

## **RETURNS TO HIGHER EDUCATION REVISITED: HUMAN CAPITAL VERSUS SCREENING**

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### **I. INTRODUCTION**

Traditionally, education is considered an important factor in determining an individual's social status as well as earnings in Korea, like other Confucian countries. Educational hierarchy by schooling level is an apparently noticeable characteristic in Korean society. Despite increased opportunities in lower levels of education, opportunities for a higher education in Korea are very competitive. Entry in college education is strictly limited.

It is widely argued that education plays three crucial roles in a society. First, education increases the productivity of an individual in the labor market. Thus, education plays a role in determining the level of an individual's earnings. The interpretation by human capital theory suggests that education enhances individual marketable skills, especially cognitive skills. Secondly, education has an informational function besides productivity augmenting effect. Thus, education may be used as an important index for employers who screen workers conditional on their educational backgrounds. Workers may signal their productivity to the firm via their schooling achievements. Thirdly, in addition, education influences the distribution of earnings among individuals. It is argued that an expansion of schooling and reduction in the variance of earnings should reduce income inequality. It is, so to speak, the egalitarian effect of education. Hence, the schooling system is regarded as a tool of egalitarianism and the source of social mobility.

Our aim in this paper is limited to the first two roles of education, the productivity augmenting effect and the informational function. Especially our focus is concentrated to the interpretation of the estimated rates of return to schooling in terms of human capital theory and screening hypothesis.

Since late 1960's, about a dozen of studies concerning the estimates of returns to education have been published in Korea. These studies are concerned about

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the rates of return to education, which are mostly calculated by the present discount value method in which internal rates of return are directly computed by equating present discount values of earnings stream to direct costs of education across schooling groups. Table A-1 contains these rates which shows a roughly irregular but apparently upward trend over schooling levels since late 1970's.

Korean economy has grown and developed rapidly during last more than two decades so that industries are widely expanded and technologically advanced. The advanced industries need more highly skilled and better educated workers. But the supply of highly skilled manpower is strictly limited due to the inflexible educational policy of college education.

Therefore, there might be a disequilibrium situation in the labor market, especially in demand and supply of highly educated workers. So it has been argued that college graduates have enjoyed excessive returns to education during the last decade, which may be called "disequilibrium quasi-rent" on higher education.

We use here the regression-estimates of returns to education which are computed from the estimation of the Mincerian human capital earnings function, instead of using the directly calculated rates of return.

Empirical applications of human capital theory to developing countries have shown considerably high explanatory powers in explaining the structure of earnings (Psacharopoulos 1977, for Morocco, and 1981 for Portugal; Liu & Wong 1981 for Singapore; Corbo & Stelcner 1983 for Chile), almost comparable to those of developed countries. (Mincer 1974 for U.S.; Layard & Psacharopoulos 1979 for U.K.) Reviewing the earnings structure in Korea, it is noted that earnings differentials are remarkably considerable by schooling level compared to the cases of other countries.

## 1. Data

The data are the cross section data tape sampled from the *Report on Occupational Wage Survey* by the Ministry of Labor, Korea 1983. The Wage Survey is based on individual informations supplied by randomly sampled 'regular' workers employed in private firms which employ more than 10 workers.

A random sub sample is used from more than 590,000 observations. Our sample has 11,310 observations after some sorting procedure.

Our data do not provide years of total job experience. Thus, we resort to the usual way of computing total job experience as  $\text{Exp} = \text{age} - \text{sch} - 6$ .

## 2. Human Capital Earnings Function

The earnings function is a mathematical and economic specification of the earnings profile. A theoretical human capital earnings function is formulated by Mincer. It provides a simple but powerful ground for the empirical study of earnings structure.<sup>1</sup>

<sup>1</sup>A rigorous derivation of the earnings function is referred to Mincer, (1974).

This human capital model is based on the equality of opportunity and equality of relative ability (equality of comparative advantage). According to Willis and Rosen (1979) and Willis (1985), the condition of equal opportunity is defined as the situation in which all individual face a common interest rate. The condition of equal relative ability means that humans are sufficiently alike in their basic capacities that the distribution of educational choices is not influenced by ability differences. So they call this type of model as the model of equalizing differential wages. Under these conditions, the long run supply of labor is perfectly elastic at a piece rate wage which is sufficient to equalize the present value to each individual lifetime earnings.

Let us review Mincerian human capital earnings function very briefly.

Suppose that an individual's earnings is proportional to his stock of human capital. And suppose also that the individual stock of human capital grows continuously at a constant proportional rate,  $r_s$ , during each year of schooling.

These assumptions imply that earnings for any person having completed  $s$  year of schooling is;

$$(1) E_s = \alpha H_s = \alpha H_0 e^{r_s s}$$

$E_s$ : the individual's earnings with  $s$  years of schooling

$H_s$ : the stock of human capital of an individual with  $s$  years of schooling

$H_0$ : the initial intrinsic stock of human capital of an individual

$r_s$ : the proportional rate by which human capital (and earnings) increases with additional year of schooling

$\alpha$ : the proportional factor regarded as annual rental rate of human capital

With taking logarithm, equivalently, individual earnings is;

$$(1') \log(E_s) = \log(\alpha H_s) = \log(\alpha H_0) + r_s S$$

which is the mincer's schooling model of educational earnings differentials.

When post-school investments, i.e., on-the-job training are introduced, the above schooling model is extended to the well-known human capital earnings function.

Suppose also that the individual's stock of skills grows continuously at a constant (but not necessarily equal to  $r_s$ ) proportional rate,  $r_p$ , during each year of OJT. Then the earnings function at time  $t$ , for an individual having  $S$  years of schooling and  $t$  years of experience is;

$$(2) E_t = \alpha H_t = \alpha H_0 e^{r_s s + r_p k}$$

$r_p$ : the proportional rate by which skills increase with additional years of training

$k_t$ : years of OJT during  $t$  years of experience

Taking logarithm,

$$(2') \log(E_t) = \log(\alpha H_0) + r_s S + r_p k_t$$

which is the basic form of the human capital earnings function.

