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Choosing the Optimum Mix of Duration and Effort in Education

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Abstract—In this paper a simple economic model is employed to analyse the determinants of expected study duration and weekly effort. Although some of the outcomes do not fit into our theoretical framework, a substantial number of the results support the hypothesis that the duration/effort ratio is determined by the relative prices of these inputs of the learning process. We find that a higher socio-economic status increases the duration/effort ratio. Children from higher income families and/or with more highly education parents expect longer durations and/or invest less weekly effort. For experienced students, the prediction that higher ability levels will decrease both effort and duration is confirmed by the findings. We consider this to be a result firmly in favour of our model. [*JEL* I21]

1. INTRODUCTION

OVER THE PAST two decades many western countries have experienced a considerable increase in enrolment rates in higher education. To a large extent these increases are due to government educational policies aimed at stimulating enrolment. The same governments, however, are now confronted with the problems of their own success. Higher enrolment rates have been stimulated by providing large subsidies for (higher) education. These subsidies are in the form of generous financial aid schemes and tuition fees far below average cost. As a solution to the problems, governments now appear to be reducing the amounts of subsidy by changing from public to private financing schemes. Moreover, measures are being proposed that aim at increasing the efficiency of the educational process.

An example of the latter can be found in the Netherlands, where the government is trying to reduce average study duration and increase average study effort. Until the early 1980s there was almost no restriction on the amount of time that Dutch students could spend in higher education. As a result, it was usual for students to spend an average of more than 7 years on studies with a nominal duration of 5. In those days it was not exceptional for students to spend 9 or 10 years on such study programmes. In the 1980s, however, the structure of the university programmes changed dramatically. First, the nominal duration was reduced from 5 to 4 years. Second, after 6 years of study students no longer receive financial aid and their tution fees double.

Although these measures had the effect of making students increase their weekly effort, the average effort that students devote to their studies still falls short of the "official standard" of 40 hours a week, on which the nominal duration of courses is based. According to these official standards, it takes a student of median level ability 6720 hours to complete a course of higher education in the Netherlands. This figure applies to all higher education courses: higher vocational and university, law, mathematics, economics, etc. Students of above- or below-median ability are supposed to devote respectively fewer or more hours of study to their courses. According to the official calculations, the total number of 6720 hours is the product of an average weekly effort of 40 hours

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sustained over 168 weeks (42 weeks of the year over a period of 4 years). Because students are allowed to remain in higher education for 6 years, they can exercise some discretion regarding their optimum mix of average weekly effort and total duration in weeks. Students who exhaust their entire 6-year (252-week) entitlement can make with an average effort of 27 hours per week. On the other hand, a weekly effort of 40 hours is not an obligatory ceiling, as every student can invest more effort if so desired. Students investing an average effort of, say, 50 hours a week are able to fulfil all the requirements within 135 weeks.

The figures included in "official standards" and nominal durations are generated by educational bureaucrats. In order to give the reader a feeling for actual figures, we would point out that in the dataset employed in the ensuing empirical analysis, first-year students in our sample had an average total load of 6453 hours, the product of an average (expected) duration of about 4.5 years and a weekly effort of almost 34 hours. Students in later years (more advanced students) had an average (expected) total load of 6584 hours, spread over an average duration of almost 5 years and an effort of 32 hours.[1] More importantly, however, for both groups the standard deviation in the study duration is slightly over 1 year, and the standard deviation in the weekly effort is about 13 hours. These figures are convincing evidence that it is not only theoretically possible to deviate from the nominal duration and effort, but that students do so to quite a large extent.

For readers who are unfamiliar with the Dutch system of higher education, the following short description may be helpful. Most study programmes in higher education are divided into a large number of short courses, which vary in length from 3 to 14 weeks of full-time study (40 hours a week). At the end of each of these short courses students are given a test, which they either fail or pass. Students who have passed tests for courses representing a cumulative study duration of 168 weeks (including a dissertation taking 10 weeks) graduate. Another important feature is that, for many study programmes, classes are not compulsory; there is in fact a separate category of students (called *extranei*) who are not allowed to attend classes but sit the same exams.

The key question that we address in this paper is which factors determine individual students' optimum mix of duration and effort. To that end in the following section we sketch a simple theoretical framework to help us to identify the factors that might be at work. The basic idea of the model is that students can produce educational output by combining effort and duration as inputs. In that sense, our analysis is an attempt to model the technology of production of the teaching aspect of the educational industry. According to Clotfelter and Rothschild (1993, p. 9) it continues to be difficult to model this production process. Our paper is meant as a contribution to this field. In section 2 we also discuss the estimation method that will be applied. The exact operationalization of the factors that we assume to be at work is described in section 3. That section starts with a brief description of our dataset. Section 4 presents and discusses the estimation results and section 5 summarizes our main conclusions.

