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# Estimating Returns to Schooling and Experience: A History of Thought

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# Estimating Returns to Schooling and Experience: A History of Thought

Barry R. Chiswick*

Abstract:

This paper is a review of the literature in economics up to the early 1980s on the issue of estimating the earnings return to schooling and labor market experience. It begins with a presentation of Adam Smith's (1776) analysis of wage determination, with the second of his five points on compensating wage differentials being "the easiness or cheapness, or the difficulty and expense" of acquiring skills. It then proceeds to the analysis by Walsh (1935) estimating the net present value of investments at various levels of educational attainment. Friedman and Kuznets (1945) also used the net present value method to study the earnings in five independent professional practices. Based on the net present value technique, Becker (1964) estimates internal rates of return from high school and college/university schooling, primarily for native-born white men, but also for other demographic groups.

The first regression-based approach is the development of the schooling-earnings function by Becker and Chiswick (1966), which relates the logarithm of earnings, as a linear function of years invested in human capital, with the application to years of schooling. This was expanded by Mincer (1974) to the "human capital earnings function" (HCEF), which added years of post-school labor market experience. Attractive features of the HCEF are discussed. Extensions of the HCEF in the 1970s and early 1980s account for interrupted labor marker experience, geographic mobility, and self-employment and unpaid family workers.

Keywords: Human Capital, Schooling Earnings Function, Human Capital Earnings Function, Schooling, Labor Market Experience, Women, Immigrants, Less Developed Countries, Self-Employed, Unpaid Workers

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## I. Introduction

The 50th anniversary of the publication of George Psacharopoulos's path-breaking study *Returns to Education: An International Comparison* (1973) was a fitting occasion for a symposium on this topic held at the World Bank in March 2023, organized by Harry Patrinos. Participation in this event encouraged me to reflect on the development in the economics literature of the study of the relationship between earnings and education. Psacharopoulos used rates of return, primarily estimated by others, based on various methodologies, from 53 data sets for 32 different countries. He found: very high private rates of return from primary schooling, rates of return decline with higher levels of schooling, rates of return from schooling were higher than from investment in physical capital, and rates of return were higher the lower the level of economic development. These findings have had important public policy implications. For just one, it emphasized the importance of investing in primary education in less developed economies.

How did the interest in, and the methodology for, estimating returns to education come about? This paper will address this question through a brief review of the literature up to the early 1980s relating earnings to schooling and on-the-job training.

## II. Adam Smith

As with much of modern-day economics, the interest in the relation between earnings and schooling can be traced back to Adam Smith. In his *An Inquiry into the Nature and Causes of the Wealth of Nations* (1776/1937), more commonly referred to simply as *The Wealth of Nations*, Book I, Chapter X is titled "Of Wages and Profits in the Different Employments of Labour and Stock" (Smith, 1776/1937).

Smith set out the basic principle that underpins modern human capital analysis and the analysis of the relation between earnings and human capital. He wrote that:

> "The whole of the advantages and disadvantages of the different employments of labour and stock, in the same neighbourhood, be either perfectly equal or continually tending to equality… This at least would be the case in a society where things were left to follow their natural course, where there was perfect liberty and where every man was perfectly free both to choose what occupation he thought proper and to change it as often as he thought proper. Every man's interest would prompt him to seek the advantageous, and to shun the disadvantageous employment" (Smith, 1776/1937, p. 99).

Smith discussed the five principles that would tend to bring about the tendency to "perfect equality," and the two he recognized would not be equalizing. He summarizes the first five as:

> "first, the agreeableness or disagreeableness of the employments themselves; secondly, the easiness or cheapness, or the difficulty and expense of learning them; thirdly, the constancy or inconstancy of employment in them; fourthly, the small or great trust which must be reposed in those who exercise them; and fifthly, the probability or improbability of success in them" (Smith, 1776/1937, p. 100).

He further discussed two reasons why wages or earnings may not tend to be equalizing, that is, why what today we would call economic rents could exist. He places a particular focus on barriers to mobility. These may arise from restrictions on the movement from one "employment" (occupation or job) to another. The restrictions may be brought about by guilds, what today would be referred to as occupational licensing or union restrictions, or restrictions on the geographic mobility of workers, in which he discusses restrictions on labor mobility across the cities of eighteenth-century England, or in contemporary terms, immigration restrictions. The second non-equalizing issue had to do with transitions between equilibria – quasi economic rents

(non-equalizing differentials) during transitions from one stable equilibrium to another (Smith, 1776/1937, p. 118-143).

In elaborating on his second equalizing principle, Smith wrote:

> "The wages of labour vary with the easiness or cheapness, or the difficulty and expense of learning the business… A man educated at the expense of much labour and time to any of these employments which require extraordinary dexterity and skill, may be compared to one of those expensive machines. The work which he learns to perform, it must be expected, over and above the usual wages of common labour, will replace to him the whole expense of his education, with at least the ordinary profits of an equally valuable capital... The difference between the wages of skilled labour and those of common labour is founded upon this principle" (Smith, 1776/1937, p. 101).

He then elaborates on these points. Smith did not provide empirical analyses.

In his Book I, Chapter X, Smith sets out the principles of human capital theory, including the cost of time spent in the training. All that has followed over the next two-and-a-half centuries can be viewed as commentaries on his points, as well as empirical analyses that have validated his propositions, in support of Smith's casual empiricism.

## III. Net Present Value Method

Writers both before and after Adam Smith viewed people, or the skills they possessed, as part of the capital stock of an economy. (See, for example, the references in Walsh (1935) and in Dublin and Lotka (1946)). But it was J. R. Walsh (1935) in his "Capital Value Applied to Man," who appears to be the first to attempt to study empirically the profitability or returns to education. He calculated the present value of the costs and earnings return from various levels of schooling and indicated that an investment in schooling is profitable if the benefits are greater than the costs, that is, if the *net* present value is positive.