### 3. The Stylized Facts

There are some stylized facts concerning earnings profiles, which are observed from the empirical findings and confirmed by the theoretical properties of the human capital earnings function.

(1) Earnings profiles are concave, hence the rate of growth is positive but has a declining rate of increase with experience.

(2) Age-earnings profiles are fanning out. (diverged) Experience-annual earnings profiles are converged. However, weekly or hourly earnings profiles are parallel. (the parallelism of the experience profiles of earnings)

(3) Variance of earnings increases with age and schooling level.

(4) The overtaking year occurs within  $1/r_p$  years of experience.

(5) Variance of earnings will tend to be U-shaped with a minimum at the overtaking year of experience.

(6) The coefficient of schooling at the overtaking year in the regression of the schooling model is interpreted as the marginal internal (own) rate of return to additional schooling.

## II. RETURNS TO EDUCATION

It is an observed fact that employers pay higher wages to the more educated workers 'on average'. Apparently, the value productivity of the better educated worker is regarded, to the employer's experience, as higher than that of the less educated worker.

The human capital produced by formal schooling is one form among several forms of human capital, although a major one. Its effect can be hardly isolated when other forms are ignored. Here, however, we focus on the pure effect of schooling, not contaminated by other forms of human capital on earnings.

### 1. Regression Estimates of the Rate of Return to Schooling

The coefficient of schooling obtained from the regression of human capital earnings function,  $\log E_i = f(S_i; X_i)$  where  $X$ 's are person-specific variables such as experience or tenure, is interpreted as the internal rate of return to schooling. This regression estimates of returns to schooling would be unbiased, if  $S$  and  $X$  variables are uncorrelated. That means, schooling and the other variables such as OJT, family background, ability are uncorrelated as well as there is no measurement errors.<sup>2</sup>

<sup>2</sup>Willis (1985) notes that in the schooling model,  $\log E = \log E_0 + r_s + u$ , if the error term is equal to each person's "absolute advantage", which is homoskedastic and statistically independent of  $S$ , then the schooling model can be estimated consistently by OLS even when the differentials of other variables are not observed.

In a rapidly growing economy as in developing countries like Taiwan or Korea, there are several factors to affect returns to education.

The one is the secular expansion of education, especially rapid expansion of elementary and secondly education in the developing countries. The slope coefficient of schooling from the regression of the schooling model would be downward biased, when the cross-section data are used, since the older groups tend to have lower schooling and the younger cohorts are likely to be more educated.

The other factor is the so-called "vintage effect" suggested by Welch (1970). In a fast growing economy, in which new management system or new technologies are often introduced, the rate of obsolescence of knowledge or skills tends to be higher and the speed of obsolescence rate is faster than in a stationary economy. Thus, the younger cohorts who graduated from school recently would take advantage of newly learned knowledge and enjoy relatively more returns to education.

Table 1 shows the regression results of the typical earnings functions which also include hours worked, tenure, several interaction terms.

All estimates of coefficients are roughly self-explanatory. The coefficient of schooling can be regarded as the returns to schooling investment from the earnings function regressions controlling for the effects of other human capital variables as prior experiences and current tenure.

The coefficient of schooling shows that the rates tend to have an increasing trend with schooling level, indicated by significant positive sign of schooling square term. It suggests that the systematic differences in the rates of return to schooling across schooling level.

[Table 1] Regressions of Human Capital Earnings functions

Explanatory Variables	Dependent Variable: log (Monthly Earnings)			
	(1)	(2)	(3)	(4)
Intercept	11.11 (245.7)	10.20 (161.0)	11.06 (157.7)	10.53 (108.9)
Schooling	.1138 (64.6)	.1309 (98.6)	-.0334 (- 3.9)	-.0410 (- 8.7)
Sch*Sch			.0075 (19.5)	.0078 (23.2)
Ex		.0875 (68.3)	.0851 (67.3)	.0820 (53.8)
Exsq		-.0015 (- 42.9)	-.0015 (- 43.4)	-.0015 (- 37.1)
ln (Hours)				.1071 (5.31)
R <sup>2</sup>	.2684	.6080	.6207	.6218
N	11,310	11,296	11,296	11,296

\*: Ex is total labor market experience.

t-values are in parentheses.

[Table 1] (Continued) Regressions of Human Capital Earnings functions

Explanatory Variables	Dependent Variable: log (Monthly Earnings)			
	(5)	(6)	(7)	(8)
Intercept	12.04 (169.6)	11.13 (143.5)	11.24 (126.8)	10.36 (98.6)
Sch (= 9)	.0080* (.54)	.2518 (8.4)	.2118 (18.8)	.2383 (16.6)
Sch (= 12)	.3286 (22.4)	.6116 (12.0)	.5337 (45.5)	.5839 (32.3)
Sch (= 14)	.7074 (23.3)	.9467 (16.8)	.8737 (39.3)	.9508 (33.7)
Sch (= 16)	1.1763 (60.2)	1.3318 (18.0)	1.2395 (83.6)	1.3374 (50.8)
Ex		.0851 (53.8)	.0620 (50.0)	.0709 (29.9)
Exsq		-.0015 (- 37.1)	-.0013 (- 33.7)	-.0014 (- 33.3)
Tenure			.0984 (46.9)	.1489 (31.6)
Tensq			-.0024 (- 18.7)	-.0022 (- 16.9)
Ln (HW)				.1390 (7.25)
Ex*Ten				-.0024 (- 16.89)
Sch*Ex				.0000 (.03)
Sch*Ten				-.0025 (- 7.13)
R <sup>2</sup>	.3304	.6208	.6542	.6642

\*: insignificant at 10% level. t-values are in parentheses. Ex in column (6) is total labor market experience. Ex in columns (7), (8) is prior labor market experience.