2. ANALYTICAL FRAMEWORK

To complete a particular study a student has to invest a given amount of total time input. This required amount of time, which we will refer to as the *total load (l)*, may differ between students in accordance with their level of innate academic ability. The total load is standardized for a student of median ability. For the median student to produce this total load requires a combination of total study duration in weeks (we refer to this variable as *duration, d*) and an average weekly effort in hours (referred to as *effort, e*). Quite naturally, therefore, we end up with a production function of total load which is of the Cobb Douglas type

$$l = d.e \qquad (1)$$

For students of above-median or below-median ability, we assume that the production function contains a multiplier γ, where $1/\gamma$ is a factor that transforms a student into a median efficiency unit. For the median student γ equals 1, for above- (or below-) median students γ exceeds (or falls short of) unity.

$$l = d.e.\gamma. \qquad (1')$$

Figure 1 contains three typical isoquants which all produce the same output in terms of efficiency units. The lower (upper) curve is the isoquant for an above-(below)-median ability student. The middle curve is the median student's isoquant.

Within the boundaries set by physical and institutional constraints, a student is free to choose the

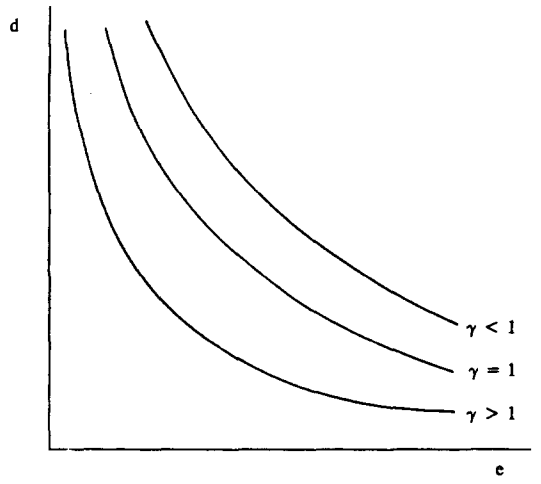

Figure 1. Choice of optimal mix of duration (d) and effort (e).

combination of duration and effort that best suits her/him. Analogous to a firm choosing the optimum quantities of factors of production to generate a given output, the student will take account of the relative prices of both inputs. The higher the relative price of effort, the steeper the isocost lines, and hence the higher the optimum d/e ratio. Since the production technique described by equation (1′) is homothetic, all students who face the same relative prices of duration and effort will choose the same d/e ratio, no matter what their ability level.[2]

With given prices for effort and duration inputs, respectively, p_e and p_d the functions that determine optimal e and d read

$$\log(e) = \tfrac{1}{2}\log(l) + \tfrac{1}{2}\log(p_d) - \tfrac{1}{2}\log(p_e) - \tfrac{1}{2}\log(\gamma) \qquad (2)$$

$$\log(d) = \tfrac{1}{2}\log(l) - \tfrac{1}{2}\log(p_d) + \tfrac{1}{2}\log(p_e) - \tfrac{1}{2}\log(\gamma). \qquad (3)$$

In terms of producer's analysis, these equations express the conditional factor–demand functions; the optimum levels of factor inputs conditional upon factor prices and the level of output. The usual approach is then to estimate the equations that form the complete system of factor–demand functions (cf. Hamermesh, 1986, p. 448).

If students really choose efficient quantities of effort and duration, as is assumed in the derivation of equations (2) and (3), several restrictions can be imposed on the coefficients of the demand equations. The level of output and the level of ability will affect effort and duration in an identical way, while the effect of the relative price p_d/p_e on duration will be the exact opposite of its effect on effort. Such restrictions across equations can be accommodated by estimating both equations simultaneously by means of maximum likelihood. This requires an assumption about the distribution from which the error terms that are added to equations (2) and (3) are drawn. We assume that these error terms are drawn from a joint normal distribution.

The restrictions imposed by our theoretical structure are quite strict. Since it is possible that students do not in fact choose efficient quantities and/or that the postulated production function is too simple, we also estimate the model in unrestricted form. The results obtained from this unrestricted model are interesting from an exploratory point of view, and moreover provide us with the statistics necessary to test whether the restrictions in (2) and (3) can be rejected.[3]

It might be argued that the (optimum) levels of production that enter the conditional factor–demand equations as explanatory variables are themselves functions of the other explanatory variables, and should for that reason not be included in the analysis. In order to accommodate this argument, we also report the estimation results from the specification that does not contain variables proxying the level of output.

3. DATA AND CHOICE OF VARIABLES

Before discussing the choice of variables, we first give a brief description of the dataset employed in our analysis.

