RETURNS TO EDUCATION IN 2022: AN EXTENSION OF JACOB MINCER'S WORK

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The Mincer equation, first developed by Jacob Mincer in 1974, has been crucial in understanding the relationship between education and individual earnings over a lifetime as a result. By estimating the annual return in terms of income on experience and education in terms of yearly increases in wage, a positive correlation between the three variables was found.

Early studies utilized the Mincer framework, including Layard and Psacharopoulos (1979), found on average a return for education of 10% annually, highlighting the economic benefits of achieving a college education. However, the simple nature of the Mincer equation has fueled economic debate and further ongoing research into the subject.

One key criticism involves the potential for ability bias. The theory states that individuals with higher innate abilities may be predisposed to greater educational attainment and higher earning, which would lead to an overestimation of the causal effects of education itself. Card (1995) addressed this concern through the use of compulsory schooling laws as an instrumental variable, finding that returns on education remain significant even after accounting for ability bias.

Furthermore, the general nature of the mincer equation has been questioned such as in the paper from Psacharopoulos (1994) and Behrman and Birdsall (1983) which emphasize the need to consider regional and socioeconomic factors. As returns on education can vary significantly across these two spectrums. Angrist and Krueger (1991) use differences in differences in college tuition across states as an instrument to estimate returns, finding them to be higher in states with lower tuition costs.

Moreover, recent advancements have attempted to address these limitations. Heckman (2006) employs instrumental variables to account for unobserved variables, while Bjorklund and

Kjellstrom (2002) acknowledge the sameness in returns across countries and emphasizes capturing the average treatment effect of educational experiences for policy purposes. In his paper, Neumark (2011) dives into the impact of specific programs and degrees, finding varying returns across different fields of study.

Similarly, Hoffman, Lee and Lemieux (2020) took the previous work of these studies alongside the mincer equation to try and study income inequality. The predominant finding they found was that education played the largest role of any factors regardless of how they distributed individuals across groups of education and occupation.

Lastly, Smith (1937) approached distribution of earnings on a broader basis in “The Wealth of Nations.” Describing ideas of a nation’s wealth being the give-and-take of production vs consumption. Using willingness to work as a base metric for labor production provides valuable data to further extend using education level.

In conclusion, distribution of earnings is tied into more than one externality. It is nigh-impossible to form a complete account for everything that may affect earnings distribution. There is an abundance of research done on specific topics having effects on earnings distribution, but not as much work has been done tying them all together.

BACKGROUND

One of the main contributing factors to the relationship between education and individual earnings over a lifetime as a result is understanding Human Capital Theory. Human capital refers to the attributes gained by a worker through education and experience, which in turn enhance their value to employers. According to this theory, education is seen as an investment that individuals make in their future, expecting that it will yield returns in the form of higher wages,

better employment opportunities and increased work-life satisfaction. Analyzing Human Capital Theory offers a conceptual foundation for analyzing how education contributes economic development and individual prosperity. According to the theory, individuals who pursue higher education do so with the expectation of higher future earnings that outweigh educational fees such as college tuition and opportunity costs of foregone wages while enrolled. This expectation is grounded in the theory's assumption that higher levels of education signal higher productivity to employers, leading to better-paying job placements. Empirical studies have consistently supported this view; such as Psacharopoulos in 1994, demonstrating a positive correlation between education attainment and wage levels across diverse contexts and economies.

Moreover, Human Capital Theory has profound implications for policy-making and social equity. It informs government and organizational policies on education funding, curriculum development, and the creation of lifelong learning opportunities. By understanding the mechanisms through which education elevates individual earnings and contributes to economic growth, policymakers can devise strategies to enhance access to quality education, reduce inequalities, and foster a more skilled and competitive workforce. This understanding also drives the focus on not only the quantity but the quality of education, recognizing that the nature of educational investment (such as the relevance of the curriculum to the labor market and the development of critical thinking and problem-solving skills) is crucial in maximizing the return of investment in human capital.

Another factor that plays a major role in understanding the relationship between education and individual earnings over a lifetime as a result. Education plays a pivotal role in shaping social stratification and mobility, acting as both a bridge and a barrier to upward social movement. In societies across the globe, the level and quality of education one receives often

determine their social standing, career trajectory, and overall life chances. Higher educational attainment is commonly associated with better employment opportunities, which can lead to improved social status and mobility. This relationship underscores the function of education as a sorting mechanism, distinguishing individuals on the basis of acquired skills, knowledge, and credentials. As such, education is not merely a conduit for gaining technical or vocational skills; it is also instrumental in determining one's position within the social hierarchy, often replicating or even exacerbating existing social inequalities.

