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Study duration and earnings

A test in relation to the human capital versus screening debate

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In this paper we propose a simple test in relation to the human capital versus screening debate. It is argued that these theories lead to different predictions with respect to the earnings effects of deviations between actual and nominal durations of a study. Earnings and study duration equations are estimated to test these predictions. The results support the human capital theory.

1. Introduction

In the literature on the economics of education, not much attention has been paid to the question of how to measure an individual's amount of education. Both actual years and efficient years have commonly been used, without focussing on possible differences between the two. This is surprising since it is possible to derive from such differences a simple test in relation to the human capital versus screening debate.

For a given course in tertiary education, we define efficient years as the number of years nominally required to obtain a degree. For all those obtaining a degree, the actual number of years of study may deviate from the nominal amount. How would such deviations affect earnings? According to the human capital view, for someone with a given level of academic ability obtaining more actual years of education should increase earnings. The reason is that education enhances the individual's productive capacity, and spending more time to complete a course of given normal duration should lead to a more thorough understanding of the curriculum. Likewise, obtaining a degree in less time than normally required should result in a weaker understanding of the curriculum.

The screening hypothesis predicts exactly the opposite effects. Spending more years on a course than the nominal duration might be regarded by employers as a screening factor indicating lower than average ability, in which case it will lead to lower earnings prospects. Similarly, obtaining a degree in less than the nominal time would signal above-average ability and lead to higher earnings.

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In its simplest form, one could test the predictions of both competing theories by estimating a single earnings equation for a sample of graduates from a given course. This equation should include as a regressor the actual period of time spent on the course. This specification, however, ignores the fact that the number of actual years is a choice variable depending among other things on the expected earnings gain, and is therefore endogenous. In this paper we correct for self-selection bias by employing a method proposed by Garen (1984), which is applicable when the choice variable is continuous.

In the remainder of this paper, we outline the model and the estimation procedure in brief (section 2), describe the data set and the choice of variables (section 3), present and discuss the estimation results (section 4) and draw our conclusions (section 5).

2. Model and estimation procedure

According to both the human capital and screening framework, there are two interdependent relationships between earnings and the amount of education. Firstly, the level of earnings depends on the amount of education. This relation results in an earnings equation in which the logarithm of earnings is explained by (among other variables) the number of years of schooling. Secondly, individuals are assumed to base their schooling decisions on the expected returns and costs. Hence, an individual's (optimal) level of education is ruled by equality of marginal returns and marginal costs.

Where g is the annual growth rate of income, w is initial earnings and r is the discount rate, the net discounted value of lifetime earnings for someone with s years of schooling is

$$N(s) = \mathrm{e}^{-rs} w/(r-g).$$

If both initial earnings w and annual growth rate g depend on the amount of education, then the derivative of N with respect to s is zero at the optimum [Garen (1984)]:

$$\partial N/\partial s = \left[(\partial \ln w/\partial s + (\partial g/\partial s)/(r-g) - r)\right] \mathrm{e}^{-rs} w/(r-g) = 0.$$

With non-longitudinal data from a cross-section, there is no information about either the initial wage rate or the annual growth rate. To solve this problem, Garen defines earnings in year t as a function of initial earnings w and growth rate g. The disturbance term in this relationship is allowed to depend on the amount of education. [1] We then have

$$w_t = w\, \mathrm{e}^{g(t-s)}\, \mathrm{e}^{\epsilon+\phi s},$$

where $\mathrm{E}(\epsilon) = 0$, $\mathrm{E}(\phi) = 0$, $\mathrm{cov}(\epsilon, \phi) = \sigma_{\epsilon\phi}$, hence $\mathrm{E}(\epsilon + \phi s) = 0$ and $\mathrm{var}(\epsilon + \phi s) = \sigma_\epsilon^2 + s^2\sigma_\phi^2 + 2s\sigma_{\epsilon\phi}$ and covariances 0. Let w and g be (log)linear functions of the amount of education s, a vector of individual characteristics X, and the product of both. The discount rate r is supposed to be a linear function of the vector of individual characteristics Z. By applying a first-order Taylor

