NOTES

EARNINGS EFFECTS OF DIFFERENT COMPONENTS OF SCHOOLING; HUMAN CAPITAL VERSUS SCREENING

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Abstract—In this paper we divide actual years of schooling into effective years, repeated years, skipped years, inefficient routing years and dropout years. Estimation of earnings functions reveals that this typology is statistically superior to the usual concepts of either actual or effective years of schooling. Based on our distinction we formulate tests which discriminate between the human capital theory and the screening hypothesis. The results give strong support to the human capital theory and refute the screening hypothesis.

I. Introduction

Although many economists make intensive use of empirical analysis, economic science lacks a tradition of precise measurement of variables. Whereas natural scientists know exactly what is meant by concepts like "gravity" or "speed," empirical economists are often satisfied with any reasonable approximation available. In this paper we analyse the impact of a more precise measurement of the variable "schooling" used in an earnings equation.[2] We do this by dividing the actual number of years of schooling an individual has received into different components. Our typology provides more information about an individual's educational career than the usual measures of either "actual years" or "effective years." We define effective years as the number of years nominally required to obtain a certain degree. In most studies it is not even discussed whether actual or effective years are included. Which variable is included mainly depends on what is readily available in the survey used. The decomposition that we propose is such that these measures are nested as special cases.

In addition to the question of how best to measure schooling, this decomposition of schooling gives the opportunity to test the human capital theory against the screening hypothesis. This is not unexpected since the literature on this controversy suggests that the question of whether schooling enhances or uncovers productivity can be settled only by taking a closer look at the educational process.

The remainder of this paper is organized into four sections. Section II provides a short description of the Dutch educational system and of our classification. In section III we consider the theoretical implications of our classification. Section IV deals with the empirical findings, and section V sums up our conclusions.

II. The Dutch Educational System

The dataset to be used in this paper contains information on a single age cohort. All respondents were in the final year of primary education in 1952 (age 12). Below we describe the structure of the Dutch educational system at that time.

Secondary education in the Netherlands is composed of two main branches: general and vocational. Within the secondary general branch, there are a number of different levels each of which can be entered immediately after primary education. These levels involve differing numbers of years of schooling (from 2 to 6).

The secondary vocational branch is divided into both levels and sectors. The main sectors are: agricultural, technical, and home economics. Each sector contains a lower and an intermediate level. Only the lower level can be entered directly after primary education. But even within this lower level courses vary in length (from 2 to 5 years). Intermediate vocational education can be attended after completing a course of lower vocational education, but in many cases some years of general secondary education may also suffice as a qualification (switching between branches is allowed).

The top of the educational pyramid consists of higher (post-secondary) education. Here too, we can distinguish between general (university) courses and vocational courses. The standard length of time needed to obtain a higher vocational degree from the end of primary education varies from 7 to 9 years. For a university degree, the standard duration of post-primary education is 11 years, or in the case of a medical degree 13 years.

Officially, virtually any pattern is permissible. Only entry to intermediate vocational education and higher education requires a certificate from the preceding

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[2] Related research in this area is the literature addressing the question of the impact of school quality on earnings (e.g., Rizzuto and Wachtel, 1980).

level, but even here admission rules are not very tight. Obviously, however, not all patterns that end up at the same level of certification are equally efficient. For instance, the "lower vocational-intermediate vocational-higher vocational-university" pattern requires more years of actual schooling than the "secondary general-university" pattern. Compared to the shortest, most efficient path, we might describe the first pattern as inefficient routing. Although not exactly the same thing, we will also label a pattern as inefficient if someone attends a course at the same or at a lower level than the level at which s/he is already qualified.

Besides inefficient routing, three other phenomena may cause a differential between actual years of schooling received and the years of schooling normally required to qualify at the highest level achieved. These phenomena are repeating classes, skipping classes and years spent in education without obtaining a diploma. We label these educational years as repeated years, skipped years and dropout years, respectively. The division is such that the actual number of years of schooling is equal to the sum of effective years, repeated years, (minus) skipped years, inefficient years and dropout years.

Our dataset contains information on individuals surveyed in 1952, when they were sixth graders, and who responded to a questionnaire circulated in 1983. The 1952 records include variables relating to IQ and social background (education of both parents and occupation of the father). The 1983 questionnaire includes questions about the post-primary educational career, present job status, earnings, etc.[3] With respect to education, the survey includes information about all post-primary education attended by the respondents,[4] and for each type of education: the year of entry, the year of departure, whether a certificate was received, and whether the course was completed in the normal time. With the information elicited by these questions, it is possible to determine the actual amount of schooling received, and to break down this amount into the components suggested in this section.