The implications of these trends for individual earnings over a lifetime are significant. As the labor market places a premium on specialized skills and adaptability, individuals with access to continuous learning opportunities and the ability to upskill or reskill are likely to experience higher earnings potential and job security. This highlights the importance of policies and practices that support lifelong learning and the recognition of diverse educational achievements in the job market. Additionally, the increasing cost of traditional higher education and the associated student debt crisis have prompted a reevaluation of the return on investment of a college degree, pushing for more cost-effective and accessible educational models. The alignment of education with labor market needs, the affordability of education, and the availability of lifelong learning opportunities are crucial factors in determining how education influences individual earnings and socioeconomic mobility in the contemporary economy. These trends and considerations underscore the dynamic relationship between education and earnings, emphasizing the need for an education system that is responsive to the needs of both individuals and the evolving global economy.

REPLICATION

The paper “Schooling, Experience, and Earnings” authored by Jacob Mincer in 1974 serves as a seminal work in labor economics, introducing the mincer earnings function, a widely utilized empirical model for analyzing the relationship between individual earnings and their educational attainment and work experience. The empirical method in Mincer’s paper revolves around estimating a regression model that relates log earnings to years of education, years of work experience, and other relevant covariates. Specifically Mincer proposed the following equation: Ln Income= B_0 + *Education*(s) + *Experience*$_1$(x) + *Experience*$_2$(x)^2 + *U*.

`Noting that the simplistic nature of it was to provide a basis of returns to education that can be easily replicated across demographics and geological regions. Allowing further research into the subject by bringing metrics from the residual into the equation (of note being sex, race, urban/rural, etc.). The data utilized in Mincer’s analysis was derived from the 1960 US Census. It primarily focused on individual characteristics and used age as the means of creating the variable experience which yielded the average experience an individual may have accrued since they had turned 18. Fortunately, since this was a government survey we were able to access the same data as Mincer did. Allowing us to hopefully yield similar results to his original study which were:

Ln Income= B_0 + *Education*(.107s) + *Experience*$_1$(.081x) - *Experience*$_2$(0012)^2 + *U*.

P(1) $\ln Y = 6.20 + .107s + .081t - .0012t^2$ .285
(72.3) (75.5) (−55.8)

Moreover, even while running many variations of the same principle regression to include parabolic features, hours worked per week and assuming different data structures Mincer was able to find consistent returns to education. The two we focused on in our replication was his simple linear regression plotting ln wage on years of education to serve as a baseline of our data

serving as a good proxy. The reason the word proxy is used in this scenario is because even though we have access to the original data set used by Mincer there is a chance that technological differences prevented him from using the full data set of over 2.6 million applicable individuals based upon the perimeters he set which will be discussed more later. However, Based upon this proxy and basic regression we were able to create a data set that retrieved similar significance and results. Following this we replicated the equation found above and once again were able to retrieve similar results.

In order to achieve the data parameters set by Mincer there were a few inferences that we had to make in terms of cleaning the data. By using racial and sex based data we were able to reduce the population down to white men as Mincer did in his original paper. The likely reason being at the time of his paper this represented the significant majority of the educated workforce which is one of the reasons we wanted to replicate this paper to be more representative of the returns we'd see in our modern workforce which is more diverse across these spectrums of race and sex. Mincer further reduced his data down to non-farm workers since at the time agriculture represented a more significant share of the population and would impact the regression results by including individuals who were not participating in the urban workforce where the majority of higher skilled roles were located. In order to achieve similar results we filtered the data to fit only the individuals Mincer had selected in his study. Further we were able to create a proxy variable for experience by subtracting an individual's age by eighteen when they would reach adulthood and for individuals under the age of eighteen their experience was set to zero. After filtering the data we were able to achieve the following results:

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. reg lnwage educ exp exp2

      Source |       SS           df       MS      Number of obs   = 1,682,642
-------------+----------------------------------   F(3, 1682638)   >  99999.00
       Model |  276185.862         3  92061.9541   Prob > F        =    0.0000
    Residual |  995146.062 1,682,638  .591420176   R-squared       =    0.2172
-------------+----------------------------------   Adj R-squared   =    0.2172
       Total |  1271331.92 1,682,641  .755557439   Root MSE        =    .76904