In fact, it has been argued in Korea that more educated workers are relatively over-paid compared to lower educated workers so that rates of return to education are greater for the higher educated and the earnings differentials by schooling level have been enlarged during the fast growth period of the Korean economy.

## 2. Derivation of Implicit Rates of Return to Schooling from Flat Potential Earnings Capacity

When we get the rates of return to schooling from the observed experience profiles, as a simple way, those returns are “hybrid” rates, since they are weighted average of the pure rates of return to schooling and the rates of return to job training.

If there is no correlation between schooling and post school job investments, then the correct effect of schooling on earnings can be yielded from the vertically parallel experience profiles across different schooling groups. The assumption of no correlation between schooling and OJT investment guarantees that the schooling effect on earnings remains "neutral" as experience varies.

In order to get a more appropriate  $r_s$  in the framework of the schooling model we need to disentangle the pure effect of schooling on earnings from the effect of experience. Therefore, we need to know the potential earning capacity of each schooling group.

A basic assumption of the human capital theory should be reminded that costless training or learning is impossible. Earning power in terms of human capital increases with work experiences, but at a cost. Earnings cannot be increased without investments on the job training, therefore, earnings profiles would be flat without investment by the assumption. Hence, the earnings differentials by the flat earnings capacities across schooling level can give us a set of correct measure of rates of return to each schooling. We may call this procedure, the "flat potential earnings capacity approach."

It is our aim here to obtain the unobservable potential earnings capacity across schooling level. To do this, first, the estimated hybrid rates of return to schooling from the regression of earnings function will be used as the discount factors in calculating potential earnings.

Next step is to obtain the flat potential earnings capacity for each schooling group, which is the present discount value of the observed experience-earnings profile by using the estimated rate of return to schooling as the discount rate.<sup>3</sup>

The pure, that means, least influenced by job experiences, rates of return to schooling are calculated by the formular as:

$$\hat{r}_{si} = \frac{\log \hat{E}_{si} - \log \hat{E}_{si-1}}{S_i - S_{i-1}}$$

The results appear in Table 2. We also use the average rates of return to schooling as the discount factor.

From the experience profile of each schooling level, find the year of experience to which the obtained the potential earnings capacity corresponds. That is called the overtaking year. It is found that the overtaking year becomes shorter as schooling level gets higher. And the implicit rates of return show also an increasing trend.

### 3. Empirics on the Overtaking Set of Experience

The above method to find the unobserved potential earnings and overtaking

<sup>3</sup>The experience profiles based on our data show sawtooth pattern, so instead of those profiles, the smooth fitted parabolic functions in terms of experience,  $\log(E) = f(ex, ex^2)$ , are used for each schooling level.

**[Table 2]** Estimation of the Overtaking Year and the Implicit Rates of Return to Schooling

	Junior High School	High School	Junior College	College
(1) $\hat{r}_s$	---	8.2	11.9	15.5
$\hat{j}_s$	9-10	8	6	5-6
discount $r$	8.4	12.0	16.8	18.0
(2) $\hat{r}_s$	---	9.8	14.7	16.5
$\hat{j}_s$	9-10	8-9	7-8	7
discount $r$	8.4	9.7	11.9	13.4

Notes: For (1), the rates of return on schooling level; For (2), the average rates to individuals are used as discount rates; both are computed from column (6) in Table 1.

year needs considerable computational job. For the purpose of easy finding of overtaking year from the experience profiles, Mincer creates a simple way. It is the "regression within experience group" approach, so-called the Mincer's short-cut method. The idea of this method is that fitting regressions of the schooling model within various experience groups first. And then, observe the  $R^2$ s to check how much strong the relationship between earnings schooling as experience varies. When  $R^2$  is at the maximum, we pick up that experience interval. This set of experience years is the overtaking set in which the regression of schooling model is least contaminated by post school investments.

Hence, without the assumption of non-correlation between schooling and post school job investments, the concept of overtaking year can play a role of sustaining schooling effect on earnings to be "least contaminated" from post school training.

In fact, at the initial stage of experience the net effect of post school investment on earnings is negative, but gradually, current investments decline and returns from the past investments are rising, so that net effect becomes positive. The point at which the net effect of the omitted post school investment is zero is the overtaking point.

Therefore, the overtaking year allows us to estimate appropriate rates of return to schooling which are independent of OJT. In addition, it also has a crucial role in the estimation of lifetime earnings inequalities due to schooling. This advantage of the overtaking year will be discussed later.

Table 3 gives the result of regressions of the schooling model for various overlapping intervals of experience.

The mean levels of log earnings are monotonically increasing as experiences increases. Variances of log earnings are also roughly increasing, not strictly though. While the mean levels of schooling are not much changed, rather stable about 10-11 years of schooling, and  $\text{var}(S)$  are apparently increasing.

The Table shows an obvious characteristic of contemporary trend of educational expansion, that is, the expansion of schooling which has provided public education (particularly primary and secondary levels) has had an effect not on



increasing average level of schooling, but on diminishing variances of schooling. It means that the educational expansion policy has affected the distribution of schooling to be more equalized.

The pattern of  $R^2$  shows roughly an inverted-U shape with a peak within 7-11 years of experience. The residual variances also show a similar trend having an U-shaped pattern with a bottom around 5-8 years of experience.

One possible explanation on why the overtaking period checked in terms of  $R^2$  comes later than that in terms of residual variances is that the increasing trend of  $\text{var}(S)$  may affect the  $R^2$  to reach a peak a little later.

