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Gender, Education, and Earnings:

Econometric Analysis of the Earnings Premiums for
Educational Attainment by Gender

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1. Introduction

The pursuit of higher education in the United States represents an expensive, but necessary, investment in one's future. The decision to spend time and money attaining a degree is fueled by the desire to pursue a professional passion and, ultimately, to increase one's earnings. As a result, we have a general expectation that an individual with a higher level of educational attainment will earn more than an otherwise similar individual who does not. There are, of course, many factors that influence one's compensation. Professional factors such as field of study, industry, and years of work experience are bound to influence earnings. Similarly, personal characteristics such as gender, race, and marital status have been shown to have an impact. In particular, the gender wage gap has been a subject of continual discussion in the United States and around the world, with the notion that women earn less than men for equivalent roles, on average. Many argue that this inequality contributes to greater poverty rates, as well as the misallocation of human capital as a result of women pursuing less productive career paths than they otherwise might. With this in mind, we are interested in answering two questions in our study:

- How do the earnings of full-time workers vary at different levels of educational attainment?
- How does the earnings premium for educational attainment vary by gender?

To address these questions, we examined a sample of roughly 30,000 full-time workers using data from the 2011 American Community Survey (ACS). With this data, we estimated two separate econometric models, one for male full-time workers and one for female full-time workers. In each model, we controlled for relevant characteristics such as age, marital status, and race in order to observe the correlation between educational attainment and earnings. We compared these models to determine how the magnitudes of the relevant variables differ by gender.

We found that the earnings premiums for educational attainment followed a similar pattern between men and women. In both models, each additional level of education attainment was correlated with higher earnings. At the highest levels of educational attainment, we found that professional degrees exhibited higher earnings premiums than doctorates and master's degrees for both male and female full-time workers. From the associate's degree level onwards, the earnings premium for educational attainment was greater for women than men, with the exception of professional degrees, for which men exhibited a slightly higher earnings premium.

2. Econometric Model and Estimation Method

We estimated our models using the ordinary least squares (OLS) method. As annual earnings demonstrated significant right skewness in our sample, we chose to use the natural log of annual earnings as our dependent variable for both models. To combat heteroskedasticity, the model also employs robust standard errors. Our independent variables for personal characteristics include age (represented in quadratic terms), marital status, and race (represented as indicators for either Black, Hispanic, or Asian, with White serving as the base category). In addition, our model includes a series of categorical variables representing the highest level of education attained. In ascending order, these variables are: high school degree, some college, associate's degree, bachelor's degree, master's degree, professional degree, and doctorate, with no high school degree serving as the base category.

3. Data

For our research, we began with a sample of 65,000 individuals aged 18 to 64 taken from the 2011 ACS. The ACS is a survey that is continually administered by the U.S. Census Bureau to provide up-to-date information about the socioeconomic status of communities around the country. If contacted by the Census Bureau, respondents are legally obligated to participate. The ACS data provides economic and demographic characteristics such as age, gender, race, marital status, educational attainment, earnings, and average weekly hours worked for each individual.

To address our research questions, we subset the original sample in a few ways. We chose to include only current, full-time workers (indicated by at least 35 hours worked in an average week and at least 40 weeks worked in the past year). To minimize erroneous entries, we chose to include only observations with earnings greater than or equal to $10,000. While this is a low earnings floor for full-time workers, we believe it is sufficient to eliminate the majority of erroneous observations. Further, we filtered out individuals who identified themselves as Native American, Pacific Islander, Biracial, or Other Race, as these races did not have enough representation in the sample to be meaningfully included in our model. Our final subsample (hereafter referred to as the "sample") consists of 30,149 observations, with 16,712 men and 13,437 women. With this number of observations, we feel that we have a sufficient sample size to generate a regression model for each gender and finalize our conclusions on a statistically significant basis.

Table 1 illustrates descriptive statistics for male and female full-time workers in our sample. For both men and women, we can see that average earnings increase at each additional level of educational attainment. This is consistent with what we would intuitively expect. At the highest levels of educational attainment, those with a professional degree earn significantly more than those with a doctorate or master's degree. On average, males earn more than females at every level of educational attainment. Consistent with these notions, the highest earning group in our sample is males with a professional degree, whose mean annual earnings are $175,333, while the lowest earning group is females with no high school degree, whose mean annual earnings are $25,329. For both genders and all levels of educational attainment, we observe significant outliers at our max values, as well as medians that are invariably lower than the respective means, indicating that the distributions are right skewed. This is to be expected and is consistent with the majority of economic theories regarding earnings distributions.

Looking at the rates of educational attainment in our sample, we can see that there is a relatively smaller proportion of women than men with no high school or only a high school degree (5.1% and 22.4% of females compared to 8.5% and 26.8% of males, respectively). At the professional degree and doctorate level, there is a slightly greater proportion of men than women in their respective samples (2.8% and 1.8% of men compared to 2.3% and 1.3% of women, respectively). However, there is a greater proportion of women than men represented at every other level of higher education. This indicates that the women in our sample have attained higher education at a greater rate than the men, on average.