Walsh wrote that:

> "Education beyond the secondary school is more apt to be undertaken for definitely economic reasons… When deciding whether to contribute to still further schooling of children, parents are surely guided above all by the expectation that the training can be turned to profitable account… Further education means income foregone, and the longer formal education continues, the larger this loss to him will be" (Walsh, 1935, p. 256-257).

Various primarily privately collected data sources that provide statistics on annual median earnings by age and completed educational level were utilized by Walsh: high school, BA/BS, MA, PhD, and professional degrees (for lawyers, medical doctors, and engineers). Net present values were calculated for the estimated costs of acquiring additional education and the additional annual median earnings. No explanation was provided for using a discount rate of 4 percent, but given that the study was done during the Great Depression, when interest rates and rates of return on physical capital investment were very low, this rate might have been quite appropriate.

In Table V, Walsh (1935, p. 268) reported the discounted value of earnings and the discounted costs for various educational degrees over a high school diploma (columns 4 and 5) and over a BA degree (columns 6 and 7). It was positive among men for the BA compared to the high school degree and a large positive value for the law and engineering degrees. Among men with a BA degree, the net present value of acquiring additional schooling was negative for the MA, PhD, and MD degrees, but it was positive compared to the high school degree.

This was followed by the study *The Money Value of Man* (1946) by Louis Dublin and Alfred Lotka, statisticians at the Metropolitan Life Insurance Company. They estimated the present value of future earnings using a discount rate of 2.5 percent, writing: "This rate was assumed because it approximates closely the yield on current long-term investments of high

quality, government securities being the best example" (Dublin and Lotka, 1946, p. 71). In retrospect, this rate seems low for either a person's nominal discount rate or the social discount rate, suggesting an over-estimate of the net present value of future earnings.

A major analysis was undertaken by Milton Friedman and Simon Kuznets, *Income from Independent Professional Practice* (1945), a study of microeconomic human capital by two future Nobel Prize winners for their work in macroeconomics. They describe the professions as occupations requiring "prolonged and specialized training and involve work that has something of an academic or intellectual flavor" (Friedman and Kuznets, 1945, p. 3). Their study focused on independent practitioners in five professions: medicine, dentistry, law, certified public accountancy, and consulting engineering. The focus on self-employed professionals had the advantage of avoiding the potential problems of labor market earnings of employees not reflecting their actual productivity. Independent professionals were relatively few in number at the time. According to the 1930 Census, 6 percent of the gainfully employed were in professional occupations, but only one percent of the gainfully employed were independent professionals as distinct from wage and salary workers (Friedman and Kuznets, 1945, p. 390). The earnings data were from various samples from different sources that vary in accuracy covering the years 1929 to 1936.

Friedman and Kuznets (1945, p. 147-148) "attempted to adjust for uncertainty directly rather than through the medium of the interest rate" and adjust the income data for several factors, including variability of income, probability of success, and length of life. They use a discount rate of 4 percent with an explanation that "… the relevant interest rate for our purposes is one that makes no allowance for uncertainty. In view of the alternative opportunities for investment open to prospective entrants, there would probably be little disagreement that 4 per

cent" is an appropriate "riskless" rate. Moreover, they cite Walsh's use of the 4 percent discount rate (Friedman and Kuznets, 1945, p. 84-85).

Friedman and Kuznets (1945, p. 391-391) calculate the "difference between the extra returns and extra costs" of professional employment. The positive difference means that the rate of return on the investment is greater than 4 percent, but they do not calculate it. They refer to this as evidence of underinvestment in professional occupations because they assume that the 4 percent discount rate is the socially efficient rate, They attribute this underinvestment to "noncompeting groups" because "the social and economic stratification of the population leaves only limited groups really free to enter the professions" (Friedman and Kuznets, 1945, p. 391). They attributed "non-competing" groups to differences in ability to study and practice the professions compared to other occupations, and differences in the resources to finance the extra costs of the training. They attribute the higher returns in medicine compared to dentistry to the greater barriers or restrictions on entry into medical schools introduced by the medical profession to increase economic rents.

## IV. Internal Rates of Return

The net present value approach indicates the money value of the difference between benefits and costs discounted to the time the investment decision is made. To compare across time, one would need to adjust the estimated net present value for changes in the price level, which requires the selection of an appropriate rate of inflation. To compare across space (currency areas), one would need to convert to a common currency – for example, converting British pounds to US dollars. Moreover, under the net present value approach, the conclusion regarding profitability is contingent on the specific discount rate selected, and is therefore sensitive to this selection.

In his 1964 volume, *Human Capital: A Theoretical and Empirical Analysis, With Special Reference to Education*, which was cited by the committee when he was awarded the Nobel Prize in Economics (1992), Gary S. Becker developed further the analysis of the relation between earnings and education. Becker's empirical innovation is that he calculated internal rates of return from education, that is, the discount rate that sets to zero the net present value of earnings (the discounted benefits minus the discounted costs). Whether an investment is profitable or not for an individual depends on whether the internal rate of return is greater or lower than the individual's discount rate.

Both the net present value approach and the internal rate of return approach require that the person's discount rate is employed to determine whether an investment enhances an investor's wealth. But the internal rate of return approach calculated from the net present value has some distinct advantages. The internal rate of return, and of course the discount rate, are pure numbers. This facilitates comparisons across time and space. Under the internal rate of return approach, the profitability is based on comparing the calculated internal rate with whatever discount rate the investigator or reader feels is appropriate.

