On the Relation Between the Mincer Coefficient and the Returns to Human Capital Investment: Implications of the Human Capital Premium for Applied Policy Analysis

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1 Introduction and conclusions

What is the rate of return to human captial investments that should be employed in applied policy analysis? This is an easy question without a convincing answer. This note demonstrates that the Mincer-coefficient in a wage equation is generally not equal to the return on investment. The coefficient on schooling in a Mincer wage equation, if properly estimated, can only be interpreted as the internal rate of return (i.e. the discount rate that renders the net present value of the investment of an extra year of schooling equal to zero) when strong requirements are met: i) negligible direct costs, ii) no risk/illiquidity of human capital, iii) no option values, iv) no capital market failures, v) no non-pecuniary costs or benefits.

Note that the conditions under which the estimated coefficient in a Mincer wage equations is unbiased are extensively discussed in the literature: no ability/selection bias, no measurement errors, etc. See also Card (1999), Ashenfelter et al. (1999), Harmon et al. (2003), and Heckman et al. (2006). The conclusion from this literature is that the OLS-estimate could be a reasonably accurate approximation of the true coefficient even after trying to control for a host of potential econometric problems. However, a presumption remains that the return might be over-estimated due to ability biases.

For policy analysis it is in general erroneous to use the coefficient of a Mincer regression as a measure for the internal rate of return on investments in human capital, since the theoretical conditions under which this is true are not met in practice. As a result, the Mincer-coefficient not only picks up the rate of return, but also the compensation for direct costs, risk, illiquidity, option values, capital market imperfections, and indirect costs or benefits. However, many of these factors are not easily verifiable to the analyst and empirical evidence regarding their quantitative importance is inconclusive. As a result, there is a human capital premium puzzle (Palacios-Huerta, 2004). The Mincer-coefficient in a wage regression is simply too high to be justified by the available empirical evidence on these other factors. Hence, simple adjustments of the commonly estimated Mincer coefficient of 8% to obtain an internal rate of return to human capital investments cannot be made easily.

From a theoretical perspective, adopting an internal rate of return to human capital investments equal to the risk-free rate in models without risk, capital market imperfections, option values, etc, should be defended by ruling out the presence of 'money machines' in economic models. For applied policy analysis, one would like to have economic models that do not have the property that private agents are not optimizing. In that case, the government can step in by simply borrowing large sums of money and massively invest in education so as to correct apparent underinvestment in human capital. Similarly, one does not want to construct economic models, where the high returns on for example stocks (i.e., the equity premium) would be a reason for the government to borrow massive amounts so as to get a free lunch by investing in the stock market. Note that this is a methodological argument, not a theoretical or an empirical argument. It rests on the assumption that individuals are optimizing so that neither the policy maker nor the analyst is able to improve on market outcomes (assuming no externalities).

Ultimately, the economist should search better for explanations of the human capital premium. It could be that behavioral economics provides insights. For example, hyperbolic discounting and other deviations from the standard, expected utility maximizing framework might explain why some individuals do not invest in human capital, even if they face large returns on these investments.

The implications of behavioral economics for applied policy analysis are not clear, however. Take the example of hyperbolic discounting. When conducting an applied welfare analysis, should the social welfare criterion respect individual preferences? In that case, no clear policy recommendations can be made, since individuals' preferences are intransitive. Or, should the policy analyst instead overrule individual preferences by adopting a transitive social welfare criterion, which corrects for the short-sightenedness of individuals? In that case, it is not clear either whether correct policy conclusions can be drawn, since the social welfare criterion does not respect individual preferences. Any non-welfarist social welfare function violates the Pareto criterion (Kaplow and Shavell, 2002). Therefore, in this example policy analysts cannot make clear-cut policy recommendations as this would inevitably imply some political/social judgement on what should be the correct welfare criterion to be employed in applied policy analysis.

