Student decisions and consequences
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1 Introduction

In the first decade of the seventies the Chinese university system had been organised according to Mao's decrees. The right to enrol in university was not related to graduation from secondary education but to occupational position. Black collar and agricultural workers were entitled to enrolment. After enrolment students did not choose a type of study according to their interests and abilities but were randomly allocated (Jung Chang, 1991, Wild swans, three daughters of China).

1.1 Subject of this thesis

Most economists will be horrified by Mao's decrees, claiming that they will rule out an optimal allocation of talent or an optimal production of human capital, but many would love to study the consequences. This thesis is about educational decisions and consequences for students in a completely different higher education system. A group of students is followed on their way through the Dutch higher education system to the labour market. During their educational career individual students have to make many decisions. In the final year of secondary education students face the decision whether or not to enrol in higher education. Furthermore, they have to decide on the level and type of higher education. Enrolling in higher education brings about new choices: whether to continue, choose another type or level of education or drop out. Students who continue face the same choice every year. When leaving higher education, after graduation or dropping out, decisions have to be made about finding and accepting a job. These sequential and interrelated decisions are the main line through this thesis. We analyse what happens to students entering and leaving the higher education system. How important are differences in ability, taste for schooling and opportunity for decisions and consequences? In other words, we analyse decisions before and during higher education and the consequences of these decisions in terms of educational performance and returns on the labour market.

Contributions
This thesis aims at contributing to the economic literature on education and to policy analysis. Traditionally, educational decisions and performances are studied by sociologists and psychologists. Economists were mainly interested in the relation between education and earnings. Since the human capital revolution of the 1960s and 1970s a wave of theoretical and empirical research emerged. In hundreds of studies economists all over the world estimated the returns to schooling. At the moment a new wave of studies is emerging about the estima-
tion of the earnings function. Despite this huge and fast growing literature economic research mainly focused on earnings and never paid much attention to education itself. In the majority of studies education is just the number of years spent in school. Quality differences in education and the allocation of talent over different levels and types of studies attracted much less attention. How students take educational decisions and what happens with ability in the schooling process has been beyond the main scope of economics. This study brings economic tools, models and methods to a relatively unknown but in our view increasingly important field for economic analysis. As a consequence we are able to ‘dig’ into the production of human capital thereby shifting attention from earnings to education. In his recent survey on returns to schooling Card (1994) concludes:

“In my opinion, further research on the role of schooling in the labour market could usefully benefit from a more explicit consideration of issues raised by a well-posed theoretical model. Among these issues: What are the underlying sources of variation in observed school choices? (...) Can individuals anticipate their own returns to education?”

This thesis explicitly takes these issues into consideration.

Learning about educational decisions and their consequences is also important for several reasons directly related to educational policy. It gives insight in the allocation of students in higher education and in the functioning of the educational system. This bears on various specific policy issues like:
- barriers for entrance to higher education;
- hidden student potential for science and engineering;
- quality of students entering teacher studies;
- positioning of higher vocational education and university education;
- determinants of dropping out.

Moreover, the effects of different educational policies like changes in college fees or tuition can be predicted. The analysis can provide useful information for students making their decisions at the start and during their educational career.

The data
The data used in the analysis come from the longitudinal research project ‘Verder Studeren’ (Continuing in Education). In this project, financed by the Dutch Ministry of Education, Culture and Science, several thousands of students have been followed on their way through the higher education system. From the start in 1991 students where surveyed on a yearly basis. Students leaving the educational system and entering the labour market for example, where also followed. The fifth and last survey took place at the end of 1995. Chapter 2 gives a

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3 More precisely, the estimation of the traditional Mincerian earnings function using the instrumental variables approach or fixed effects methods.
description of this project. Two other datasets from related projects were used in the analysis. These datasets are described in the relevant chapters.

Outline of this study: from secondary education to the labour market

This study analyses decisions and consequences for students on their way through the higher education system to the labour market. The sequence of decisions and consequences is the main line in this study. We distinguish three sections. Section A contains the preliminary chapters, Section B contains the chapters on decisions and the chapters in Section C deal with the consequences. Besides this introductory chapter, on the subject and the theoretical background of this thesis, the preliminary section has two other chapters. In Chapter 2 some background material is given: a detailed description of the data used in the analyses, the history and the main findings of the research project 'Verder Studeren'. Chapter 3 deals with graduation in secondary education. Despite its analytical character we included this chapter in the preliminary section because the topic is preliminary to higher education and the analysis is not as elaborated as the analyses in the other chapters.