Comparing the internal rate of return to the discount rate will indicate the profitability of an investment, but caution is needed if two or more investments are not independent of each other. In comparing investments that are not independent, for example, mutually exclusive investments, the one with the highest internal rate of return may not be the wealth maximizing investment. For a given discount rate, the investment with the highest net present value will be wealth maximizing.

Becker (1964, Chapter IV, and especially p. 93, 128) estimated high internal rates of return to educational attainment in the US using census data from 1940 and 1950, primarily for

white native-born men. These rates of return in 1950 were about 13 percent for college graduates compared to high school graduates, and about 20 percent for high school compared to primary school. White native-born college dropouts received a rate of return of about 8 percent, compared to the 13 percent for graduates. He therefore found rates of return that decline with higher levels of schooling, that are higher than on physical capital investments, and that drop-outs receive lower returns on their investments than graduates.

Becker (1964) also estimated the rate of return for segments of the population. He estimated that non-white males have rates of return from completing college of about 12 percent in the South and 8 percent in the non-South, compared to 14.5 percent for native white males nationwide. The higher rates of return nationwide are due to the higher levels of income for all educational levels outside the South and the lower levels of schooling in the South. He also estimates the changes in rates of return over time: "…rates of return on both high-school and college education declined rather significantly during the first forty years of the century, and then stopped declining and even rose during the next twenty years" (Becker, 1964, p. 134). Becker also sought to adjust estimated rates of return for differences in ability, in particular the apparently higher level of ability of those who obtained higher levels of schooling (Becker, 1964, p. 79-88 and 124-129).

## V. The Schooling-Earnings Function

The next conceptual stage in the development of the relation between earnings and schooling was in the Becker-Chiswick paper "Education and the Distribution of Earnings," (1966, p. 358-369). This was a report on early stages of work on the distribution of earnings – the development of a "theory of income distribution that both articulates well with general

economic theory and is useful in explaining differences among regions, countries, and time periods" (Becker and Chiswick, 1966, p. 358).

This study had two main components. The first was a supply and demand theory of investment in human capital. There is an upward rising supply curve of funds for investment in human capital by individuals and a downward sloping demand curve for investment funds, where the "price" is the interest rate. Optimal investment for the individual occurs where the supply curve (the marginal interest cost of funds) intersects the demand curve (the marginal internal rate of return on the investment). At the individual's optimal level of investment, the area under the demand curve is the person's earnings, the area under the supply curve is the "repayment" to the "lender" of the funds, while the difference between the two curves is the net increase in wealth from the investment. Supply and demand conditions differ across individuals and the resulting distribution of earnings is determined by the distribution across individuals of the supply curves and the demand curves, and the correlation across individuals of these curves. This approach for understanding the distribution of earnings is developed in more detail in Becker (1967).

The second component of this study was the development and preliminary application of the schooling-earnings function to an econometric regression analysis for understanding earnings distributions. Although the linear OLS regression relating the natural logarithm of earnings to the years of schooling completed was developed in more detail in Becker and Chiswick (1966), a simpler version is presented here:

Let $E_j$ be earnings after $j$ periods of investment, $E_0$ is earnings if there is no investment, $C_j$ is the (direct and opportunity) cost of the investment in period j, and $r$ is the rate of return on the investment. Then, after one period of investment, for the $i^{th}$ person:

$$(1) \qquad E_{1,i} = E_{0,i} + rC_{1,i} = (1 + rk_1)E_{0,i} \ ,$$

where $k_j = \frac{C_j}{E_{j-1}}$ is the fraction of potential earnings that are invested in period *j=1*. Then, for convenience dropping the subscript *i* and assuming *r* is constant for all levels of investment, from the principle of mathematical induction, after *n* periods of investment:

$$(2) \qquad E_n = \prod_{j=1}^{n} (1 + rk_j)E_0$$

and, taking logarithms,

$$(3) \qquad \ln E_n = \sum_{j=1}^{n} \ln(1 + rk_j) + \ln E_0 \approx \ln E_0 + \sum_{j=1}^{n} rk_j$$

since $\ln(1 + \alpha) \approx \alpha$ when $\alpha$ is a small number. If there are only S years of schooling investment, and if *r* and *k* do not vary across individuals or years of schooling,

$$(4) \qquad \ln E_{S,i} = \ln E_{0,i} + (rk)S_i \ .$$

Hence, the linear relation between the natural logarithm of earnings and years of schooling. Note that even given the assumptions needed to develop this relationship, the coefficient of schooling is *not* the estimated rate of return, but rather *rk*, the rate of return multiplied by the fraction of potential earnings invested in a year of schooling. Too often this caveat is ignored in the empirical literature.

Becker and Chiswick (1966, p. 366) then presented estimated rates of return from schooling calculated from the 1960 US Census, separately by region (South vs. non-South) and level of education (primary, secondary, and higher education). These regression estimates were not based on an analysis of 1960 microdata, which were not yet available, but rather on published grouped data on earnings by schooling. Although they assume *k*=1, the estimated

coefficients of schooling for white men age 25 to 64 years in the regression equations that do not control for other variables are low compared to estimates obtained from the net present value method, even after adjusting for a value of *k* not equal to unity. For higher education, the coefficients are 8 percent for the non-South and 9 percent for the South. The reason for these low regression estimated rates of return from schooling are explored below.