2 The human capital model

This section demonstrates why the Mincer-coefficient in a wage equation does not equal the rate of return to human capital investment. To that end, we consider a version of the standard human capital model without training on-the-job, see for example Mincer (1958, 1962), Schulz (1963), or Becker (1964). We assume that an individual lives from $t = 0$ until time $t = T$. He optimally chooses S years in education to maximize expected lifetime income. For now we assume that there are no immaterial costs or benefits of human capital investment. The individual uses a discount rate r, which is adjusted for risk/liquidity. This discount rate reflects the opportunity cost of funds of investing a marginal euro in another asset, which has the same risk/liquidity properties as human capital. We have implicitly assumed that capital markets are perfect so that the individual can always acquire sufficient funds to finance the investment in human capital. In this note we abstract from taxes, subsidies, etc. See Jacobs (2007a) for more on these issues. We also abstract from externalities from human capital, since externalities cannot be detected in Mincer-coefficients that are obtained from individual micro data. See Jacobs and Van der Ploeg (2006) for a discussion of externalities, social, and private returns.

Earnings per year are denoted by $W(S)$ and earnings increase at a diminishing rate in schooling S: $W(S)$, $W' > 0$, $W'' < 0$. Alternatively, $W(S)$ can be viewed as the production function of human capital. We assume for simplicity that $W(S)$ is time-invariant. Each year of schooling requires P in time-invariant direct costs.

Expected income $Y(S)$ associated with education level S is given by

$$Y(S) \equiv \int_S^T W(S) \exp(-rt)\, dt - \int_0^S P \exp(-rt) dt. \tag{1}$$

Optimal years of schooling follow from taking the first-order condition with respect to S:

$$\frac{\partial Y(S)}{\partial S} = \int_S^T W'(S) \exp(-rt)\, dt - W(S) \exp(-rS) - P \exp(-rS) = 0. \tag{2}$$

Rearranging yields

$$\int_S^T W'(S) \exp(-r(t-S)) dt = W(S) + P. \tag{3}$$

Integration gives

$$\frac{W'(S)}{r} \left[1 - \exp(-r(T-S))\right] = W(S) + P. \tag{4}$$

Thus, the discounted value of marginal increase increase in wages due to an extra year of schooling equals the marginal costs of an extra year of schooling in the form of forgone earnings $W(S)$ and direct costs P. $[1-\exp(-r(T-S))]$ is an annuity term capturing the finite time-horizon. If $T=\infty$, this term equals one.

Remark: when analyzing increases in investments in human capital in policy analysis, it is important to include forgone labor earnings in the cost calculation of higher education investments. Hence, applied policy analysis needs to take into account that individuals are enrolled in school for a longer time when investment in human capital increases.

3 Mincer coefficients and returns to education

If individuals have an infinite horizon ($T=\infty$) and direct costs of education are negligible ($P=0$), then we find the following equation

$$\frac{W'(S)}{W(S)}=r. \tag{5}$$

In other words, the percentage increase in wages if the individual gets one year of schooling equals the discount rate r. Therefore, r is the internal rate of return that renders the individual indifferent for the marginal investment in schooling. Standard wage equations estimate log wages on years of education. Hence, under the assumption of parallel earnings profiles, no selectivity/endogeneity, etc, the coefficient on years of schooling is a measure for the internal rate of return, if all the other assumptions hold as well. Assuming that $T=\infty$ is not a too severe restriction if discount rates are sufficiently large. For example if $T=65$, $S=15$, and $r=6\%$, then we have $[1-\exp(-r(T-S))]=0.95$. Hence, we will assume $T=\infty$ in the remainder.

4 Should Mincer coefficients be adjusted?

The Mincer coefficient from estimating log wages on years of education is a rate of return to human capital investment under strong assumptions that are not met in practice. How should the coefficient from the wage regression be adjusted so as to interpret it as a return?

1. *No direct costs.* If there are direct costs, we find $\frac{W'(S)}{W(S)}=r\left(1+\frac{P}{W(S)}\right)$. Consequently, the return obtained in estimating the Mincer equation is biased upwards, since it captures the compensation for invested direct costs as well. The direct costs are typically about 1/4 of total cost, i.e. $P/W(S)=1/3$

(Becker, 1964; Trostel, 1993), the coefficient of 8% should be divided by 4/3 to obtain an internal rate of return to education equal to 6%. However, when Mincer-coefficients are estimated on microdata in countries where the individual direct cost is heavily subsdized, like in the Netherlands, the correction for direct costs of education is only minor. For example, if individual direct costs are only 15% of total direct costs as in the NL for higher education, and direct costs are one third of opportunity costs, then the internal rate of return would be as large as $\frac{1}{1.05} \simeq 0.95$ times the Mincer-coefficient.

