (College Tuition)	US News and World Report

Table 4: Parameters

4 Results

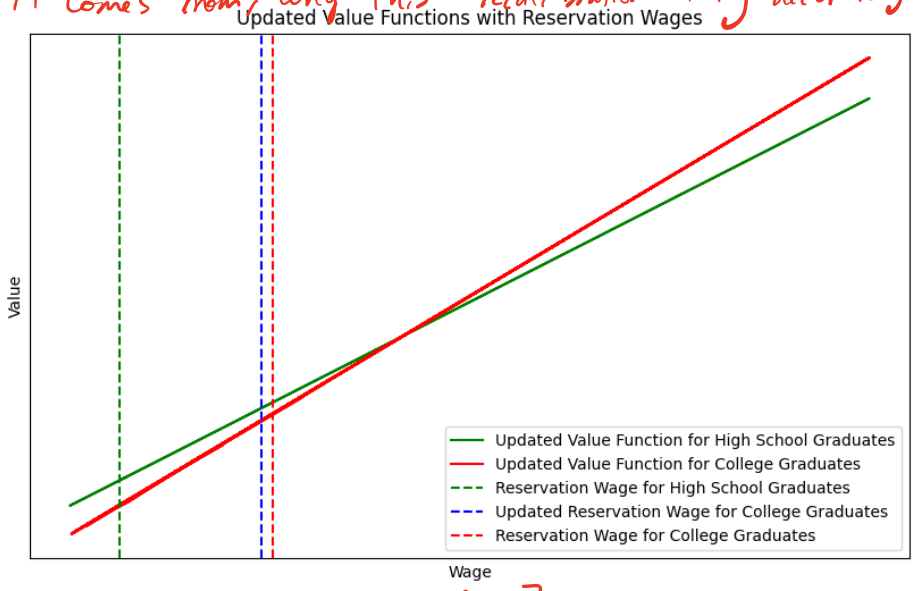
Figure 4 shows the optimal value functions and reservation wages for those with a high school degree and those with a college degree, when considering the full unemployment differences.

3. See the Average College Tuition in 2023-2024, www.usnews.com/education/best-colleges/paying-for-college/articles/paying-for-college-infographic. Accessed 5 Mar. 2024.

The blue line shows us how much lower the reservation wage for attending college is when the differing unemployment rates and arrival rates are considered. From the value functions we can see that at lower wage levels, individuals with a high school degree have a higher net utility due to lower costs associated with their education. As a result, a high school diploma may be more attractive at these lower wage levels. As wages increase, the benefits of a college degree (such as higher wages and potentially more stable employment) start to outweigh the initial costs, making it a more attractive option.

I find that the reservation wage for attending college is lower by $\$7,000$. Thus I find that 28.66% of people would change their decision and attend college when they consider the full impact of education on unemployment rates. This group of people doesn't realize the full benefit of college and would benefit from furthering their education.

lower than what? This needs to be explained more clearly. This is the key result! But we are not told where it comes from, why this "recalibration" thing accurately captures some sort of mistake that people are making, or what exactly in your model is responsible for this result.



Are these wage offers?

Figure 4: Value Functions for High School and College Graduates

5 Summary

The empirical results confirm the positive effects of education on earnings, and show that this effect is understated when just considering the wage differentials. The unemployment

rate decreases with education, and income increases with education and this pattern is consistent across time. Together these results motivate the model which I used to calculate reservation wages and value functions for high school and college graduates. The value function crossing shows us that at lower wage levels, individuals with a high school degree have a higher net utility since they have lower costs associated with education. As wages increase, the benefits of a college degree (such as higher wages and potentially more stable employment) start to outweigh the initial costs, making it a more attractive option. I find that the reservation wage for attending college is lower by $\$7,000$ when considering the different job arrival and destruction rates for high school and college graduates. This means that 28.66% of people would change their decision and attend college if they consider not just their wage differential, but also the differences in unemployment rates. This yields various policy suggestions such as as increasing awareness of the full costs of not attending college.

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