Chiswick (1967) used this linear regression of log earnings on years of schooling based on grouped data to estimate the rates of return from schooling for the states of the United States and the provinces of Canada for the analysis of regional (state/provincial) differences in the inequality of earnings and the skewness of earnings. In this analysis, the inequality in earnings, that is, the variance in the natural logarithm of earnings, is expressed as a function of the estimated rate of return from schooling and the variance in the years of schooling. This approach was very successful for analyzing differences in earnings inequality across states/provinces in the United States and Canada, and for countries as diverse as Britain, Israel, and Mexico. [1]

## VI. The Human Capital Earnings Function

The regression analyses of log earnings on years of schooling completed consistently resulted in estimates of rates of return from schooling that were low compared to estimates of the internal rate of return using the net present value approach. This was a problem that perplexed B. Chiswick, Becker, and Mincer, who were all working on the human capital analysis of

[1] Taking the variance of both sides of equation (4), $\sigma^2(\ln E) = \sigma^2(\ln E_0) + (rk)^2\sigma(S) + 2\mathrm{cov}(\ln E_0, S_i)$, gives the variance of the natural logarithm of earnings, a standard measure of earnings inequality, as a function of *rk* and the variance of years of schooling. If schooling level (*S*) is uncorrelated with non-human capital factors that determine earnings ($E_0$), the covariance term is zero. For an extended analysis of the application of the model to regional and time series differences in earnings inequality, see Chiswick (1974, Part B). For the analysis of the positive skewness in the distribution of earnings, see Chiswick (1970).

earnings at the NBER and the Columbia University Labor Workshop.[2] It was Mincer who finally resolved the conundrum.

Becker and Chiswick (1966, p. 367, footnote 17) suggested that the lower estimated rates of return from the log earnings-schooling equation may be due to "a negative correlation between schooling years and the years invested in other human capital," however, they did not follow up on how or why this occurs. Mincer (1974) expanded on equation (3) by splitting the number of periods of investment into years of schooling (*S*) and years of post-school investments (*T*), or on-the-job training. Recognizing that while it might be appropriate to assume that $k_j$ for schooling would not decline to zero, Mincer postulated that $k_j$ for on-the-job training would be larger in the first years in the labor market, but then decline over time until there were no further net on-the-job training investments. In a simple version, he postulated that $k_j$ for on-the-job training (OJT) would decline linearly over time (Mincer, 1974, Chapter 5). Then, $k_j = k_0 - \frac{k_0}{T^*} T_j$, where $k_j$ is the fraction of potential earnings invested in post-schooling training in year *j*, $k_0$ is investment in the initial OJT period, and $T^*$ is the period of positive net investment, that is, the number of years until $k_j$ declines to zero. Then, using the continuous form, Mincer shows that earning from on-the-job training ($E_{OJT}$) would be:

$$(6) \qquad E_{0JT} = r_t \int_{j=1}^{j=n} k_j d_j = r_t \left[ k_0 T - \frac{k_0}{2T^*} T^2 \right]$$

which gives, for individual *i*:

[2] For a history of the Columbia University Labor Workshop under the supervision of Becker and Mincer, see Grossbard and Beller (2022).

$$(7) \qquad \ln E_{n,i} = \ln E_{0,i} + (r_S k_S)S_i + (r_t k_0)T_i - \left(\frac{r_t k_0}{2T^*}\right)T_i^2,$$

where $r_s$ and $r_t$ are the rates of return from schooling and on-the-job training, respectively. This can be rewritten as:

$$(8) \qquad \ln E_{n,i} = b_0 + b_1 S_i + b_2 T_i + b_3 T_i^2,$$

where $T_i$ in this framework is the $i^{th}$ person's number of years since leaving school. This is the standard form of the "Human Capital Earnings Function" (HCEF), sometimes referred to as the Mincer equation.

The coefficient of experience is not the rate of return from on-the-job training, even if one were to ignore the squared experience term. The coefficient of *T* is the rate of return multiplied by the fraction of potential earnings invested in the initial work period. If, for example, $k_0$ is 0.20 (i.e., forgone earnings are 20 percent of potential earnings) and the estimated coefficient of *T* is 0.03, the estimated rate of return for on-the-job training would be 0.15 or 15 percent.

Note that this simple development indicates that years since leaving school rather than age per se is the relevant experience variable. Suppose age is used instead of experience where $Age = S + T + 6$ if schooling is started at age 6. Then, ignoring the squared experience term, the coefficient on *S* controlling for Age is $a_1$, but

$$(9) \qquad \ln E = a_0 + a_1 S + a_2(S + T + 6) = (a_0 + a_2 6) + (a_1 + a_2)S + a_2 T,$$

meaning that the coefficient on *S,* controlling for experience, is $a_1 + a_2$. Controlling for Age rather than labor market experience does not bias the coefficient on experience, but it does bias downward the coefficient of years of schooling. If neither experience nor age is held constant,

there is the omitted variable, years of experience, which is negatively correlated with years of schooling, thereby biasing downward the coefficient of schooling. This resolved the issue of the low estimated return from schooling when using the schooling-earnings function.[3]

There are several attractive features of the HCEF:

1. It is not an ad hoc specification, but rather is derived from an identity, although based on several simplifying assumptions. As a result, the coefficients have economic interpretations.
2. The HCEF converts a relation between earnings and dollars invested into a relation between the log of earnings and the time equivalent of investment in schooling and job training. Data on the money costs of investment in schooling and especially on labor market experience (or on-the-job training) are very rare, yet there are now abundant data internationally on years of schooling completed and on years since completing schooling (labor market experience) for those fully attached to the paid labor market.
3. Earnings distributions tend to be positively skewed, and the variance in earnings increase with higher levels of schooling. The HCEF specifies that the dependent variable is the natural logarithm of earnings. Therefore, one of the advantages of using log earnings rather than earnings per se as the dependent variable in a regression analysis is that the residuals in the equation are closer to being normally distributed and homoscedastic.
4. As distinct from the net present value approach, tests of statistical significance can be performed on the schooling and experience variables in the HCEF and these coefficients

[3] For an application of the HCEF to explain the effects of rates of return from schooling and the inequality of schooling and experience on state/provincial differences in earnings inequality in the US and Canada and changes over time, see Chiswick (1974, Part C) and Chiswick and Mincer (1972), respectively.

are in percent forms, rather than absolute values, facilitating comparisons across time and currency regimes.