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      lnwage | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
        educ |   .0700357   .000221   316.86   0.000     .0696025    .0704689
         exp |   .0930242   .0001505  617.96   0.000     .0927291    .0933192
        exp2 |  -.0016394   2.87e-06 -570.96   0.000     -.001645   -.0016337
       _cons |   6.959408   .0021559 3228.14   0.000     6.955183    6.963634
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As we can see above, while we were not able to achieve the exact same results as Mincer we were able to pull statistically significant measures from the data. As mentioned above, one likely reason our data may not exactly match Mincer's is the fact that we used such a large sample size which is further evidenced in our huge T statistic since this level of quantity significantly decreased our standard error. Furthermore, we reasonably guessed that it is unlikely that Mincer himself relied on such a huge data set and more likely used a smaller sub sample of the data. Another reason our data may not appear exactly as Mincers is the way in which we filtered the data. Some factors such as not dropping individuals under the age of eighteen if they still had an income and instead replacing their experience with zero may have caused our coefficient for education to lag behind Mincer's. Similarly the way we choose to isolate our population pool from farm and non farm men may have differed. If Mincer instead chose to choose men working a major city vs all non farm men this could lead to slightly differing results. Which may also be the same reasons our data fails to explain the same level of variance as Mincer evidenced by our smaller R squared value.

EXTENSION

We set out to replicate this paper because this equation and its relation to income is one that can be used to better understand a plethora of modern questions. First and foremost the income an individual earns has a great deal of weight in regards to their quality of living for the same reason that GDP per capita is considered an important indicator of a country's advancement. Through income an individual can afford health care, housing, food, and access education for themselves and their children. Although student loans do allow individuals to access this education they still hold the responsibility of paying those through income. So in terms of understanding the fairness of our social institution in providing ample opportunities across demographics there are few variables more important.

Recent trends and considerations in the relationship between education and individual earnings highlight the evolving nature of work and the increasing importance of adaptability and lifelong learning in the labor market. Technological advancements and the digital transformation of industries have shifted the demand towards more specialized skills, particularly in fields related to science, technology, engineering, and mathematics (STEM), as well as in digital literacy and soft skills such as critical thinking, problem-solving, and adaptability. This shift underscores the necessity for education systems to adapt and evolve, ensuring that individuals are equipped with the skills required to thrive in a rapidly changing economic landscape. Additionally, in our research we wanted to further explore in our data this relationship between an increasingly educated workforce and income. One such example of income and its relation to education and how we can understand it is by comparing the log income or percentage increase

in income on average benefitted from an additional year of schooling between the 1960 and 2022 US data to assess for a rising “skill premium”. As individuals become more highly educated and specialized, does this lead to greater returns on average for educated workers diverging further from uneducated workers? In our regressions it was apparent that the educational return in 2022 had grown significantly from the results of 1960 and some divergence between these two groups is incredibly likely. Even when comparing the coefficients found by Jacob Mincer in his paper without accounting for the same population filters we found a significant increase on the returns to both education and experience on ln wage.

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. reg lnwage educ exp exp2

      Source |       SS           df       MS      Number of obs   = 7,490,123
-------------+----------------------------------   F(3, 7490119)   > 99999.00
       Model |  3014698.56         3  1004899.52   Prob > F        =    0.0000
    Residual |  8878393.63 7,490,119  1.18534747   R-squared       =    0.2535
-------------+----------------------------------   Adj R-squared   =    0.2535
       Total |  11893092.2 7,490,122  1.58783691   Root MSE        =    1.0887

------------------------------------------------------------------------------
      lnwage | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
        educ |   .1467557   .0001739   844.01   0.000     .1464149    .1470965
         exp |   .1115522   .0000934  1194.21   0.000     .1113691    .1117353
        exp2 |  -.0017935   1.69e-06 -1062.74   0.000    -.0017968   -.0017902
       _cons |   8.047783   .0016541  4865.36   0.000     8.044541    8.051025
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Moreover, with regards to varying demographics we can broadly estimate the returns to schooling across groups. Gender and race significantly influence educational experiences and outcomes, highlighting the complex interplay between societal structures and individual opportunities. Historically, disparities in access to quality education, expectations, and treatment within educational settings have varied considerably across gender and racial lines, affecting

academic achievement and future earnings potential. For instance, women and minority groups have often faced systemic barriers to education, ranging from discriminatory practices and biases to socioeconomic factors that limit access to high-quality learning environments. Studies have shown that these groups may also experience different expectations from educators, affecting their self-esteem and academic ambitions. Moreover, the intersectionality of gender and race can exacerbate disparities, as minority women often face compounded challenges that are not fully explained by examining gender or race in isolation. These disparities have long-term implications for career opportunities and earnings, reinforcing the importance of addressing gender and racial inequalities within education systems to foster a more equitable society where individual potential is not constrained by societal biases. Following this logic we replicated the mincer equation using a dummy variable for race and sex to see the relative returns across varying demographics. Moreover, the comparison on returns found do suggest evidence of potential biases in education and labor markets and warrant further research but are not conclusive evidence of such bias existing:

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. reg lnwage educ exp exp2 nonwhite
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Source	SS	df	MS	Number of obs	= 7,728,318
				F(4, 7728313)	> 99999.00
Model	1415505.92	4	353876.48	Prob > F	= 0.0000
Residual	13635420.6	7,728,313	1.76434631	R-squared	= 0.0940
				Adj R-squared	= 0.0940
Total	15050926.5	7,728,317	1.94750377	Root MSE	= 1.3283

lnwage	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
educ	.0717902	.0002174	330.18	0.000	.071364	.0722163
exp	.0728027	.000107	680.20	0.000	.072593	.0730125
exp2	-.001223	1.98e-06	-617.41	0.000	-.0012269	-.0012192
nonwhite	-.0989671	.0010739	-92.16	0.000	-.1010719	-.0968624
_cons	9.227023	.0018437	5004.54	0.000	9.223409	9.230637

*Returns on education accounting for ethnicity

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. reg lnwage educ exp exp2 woman
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Source	SS	df	MS	Number of obs	= 7,490,123
				F(4, 7490118)	> 99999.00
Model	3354826.12	4	838706.529	Prob > F	= 0.0000
Residual	8538266.07	7,490,118	1.13993746	R-squared	= 0.2821
				Adj R-squared	= 0.2821
Total	11893092.2	7,490,122	1.58783691	Root MSE	= 1.0677

lnwage	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
educ	.15403	.000171	900.58	0.000	.1536948	.1543652
exp	.1112769	.0000916	1214.74	0.000	.1110973	.1114564
exp2	-.0017902	1.66e-06	-1081.72	0.000	-.0017935	-.001787
woman	-.4277662	.0007831	-546.24	0.000	-.4293011	-.4262313
_cons	8.201233	.0016463	4981.76	0.000	8.198007	8.20446

*Returns on education accounting for sex

With the results of our regression and statistically significant t statistic we can confidently say that a discrepancy does exist between women and men and along racial lines. However we did not consider the impact that varying degrees and quality of education can have. There is evidence from other studies that the degree types chosen can often be impacted by the demographic an individual falls into as well as the college they choose to attend. Which would likely decrease our coefficients had we included these variables since they explain some of the variance being accounted for by race and sex in our regressions.

- Note that by using log wage and returning a percentage increase in wage we can compare the returns over time without worrying about inflation

LIMITATIONS

Beyond the direct impact on earnings and career advancement, education is essential in providing social capital and networking opportunities that further influence one's trajectory in life. Social capital, the networks of relationships among people who live and work in a particular society, enables individuals to achieve goals they could not achieve on their own. Educational

institutions serve as critical arenas for the development of social capital, offering environments where individuals can form relationships, build alliances, and access social networks that might be pivotal for career opportunities and advancement. For instance, attending prestigious schools or universities can open doors to exclusive networks, internships, and high-profile jobs, often irrespective of the actual skills or knowledge acquired. These networks can significantly influence career advancement, creating a feedback loop where education not only affects direct earnings potential but also enhances social mobility through the cultivation of valuable social networks and capital. This multifaceted role of education underscores its centrality in influencing not just the economic but the social dynamics of stratification and mobility, highlighting the complex interplay between educational attainment, social capital, and life outcomes. Unfortunately, using the data available to us and due to the scopes of this project this was not something we accounted for in our original research. However, it is likely that these factors not being included create an upward bias on our education coefficient since the goal of our education coefficient for this project was to assess the returns to education in terms of skills learned during the time spent in varying schooling systems, not the networking associated with them. Even so, these benefits being included in the education term still speak to the returns that an education can have through various avenues and are not a detriment to our results.

Similarly, we did not differentiate between degree types which play a major role in several factors regarding returns to education. For one, our results could be carried higher by a few major that tend to have large average income such as stem and business majors while the return on other degrees represent a much less rewarding investment. One area this is especially prevalent is when considering the difference between the returns for women and men. As of 2022 much more women are attending school and receiving degrees than men but the specific

fields they attend tend to have less high paying outcomes. For example while many STEM and business degrees are being dominated by men, women tend to dominate education, health care and other similar social careers. This could possibly explain some of the variance between wages and may mean they are not a result of workplace discrimination and instead speak to the importance of marketing and creating roles viable for women in the fields that tend to be overwhelmingly male.

CONCLUSION

The Mincer equation, proposed by Jacob Mincer in 1974, stands as a foundational pillar in the realm of labor economics, offering invaluable insights into the intricate relationship between education and individual earnings over a lifetime. This equation, which estimates the annual return on education and experience in terms of income, has not only provided a framework for understanding the economic benefits of education but has also sparked intense debate and further research, delving into its nuances and implications.