Data

The dataset employed in this paper is a sub-sample of a nationwide sample among all Dutch students. In that sample about 4000 students were interviewed first in 1991 and for a second time in 1992. The plan is to re-interview the sample about five times. The sub-sample that we selected consists of all students who were already enrolled in higher education in 1991. The remainder of the sample consists of students who were then in secondary education. Our sub-sample is a stratified sample among higher education students. The strata are defined in terms of level of higher education (university versus higher vocational), the stage of study (first-years and more advanced students) and the type of study (ten different fields were distinguished).

Analyses regarding the representativeness of the sample indicate that for some sectors of study there is an over-representation of females and younger students in the sample. For the other sectors there is no indication of any systematic bias. A detailed description of the collection of the data along with all kinds of cross-tabulations can be found in Van Dijk *et al.* (1993).

Choice of Variables

The dependent variables in our model are effort and duration. Our measure of effort is based on the question: "On average, how many hours a week do you spend on education (classes, practicals and preparation)?". The questionnaire elicits no information about any further break-down of this number of hours. A general objection to asking people how they spend their time is that the answers may be biased. Although it is not convincing proof that biases do not appear in our dataset, it is encouraging that other methods (in particular detailed time accounting) produce virtually identical average effort levels (cf. Van der Drift and Vos, 1987).

Our measure of duration is based on the question: "How long do you think you will have studied in total when you graduate from your present course of study?" Obviously this question relates to the duration that the student expects, which may deviate from the actual duration. Use of such subjective variables in applied economics is quite uncommon. At present, most economists express the view that such variables are useless, as there is no guarantee that respondents answer questions of this type honestly. Manski (1993) however, makes a strong plea for the inclusion of such variables in analyses of economics (of education). His argument runs as follows. Educational decisions by young people are determined by expectations. To understand the decisions we have to know, therefore, how expectations are formed. He continues that if young people "form their expectations in anything like the manner that econometricians study the returns to schooling, then prevailing expectations assumptions cannot be correct. . . . progress is possible only if economists become more willing to entertain the use of subjective data in empirical analysis" (p. 55). Although Manski is aware of the possibility that such subjective information may not provide lessons about young people's expectations, he concludes that "we shall not know whether this is feasible until we try" (p. 56). Our analysis of expected study duration can be seen as such a trial.

The explanatory variables for the optimum amounts of duration and effort are the logarithms of the respective prices (p_d and p_e), the logarithm of the level of output and the logarithm of student's level of academic ability (θ). For neither of these variables is there any straightforward means of measurement; there is no such thing as the price of effort, or any well-defined measure of the output of education (cf. Hanushek, 1986). We discuss below which variables to use to proxy the unobserved correct variables, and discuss the expected signs of the coefficients of these proxies in the effort and duration equations.

Prices of duration and effort. Each week spent on a longer duration of study costs the student the present value of the foregone earnings of that week. The price of duration therefore varies in line with the expected future earnings and the individual's discount rate. The higher the expected earnings and the discount rate, the higher the price of a longer duration. Our dataset includes information about expected future earnings since our questionnaire contained the question "What do you think your net monthly earnings will be after you finish your study?". We have no direct information regarding the student's time preference (discount rate). We therefore follow the custom of approximating this variable by including variables related to the student's social background (cf. Willis and Rosen, 1979). It is assumed that the time preference decreases with social background; wealthy people are in less of a hurry. We include the following variables to measure social background: the educational levels of the parents, the income level of the parents, the total number of siblings and whether siblings are or have been enrolled in higher education. Moreover, we include as an indicator for the discount rate the respondent's score in relation to the statement "For financial reasons I cannot afford to spend a long time on my study" [AFFORD].

Our hypothesis is that educational levels of the parents, parents' income and siblings enrolled in higher education have a positive effect on duration and a negative effect on effort, whereas for total number of siblings and the score for AFFORD we assume the opposite to hold.

There is no explicit measure available for the price of effort. Ideally, we would have information about the shadow price of leisure. Three questions have been asked which are closely related to the individual's valuation of leisure. The first two are extracted

from the respondents' scores in relation to the statements

> "My extracurricular activities don't allow me to devote myself fully to my study" [ACTIVITIES],

and

> "Why should I finish my study sooner than necessary when my student years are the best time of my life" [BEST TIME].

It is likely that respondents who identify with these statements have a high preference for things other than studying and hence have high opportunity costs. Moreover, the model proposed in the previous section may be considered too simple because it ignores the possibility that there are consumptive aspects associated with schooling. Without claiming to capture this whole effect by including one extra variable, we think that the BEST TIME variable can do a pretty good job in this respect. The third variable related to the shadow price of leisure is a dummy variable indicating whether a student is enrolled full-time or part-time in higher education. Most part-time students spend a considerable amount of their time in paid employment, which probably raises the shadow price of their remaining leisure.