5. Also, as distinct from the net present value approach, the HCEF is flexible and facilitates the consideration of additional control variables in a regression analysis of earnings. The coefficients of these additional variables have economic interpretations and can be subject to tests of statistical significance. Various control variables that have been used include demographic characteristics, such as gender, marital status, race/ethnicity, nativity, region of residence, and labor market characteristics such as time worked, industry, and occupation.
6. Moreover, while the net present value approach requires a re-computation of the discounted benefits and costs to determine the profitability of an investment for each selected discount rate, the internal rate of return approach enables a direct determination of profitability for any selected discount rate.

## VII. Extensions of the Human Capital Earnings Function

The human capital earnings function (HCEF) developed by Mincer (1974) and applied extensively in the literature was based on the assumption of continuous attachment to a particular labor market in an advanced, modern economy. The next three sections break down these assumptions and discuss the implications of extensions of the model for analyses of earnings and the returns to schooling and labor market experience. The first develops the implications for individuals who periodically shift between the paid labor market and unpaid home production activities. The application is to the experience of married women. The second considers the implications of the analysis of earnings and the returns to schooling and labor market experience from working in one labor market when some or all of the human capital is obtained in a

different economic environment. The application is to migrants, in particular to international immigrants. The third looks at how one estimates the HCEF in an economy with a large informal economic sector characterized by many working self-employed by themselves or in small family owned and operated businesses or farms that do not report earnings for each participant. The application is to less developed economies in general, and estimates for Thailand in particular.

Each of these extensions were seminal and developed a new literature that has expanded our understanding of the operation of labor markets.

A. Shifting In and Out of the Labor Market

Workers in a particular labor market may voluntarily or involuntarily move in and out of the paid labor market. The most obvious example is women who sometimes, more so in the past than currently, exit the paid labor market for home production at marriage or on the birth of a child, and then reenter the labor market. Other examples would be those who leave the paid civilian labor force because they join the Armed Forces or because they are incarcerated or they become "house husbands" who care for the children in support of their wives' educational or career goals.[4] What are the implications for earnings?

Solomon Polachek in the early 1970s was interested in why women earned less than men. Moreover, he was also intrigued that the earnings gap between never married men and never married women was relatively small (less than 10 percent) after controlling for schooling and age, compared to the very large gap (over 50 percent) for men and women married only once and

[4] For an analysis of some of the extensions, see, for example, Goldman, et al. (2021), Doleac (2023), and Denver, et al. (2017).

living with their spouse (Polachek, email 6/10/23). He sought to find an explanation in the substantial difference in their occupational distributions, under the supposition that men were in high paying jobs compared to women. But the different occupational distributions explained only about 28 percent of the gender earnings differences among whites (Chiswick, et al, 1975). Moreover, if occupational segregation were the cause of gender differences in earnings, it would beg the question: Why are there occupational differences by gender?

In "Differences in Expected Post-School Investments as a Determinant of Market Wage Differentials," Polachek (1975) analyzed differences by gender in post-school investments by differences in marital status. He writes: "Regardless of the reason these differences in life cycle LFP (labor force participation) exist, the expectation of such behavioral differences brings about systematic responses in the post-school investment process. Those with smaller expectations of life cycle LFP have been shown to invest less even while at work, and have accumulated less human capital stock" (Polachek, 1975, p. 459-460).

In "Family Investments in Human Capital: Earnings of Women," Mincer and Polachek (1974) focused on the analysis of the on-the-job investment term ($k_j$) in the human capital earnings function, equation (6). They argued that the assumption for men of a continuous attachment to the labor force and a linear decline in their investments ($k_j$) with time appears to be warranted, but this assumption deviates too far from reality for many women, particularly married women. Thus, they rejected the use for women in the HCEF of "potential experience" or years since leaving school. They preferred the concept of intermittent or interrupted work experience separating time since leaving school into periods of labor market employment and periods of absence while engaged in home production. Women being aware of their likely intermittent labor force activities would take that into account in making their investment

decisions regarding occupational choice and on-the-job training. They assumed women would tend to avoid jobs or occupations that involved much labor market specific job training in favor of activities with less investment on their part in job training or training that had transferability to home production. This had implications for experience earnings profiles: continuous concave downward profiles for those fully attached to the labor market (men and most never married women) and discontinuous profiles for married women, with subsequent earnings depreciating during periods of absence from the labor market.

Mincer and Polachek (1974) tested their hypothesis using the 1967 National Longitudinal Survey of Work Experience (NLS) for adult (age 30-44) women through which they could analyze retrospectively reported family and work histories and current earnings. Empirically, they analyzed for white women married once and living with their spouse periods of time in the labor market and period of time outside the labor market (associated with marriage and birth of their first child) and found that current earnings increased with greater time spent working, but current earnings decreased with time in the past spent outside the labor market. Moreover, when using the segmented labor market experience variables rather than the potential experience (years since leaving school) and its square, the coefficient on schooling declined (from 7.6 percent to 6.3 percent) and the explanatory power of the equation increased (from 16 percent to 25 percent) (Mincer and Polachek, 1974, p. 590, Table 4). When the equations were computed for never married women, who have been continuously in the labor market, their experience earnings profiles look similar to those of men.