Section B deals with the decisions on entering higher education. At the end of secondary education a student has to deal with several related questions:
- to enrol or not?
- which level of higher education?
- which type of higher education?

The enrolment decision is analysed in Chapter 4. Chapter 5 deals with the choice between university and higher education. Chapter 6 and 7 analyse decisions on the type of education focusing on two specific types. In Chapter 6 we analyse the enrolment in science and engineering studies, in Chapter 7 the attention is directed to teacher studies.

In Section C we analyse the consequences. Chapter 8 and 9 deal with educational results. Chapter 8 is about drop-out from higher education. In Chapter 9 the relation between the characteristics of the students at the start of the study and their educational performance is analysed. The last two analytical chapters deal with labour market topics. In Chapter 10 the returns on the labour market are analysed. Chapter 11 analyses the correspondence between expectations during the study in 1991 and realisations on the labour market four years later. Chapter 12 traces the main lines through all the chapters and gives a summary of the findings in each separate chapter.

In this thesis we do not attempt to estimate 'the grand model' for studying in higher education including all the interrelated decisions. This kind of model is simply too ambitious for our longitudinal dataset consisting of students in all types, levels and years of higher education. Moreover, the research reported here unfolded as year after year the data came available and we added partial analysis along the way.
The next section of this chapter gives a description of the theoretical foundation of this thesis. As this study deals with various topics on educational decisions and consequences we only describe the main theoretical lines. In each separate chapter an overview will be given of theory and empirical evidence related to the specific topics in the analysis.

1.2 Theoretical foundation

In his classical lecture for the American Economic Association Schultz (1961) defined the acquisition of useful skills and knowledge as investment in human capital. The main idea of the human capital theory is that education is an investment of current time and money for future pay (Freeman, 1986, p.367). Education and training increase an individual’s productivity and future income. In this view education should be treated like a standard investment project and therefore evaluated by the rate of return.  

The basic model

From this basic idea Becker (1964) and Mincer (1974) developed the schooling model. An individual, facing the decision on the length of schooling, is assumed to maximise lifetime wealth \( N(\cdot) \). To this end the optimal length of education(s) has to be chosen. This leads to the following optimisation problem

\[
N(s) = - \int_0^r C e^{-r} dt + \int_s^T W_t e^{-r} dt
\]

where \( C \) is direct cost per schooling period, \( r \) is the individual discount rate, \( W_s \) is earnings after \( s \) years of schooling and \( T \) is the number of years in the labour force. Solving (1) gives:

\[
N(s) = - \frac{C}{r} (1 - e^{-rT}) + \frac{W_s}{r} (e^{-rT} - e^{-rT})
\]

Maximising and assuming \( T \) tends to infinity we get

\[
r(C + W_s) = \frac{\partial W_s}{\partial s}
\]

This equation is the algebraic representation of the human capital notion: an individual will choose to follow education until marginal costs equate marginal returns. Marginal costs consist of two components; direct costs \( C \) and the indirect

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2 Hardly any economic notion gained so much ground as the 'human capital' concept. For example, American president Bill Clinton and former president George Bush used the words 'investing in human capital' in their presidential campaign. Recently the success of the human capital notion gets fuelled through the policy hype of 'lifelong learning'.

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cost of forgone earnings $W$ (valued at capital costs). Marginal returns consist of increased earnings.