2. *No risk/liquidity premium.* In the presence of risk, the Mincer return also captures a risk/liquidity premium of human capital in wages. Human capital cannot be liquidized, since it is embodied in human beings. It is also a non-tradable asset, since slavery is forbidden. Finally, insuring human capital risks is generally not possible since this requires state-contingent claims on human capital (Jacobs and Van Wijnbergen, 2007). Empirical evidence for the importance of a human capital premium is provided in Palacios-Huerta (2004, 2006) and Hartog (2005). Therefore, suppose that $r \equiv \rho + \pi$, where ρ is the risk-free rate of return and π is the risk/liquidity premium to be applied to investments of similar risk/liquidity as human capital, then we have $\frac{W'(S)}{W(S)} = (\rho + \pi)\left(1 + \frac{P}{W(S)}\right)$. In that case the true rate of return ρ equals r (6%) minus the risk-premium. The latter is often taken to be around 2% (CPB, 2006). Note that in our formulation we took the individual to be income maximizing using a risk-adjusted discount rate r to discount an uncertain income flow from increased labor earnings. This is roughly equivalent to expected utility maximization where ρ would be taken as the discount rate instead. An important caveat is in order here. Although human capital is risky on average (Palacios-Huerta, 2004), it does not need to be risky at the margin (Levhari and Weiss, 1974). The marginal investment can indeed raise the exposure to income risk. In that case the marginal investment contains a risk-premium. However, human capital may also reduce the exposure to income risk, since better educated individuals face lower unemployment, sickness, and disability risks. In that case, the marginal investment in human capital would require a lower rate of return than the safe rate of interest, since larger human capital investment also provides insurance benefits. Hence, if human capital serves as a hedge against labor market risk, a *negative* risk-premium, i.e., an insurance benefit, should be applied instead. Empirical evidence that a higher level of human capital reduces exposure to labor market risk is provided in Palacios-Huerta (2004, 2006). Thus, it is not clear whether there should be a compensation for risk in the Mincer coefficient.

3. *No capital market failures.* If the opportunity cost of funds is bigger than safe

interest rate (e.g. the consumption interest rate), then the estimated wage premium for education also contains a compensation for liquidity constraints. The effects are comparable to a larger ρ. This is not an empirically strong argument, however. Empirical evidence for credit constraints is weak, see for example Carneiro and Heckman (2003) for an elaborate discussion.

4. *No option values.* Education is not only illiquid, it is also an irreversible investment made under uncertainty regarding the returns of the investment. Hence, there is a positive option value of postponing the investment (Jacobs, 2007). If individuals do invest, they give up a valuable option to wait. Hence they must be compensated with larger returns than the risk-free rate. However, education can also encompass growth options. Individuals are willing to sacrifice on the returns to education of finishing an earlier stage (e.g. secondary education) if this gives them the option, not the obligation, to continue to a later stage (e.g. higher education). These growth options tend to lower required rates of return so that the Mincer return would underestimate the true rate of return (Heckman et al. 2006). Consequently, it is unclear, again, how to adjust Mincer coefficients for real options.

5. *No immaterial costs or benefits.* Suppose that studying gives a utility cost, i.e. studying costs blood sweat and tears. Assume that individual preferences are separable and individuals maximize the following quasi-linear utility function:

$$U(S) \equiv \int_S^T W(S) \exp(-rt)\, dt - \int_0^S P \exp(-rt) dt - V(S). \qquad (6)$$

where $V' > 0$ and $V'' > 0$. The optimal choice of education then satisfies (still assuming that $T = \infty$)

$$\frac{W'(S)}{W(S)} = r\left(1 + \frac{P + V'(S)/r}{W(S)}\right). \qquad (7)$$

Thus, the estimated Mincer return is also a compensation for immaterial costs $V'(S)/r$ of education. Note that immaterial costs raise required the Mincer return, just like direct costs. Heckman et al. (2006) survey studies that demonstrate that immaterial costs ('psychic costs') are important especially for individuals in the low end of the skill-distribution. The reverse holds when individuals derive utility or indirect benefits from schooling (joy of education, health, etc). In that case, true returns would be higher as individuals are willing to accept a lower rate of returns if education provides utility benefits. No solid empirical evidence exists on immaterial benefits of education. However, an estimated return to education above the risk-free rate is rather difficult to reconcile with consumption benefits of education (Judd, 2000).

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