Let us consider the expanded schooling model incorporating post school investment is,

$$(2-2) \log E_{ij} = a_j + r_j S + f_i(j) + u_{ij}$$

$f(j)$ : net effect of PSI after  $j$  years of experience  
 $f(0) < 0, f'(j) > 0$   
 $f(j) = 0$  at  $j = \hat{j}$  (at overtaking year)

Take variance, assuming that  $r$  is fixed for individuals.

$$\sigma_j^2(\log E) = r_j^2 \sigma_j^2(S) + \sigma_j^2(f) + \sigma_j^2(u)$$

Then,

$$R^2(j) = r_j^2 \sigma_j^2(S) / [r_j^2 \sigma_j^2(S) + \sigma_j^2(f) + \sigma_j^2(u)]$$

$\sigma_j^2(f)$  reaches its minimum at  $\hat{j}$ . If  $r^2 \sigma^2(S)$  and  $\sigma^2(u)$  are roughly constant, then  $R^2(j)$  reaches the maximum at  $\hat{j}$ .

Brown (1980) has found that the  $R^2$ s are less regular and peak later than

[Table 3] Schooling Regressions within Experience Groups

Years of Experience	R2	Residual Variances	log (E)	Var (log(E))	S	Var (S)	N
0-2	.3433	.1237	11.76	.1874	11.17	3.51	828
3-5	.4724	.1039	11.90	.1965	10.63	5.09	2,065
4-6	.5340	.1026	11.97	.2198	10.58	6.29	2,116
5-7	.5880	.1010	12.04	.2446	10.60	7.30	2,112
6-8	.6030	.1009*	12.11	.2538	10.58	7.83	2,095
7-9	.6158	.1035	12.18	.2689	10.67	8.25	1,866
8-10	.6148	.1045	12.27	.2706	10.67	8.69	1,618
9-11	.6185*	.1069	12.38	.2795	10.82	8.98	1,397
10-12	.5918	.1117	12.46	.2728	10.88	8.88	1,264
12-14	.4896	.1433	1258	.2797	11.20	8.01	1,035
15-17	.4618	.1506	12.70	.2786	10.97	8.37	895
18-20	.4492	.1672	12.74	.3017	10.77	9.41	693

\*: The most probable overtaking year of experience.

residual variances. He argues that the residual variances provide more support for the Mincer's finding.

A basis of his finding is that it is unlikely  $\sigma_j^2(S)$  would be constant in a cross-section, given secular expansion of schooling. Equation indicates  $R^2$  can increase as  $\sigma_j^2(S)$  increases. If  $\sigma_j^2(S)$  are rising,  $R^2(j)$  would peak after  $\hat{j}$ . However, the residual variances equal  $[\sigma_j^2(f) + \sigma_j^2(u)]$  so that they are not distorted by variations in  $r_j\sigma_j^2(S)$ . Therefore, they provide a more reliable guide to the pattern of the  $\sigma_j^2(f)$ , variations of post school investment.

Nevertheless, in order to ensure the non-correlation between post school investment and potential earnings, we still require the assumption that  $f_i(j)$  is uncorrelated with the remaining terms. If this is not true, the residual variances need not reach a minimum at  $\hat{j}$ , even a monotonic pattern is possible.

As Mincer pointed out, if the correlation between post school investment ratio  $k_0$  and earnings capacity is weak, then the profile of  $\text{var}(\log E)$  is U-shaped with the bottom at  $\hat{j}$ . But they are positively (or negatively) correlated, the profile of  $\text{var}(\log E)$  would be increasing (or decreasing).

#### 4. Correlation between Schooling and Post School Investment

Some empirical implications suggested by the human capital theory are more or less dependent upon the degree of correlation between the level of schooling (or earnings capacity after completion of schooling) and post school investments and their returns. If schooling is not independent of post school investment, this dependency may affect some implications of the human capital theory.

(1) The positive correlation between schooling and the returns to post school investments could affect the amount of PSI. The positive correlation affects the investment amounts positively, on the one hand, in sense that the more schooled are more efficient to produce human capital, on the other hand, negatively in sense that the more schooled have higher opportunity costs in terms of foregone earnings.

The finding that the overtaking year is shorter for higher educated groups implies that there may be a positive relationship between schooling and the rate of return to post school investments,  $r_p$  (since  $\hat{j} < 1/r_p$ ). The more educated are relatively more efficient than the less educated in the production of human capital. The ability to acquire human capital may not be neutral with respect to education.<sup>4</sup>

(2) The parallelism of experience profiles can be sustained under the assumption that schooling is almost uncorrelated with post school investment. In this circumstances, the schooling effect on earnings do not change over the years of experience.<sup>5</sup>

<sup>4</sup>Our estimates of the implicit investment profiles show that schooling is positively related with  $r_p$  and  $T$ , investment time span and negatively with  $K_0$ . A more detailed estimation result of the parameters of implicit investment profiles is referred to Chapter II of my dissertation.

<sup>5</sup>The slope of the experience profiles depends on  $r_p$ , initial investment of PSI,  $k_0$  and investment period,  $T$ . Even though  $r_p$  is increasing with schooling level, the experience profiles can still maintain the parallelism, if  $k_0$  is higher for lower schooling groups.

(3) With the positive correlation, the  $r_s$  obtained from the parallel experience profiles would be biased upward, since the year of minimum variance of residuals is coming before the overtaking year.

(4) If schooling level is positively correlated with post school investment, variance of earnings may not have the U-shaped pattern. The variance is likely to increase monotonically, (Brown 1980, Willis, 1985). And variance of residuals may not reach a minimum at the overtaking, rather reach a minimum before the overtaking.