[1] Note that this assumption is not a special virtue of the model with a continuous choice variable. Willis and Rosen's (1979) model with a dichotomous choice variable might be rewritten in a similar fashion: the college and non-college earnings equations $\ln y_c = A\beta_c + u_1$ if $I = 1$, and $\ln y_n = A\beta_n + u_2$ if $I = 0$, might be rewritten as $\ln y = A\beta_n + A(\beta_c - \beta_n)I + u_2 + (u_1 - u_2)I$, where the disturbance term depends on the choice variable I.

approximation to the model, the following equations are derived for the optimal amount of education and earnings in year t [Garen (1984, pp. 1209–1210)]:

$$s = \pi_0 + \pi_1 X + \pi_2 Z + \mu,$$

$$\ln w_t = R\beta + \epsilon + \phi s,$$

where R is a vector consisting of the variables s, X, $t-s$ and their products. Estimation of the earnings equation with OLS gives inconsistent estimates because of the endogeneity of s. Garen proves that the conditional expectation of $\ln w_t$, given s, X and $t-s$ is equal to (p. 1210)

$$\mathrm{E}(\ln w_t \mid s, X, t) = R\beta + \mathrm{E}(\epsilon + \phi s \mid s, X, t) = R\beta + \mu\sigma_{\epsilon\mu}/\sigma_\mu^2 + \mu s\sigma_{\phi\mu}/\sigma_\mu^2,$$

with $\sigma_{\epsilon\mu}$ the covariance of ϵ and μ, and $\sigma_{\phi\mu}$ the covariance of ϕ and μ. Estimation of this equation with OLS gives consistent estimates. A consistent estimate of μ, $\hat{\mu}$, is obtained from the estimation of the schooling equation $\hat{\mu} = s - \hat{\pi}_0 - \hat{\pi}_1 X - \hat{\pi}_1 Z$.

3. Data

For the empirical analysis, we employ a data set which consists entirely of a sample of individuals who each obtained an academic degree in economics from a Dutch university. Unlike in some other countries, universities in the Netherlands are supposed to be homogeneous, meaning that all universities offer curricula which are essentially the same. [2]

In 1987 a questionnaire was sent out to all Dutch economists who receive the monthly review *Economenblad*. The data were collected by researchers from the Department of Economics and the Centre for Educational Research of the University of Amsterdam. Questions were asked with respect to education, earnings, occupation and various background characteristics. After deleting all observations for which information on relevant variables is missing, 1377 observations are left for our analysis.

The dependent variables in our analysis are the duration of study and the level of earnings. Variables that are assumed to affect study duration (the vectors X en Z) are:

- average test score in secondary education as a measure of ability (score);
- educational levels of the parents;
- the university from which the respondent obtained his or her degree (University of Amsterdam, Free University, Erasmus University Rotterdam, Tilburg University, University of Groningen and other institutes [3]);
- three dummy variables indicating whether during his or her period of study the respondent spent time on (i) part-time work; (ii) teaching or research assistance (assistance); (iii) the board of a students' club (students' club).

Variables that are included in the vector R, and which are allowed to affect earnings, are:

- study duration (duration);
- experience and experience squared;
- average test score in secondary education (score);
- several interaction terms of the above three variables.

[2] See Oosterbeek et al. (1992) for an analysis of differences between homogeneous universities.
[3] Other institutes include the Agricultural University of Wageningen and foreign universities.

4. Results

In this section we present the estimation results for the study duration equation and the earnings equation.

The results for the study duration equation are listed in table 1. These results indicate the following findings. Students of lower ability as measured by the average score in secondary education, take more time to obtain their degrees in economics. Those with an average score of 'fair' need one year less than those with an average score of 'sufficient'. Children of more highly educated fathers also take more time to complete their study in economics. Although this effect is significant, it is rather modest. The difference between the two extremes (primary education versus higher education) is only four months. Between different universities we observe some notable differences. Relative to the *Erasmus University Rotterdam*, it takes five months more to obtain a degree from the *University of Amsterdam*, and four to six months less to graduate from the *Tilburg University Brabant* or the *University of Groningen*. Finally, we note that holding office in a students' club and working part-time both extend the duration of study.