III. Theoretical Predictions

The decomposition of schooling into several components is not only relevant from the point of view of how to measure schooling, but may also give further insight into the controversy between the human capital theory and the screening hypothesis. Our test to discriminate between these two theories relies on two predictions of the screening theory: (i) that more rapid completion of a degree signals greater ability and should therefore lead to higher earnings, and (ii) that years spent in education without obtaining a degree should not increase earnings.

Both the human capital and the screening theory predict that effective years of schooling will raise wages: in the human capital theory because effective years increase human capital, in the screening theory because they provide a signal of higher ability.

Repeated years will have a non-negative effect on wages in the human capital model, and a negative effect according to the screening model. If repeated years do not increase human capital, they will not affect wages in the human capital model; if they lead to a more thorough understanding of what is taught and increase human capital, they may have a slight positive effect on wages. Within the screening framework, repeated years yield a negative signal to potential employers; they signal that the worker is of lesser ability than workers with the same effective schooling completed in standard time. Thus screening theory predicts that repeated years have a negative wage effect.

As skipping a year is the reverse of repeating a year, the predicted effect is the opposite. Skipped years will have a non-positive wage effect according to the human capital model, and a positive effect in the screening model.

In the human capital model, faster (slower) completion may lead to higher (lower) earnings if it is the consequence of higher (lower) ability. In order to prevent repeating and skipping measuring such endowed human capital, the human capital predictions for these variables are conditional on ability and an ability measure should therefore be included in the earnings equation. On the other hand, the screening predictions about the earnings effects of repeating and skipping are based on the assumption that employers fail to observe ability directly but utilize information about educational careers instead. For the screening predictions to hold, the earnings equation should not include an ability measure.

Given homogeneous human capital, inefficient years will have a positive wage effect since these years increase human capital. If human capital is heterogeneous, however, inefficient years will have no effect on wages as they do not increase the relevant human capital. In the screening model, inefficient years will have no effect on wages since they provide no useful information on ability.

Years of schooling without a certificate will have a positive wage effect in the human capital model since these years increase human capital. According to the screening theory, however, graduation from a course should provide more evidence of ability and staying power than mere attendance for a number of years. For this reason, the screening theory predicts that

[3] For an extensive description of the dataset see Hartog (1989).

[4] Coded according to the International Standard Classification of Education.

TABLE 1.—EARNINGS EQUATIONS: MALES

Variable	Equation (1)	Equation (2)	Equation (3a)	Equation (3b)
constant	1.339 (4.0)[a]	1.305 (3.8)[a]	1.295 (3.8)[a]	1.653 (5.2)[a]
s_a	0.043 (8.7)[a]			
s_e		0.050 (8.3)[a]	0.065 (9.1)[a]	0.071 (10.2)[a]
s_s			−0.089 (2.9)[a]	−0.093 (3.0)[a]
s_r			0.005 (0.2)	0.009 (0.5)
s_i			−0.014 (0.9)	−0.012 (0.8)
s_d			0.050 (4.3)[a]	0.056 (4.9)[a]
$iq/10$	0.040 (3.4)[a]	0.046 (3.9)[a]	0.037 (3.2)[a]	
experience	0.061 (2.2)[a]	0.063 (2.3)[a]	0.057 (2.1)[a]	0.056 (2.0)[a]
$experience^2 / 10$	−0.012 (2.0)[a]	−0.013 (2.2)[a]	−0.010 (1.7)	−0.010 (1.6)
Adjusted R^2	0.157	0.151	0.171	0.163
No. of cases	928	928	928	928

Note: t-values in parentheses.
[a] Significant at the 5% level.

years of schooling without certification will have no effect on wages. This argument is called the "sheepskin argument" (Layard and Psacharopoulos, 1974).

Advocates of the screening theory might argue that the tests with respect to this hypothesis are rather severe; we require the screening effects of schooling on wages to last even after more than 20 years of working experience. This precludes the possibility of these screening effects vanishing as employers learn about workers' individual abilities during working life. The persistence of the screening effects is, however, exactly what we expect in a screening equilibrium (Spence, 1973). The signals are self-confirming, and so changes in the wage–signal relation have no rationale. But if the influence of the signal on wages is merely a temporary phenomenon then it must be asked why we should engage at all in the argument about screening versus human capital. Moreover, if signals have only a temporary effect, then a straightforward implication of the screening view would be a zero coefficient for effective years of schooling in our sample.