Polachek (1981) also used NSL data for adult women and found that women reduced the cost to them of intermittent labor force attachment by entering occupations in which there is a smaller decline in earnings with absence from the labor force ("skill atrophy").

The issue of occupational skill atrophy due to labor market exit would be of less concern for those (e.g., males) who expect to be fully attached to the labor market. The implication is that family decision making regarding how wives and husbands allocate their time between the labor market and home production will influence gender differences in occupations (occupational segregation) and the gender wage gap. Moreover, employers anticipating gender differences in labor market exit would have an incentive to provide different levels of employer-financed on-the-job training, reinforcing this effect.

Another implication is that the increase in the labor market attachment of women over the post-World War II period would have increased occupational segregation initially as more marginally attached women entered the paid labor market, and then decreased it as their attachment became stronger and interruptions less frequent and with shorter durations. The result is a decline in gender based occupational segregation and a decline in the gender wage gap.

B. Schooling and Experience in Different Labor Markets

The analysis of the relationships among earnings and its determinants, schooling and labor market experience, in the human capital earnings function up to this point has been limited to individuals in a single unchanged labor market. But, what if earnings are determined in one labor market but some of the education (including schooling, on-the-job training, and language skills), which prepare workers for a particular labor market, are acquired elsewhere? We can think of this occurring for international migrants, but also for internal migrants, such as rural to urban migrants, or in the US context, migrants form the South to the North over a century ago. It may also be useful if there are dramatic changes in technology or in the organization of the economy. For example, workers trained in the pre-information technology economy working in

a fully computerized/electronic work setting, or those who grew up in a communist regime confronting a newly introduced market economy.

These are issues introduced and explored for the first time in B. Chiswick (1978) "The Effect of Americanization on the Earnings of Foreign-born Men." This paper introduces the idea that a worker has schooling and total labor market experience (expressed as years since leaving school), but that some of this schooling and experience may be acquired in a labor market that is different from that in which the person works. The human capital earnings function in a pooled sample of immigrants and native born when the immigrants have worked in both labor markets may be written as:

$$(10) \qquad \ln E_i = b_0 + b_1 S_i + b_2 T_i + b_3 T_i^2 + b_4(FOR_i) + b_5 S_i(FOR_i) + b_6(FOR_i)(YSM_i) + b_7(FOR_i)(YSM_i)^2,$$

where $S_i$ is years of schooling, $T_i$ is age minus schooling minus 6, *FOR*=1 for an immigrant, otherwise =0; and, *YSM* = Years Since Migration for the immigrant. Under the expectation that the labor market experience effect is quadratic, the hypothesized signs for the coefficients are: $b_1+$; $b_2+$; $b_3-$; $b_4-$; $b_5-$; $b_6+$; and $b_7-$. Then $b_4$ reflects the difference in earnings between immigrants who just arrived and the native born, other variables the same, $b_5$ reflects the differential partial effect of schooling for immigrants compared to the native born, and the coefficients on the time in the destination terms (*YSM* and $YSM^2$) reflect the effects on earnings of duration in the destination when total experience is held constant. Although equation (10) is not explicit as to where the schooling of the immigrants is acquired, it is easily modified to allow for two schooling variables for immigrants, years of schooling obtained in the origin before immigration ($S_{i,b}$) and years of schooling post immigration ($S_{i,p}$).

The application in Chiswick (1978) is to the labor market earnings of native-born and foreign-born adult (age 25 to 64) men in the United States in the microdata sample from the 1970 Census of Population. Using the human capital earnings function and controlling for other variables, among the native-born the coefficient of schooling is 7.2 percent and the coefficients on experience and its square are 3.2 percent and -0.05 percent, respectively, all highly statistically significant (Chiswick, 1978, Table 2). Among the foreign born, the coefficient on schooling is to 5.7 percent, and the labor market experience and its square terms are 2.0 percent and -0.03 percent, respectively. The variables for duration in the US labor market among the immigrants, measured by years since migration and its square, are also statistically significant at 1.5 percent and -0.02 percent, respectively.

The implication is that human capital (schooling and experience) acquired before immigration has a smaller partial effect on earnings in the United States than the human capital acquired by the native born. This relates to the human capital acquired in one economy being less than perfectly transferable to another. However, during their time in the destination, the earnings growth for immigrants is steeper than for the native born. This arises from two fundamental reasons. One is that new immigrants initially accept lower earnings than their potential earnings as they are investing in new destination-specific human capital, or human capital that transforms origin skills into destination skills. These investments include language training, job market skills, and labor market information. As their investments decrease and as they receive returns on earlier post-migration investments, their earnings increase; that is, they have steeper experience-earnings profiles in the destination than do the native born. Then, the longer a cohort of immigrants is in a destination, the smaller the gap between their earnings and comparable native-born workers.

Other research suggests that economic migrants (those motivated by better economic opportunities in the destination) tend to be more favorably selected for economic success than their compatriots who remain at home, perhaps because the former have a higher level of innate ability, or they are better at allocative efficiency (decision making skills). If so, assuming the distribution of ability is the same across countries, then unmeasured dimensions of ability among the immigrants would be greater than that of the native born. If the advantages of their greater unmeasured ability are sufficiently large that they outweigh the disadvantages of the lower transferability of their pre-immigration skills and labor market discrimination against immigrants, the earnings of immigrants can even catch up and then exceed those of comparable native-born workers. Indeed, Chiswick (1978, p. 919) concludes that among white men in 1970: "Other things the same, 5 years after immigration foreign-born white men have weekly earnings 10 percent lower than the native born, but earnings are approximately equal after 13 years and are 6 percent higher after 20 years. The earnings cross-over at 10-15 years appears to be quite robust."