Another problem is the correlation between the level of schooling and the returns to schooling, and the return to post school investment. Becker (1975, chap II) claims that supply and demand curves for investing in schooling shift in such a way that a theoretical qualitative prediction on the positive or negative dependence between rates of return to schooling and schooling is impossible.

The positive correlation between schooling and the returns to education could affect  $r_s$  obtained the observed experience. When we get the rates of return to schooling from the parallel experience profiles, the non-identical overtaking years across different schooling levels may be a cause to lead the rates of return to be biased.

If the overtaking year comes earlier for the higher educated groups, then the vertical measure of rates of return to schooling from the experience profiles ( $E'_{s1}/E_{s0}$ ) could not be a correct measure for  $r_s$ , even if those profiles are parallel. Figure 1 shows that the correct measure is just ( $\hat{E}_{s1}/E_{s0}$ ). The estimated potential  $E_s$  for higher educated groups will be reduced due to early  $\hat{j}$ , so that the potential earnings differentials ( $E_{s1}/E_{s0}$ ) would be diminished. Consequently, the  $r_s$  for higher schooled groups will be depressed, as the Figure 1 shows.

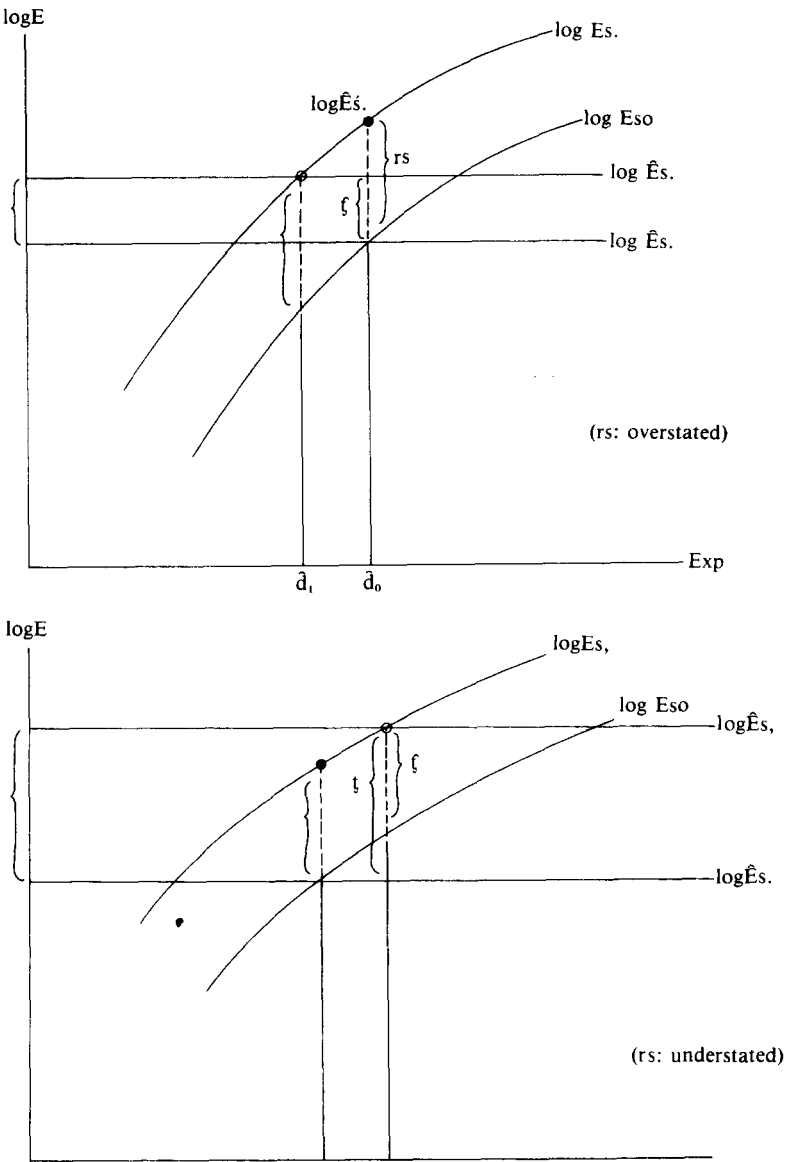
If the experience profiles are cross-over at  $\hat{j}_0$ , i.e., the  $R^2$  pattern reaches a maximum at  $\hat{j}_0$ , then the  $r_s$  obtained from the experience profiles for the high educated groups is "overestimated". And vice versa: if we take  $\hat{j}_1$  as the cross-over year,  $r_s$  for the low educated group is relatively "under-estimated."

In this case, the conventional rates of return to education computed from the observed experience profiles may be misleading, because we can not infer the correct measure of  $r_s$  from the parallel experience profiles. The earlier overtaking year for the higher educated groups will depress the conventional  $r_s$  of that groups.

Consequently, in order that we get a correct measure of  $r_s$  from the vertically parallel experience profiles, the overtaking year  $\hat{j}$ 's has to be coincided across schooling levels.

The rates of return obtained by the short-cut method are reported in Table 4. The rates in (4) are calculated, when  $\hat{j} = 7$  (based on the residual variance criterion), and the rates in (5) are, when  $\hat{j} = 10$  (based on the  $R^2$  criterion).

The rates in (6) are the adjusted  $r_s$  which take into account of differential overtaking years according to schooling level. In fact, the  $r_s$  for the higher educated groups is overstated (when  $\hat{j} = 10$ ), and the  $r_s$  for the lower schooled groups is



[Figure 1] Bias in Rates of Return to Schooling, when Overtaking Years are Different across Schooling Level

understated (when  $\hat{j} = 7$ ). Comparing these adjusted rates with the rates of column 2 computed from the flat potential earnings, we find that the two sets of  $r_s$  are quite similar.