The prediction of our model is thus that duration will be increased and effort decreased by high scores on ACTIVITIES and BEST TIME and by being a part-time student.

Academic ability. The nominal load is based on the student of median ability. Individual students may have a different actual study load. Students of above-median ability can manage with less, while others will require more effort and/or duration. The optimum mix therefore depends upon the student's level of academic ability, and this can be looked upon as a third factor of production. Unlike the other factors, however, the level of this factor is not a choice variable. We include in our analysis the following variables which are thought to be good measures of academic ability: (i) the average final score in secondary education; (ii) the level of secondary education;[4] (iii) the number of courses in secondary education in the beta cluster (i.e. sciences), and (iv) the number of times the student repeated a year in primary and secondary education. Our theoretical hypothesis is that an above-median level of ability will lead to shorter duration and/or lower effort. The logic behind this hypothesis is most easily demonstrated by reference to Figure 1. For a given level of output, the student with $\gamma > 1$ can suffice with both lower e and lower d than a $\gamma = 1$ student of a $\gamma < 1$ student. However, because the ability indicators that we have at our disposal are to a certain degree endogenous, we cannot preclude the possibility of a positive association between these measures and the amount of effort. This relation is then found because those who invest great effort in higher education also did so in secondary education and therefore have better scores on our ability measures. To some extent we correct for this endogeneity by including the respondent's score in relation to the statement "I always attempt to get grades as high as possible" [HIGH GRADES].

Hence, higher average final scores, the higher level of secondary education, more beta courses and fewer repeat years are predicted to have a negative impact on both duration and effort.

Level of output. We assume that the final result of studying (the output) is to obtain a particular qualification. Although for a median ability student all courses of study in higher education in the Netherlands formally require the same amount of time investment, it seems natural to allow for the possibility that some are more demand than others. We measure this possible product differentiation in relation to two dimensions. The first dimension is the level of higher education: university versus higher vocational education. The second is the type of study programme, where we distinguish between alpha type (language and arts), beta type (science, engineering and medicine) and gamma type (humanities, economics and law). Our model provides no *a priori* prediction about the influence of different levels and types of study on the levels of effort and duration.

Since the sample consists of students who are currently enrolled, it is not certain that each student will actually graduate. To correct for this uncertainty we include the subjective probability that the student attaches to the event of his/her graduation. Note that this subjective probability of graduation can also be an indicator of the student's perceived ability; we will account for this when interpreting our results. If the subjective probability relates to output, the higher the value of the variable, the higher the level of output and thus the greater we expect duration and effort to be. On the other hand, if the subjective probability of graduation mainly captures perceived ability, the

opposite prediction should be made: the higher the probability, the higher the perceived ability and hence the less the effort and duration are supposed to be.

We performed the analysis separately for first-year students and for students at a later stage. There are two reasons for this: (i) as far as the analysis is concerned with expectations about duration, we anticipate that freshmen have poorer judgment in this regard; (ii) as far as effort is concerned, we recognize that the answers of freshmen are based on ignorance whereas students in later years may be considered as experienced subjects. Finally we include in our analysis a control variable for gender.[5]

4. EMPIRICAL RESULTS

As mentioned in the previous sections we have estimated three different versions of our model: (i) the unrestricted version in which the restriction across the equations (2) and (3) are ignored; (ii) the restricted version which takes the cross-equations restrictions into account; and (iii) the 'reduced form' version in which the variables related to output are not included. The estimation results for both sub-samples (first-year students and more advanced students) clearly point to rejection of the restricted version.[6]

In order to save space we will therefore not present the estimation results of the restricted version.[7] Table 1 presents the estimation results for the first-year students. The last two columns contain the outcomes for the unrestricted versions of equations (2) and (3). The results for the reduced form version of the model are presented in the first two columns. We start with a discussion of the results of the unconstrained version and then comment briefly upon the results of the 'reduced form' version.

The following comments are in order. Firstly, students who are enrolled in university education have an expected study duration exceeding that of their counterparts in higher vocational education by about 5%. For the amount of effort, the opposite is true: students enrolled in university education have an effort level that is on average 12% below that of students in higher vocational education. As we anticipated in the previous section, the interpretation of the subjective probability of graduation is indeed ambiguous; the positive effect on effort suggests that it measures a higher level of production, whereas the negative effect on duration is in line with an interpretation in terms of perceived ability.