This approach suggests the usefulness at differentiating among immigrants on the basis of motive for migrating (e.g., economic migrants vs. refugees) and on the degree of the transferability of the skills acquired in the origin to the destination labor market. Subsequent research has shown that immigrant cohorts with a greater proportion of refugees (whose migration is not primarily caused by economic incentives) compared to economic migrants have smaller coefficients on schooling and total labor market experience, but a larger coefficient on duration in the destination. While the gap in the earnings of refugees compared to economic migrants narrows with duration, the gap does not appear to close.

Positive assimilation occurs when immigrants make investments to create new skills or increase the transferability of previously acquired skills and invest in US labor market information. "Negative" assimilation occurs when, with a longer duration in the destination, immigrants experience a decline in their earnings because of a decline in the economic rents that stimulated their migration (Chiswick and Miller, 2012). "Negative" assimilation is found when analyzing the earnings of immigrants in the destination who come from origins with a similar level of income and between which labor market and language skills are highly transferable. This has been found among immigrants to English-speaking developed countries from other English-speaking developed economies, as well as among immigrants to Sweden from other Nordic countries.

In his *Returns to Education*, Psacharopoulos (1973, p. 15-16 and p. 144-148) developed the concept of what he calls the "cross-rate of return" to education. This is a rate of return from the combined acts of investing in a university education in the origin country and immediately upon graduation emigrating permanently to the United States and earning in the US what a university graduate (not an immigrant) would earn. The US earnings data are adjusted for international cost of living differences. He reported (1973, p. 147, Table 9.1) both the domestic private rates of return and the cross-rates from university education for 14 countries. The cross-rates are much greater than the private domestic rates of return from a university education for most of the countries, with the gap greater the lower the level of economic development of the country of origin. He noted that even if domestic rates of return are low, the cross-rate may make university education in the origin highly profitable, particularly if it facilitated emigration

to the US.[5] This has implications for incentives for international migration. Moreover, while this concept was applied by Psacharopoulos (1973) to international migration, it could easily be applied to internal migration, including rural to urban migration.

C. Application to Less Developed Countries (LDCs)

Early estimates of rates of return to schooling obtained from LDC data were notably higher than market rates of interest for investments in physical and financial capital, suggesting disequilibrium in LDC factor markets and hence an incentive to reallocate investments toward formal education. These findings also stimulated the development of improved statistics and methodologies for adapting the human capital earnings function to LDC conditions, adaptations that would refine our understanding of labor markets and their relationship to educational needs in LDCs.

LDC labor markets are characterized – by definition – as "dual" in that they have a small "modern" sector with the same technological knowledge as in developed countries and a large "traditional" sector without those technologies. The stereotypical modern-sector firm uses large amounts of highly productive physical capital and requires skilled labor to manage and operate it, relegating unskilled labor to menial jobs, like janitors or messengers. The stereotypical traditional-sector firm uses workers with little or no schooling who work with a small or even negligible amount of low-productivity physical capital.

Modern-sector workers are generally hired by a large "formal" firm (i.e., one recognized by the tax authorities and hence included in official statistics), firms that pay wages to production

[5] This might be thought of as the "option value" of schooling, that is, a level of schooling may have a low rate of return by itself, but may generate a high rate of return if it provides the option for a very highly profitable investment, such as emigrating to a higher income labor market.

workers and low-skilled support staff and salaries to managers and professional staff. In contrast, traditional-sector workers are typically self-employed in "informal" urban enterprises or family-based farms. In general, formal schooling or training programs provide skills that are highly productive, and therefore well-paid, in the modern sector but of limited value in the traditional sector. As a result, people with high schooling levels work primarily, if not exclusively, in the modern sector. People with low schooling levels that have other types of human capital, such as entrepreneurship or allocative skill, can earn more working in the informal sector than in the menial jobs available for them in the modern sector.

Early LDC estimates of the human capital earnings function faced severe data limitations since statistics on wages were limited to the "modern" or "formal" sector of the economy. This limitation introduced a potential correlation between unobserved human capital characteristics and years of formal schooling. Even if these unobserved characteristics were randomly distributed within the population, people with high levels of unobservables but low values of schooling are much less likely to be modern-sector wage earners. At the same time, people with high levels of schooling would rarely be found working in the traditional sector. This selection bias raises the estimated modern-sector coefficient of schooling above that for the labor force as a whole, and it reduces the coefficient of schooling within the traditional sector. To compound this effect, most LDCs during the 20$^{th}$ century had a much larger proportion of their labor force in the traditional sector for which no earnings data were available, so the high rates of return estimated with modern-sector data characterized only a small fraction of the labor force.

Estimation of a human capital earnings function for an LDC required modifications to include the entire labor pool. At the very least this would involve data that included self-employment income and people working in the informal sector (C. Chiswick, 1977). Self-

employment income is often earned in a household where various family members contribute labor, but self-employment earnings are reported not by individual workers but rather by the "head" of a household farm or business. An unbiased estimated earnings function for the entire LDC labor force must therefore include data on schooling and labor market experience not only for wage and salary earners but also for the self-employed and for unpaid family workers.

Estimating an earnings function for the entire labor force requires a pooled sample of all workers for whom earnings data are not always comparable. One problem is identifying unpaid family workers who by definition have no reported earnings. Another problem is that wage income is entirely a return to the earnings of labor, while income from a farm or business includes returns to land and nonhuman capital. Yet another problem is that profits are subject to year-to-year fluctuations that may cause the reported annual earnings from self-employment to deviate from that year's wage opportunity cost. Finally, there is the problem that LDC workers in some occupations receive a non-negligible portion of their earnings in kind, the value of which is not included in their reported income.