Table 4 summarizes the estimates of the rates of return to schooling and post school investments.

**[Table 4]** Summary Estimates of Rates of Return to Schooling Level and Rates of Return to Post School Investments

	Junior High School	High School	Junior College	College
(1)	8.4	12.0	16.8	18.0
(2)	—	8.2	11.9	15.5
(3)	5.3	14.7	15.7	17.5
(4)	5.7	12.4	17.5	18.3
(5)	7.0	12.5	16.8	17.5
(6)	6.8	8.6	11.0	14.5
(7)	7.9	9.9	14.8	16.6
(8)	10.5	12.5	16.7	18.2

Notes: (1); Regression-derived rates from column (1) in Table 1

(2); the implicit rates from the flat-potential earnings differentials in (1) of Table 2.

(3); from the schooling model regressions within experience groups, at 6-8 overtaking years of experience.

(4); by the short-cut method, when the overtaking year is 7.

(5); by the short-cut method, when the overtaking year is 10.

(6); by the short-cut method, adjusted for the different overtaking years across schooling level.

(7); the rates of return to post school investments from the implicit investment profiles.

(8); the upper bound rates of return to post school investments from the overtaking years.

In addition, Table A-2 shows an international comparison of the estimates of  $r_s$  by schooling levels. The estimated  $r_s$  from the U.S. and Britain roughly show a downward trend with schooling level.

In such developing countries as Turkey and Korea, private rates of return on education show an upward trend with educational attainment. So the demand for additional schooling would be upward sloping. Krueger (1972) calls it "imbalance of educational pyramid."

Economic theory suggests that such an imbalance would result in lowering the wage of college graduates, and it would discourage people from investing in college education. Then the imbalance in the supply of educated manpower would be corrected overtime. Yet in developing countries such an equilibrating mechanism does not appear to be operative. The reasons lie in institutional arrangements surrounding higher education and job selection. And the capital market in developing countries is generally imperfect.

Such a strict system of educational pyramid absolutely affects the returns on education in favor of higher education. Some portion of the rates of return to higher education would reflect an advantage of ability which may not be negligible.

## 5. Interpretation of the Estimated Rates of Return to Education: Human Capital Theory versus Screening Hypothesis

### (i) Some Implications from the Theories

Human capital theory suggests that  $R^2$  of the schooling model would reach a

peak at the overtaking year of experience.

In fact, it is found in empirical studies that the coefficient of determination of the schooling model is increasing over the first decade of experience, and then declined thereafter. This finding has shown a simple and clear explanation on the puzzling inverted U-shaped pattern of correlation between schooling and earnings.

A rising correlation between schooling and earnings implies greater effect of schooling on earnings. Then it is claimed that the greater the effect of schooling on earnings, the larger the (partial) coefficient of schooling. Therefore, the pattern of rates of return to schooling tend to show the inverted U-shaped.

As an alternative theory about the determination of earnings and earning growth, the informational screening theory has been developed. The screening hypothesis is seemingly contradictory to the human capital theory. Because human capital theorists argue that schooling augments individual productivity, while screening theory supporters argue that, in a strict sense, schooling does not increase worker's productivity, but just signals it.

First, screening theory predicts that variances of earnings are increasing with job experience due to employer's correction of wage offers which reflect worker's revealed true productivity.

Secondly, this theory also suggests that the effect of schooling on earnings would be constant, if the screening by firm is permanent (the strong version), or would be decreasing with experience, if the sorting effect is temporary (the weak versions, i.e., firm corrects wage offers due to true productivity. Hence, it is expected that the returns to education will fall with work experience.<sup>6</sup> (Layard & Psacharopoulos, 1974)

According to the screening hypothesis, at the hiring stage, when employer is uncertain about worker's true productivity, workers are hired on the basis of the expected future productivity conditional to their educational achievements. As work experience increases, informations about worker's productivity are transmitted to the employer so that he could have better assessments about their true productivity. Hence, the employer will rely later more on on-the-job performance than the educational backgrounds.

Chiswick (1973) argued that the observation of U-shaped pattern of residuals is an evidence against the screening hypothesis which products an monotonic increase of residuals. It implies from the screening hypothesis that only the certificate of schooling is important when employer makes a hiring decision, as Chiswick call it "sheepskin" effect of education.

It has been recently argued that screening hypothesis is not inconsistent with human capital theory' (Riley, 1976 and MacDonald, 1980). Riley (1979) confirms

<sup>6</sup>However, Liu & Wong (1982) pointed out that there is no a priori reason for the effect of schooling to decrease. Because we need not to assume that firm makes systematic errors in prediction of worker's productivity, since prediction by firm according to the screening hypothesis, is correct 'on average'.

<sup>7</sup>Riley (1975) has derived a Mincerian earnings function from the infirmational screening framework.

[Table 5] Rates of Return to Schooling by Schooling Level within Experience Groups

Years of Experience	Junior High School	High School	Junior College	College
0-2	- 0.8*	10.4*	14.0	[20.7]
3-5	3.5	10.9	[23.7]	19.7
4-6	4.7	11.8	22.1	18.9
5-7	5.1	13.3	19.9	18.5
6-8	5.3	14.7	15.7	17.5
7-9	4.6	15.6	13.2	17.7
8-10	5.4	[15.7]	11.6	17.1
9-11	8.2	14.7	12.0	16.7
10-12	[10.7]	12.6	14.4	16.4
12-14	10.6	10.3	15.8	16.9
15-17	2.7**	9.7**	16.6	19.0
18-20	9.1	9.5	20.7	15.6

Notes: \*: The rates are insignificant at 10% level.  
\*\*: The rates are insignificant at 5% level.  
The highest rates of return to schooling by education level are in ( ).

also the U-shaped pattern of the residuals, and finds the “overtaking” effect. In the sense that workers invest in employer’s informations about their quality, the screening hypothesis can be regarded as a “specific version” of human capital theory in which capital acquired is just informations about productivity (Stigler, 1962; Harris & Holmstrom, 1982). Therefore, as Stigler argued, variance of earnings is increasing due to better recognition of increase in productivity by employers with job experience.