For variables relating to social background, those with a coefficient that differs significantly from zero have signs as predicted by our economic framework. A higher level of parental education is associated with a longer expected duration. Although this effect is significant at the 10% level, the size of the effect is modest. Where the father (mother) has completed a university education as compared with only primary education, the expected duration increases by about 7 (8)%. Parental education starts to make a greater difference if we compare a student with two less well-educated parents with a student with two more highly educated parents. In that case, the difference can amount to 15%. As there is assortive mating among parents (the correlation coefficient between father's and mother's education is 0.59), this result indicates that students from a more favourable social background stay longer in higher education. Since at the same time weekly effort decreases with parental income, our results suggest that policy measures aimed at increasing the ratio of effort to duration should in the first place be directed at students with a higher socio-economic status. The recent proposal by the Dutch Minister of Education to replace the current grants system by a loans system with additional support for low-income students is a move in this direction.[8]

Concerning the variables relating to relative prices of duration and effort, we note that a higher level of expected future income increases the expected duration. Theoretically, we would have expected the opposite sign. An *ad hoc* explanation for this result is that a higher expected income induces an income effect of which a part is spent on a longer study duration. Also surprising is the fact that a high score for the ACTIVITIES variable is not associated with a lower weekly effort, but is associated with a longer expected duration. The positive sign of the coefficient of the BEST TIME variable in the duration equation suggests that a longer duration can indeed to some extent be regarded as the result of consumptive motives.

The results for the first-year students with regard to ability also deviate from those which would be expected on theoretical grounds. More able students (higher scores and more beta courses) invest more weekly effort in their studies. This result holds irrespective of whether or not we include the score for HIGH GRADES. A final notable result regarding Table 1 is that male students have a weekly effort level 10% below that of female students. This lower

Table 1. Duration and effort equations; first-year students

Variable	'Reduced form' version log(duration)	'Reduced form' version log(effort)	Unrestricted version log(duration)	Unrestricted version log(effort)
Constant	0.595 (2.5)*	2.572 (6.4)*	1.273 (5.0)*	2.034 (4.6)*
Ability				
— average final score	−0.016 (1.1)	0.060 (2.5)*	−0.016 (1.2)	0.069 (2.8)*
— # beta courses	−0.004 (0.7)	0.059 (5.5)*	−0.003 (0.4)	0.043 (3.3)*
— # repeated years	0.002 (0.2)	−0.039 (1.9)†	0.001 (0.1)	−0.038 (1.8)
— high level = 1	0.131 (7.4)*	−0.094 (3.1)*	0.102 (5.0)*	−0.021 (0.6)
— HIGH GRADES	−0.004 (0.3)	0.016 (0.8)	0.008 (0.7)	0.003 (0.2)
Production				
— alpha study			−0.009 (0.3)	−0.064 (1.2)
— beta study			0.007 (0.3)	0.045 (1.3)
— university = 1			0.048 (2.4)*	−0.116 (3.3)*
— log (probability of graduation)			−0.175 (6.0)*	0.110 (2.2)*
Discount rate				
— education mother	0.006 (1.6)	−0.007 (1.2)	0.007 (1.9)†	−0.007 (1.2)
— education father	0.006 (2.0)*	0.001 (0.2)	0.006 (1.9)†	0.002 (0.3)
— log(income parents)	−0.006 (0.9)	−0.031 (2.5)†	−0.005 (0.8)	−0.030 (2.5)*
— # siblings	−0.005 (0.5)	0.017 (1.1)	−0.005 (0.5)	0.019 (1.2)
— siblings higher education	−0.028 (1.6)	−0.038 (1.3)	−0.026 (1.5)	−0.036 (1.2)
— AFFORD	−0.006 (0.7)	0.014 (0.9)	−0.004 (0.5)	0.013 (0.9)
Prices				
— log(expected earnings)	0.057 (2.4)*	0.052 (1.2)	0.059 (2.4)*	0.063 (1.5)
ACTIVITIES	0.038 (3.7)*	0.002 (0.1)	0.035 (3.4)*	0.005 (0.3)
— BEST TIME	0.015 (1.8)†	0.013 (0.9)	0.014 (1.7)	0.017 (1.2)
— dummy part-time = 1	−0.224 (7.2)*	−0.603 (11.2)*	−0.229 (7.4)*	−0.595 (11.1)*
Other variables				
— dummy male = 1	0.029 (1.7)†	−0.093 (3.1)*	0.023 (1.3)	−0.095 (3.1)*
σ	0.27 (47.1)*	0.46 (47.1)*	0.26 (47.1)*	0.46 (47.1)*
ρ	0.029 (1.0)		0.050 (1.7)†	
log likelihood	−841.0		−808.5	
# observations	1107		1107	

Note: Absolute t-values in parentheses; *indicates significance at the 5% level;† indicates significance at the 10% level; σ is the standard deviation of the error term and ρ stands for the correlation between the error terms.

effort level is not compensated by a longer expected duration.