A straightforward methodology for resolving these problems is developed in C. Chiswick (1983), "An Analysis of Earnings from Household Enterprises: Methodology and Application to Thailand." The earnings function is estimated with individual workers as observations, with a dichotomous variable ($p_i$) to identify people whose income is from profits rather than wages and another dichotomous variable ($u_i$) to identify unpaid family workers. Unpaid family workers are identified in the sample by assuming that any non-earning household member reporting the same occupation as his or her self-employed household head is an unpaid family worker. In every household with unpaid workers, the profit income reported by the household head is averaged over all workers in the farm or business and that average is used as the dependent variable for

each individual. This procedure requires another control variable ($\varphi_i$) for the proportion of unpaid workers in the family business, the value of which is zero for all individuals not working in such an enterprise. Because unpaid workers include women as well as men, all estimates should be made from a pooled sample with a dichotomous variable ($f_i$) identifying women. This dichotomous variable should also be interacted with the explanatory variables like schooling, marital status, and labor market experience, whose effects on earnings might differ between men and women. Finally, capturing the effects of in-kind earnings requires controls ($KIND_i$) for occupations such as farmers or live-in domestic service workers, in which in-kind income is fairly important.

Applying this methodology (C. Chiswick, 1983) to a pooled sample of wage and salaried workers, employers, the self-employed, and unpaid family workers, the estimating equation for individual i is:

$$(11) \qquad \text{Ln } Y_i^* = HCEF_i + \beta_1 p_i + \beta_2 u_i + \beta_3 \varphi_i p_i + \beta_4 KIND_i$$

where Ln Y* = is the logarithm of a modified income variable as described above;

$HCEF_i$ = the standard human capital earnings function for a pooled sample of men and women;

$p_i$ = 1 for anyone working for non-wage income; 0 otherwise

$u_i$ = 1 for an unpaid family worker, 0 otherwise

$\varphi_i$ = the proportion of unpaid family workers in the household enterprise

and $KIND_i$ = dummy variable(s) for occupations paying in-kind benefits.

Assuming that the standard human capital earnings function predicts the full returns to labor for each person, coefficients for the four additional variables can be interpreted as adjustments for any discrepancy between these earnings and reported money income. The coefficient $\beta_1$ provides an estimate of the fraction of enterprise income attributable to non-labor inputs and/or annual fluctuations in profits. The coefficient $\beta_2$ provides an estimate of any systematic discrepancy in work intensity between workers who are unpaid and those reporting earnings. The coefficient $\beta_3$ has information about the prevalence of family workers, suggesting poor access to a labor pool from which outside workers can be hired and/or in which family members can find other employment. The coefficient $\beta_4$ provides an estimate of the monetary value of non-money benefits, including in-kind consumption and bartering.

This methodology was first applied to microdata from a survey of household consumption in Thailand in the mid-1970s, the results of which are reported in C. Chiswick (1983). Earnings functions were estimated separately for urban and rural areas for each of the country's five regions, four of which were mainly agricultural and the fifth a major metropolis – Bangkok – with both informal and modern sectors. As expected, coefficients of the schooling variable were lowest in rural areas and highest in Bangkok where it was very similar to that obtained for the US and other developed countries.

In the large capital city where most of Thailand's modern sector was concentrated, where schooling was available at every level, and where both businesses and workers competed in international markets, the estimated return to schooling was effectively comparable to that of developed countries and no major disequilibrium was indicated. In contrast, rural areas were characterized by fewer if any schools at the middle and higher-education levels and less accessibility to competing labor markets. For people in rural areas, acquiring higher schooling

levels typically meant moving to an urban area. Upon graduation, educated people would find non-farm work in the modern sector or the urban informal sector. This suggests – and hindsight supports the idea – that investments in rural schooling would serve as an important engine of economic development by expanding the share of employment in the modern sector.

## VIII. Summary and Conclusions

This paper presents an overview of the literature in economics up to the early 1980s on the issue of estimating the earnings returns to schooling and labor market experience. It begins with a presentation of Adam Smith's (1776) analysis of wage determination, with the second of his five points on compensating wage differentials "the easiness or cheapness, or the difficulty and expense" of acquiring skills. It then proceeds to the analysis by Walsh (1935) estimating the net present value of investments at various levels of educational attainment. Friedman and Kuznets (1945) also used the net present value method to study the earnings in five independent professional practices. Based on the net present value technique, Becker (1964) estimated internal rates of return from high school and college/university schooling, primarily for native-born white men, but also for other demographic groups.

The first regression-based approach is the development of the schooling-earnings function by Becker and Chiswick (1966). This related the natural logarithm of earnings, as a linear function of years invested in human capital, with the application to years of schooling. This was expanded by Mincer (1974) to the "human capital earnings function" (HCEF), which expresses the logarithm of earnings as a linear function of years of schooling and years of post-school labor market experience and its square. Attractive features of the HCEF are discussed.

The last substantive section presents extensions of the HCEF in the 1970s and early 1980s to account for the effects of human capital on earnings due to: (a) movement in and out of the labor market; (b) geographic migration across labor markets; and, (c) less developed economies characterized by both a small modern formal sector and a large traditional informal economy with many self-employed and unpaid family workers.

The economic models relating labor market earnings to human capital investments have progressed over the past two centuries in pace with the evolution of the quantity, quality, and accessibility of the data. They have been essential for our understanding of the role of human capital investments in labor market outcomes over time and across space.

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