Examining the personal characteristics accounted for in our sample, we observe a somewhat similar distribution of race/ethnicity between our male and female samples. The highest represented group in both samples is White (73.8% for males and 71.5% for females), with the remaining proportions split between Black, Asian, and Hispanic. Average age is similar between the two samples, with a mean of 43 for men and 43.6 for women. There appears to be a significantly higher proportion of married men than married women in our sample (67% of men compared to 57.5% of women). This differs greatly from the full sample, in which 52.6% of men and 53.6% of women are married. This might indicate that married

men are more likely to work full-time than married women. Comparing sample size for each gender in our sample, we see that males are somewhat more represented than females, with 55.4% males and 44.6% females. This also differs from the full sample, which contained 49.2% males and 51.8% females.

Table 1: Descriptive Statistics

Variable	Mean	Median	St. Dev.	Min	Max	Count (%)
Model 1: Male full-time						
Annual Earnings by Education						
No High School	32,917	28,000	22,778	10,000	400,000	1,431 (8.5)
High School Degree	43,788	38,000	31,654	10,000	507,000	4,479 (26.8)
Some College	52,151	45,000	38,003	10,000	398,000	3,594 (21.5)
Associate's Degree	56,184	50,000	38,841	10,000	398,000	1,371 (8.2)
Bachelor's Degree	82,443	65,000	69,685	10,000	577,000	3,625 (21.7)
Master's Degree	104,514	80,000	90,022	10,000	577,000	1,445 (8.7)
Professional Degree	175,333	125,000	130,177	10,000	507,000	462 (2.8)
Doctoral Degree	110,694	88,000	86,282	10,000	507,000	305 (1.8)
Race/Ethnicity						
White	0.74	1		0	1	12,336 (74)
Black	0.07	0		0	1	1,212 (7)
Asian	0.05	0		0	1	905 (5)
Hispanic	0.14	0		0	1	2,259 (14)
Married	0.67	1		0	1	11,191 (67)
Age in years	43	44	12	18	64	
Model 2: Female full-time						
Annual Earnings by Education						
No High School	25,329	21,000	16,463	10,000	210,000	687 (5.1)
High School Degree	31,610	28,000	17,683	10,000	285,000	3,011 (22.4)
Some College	37,465	32,000	23,566	10,000	507,000	3,024 (22.5)
Associate's Degree	42,769	37,000	25,646	10,000	360,000	1,457 (10.8)
Bachelor's Degree	56,856	46,950	42,670	10,000	577,000	3,232 (24.1)
Master's Degree	65,635	57,500	39,488	10,000	507,000	1,544 (11.5)
Professional Degree	110,379	79,000	87,357	10,000	400,000	308 (2.3)
Doctoral Degree	91,819	73,000	71,744	12,000	398,000	174 (1.3)
Race/Ethnicity						
White	0.71	1		0	1	9,601 (71)
Black	0.12	0		0	1	1,568 (12)
Asian	0.06	0		0	1	739 (6)
Hispanic	0.11	0		0	1	1,529 (11)
Married	0.57	1		0	1	7,725 (57)
Age in years	43.6	45	11.8	18	64	

4. Empirical Results

Our final econometric estimates are presented in Table 2 below. Our dependent variable in each model is the natural log of annual earnings. We find that all independent variables included in our models are statistically significant at the 5% level. This indicates that we have sufficient evidence to reject the null hypothesis that any of our independent variables are not correlated with our dependent variable.

Table 3 interprets the coefficients from our econometric models in Table 2 to give us the earnings premiums for males and females at each level of educational attainment, controlling for age, race, and marital status. According to our models, individuals with a high school degree are expected to earn roughly 22-23% more than those without a high school degree, on average. We observe a significant difference in earnings between individuals with a bachelor's degree and a high school degree (roughly 83% higher for males and 92% higher for females, when compared to no high school). A similar difference is observed between individuals with a master's degree and those with a bachelor's degree (roughly 40% higher for males and 35% higher for females, when compared to no high school). Intuitively, this is expected, as the attainments of bachelor's and master's degrees are significant educational milestones which increase the value of an individual in the workforce.

Interestingly, a much larger gap is observed between the earnings of women with a doctorate compared to those with a bachelor's degree than that of men with a doctorate to those with a bachelor's degree. While men with a doctorate exhibit an average of roughly 51% higher earnings than those with a bachelor's degree when compared to no high school, women with a doctorate exhibit an average of roughly 105% higher earnings than those with a bachelor's degree when compared to no high school. While this appears to be an economically significant difference, we are hesitant to draw any conclusions from this observation, as the subsamples for full-time workers with doctorates are relatively small. This might be an interesting topic for future research. Finally, professional degrees exhibit the greatest earnings premium for both men and women (roughly 169% higher earnings than a bachelor's degree for males and 154% higher than a bachelor's degree for females, when compared to no high school).