IV. Empirical Results

In this section we present the estimation results for three different specifications of earnings functions. In the first specification, schooling is measured in actual years (s_a), in the second in effective years (s_e), and in the third using our classification of effective, skipped (s_s), repeated (s_r), inefficient (s_i) and dropout (s_d) years. Ignoring other explanatory variables, the three specifications to be estimated are

$$\ln w_i = \alpha_1 s_a \quad (1)$$

$$\ln w_i = \beta_1 s_e \quad (2)$$

$$\ln w_i = \gamma_1 s_e + \gamma_2 s_s + \gamma_3 s_r + \gamma_4 s_i + \gamma_5 s_d . \quad (3)$$

Note that the first and second equations are both special cases of the third. Equation (1) emerges if $\gamma_1 = -\gamma_2 = \gamma_3 = \gamma_4 = \gamma_5$, and equation (2) emerges if $\gamma_2 = \gamma_3 = \gamma_4 = \gamma_5 = 0$. This property allows us to test whether the extended version of the earnings function gives a better description of the data than the usual equations (1) and (2). Furthermore, the third specification makes it possible to test the predictions of the human capital theory and the screening hypothesis about the separate influences of s_e, s_s, s_r, s_i and s_d on earnings. We estimated the third specification with and without an ability measure (the score on a standard IQ-test), to do justice to the human capital and the screening predictions, respectively.

Tables 1 and 2 give the estimation results for the earnings equations of males and females separately. In addition to the schooling (and ability) variables, we also include experience and experience squared in the equations.[5] The dependent variable is the logarithm of the net wage rate. For males, the results in columns 3a and 3b provide strong support for the human capital theory and refute the predictions of the screening hypothesis. Skipped years have a significantly negative influence on future earnings. According to the screening hypothesis this effect should be positive since skipping a class gives a positive signal to potential employers, whereas within a human capital framework the finding can be explained as the manifestation of a less than thorough understanding of the curriculum. The similarity between the results in the third and fourth column point to a weak correlation between IQ and skipped years ($\rho = 0.06$). This weak correlation partly saves the screening hypothesis, because it can be argued that employers are right not to use skipping a

[5] Although all respondents are about the same age, experience is not simply age − actual years of education − 6 (= potential experience). Due to military service, child care, unemployment and (temporary) disability, the Pearson correlation coefficient between potential and actual experience is 0.499. Actual experience is measured as the sum of reported employment spells.

TABLE 2.—EARNINGS EQUATIONS: FEMALES

Variable	Equation (1)	Equation (2)	Equation (3a)	Equation (3b)
constant	1.245 (2.0)[a]	1.504 (2.4)[a]	1.619 (2.6)[a]	1.886 (3.7)[a]
s_a	0.083 (4.9)[a]			
s_e		0.111 (5.6)[a]	0.123 (4.7)[a]	0.130 (5.4)[a]
s_s			−0.038 (0.4)	−0.032 (0.3)
s_r			−0.005 (0.1)	−0.005 (0.1)
s_i			0.014 (0.3)	0.012 (0.2)
s_d			0.093 (1.8)	0.098 (1.9)
iq/10	0.053 (1.3)	0.036 (0.9)	0.030 (0.0)	
experience	0.058 (1.0)	0.044 (0.8)	0.023 (0.4)	0.025 (0.4)
experience^2/10	−0.024 (1.7)	−0.020 (1.4)	−0.014 (1.0)	−0.014 (1.0)
Adjusted R^2	0.225	0.243	0.242	0.243
No. of cases	289	289	289	289

Note: *t*-values in parentheses.
[a] Significant at the 5% level.

grade as a signal of ability. However, at best this argument can explain a zero effect of skipping a grade on earnings, it cannot explain the negative impact. Furthermore, that skipping a grade is uncorrelated with IQ doesn't mean that it is uncorrelated with other characteristics that employers might value such as the need for achievement and work effort. Unfortunately, we have no information in our dataset to check this.

Repeated years have no effect on future earnings. This is in accordance with the human capital theory, whereas the screening hypothesis predicts a negative effect because of the negative signal repeated years give to employers. The absence of influence on earnings from inefficient years of schooling agrees with both the human capital and screening predictions. Finally, the positive return on dropout years is in line with the human capital theory and refutes the sheepskin version of the screening theory. For females, too, the results in columns 3a and 3b are in line with the human capital predictions and refute the screening theory. The level of significance of the coefficient for dropout years drops, however, from 5% for males to 10% for females. Comparison of the results for males and females exposes some notable differences. Whereas males obtain rewards both for schooling components and for endowed ability (IQ), females are only paid for their effective (and dropout) years of schooling.[6] An explanation for this might be that women have a weaker attachment to the labor market. Therefore employers have little opportunity and incentive to learn about their endowed ability and thus will not pay them for it.

[6] The difference is not caused by selection bias. We estimated the earnings equations for females accounting for such bias, including marital status, presence of children and IQ in the selection function. This made no difference to the estimation results of the earnings equations.

TABLE 3.—*F*-STATISTICS FOR RESTRICTIONS ON COEFFICIENTS

Restriction	Males	Females
$\gamma_1 = -\gamma_2 = \gamma_3 = \gamma_4 = \gamma_5$	5.04[a]	2.51[b]
$\gamma_2 = \gamma_3 = \gamma_4 = \gamma_5 = 0$	6.71[a]	0.90
$\gamma_1 = -\gamma_2$	0.69	3.06
$\gamma_1 = \gamma_3$	6.70[a]	3.23
$\gamma_1 = \gamma_4$	17.88[a]	2.98
$\gamma_1 = \gamma_5$	1.63	0.40

[a] Significant at 1%.
[b] Significant at 5%.