With regard to the estimation results of the 'reduced form' version which are presented in the first two columns in the table, the important conclusion is that, for all variables included, the estimates are almost identical to those of the unrestricted version. This indicates the robustness of the findings discussed above.

Table 2 presents the estimation results for students passing their first-year examinations. The last two columns relate to the unrestricted version of the model, while the results for the reduced form version are in the first two columns. Again we start with a discussion of the results of the unrestricted version.

For the ability variables, the results are in line with our theoretical predictions. For older students we find that higher ability (higher grades and fewer repeated years) produces lower effort levels or shorter durations. This confirms our hypothesis that a higher ability level shifts the isoquant inwards. Also, those who think grades are important have higher effort levels. The different findings for first-year students and older students as regards the relation between ability and effort suggests that there is a negative correlation between initial effort levels and later effort levels. Such a relation is predicted in a theoretical model of students' drop-out decisions in Oosterbeek (1992; Chapter 4). The basic mechanism underlying this prediction is that students have been diligent in the past have increased their subjective probability of graduation by such an amount that they can permit themselves to be slightly indolent in the future. For students who have been idle in the past, the opposite is true.

Table 2. Duration and effort equations; more advanced students

Variable	'Reduced form' version log(duration)	'Reduced form' version log(effort)	Unrestricted version log(duration)	Unrestricted version log(effort)
Constant	1.078 (5.8)*	3.90 (10.6)*	1.987 (8.0)*	3.325 (6.7)*
Ability				
— average final score	0.012 (1.0)	−0.048 (2.1)*	0.003 (0.3)	−0.050 (2.1)*
— # beta courses	0.002 (0.5)	0.048 (5.0)*	0.004 (0.7)	0.023 (1.9)*
— # repeated classes	0.029 (2.8)*	−0.002 (0.1)	0.025 (2.5)*	−0.002 (0.1)
— high level = 1	0.170 (11.1)*	−0.107 (3.5)*	0.119 (6.7)*	−0.036 (1.0)
— HIGH GRADES	−0.001 (0.3)	0.025 (4.6)*	0.000 (0.1)	0.024 (4.5)*
Production				
— alpha study			0.049 (1.9)*	0.118 (2.3)*
— beta study			0.006 (0.3)	0.141 (3.9)*
— university = 1			0.092 (5.1)*	−0.102 (2.9)*
— log (probability of graduation)			−0.161 (4.4)*	0.075 (1.0)
Discount rate				
— education mother	0.005 (1.6)	−0.012 (2.1)*	0.004 (1.5)	−0.011 (1.9)*
— education father	0.001 (0.6)	0.006 (1.2)	0.001 (0.5)	0.006 (1.1)
— log(income parents)	−0.005 (0.6)	−0.009 (0.6)	−0.006 (0.8)	−0.008 (0.5)
— # siblings	0.007 (1.0)	−0.023 (1.6)	0.005 (0.6)	−0.022 (1.6)
— siblings higher education	−0.010 (0.7)	0.007 (0.2)	−0.011 (0.7)	0.011 (0.4)
— AFFORD	−0.003 (1.2)	0.008 (1.8)†	−0.004 (2.0)*	0.009 (2.0)*
Prices				
— log(expected income)	0.026 (1.3)	−0.014 (0.3)	0.010 (0.5)	0.014 (0.3)
— ACTIVITIES	0.007 (3.0)*	−0.024 (5.2)*	0.006 (2.5)*	−0.021 (4.7)*
— BEST TIME	0.012 (5.5)*	−0.016 (3.5)*	0.011 (4.8)*	−0.013 (3.0)*
— dummy part-time = 1	−0.078 (2.7)*	−0.644 (11.1)*	−0.072 (2.5)*	−0.631 (10.9)*
Other variables				
— dummy male = 1	0.011 (0.7)	−0.014 (0.5)	0.017 (1.2)	−0.018 (0.6)
σ	0.24 (50.1)	0.47 (50.1)	0.23 (50.1)*	0.47 (50.1)*
ρ	0.021 (0.7)		0.037 (1.3)	
log likelihood	−815.4		−773.7	
# observations	1253		1253	

Note: Absolute t-values in parentheses; *indicates significance at the 5% level;† indicates significance at the 10% level; σ is the standard deviation of the error term and ρ stands for the correlation between the error terms.

For the older students, too, it is the case that university students have on average a longer duration and a lower effort level than students enrolled in higher vocational education. For the older students, however, the 10% lower effort level is almost completely compensated by a duration that is 9% longer. Furthermore, here, too, we observe major differences between different clusters of studies. Students in the alpha and beta clusters have a higher weekly effort level than students in the gamma cluster. Moreover, students in the alpha cluster expect a longer duration than students in the gamma cluster.