(ii) Interpretation of the pattern of the returns to education

Let us turn to the empirical results shown in Table 5.

Table 5 gives the trend of marginal rates of return to each schooling level for various overlapping sets of experience. Each educational group shows an unique trend of the rates.

The rates for 9 years schooling group have an increasing trend over experience. On the contrary, the rates for college graduates have an umbiguously downward declining trend.

The rates for high school graduates show an inverted U-shaped pattern having a maximum around 7-10 years of experience, which is consistent with the U-shaped profile of log variances. But the returns to junior college level show an U-shaped pattern, a little irregular though.

We also show the average rates of return to education for individuals (or groups) in Table 6, not the rates of return to schooling level per se. It is computed by the formular as following:

(7) 
$$\hat{r}_{si} = \frac{\log \hat{E}_{si} - \log \hat{E}_{s0}}{S_i - S_0}$$

**[Table 6]** Average Rates of Return to Schooling Within Experience Groups

Years of Experience	Junior High School	High School	Junior College	College
0-2	-0.8*	4.8	7.1	11.2
3-5	3.5	7.4	11.5	12.3
4-6	4.7	8.3	11.7	12.5
5-7	5.1	9.2	11.9	12.9
6-8	5.3	10.0	11.4	13.0
7-9	4.6	10.1	10.9	13.1
8-10	5.4	10.6	10.8	13.2
9-11	8.2	11.5	11.6	[13.6]
10-12	[10.7]	[11.7]	[12.3]	[13.6]
12-14	10.6	10.5	11.8	13.0
15-17	2.7*	6.2	8.8	11.3
18-20	9.1	9.3	12.2	11.8

\*: The rates are insignificant.

The highest average rates of return to schooling by educational level are in ( ).

The changing pattern of the average returns from education to individuals is quite contrary to the pattern of the returns to educational level per se in Table 5. Interestingly enough, the trends of average returns to each schooling groups are all alike regardless of the educational achievements, showing the inverted U-shaped pattern.

The results shown in Table II-5 seem to be consistent with the prediction of the screening hypothesis. It can be claimed that the declining patterns of the rates of return to schooling of college graduates is due to sheepskin effect. Whereas, the trend for the 9-years schooling group show the opposite case indicating an increasing pattern of  $r_s$  due to, if we may call it, "reversed" sheepskin effect.

Nevertheless, those two seemingly opposite trends could be explained simultaneously by the screening hypothesis. If employer relies heavily on workers' educational backgrounds at the initial stage of job experience, he may mis-evaluate their true productivity such that very highly educated groups are likely to be over-evaluated, while very low educated groups are under-evaluated. If so, we may say education has an "unfair screening effect" against the lower educated groups.

As job tenure increases, employer gets better informations about their abilities. If he would pay wages according to their productivity, then the over-estimated groups in the beginning of job tenure will be paid less over time, whereas, the underestimated workers will be paid more later, even in the absence of OJT in job tenure.<sup>8</sup>

<sup>8</sup>In fact, it has been argued that lower educated workers in Korea have been "exploited", paid even at the subsistence level in some industries. The highly educated workers are relatively well paid. It is partly because of considerably high initial wages of college graduates which reflect a temporary phenomenon in the early 1980's that the supply of college level highly skilled workers is short of the demand of firms.



The trend of the rates of return to schooling of high school graduates coincides with the finding that experience profile of log variances are largely U-shaped in the 12-years schooling groups. We may say, from the viewpoint of screening hypothesis, that the assessments of productivity of 12-years schooled workers are least unbiased by the employer who has "prejudiced" expectations on workers' education. So they seem to be paid 'fairly' in terms of their educational backgrounds. In this case, there is no screening effect, and the overtaking effect may work dominantly on earnings over the first decade of experience.

From the fact that the rates of return to college education are monotonically decreasing, it may be inferred that educational screening is important for explaining the trend of rates of return to college education. It is recognized that the overtaking effect exists over the first decade of experience. However, it is possible that the screening effect of education on earnings can outweigh the overtaking effect, especially for the higher educated workers.

But Brown (1980) supplies clearly an explanation on this point. The returns to schooling could be 'declined monotonically' with experience, without upsetting the conclusion predicted by human capital theory that the pattern of  $R^2$  has a inverted U-shape. Because if  $\text{var}(S)$  is increasing, it is possible that  $R^2$  is not affected, even though the returns to schooling is falling monotonically over the first decade of experience.

Table 3 shows that the pattern of  $R^2$  has a peak roughly before a decade of experience. This empirical evidence confirms the prediction of human capital theory, as Chiswick argues, that the correlation of schooling and earnings rises with experience for the first decade and then declines.

Furthermore, Table 6 reports the changing pattern on the returns from education based on the average rates for individuals which is contrary to the pattern of Table 5, and lend support to the human capital theory. Surprisingly, the trends of the rates of return for each schooling groups are all alike regardless of the educational level. They show unanimously the inverted U-shaped pattern reaching a peak rate at 10-12 years of experience.<sup>9</sup> This finding coincides almost with the pattern of  $R^2$ , that has a peak at 9-11 years of experience in Table 4.<sup>10</sup>

### III. Concluding Remarks

This paper deals with the correct measure of the rates of return to schooling along with the empirical results of human capital earnings function. It is also concerned about the interpretation of the rate of return to higher education in terms of the implications from the human capital theory and the signalling and screen-

<sup>9</sup>The highest rates are not far from the average returns to schooling, 13.1% in Table 1, column 3.