Using *F*-tests on the sums of squared residuals, we tested whether there are significant differences between the first and third specifications and the second and the third. Likewise we tested whether the coefficients of the different schooling components in the third columns differ significantly. Table 3 displays the test results. For males, the restrictions $\gamma_1 = -\gamma_2 = \gamma_3 = \gamma_4 = \gamma_5$ and $\gamma_2 = \gamma_3 = \gamma_4 = \gamma_5 = 0$ are both rejected. This implies that using either actual or effective years of schooling in the estimation of earnings equations ignores the fact that the separate components of schooling contribute differently to earnings. For females, the third specification is statistically superior to the first at the 5% level, but not to the second specification.

For males, equality of the coefficients of s_e and s_r, and s_e and s_i is rejected. On the other hand, equality of s_e and s_s, and of s_e and s_d is not rejected at the 5% level. Thus, whereas the point estimates of 0.065 for s_e and −0.089 for s_s suggest that someone who finished a four-year course in three years gets paid as if s/he had received 2.6 effective years, the equality of γ_1 and $-\gamma_2$ indicates that all three years are rewarded as being effective. A similar reasoning applies to the difference between 0.065 for s_e and 0.050 for s_d. The equality of the coefficients of s_e and s_d implies that the returns on each year of schooling are equal irrespective of whether a certificate was obtained or not. This also refutes the sheepskin argument.

For females, tests on the equality of the coefficients of the five components of schooling reveal that there are no significant differences between the coefficients. This might be caused by the relatively small number of observations.

V. Conclusions

In this paper we split the number of actual years of schooling into five components: effective years, repeated years, skipped years, inefficient routing years and dropout years. Estimation of earnings equations using these explanatory variables produces some interesting empirical and theoretical results.

The main empirical finding is that the concepts of actual and effective years of schooling that are usually used in the estimation of earnings equations are statistically inferior to our classification. Both concepts provide too crude a description of individuals' stocks of human capital.

Our classification also enables us to test some competing predictions of the human capital theory and the screening hypothesis. The results provide strong support for the human capital theory and refute the screening hypothesis. Most important are the negative effect of class-skipping, the neutral effect of class-failing and the positive effect of dropout years.

REFERENCES

Hartog, J., "Survey Non-response in Relation to Ability and Family Background: Structure and Effects on Estimated Earnings Functions," *Applied Economics* 21 (1989), 387–395.

Layard, R., and G. Psacharopoulos, "The Screening Hypothesis and the Returns to Education," *Journal of Political Economy* 82 (1974), 985–998.

Rizzuto, R., and P. Wachtel, "Further Evidence on the Returns to School Quality," *Journal of Human Resources* 15 (1980), 240–254.

Spence, A. M., "Job Market Signaling," *Quarterly Journal of Economics* 87 (1973), 355–374.

SCALE ECONOMIES AND THE VOLUME OF TRADE

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Abstract—This paper offers a theoretical explanation of why previous attempts to statistically explain intra-industry trade have been unsuccessful, and proposes an econometric approach that tests the implications of the monopolistic competition model for the volume of trade. Using disaggregated data on 1983 manufacturing trade within the OECD, the paper finds strong evidence that bilateral imports depend systematically on the exporting country's output, and somewhat weaker evidence that the volume of trade is higher in sectors with larger scale economies.

Scale Economies and the Volume of Trade

A dominant theme in the pure theory of international trade for a decade has been the influence of scale economies on the volume of trade. Krugman's seminal paper in 1979 has, by now, spawned a large literature and something of a professional consensus that transnational exploitation of scale economies is a major cause of trade, and that trade that arises because of scale economies can have very different welfare properties than trade caused by traditional comparative advantage considerations.

This intellectual development can largely be traced to Grubel and Lloyd's (1975) demonstration that industrialized nations trade back and forth many goods that seem to be quite similar. The index that Grubel and Lloyd defined to quantify such "intra-industry trade" is

$$IIT_{ijk} \equiv \frac{X_{ijk} + M_{ijk} - |X_{ijk} - M_{ijk}|}{X_{ijk} + M_{ijk}} \tag{1}$$

where X_{ijk} is exports of product category i by country j to country k, and M_{ijk} is imports of product category i by country j from country k. This index, commonly called the Grubel-Lloyd index, ranges between 0, when country j has either no imports from or no exports to country k, and 1 when countries j and k have exactly balanced trade in product category i.

The most popular general equilibrium model of intra-industry trade is the monopolistic competition

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