In the universities the average real load deviates considerably from the nominal load of 6720 hours. In the alpha, beta and gamma clusters, the ratios of average real to nominal loads are, respectively, 0.90, 1.15 and 0.84. In the higher vocational courses on the other hand, the dispersion is not so large; the respective ratios here are 0.99, 0.96 and 0.90. University students in the gamma cluster spend 16% less time than the nominal loads, whereas university students in the beta cluster spend 15% more. This result is only compatible with a system in which nominal loads give a good indication of the load for a median student if a majority of the students in the university beta cluster have below-median ability levels, whereas students in the university gamma cluster have above-median ability levels. This explanation is, however, not supported by our data: the average score in secondary education is in fact higher for the first group than the second. This indicates, therefore, that university gamma studies are too easy and university beta studies are too difficult relative to the nominal duration. This relative difficulty of university beta studies

might be an important reason why too few students are attracted to these studies.

As with first-year students, we find that social background similarly affects the duration/effort ratio of older students. The higher the level of the mother's education, the lower the weekly effort. The more important contribution from the variables listed under "discount rate" comes however from the AFFORD variable. The more strongly students agree with the statement that they cannot afford to study long for financial reasons, the shorter the duration and the higher the effort level will be.

With regard to the price variables, it turns out that both effort and duration are influenced by our indicators of the price of effort. Students who think other activities are important and who feel that their student years are the best time of their lives expect a longer duration and invest less effort per week.

For older students too, the findings of the reduced form version are almost identical to those of the unrestricted version. Again this might be considered as an indication of the robustness of our results.

At the beginning of this section we mentioned that the restrictions on the coefficients suggested by our theoretical model in section 2 have to be rejected. This means that students' perceptions of how to obtain a degree differ from our postulated production function. Several explanations of this discrepancy between theory and practice come to mind. Firstly, it may be that the production technology that we impose is too simple to provide a good description of such a complex activity as the transmission of knowledge. Secondly, it is possible that students just don't behave optimally, either because they are not interested in doing so or because they don't know how to. Finally, it may be that students need time to learn how the production process works. The finding that the results for older students are more in line with the theoretical model than those for first-year students supports this latter explanation.

5. CONCLUSION

Employing a simple economic model, we analysed the determinants of expected study duration and weekly effort. The results at least partially support the hypothesis that the duration/effort ratio is determined by the relative prices of these inputs to the learning process. For both first-year and more advanced students, we find that a higher socio-economic status increases the duration/effort ratio. Children from higher income families and/or more highly educated parents expect longer durations and/or invest less weekly effort. For more advanced students, our prediction that higher ability levels will decrease both effort and duration is confirmed by our findings. We consider this to be a strong result in favour of our model.

There are large differences in effort levels and expected duration between different levels and types of study. Expected duration is longer and weekly effort lower for university students than for higher vocational students. The same is true of students in the alpha and gamma clusters relative to those in the beta cluster. Differences in duration and effort do not exactly compensate for each other in the sense that the total load is equal. The ratio between actual and nominal load varies from 0.84 for university gamma students to 1.15 for university beta students. It is very unlikely that differences in ability can explain these disparities.

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NOTES

1. The exact figures can be found in the descriptive statistics included in the appendix to this paper.
2. Notice that the form in equation (1′) is consistent with the notion that smarter students have greater absorptive capacity and therefore a production function that at a given level of effort and duration is steeper than for students who are less gifted ($\partial^2 l/\partial e \partial \gamma > 0$).
3. Note that the ML estimators in the unrestricted version of the model can also be obtained by OLS.
4. There are two levels of secondary education in the Netherlands which qualify young people to enter higher education. The lower level requires 5 years of secondary education and permits the student to enter higher vocational education but not university. The higher level requires 6 years of secondary education and allows the student to embark on either the higher vocational or the university path.

5. The appendix to this paper provides a description of the exact creation of variables along with some descriptive statistics.
6. The critical value of the χ^2 distribution at the 10% level with 18 degrees of freedom is 26. For first-year students the likelihood ratio statistic equals 144.6, and for more advanced students it is 95.
7. The results are available from the author on request.
8. For an analysis of the effect of this change in the financial aid system on enrolment rates see Oosterbeek and Webbink (1995).

REFERENCES

CLOTFELTER, C.T. and ROTHSCHILD, M. (1993) Introduction. In *Studies of Supply and Demand in Higher Education* (Edited by Clotfelter, C.T. and Rothschild, M.). Chicago: The University of Chicago Press.