<sup>10</sup>The profiles of the coefficient of variation of log earnings ((standard deviation/mean of logE)\*100) with experience are drawn too. The C-V profiles across schooling level largely seem to have weak U-shaped pattern with somewhat flat bottom around 7-11 years of experience.

ing arguments.

For the purpose of measuring the correct returns to education, the overtaking analysis is used to disentangle the pure effect of schooling on earnings from the effect of job experience. The empirical results of the schooling model show that the overtaking occurs around 10 years of experience. It confirms the implication by the human capital theory. It is also found that the rate of return to schooling is increasing over the schooling year, and the overtaking year becomes shorter as educational level is higher.

The non-identical overtaking across schooling levels may lead the rates of return to be biased. That means, the rate of return to higher education may be relatively upward biased, because there would be positive correlation between schooling level and the rate of return and post school investments.

The pattern on the average rates of return to each educational group looks all alike regardless of the schooling achievements, showing the inverted U-shaped pattern confirmed by the human capital theory. However, the pattern of the marginal rates are quite interesting. Especially the trend of the higher educational group is consistent with the prediction of the screening hypothesis.

[Table A-1] Previous Estimates of the Rates of Return to Education in Korea

Researcher	Year of Estimation	Junior High School	High School	College
K. Kim	1967	12.0	9.0	5.0
R. Morgan	1969	20.0	11.0	9.5
Y. Kim	1969	-1.0	15.0	8.5
C. Jeong	1971	8.2	14.6	9.3
Nam & Jeong	1971	2.9	5.7	1.9
Nam & Jeong	1972	3.7	2.9	1.3
J. Bae	1977	2.8	9.9	13.8
S. Park	1980	2.9	8.1	11.7
KEDI	1982	9.5	12.3	11.0

Note: The above rates are all social rates. (%)

Sources: 1) Kwang-Suk Kim (1968), *Rates of Return in Education in Korea*.

2) Robert M. Morgan ed. (1971), *Systems Analysis for Educational Change: The Republic of Korea*, Florida State Univ. .

3) Yoon T. Kim(1971), "Measurement of the Effect of Investments on Human Resources," Institute of Human Resource Development.

4) W. Nam & C. Jeong(1973), "Economic Analysis of Educational Investments in Korea," Korea Development Institute.

5) Chang Y. Jeong(1974), *Rate of Return on Investment in Education: The Case of Korea*, KDI.

6) Jong K. Bae(1977), "A Study on Optimal Educational Investment and Economic Effects," Korea Educational Development Institute (KEDI).

7) Se-Il Park(1982), "Analysis of Rates of Return to Education in Korea," KDI.

8) Research Report(1983), *Educational Contribution to the Economic Development*, KEDI.

\*: The above table is cited from the KEDI Research Report, (1983), p. 82.

[Table A-2] International Comparison of the Rates of Return to Schooling by Schooling Level

Years of Schooling	U.S.A.				Japan		Turkey	Portugal	Korea	U.K		
	(a)	(b)	(c)	(d)	(a)	(b)				(a)	(b)	(c)
6			19.4						7.9			
8	21.8	21.8	18.8	17.4			21-23					
9								6.9	8.4			
10	18.5	16.3	18.2	16.3	6.6	6.6						
11							23-25	7.8				
12	17.5	16.0	17.6	15.1	10.0	11.4			12.0	13.0	13.5	(0)
13					8.4	7.8				11.7	9.2	8.0(A)
14	12.5	7.1	17.0	13.9				7.2	16.8			
15							25-27					
16	12.4	12.2	16.5	12.8	10.2	14.3		13.3	18.0			
17+	11.0	7.0	15.6							9.6	7.7	20.0(D)
										22.1	22.1	18.0*
												17.5**

\*Notes: 1) For U.S.A. columns (a,c) are average rates, and columns (b,d) are marginal rates. Column(a), [(c)] are relative to 5-7, (zero) years of schooling. Columns (a), (b) are from G. Hanoch, (1976) "An Economic Analysis of Earnings and Schooling," *Journal of Human Resources*, Summer.

2) Column (c) are estimated by Chiswick on the basis of Mincer's regression results (Mincer, 1974, pp. 92-93), copied from A. Marin and G. Psacharopoulos, "Schooling and Income Distribution," *Review of Economics and Statistics*, August, 1976. Column (d) are calculated from the Mincer's result (Mincer, p. 92),  $r_s = d\log(E)/ds = .255-.0058S-.0043t$  at the over-taking year( $t=8$ ).

3) The results for Japan are from A. Danielsen and K. Okachi, "Private Rates of Return to Schooling in Japan", *Journal of Human Resources*, Summer 1971. Column (a) are average rates, which are relative to 0-9 years of schooling, and column (b) are marginal rates.

4) The result was estimated by A. Krueger (1972), "Rates of Return to Turkish Higher Education," *Journal of Human Resources*, Fall.

5) The result for Portugal was estimated by G. Psacharopoulos, (1981).

6) From the Table 1.

7) For U.K. columns (a), (b) are estimated by G. Psacharopoulos and R. Layard, (1979). The dependent variable of the regression is Annual earnings for (a), Weekly earnings for (b). The average years of schooling are 11.9 years (for 0-level), 13.4 years (for A-level), 17.7 years (for First Degree), and 18.7 years (for Higher Degree).

\*Column (c) is estimated by A. Ziederman (1978), "Rates of Return on Investment in Education: Recent Results for Britain," *Journal of Human Resources*, Winter.

\*For (a), (b), (c) commonly, "No-Qualification" level is the omitted category in the regression.

\*: First Degree to M.A. Degree.

\*\*: First Degree to Doctorate.

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