Table 2 presents the results for the earnings equation, for comparison we also display the OLS estimates. The results prompt the following comments. Of greatest interest is the finding with respect to study duration. The total effect of duration on earnings consists of an independent effect (*duration*) along with three interaction terms (*duration * experience, duration * score* and *duration * experience * score*). Only the separate effect differs significantly from zero. The sign of the coefficient is positive, indicating that for any given ability (test score in secondary education) a longer period of study increases earnings. This suggests that longer study duration enhances the amount learned. This result clearly supports the prediction of the human capital theory and refutes that of the screening hypothesis; obtaining a degree in a short amount of time is not regarded by employers as a sign of higher potential productivity. [4] From the point of view of educational policy,

Table 1
Study duration equation.

Variable	Coefficient	Absolute t-value
Intercept	7.107	32.8 *
score	−0.230	4.8 *
education father	0.049	2.0 *
education mother	−0.021	0.6
University of Amsterdam = 1	0.399	2.8 *
Free University = 1	−0.167	1.1
University of Groningen = 1	−0.534	3.5 *
Tilburg University = 1	−0.359	2.6 *
Other institute = 1	−0.525	1.9
students' club = 1	0.248	2.5 *
assistance = 1	0.118	0.9
part-time work = 1	0.707	6.9 *
Adjusted R^2	0.0812	
F-value	12.1 *	
Number of observations	1377	

* Significant at the 5% level.

[4] A similar result is reported in Groot and Oosterbeek (1992), where the earnings effects of different components of education are analyzed for a sample consisting of individuals from a wide range of educational levels.

Table 2
Earnings equation.

Variable	With correction terms		Without correction terms	
	Coeff.	Abs. t-value	Coeff.	Abs. t-value
Intercept	2.387	11.1 *	3.029	19.7 *
duration	0.079	2.6 *	−0.003	0.1
experience	0.064	13.1 *	0.067	13.6 *
experience squared/10	−0.012	13.8 *	−0.001	13.5 *
score	−0.014	0.4	−0.027	0.7
duration * *score*	0.007	1.3	0.006	1.1
duration * *experience*	0.000	0.2	−0.000	0.4
duration * *experience* * *score*	0.000	0.1	−0.000	0.4
μ	−0.152	6.9 *		
μ * *duration*	0.005	4.7 *		
adjusted R^2	0.3691		0.3458	
F-value	90.4 *		104.9 *	
Number of observations	1377		1377	

* Significant at the 5% level.

the size of the coefficient is of interest. Since the dependent variable is the logarithm of earnings, the coefficient can be interpreted as a rate of return. The estimate of 0.079 indicates that the rate of return on one extra year spent obtaining a degree in economics is about 8 percent. This value suggests that it is profitable to spend an extra year in an economics department. [5] Note that the OLS estimates, which don't take account of selection bias, are quite misleading.

Another interesting result in table 2 concerns the terms that clear the results of self-selection bias. Both terms have coefficients that differ significantly from zero; the first one negative, the second positive. This results supports the comparative advantage hypothesis [Willis and Rosen (1979)]. An individual with unobserved (by the researcher) characteristics which cause him or her to spend more time on his or her study (a positive value for μ), would have earned less with a short spell than others with a short spell. For negative values of μ the opposite holds.

5. Conclusion

Our main conclusion is that for an individual of any given ability, it will be profitable to spend a longer period on a study of a given nominal duration. This result supports the human capital view that a longer period of study may lead to a more thorough understanding of the curriculum, and refutes our hypothesis, based on the screening framework, that a longer (shorter) period of study is a negative (positive) signal of ability.

One other result is of particular interest in relation to the policy aim of reducing the average time that students spend in higher education. Since those spending more time also have lower average test scores in secondary education, selective admittance might be helpful.

[5] It is obvious that one cannot go on and on spending more years to obtain a degree that normally requires about five years. We also ran a regression including duration squared, but that variable had no significant coefficient. Probably the number of observations with very long periods of study is too small to trace out an inversed u-profile.

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