HAMERMESH, D.S. (1986) The demand for labor in the long run. In *Handbook of Labor Economics*, volume I (Edited by Ashenfelter, O.C. and Layard, R.). Amsterdam: North-Holland.

HANUSHEK, E. (1986) The economics of schooling: production and efficiency in public schools. *Journal of Economic Literature* **24**, 1141–1177.

MANSKI, C.F. (1993) Adolescent econometricians: how do youth infer the returns to schooling? In *Studies of Supply and Demand in Higher Education* (Edited by Clotfelter, C.T. and Rothschild, M.). Chicago: The University of Chicago Press.

OOSTERBEEK, H. (1992) *Essays on Human Capital Theory*. Amsterdam: Thesis.

OOSTERBEEK, H. and WEBBINK, H.D. (1995) Enrolment in higher education in the Netherlands. *De Economist*, forthcoming.

VAN DER DRIFT, K.D.J.M. and VOS, P. (1987) *Anatomie van een Leeromgeving*. Lisse: Swets & Zeitlinger.

VAN DIJK, J.C., DE JONG, U., OOSTERBEEK, H., ROELEVELD, J. and WEBBINK, H.D. (1993) Studiekeuzen van eindexamenkandidaten en studenten in 1991. Amsterdam: Stichting voor Economisch Onderzoek.

WILLIS, R. and ROSEN, S. (1979) Education and self-selection. *Journal of Political Economy* **87**, S7–S36.

APPENDIX

Description of the variables

VARIABLE: description	Mean (standard deviation) first-year	more advanced
STUDY DURATION: Measured in years	4.46 (1.06)	4.94 (1.21)
WEEKLY EFFORT: Average number of hours per week (includes classes, practicals and preparation)	33.01 (12.20)	31.40 (12.25)
AVERAGE FINAL SCORE: Average final score for all courses in secondary education	6.82 (0.61)	6.89 (0.62)
NUMBER OF BETA COURSES: Number of subjects in the mathematics, science, chemistry and biology cluster in which the student sat his school-leaving exam	2.47 (1.40)	2.64 (1.50)
NUMBER OF REPEATED YEARS: Number of times that the student failed a year in primary and/or secondary education	0.49 (0.71)	0.47 (0.70)
HIGH LEVEL: Dummy variable with value 1 if level of secondary schooling is high (vwo)	0.59 (0.49)	0.64 (0.48)
ALPHA STUDY: The respondent is following a course in the arts and languages cluster	0.08 (0.28)	0.08 (0.27)
BETA STUDY: The respondent is following a course in the health, science, agriculture and engineering cluster	0.46 (0.50)	0.51 (0.49)
GAMMA STUDY: The respondent is following a course in the economics, social sciences, education and law cluster	0.46 (0.50)	0.41 (0.49)
UNIVERSITY: The study is at the university as opposed to higher vocational level	0.52 (0.50)	0.61 (0.49)
EDUCATION MOTHER: measured on a 12-point scale: 1 = primary ... 12 = university degree	5.73 (2.90)	5.72 (2.88)
EDUCATION FATHER: measured on a 12-point scale: 1 = primary ... 12 = university degree	7.19 (3.38)	7.29 (3.40)
PARENTAL INCOME: Net monthly income of the parents in guilders	4439.6 (1890.9)	4435.0 (1920.6)
NUMBER OF SIBLINGS: Number of children in the family minus one	1.64 (0.99)	1.75 (1.01)
NUMBER OF SIBLINGS WITH HIGHER EDUCATION: Number of siblings who are or have been enrolled in higher education	0.44 (0.50)	0.61 (0.49)
PROBABILITY OF GRADUATION: The subjective probability of graduation as gauged by the student, in percentages	78.85 (16.13)	91.47 (12.32)
EXPECTED FUTURE EARNINGS: Net initial monthly earnings expected after graduation	2716.02 (1208.7)	2554.8 (1085.3)
DUMMY MALE	0.56 (0.50)	0.54 (0.50)
DUMMY PART-TIME: Value 1 if the respondent is receiving his/her education as a part-time student	0.08 (0.27)	0.07 (0.25)
HIGH GRADES: Score on a 10-point scale for the statement "I always attempt to get grades as high as possible"	6.07 (0.74)	6.02 (2.56)
ACTIVITIES: Score on a 10-point scale for the statement "my extracurricular activities don't allow me to devote myself fully to my study"	4.45 (0.85)	4.49 (3.03)
BEST TIME: Score on a 10-point scale for the statement "why should I finish my study sooner than necessary when my student years are the best time of my life"	4.16 (0.99)	4.35 (3.23)
AFFORD: Score on a 10-point scale for the statement "for financial reasons I cannot afford to spend a long time on my study"	4.15 (0.99)	4.03 (3.23)