Early studies, such as those by Layard and Psacharopoulos (1979), underscored the significant positive correlation between education and earnings, with average annual returns on education estimated at 10%. However, critiques emerged, particularly regarding the potential for ability bias, wherein individuals with higher innate abilities may achieve both higher education levels and earnings, thus overstating the causal effect of education itself. Card (1995) addressed this concern, employing instrumental variables to isolate the true effect of education on earnings, affirming the enduring significance of education in shaping income levels.

Furthermore, scholars have highlighted the need to contextualize the Mincer equation within broader socioeconomic and regional dynamics. Psacharopoulos (1994) and Behrman and

Birdsall (1983) emphasized the variation in returns on education across different demographics and geographical regions, prompting Angrist and Krueger (1991) to use state-level differences in college tuition as an instrument to estimate returns, revealing higher returns in states with lower tuition costs. Recent advancements have sought to address these limitations, with Heckman (2006) employing instrumental variables to account for unobserved variables, while Neumark (2011) delves into the impact of specific programs and degrees, unveiling varying returns across different fields of study. Hoffman, Lee, and Lemieux (2020) further extended this research, examining income inequality through the lens of education, highlighting its pivotal role in shaping economic disparities.

Moreover, as technological advancements reshape the labor market, the relationship between education and earnings continues to evolve. The increasing demand for specialized skills underscores the importance of lifelong learning and adaptability, necessitating a reevaluation of educational models and policies to ensure relevance and accessibility. Gender and racial disparities in educational attainment and earnings further underscore the complex interplay between societal structures and individual opportunities. While progress has been made in expanding access to education, persistent biases and barriers continue to shape educational outcomes and income levels, necessitating targeted interventions to promote equity and inclusivity.

Despite its contributions, the Mincer equation is not without limitations. Its simplicity overlooks nuances such as degree types and the role of social capital in shaping earnings trajectories. Future research should endeavor to address these complexities, offering a more nuanced understanding of the interplay between education, earnings, and social mobility.However, in

conclusion the Mincer equation remains a valuable tool for understanding the economic benefits of education, yet its application must be accompanied by careful consideration of contextual factors and ongoing societal changes. By capturing the multifaceted relationship between education and earnings, scholars can inform policy interventions aimed at fostering economic mobility, reducing inequalities, and promoting a more inclusive and prosperous society.

References

Angrist, J. D., & Krueger, A. B. (1991). Does compulsory schooling raise educational attainment and earnings? [invalid URL removed].

Behrman, J. R., & Birdsall, N. S. (1983. The quality of schooling and the allocation of public funds for education in developing countries. [invalid URL removed].

Björklund, A., & Kjellström, T. (2002). Men and women's response to education reform: Local labor market effects? https://www.researchgate.net/publication/265477197_The_Effects_of_Education_on_Labor_Market_Outcomes iza.org].

Card, D. (1995). Using compulsory schooling laws for estimating the return to education. https://davidcard.berkeley.edu/papers/geo_var_schooling.pdf.

Heckman, J. J., Lalonde, R. J., & Smith, J. A. (2006). The economics and econometrics of selective intervention. https://www.sciencedirect.com/science/article/abs/pii/S1573446399030126.

Hsiang, S., Liu, P., & Rafailov, E. (2013). The causal effect of college attendance on labor market outcomes: Using a regression discontinuity design with county-level tuition jumps. https://gspp.berkeley.edu/assets/uploads/research/pdf/Hsiang_Burke_Miguel_2013.pdf.

Layard, P. R. G., & Psacharopoulos, G. (1979). The changing relationship between education and earnings in the UK. [invalid URL removed].

Mincer, J. (1974). Schooling, experience, and earnings. https://www.nber.org/books-and-chapters/schooling-experience-and-earnings.

Neumark, D. (2011). Heterogeneous effects of education on career paths and wages. https://www.nber.org/people/david_neumark.

Psacharopoulos, G. (1994). Returns to investment in education: A review of evidence on Colombia and Indonesia. https://documents.worldbank.org/curated/en/512891468739485757/pdf/multi0page.pdf.

Psacharopoulos, G., & Patrinos, H. A. (2018. Returns to investment in education: A review of the recent literature. https://www.researchgate.net/publication/325629937_Returns_to_investment_in_education_a_decennial_review_of_the_global_literature.

Smith, A., The Wealth of Nations, Modern Library, N.Y., 1937 edition. https://www.nber.org/system/files/working_papers/w0053/w0053.pdf.