Examining the coefficients for age in our models, we observe a relationship in which earnings increase at a decreasing rate as age increases, up until a peak age at which earnings begin to decrease at an increasing rate. The peak age for earnings differs slightly between our male and female models. For men, the peak age for earnings is roughly 49 years, while for women, the peak age for earnings is roughly 53 years. This finding contrasts with several articles that we read prior to conducting our study, which claim that the peak earnings age for women is much younger, at around 39. We believe this discrepancy may be due to our observing the full-time working population only. Similarly, we find that while the coefficient for marriage is positive for both genders, it is significantly higher for men than women. All other things equal, a married male is expected to earn 19.4% more than an unmarried male, on average. In comparison, all other things equal, a married female is expected to earn only 2.1% more than an unmarried female, on average. In this case, we can conclude that the coefficient for marriage is economically significant for men, but not for women.

The coefficients of determination for our male and female models were 35.7% and 32.9%, respectively. This indicates that 35.7% of total variation in our dependent variable can be explained by the independent variables in our male model. Similarly, 32.9% of total variation in our dependent variable can be explained by the independent variables in our female model. We believe these values to be appropriate for our purposes.

Table 2: Econometric Models

Effect of Education on Earnings - Male vs Female

	Dependent Variable:	
	Natural Log of Annual Earnings	
	Male	Female
Age	0.0782*** (0.0029)	0.0634*** (0.0028)
Age.Squared	-0.0008*** (0.00003)	-0.0006*** (0.00003)
Married	0.1773*** (0.0099)	0.0215*** (0.0090)
Black	-0.1990*** (0.0162)	-0.0700*** (0.0130)
Asian	-0.0681*** (0.0217)	0.0447*** (0.0215)
Hispanic	-0.1745*** (0.0135)	-0.0703*** (0.0136)
High.School.Degree.or.GED	0.2056*** (0.0162)	0.2019*** (0.0203)
Some.College	0.3660*** (0.0170)	0.3738*** (0.0206)
Associates.Degree	0.4195*** (0.0202)	0.4876*** (0.0228)
Bachelors.Degree	0.7203*** (0.0181)	0.7634*** (0.0211)
Masters.Degree	0.8991*** (0.0228)	0.9200*** (0.0224)
Professional.Degree	1.321*** (0.0407)	1.304*** (0.0427)
Doctorate	0.9413*** (0.0413)	1.161*** (0.0489)
Constant	8.435*** (0.0576)	8.501*** (0.0577)
Observations	16,712	13,437
R-squared	0.357	0.329
Adjusted R-squared	0.357	0.329
Residual Std. Error	0.564 (df = 16,698)	0.500 (df = 13,423)
F Statistic	714.692*** (df = 13; 16,698)	507.198*** (df = 13; 13,423)
Note:	$p<0.1$; **$p<0.05$**; $p<0.01$	(Robust Standard Errors)

Table 3: Earnings Premiums for Education

Educational Attainment	Male	Female
Average Earnings Premium (%)		
High School Degree	22.9%	22.4%
Some College	44.2%	45.4%
Associate's Degree	52.0%	62.9%
Bachelor's Degree	105.4%	114.5%
Master's Degree	145.7%	150.9%
Professional Degree	274.7%	268.4%
Doctoral Degree	156.3%	219.3%

(Controlling for age, race, and marital status)

5. Conclusion

In conclusion, we found that educational attainment is positively correlated with earnings for both male and female full-time workers. We determined that this correlation is economically significant at all levels of educational attainment. At the highest levels of educational attainment, we found that professional degrees exhibit the greatest earnings premiums for full-time workers by a substantial margin. This indicates that pursuing higher education yields positive returns for full-time workers, but that some advanced degrees yield higher earnings premiums than others.

We also found that the earnings premium for attaining an associate's, bachelor's, or master's degree was slightly higher for female full-time workers than for male full-time workers. At the doctorate level, the earnings premium was significantly higher for women than men. At the professional degree level, however, the earnings premium was slightly higher for men than women. Overall, this might suggest that female full-time workers benefit slightly more from attaining higher education than male full-time workers. However, it is difficult to draw a direct comparison as our model coefficients measure only the earnings premiums relative to the omitted category, no high school. Thus, it is possible that males without a high school degree have greater earnings opportunities than their female counterparts, which would influence their respective coefficients.

Our study is subject to several limitations. In estimating our econometric models, there are a few key variables that we were unable to include based on the data available. For one, we believe that incorporating field of study into our model would help to draw more relevant comparisons. While we would expect a master's degree to increase an individual's earning potential in the labor market, we also expect that certain master's degrees are more valuable than others. Similarly, we expect that the industry an individual works in might influence their earnings. By incorporating these factors into future research, we might also find that men and women pursue certain fields of study or careers in certain industries at different rates. Another potential limitation to our study is that the ACS data used is self-reported. This means that some response error is possible, but more importantly, it introduces the possibility for bias. For instance, it is possible that men are more likely to exaggerate their earnings than women, or vice versa. That said, we do not have any evidence to suggest that this type of bias exists in our sample.

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Contributions