The next step in the model is to introduce differences in marginal returns or marginal costs between individuals. These differences explain the variation in schooling choices across individuals. Card (1994), following Becker (1967), assumes that the marginal return to schooling and the marginal cost are linear functions of the years of education with person-specific intercepts and homogenous slopes. The marginal return decreases and the marginal cost increases with years of education.

$$\frac{\partial W}{\partial s} = b_0 - b_1 s \quad (1.4)$$

$$r(C + W_s) = c_0i + c_1 s \quad (1.5)$$

Differences between individuals in marginal costs or marginal returns work through the person specific intercepts. Variation in marginal returns (variation in $b_0$) is assumed to correspond to variation in ‘ability’. This means that individuals with higher ability have higher marginal returns from education. Variation in marginal costs (variation in $c_0$) is assumed to correspond to variation in ‘access to funds’ (family wealth) or ‘tastes for schooling’. Individuals with a more favorable social background (in terms of family wealth) may have lower transaction costs in obtaining funds needed for schooling. Marginal costs can also be influenced by ‘ability’ as individuals with higher ability have higher probabilities of getting scholarships. Moreover, abler persons might also have higher forgone earnings. If the ability effect on the marginal return is greater than the ability effect on the marginal cost than more able persons will follow more education.

Some applications of this model were already laid out by Becker (1967) in his Woytinsky Lecture. Within a demand and supply framework he identifies individual specific demand and supply curves. The demand curves ($D$) present the marginal benefit to a particular person of each additional dollar of investment in human capital. Becker assumes that more able persons have higher marginal benefits. The supply curves ($S$) show the marginal cost to a particular person of each additional dollar of investment in human capital. Individuals with a more favourable social background are assumed to have lower marginal costs. In other words, they have superior opportunities for investing in education. Figure 1/1 shows several demand and supply curves for persons who differ in ability and social background. Along the horizontal axis the amount invested in human capital measured in dollars has been plotted. If $D_i$ exceeds $S_i$ for a particular individual, the marginal rate of return exceeds the marginal cost, and an additional investment in human capital would increase lifetime wealth. The opposite is true.

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3 Empirical evidence for this was found in Ranasinghe and Hartog (1997). However, Hartog (1994) concludes that the ability effects on marginal costs or marginal returns are not ‘solidly established empirically’. 
if \( S_i \) exceeds \( D_i \). Wealth is maximised when an individual invests in human capital up to the point where \( D_i = S_i \).

In Figure 1/1, individuals with higher demand curves or lower supply curves will follow more education than individuals with lower demand curves or higher supply curves. Implicating, that they will also have higher lifetime earnings (Equation 1.1). Figure 1/1 also shows that individuals who differ in ability or social background can invest the same amount in education. For instance, persons with \( D_3 \) and \( S_3 \), \( D_2 \) and \( S_2 \), and \( D_1 \) and \( S_1 \), would invest the same amount in education. The distribution of earnings depends on the variation in demand and supply curves and the slopes of these curves. Becker shows that the distribution of earnings also depends on the correlation between demand and supply curves. Supply and demand conditions might be correlated for several reasons. For instance, high ability persons (high demand curves) might have higher probabilities of obtaining scholarships (lower supply curves). Or individuals with more favourable social backgrounds might on average be more intelligent. This suggests a positive correlation between demand and supply conditions increasing the inequality in both investments in education and in earnings.

Becker uses the demand and supply curves for investment in human capital to illuminate the implications of several issues on equality of opportunity, objective selection, compulsory schooling and improvements in the capital market.

**Human capital as a flexible framework**

In the previous formulation of the human capital model many assumptions are made. For instance, it is assumed that individuals maximise lifetime wealth, there is no uncertainty about future income, labour market prospects or the probability of graduation, and all human capital is homogenous and can be obtained in every quantity desired. Of course, many of these assumptions are unrealistic and in the literature many extensions from the basic model can be found. The basic model proves to be a flexible framework that can be used for a wide range of applications. Below some examples which are relevant for this thesis are given.

In a more general formulation of the human capital model an individual maximises lifetime utility. A direct approach to such a general model is to include non-monetary cost and income elements. For instance, attractive characteristics of jobs like status, career prospects, nice colleagues, challenging and intellectual work, add to the non-monetary income and can in principle be incorporated in the earnings variables by accounting monetary equivalents. In fact, Becker (1967) already included the monetary equivalents of ‘psychic’ income in his model.

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5. The separation theorem deals with the transformation of lifetime earnings into utility. In the first stage, an individual maximises net discounted wealth by means of the choice of the amount of education. In the second stage, decisions are made upon the optimal allocation of wealth over commodities during the life cycle (see Kodde (1985), p. 65).

Figure 1/1 Equilibrium levels of investment in human capital

Marginal rate of return or cost

D1 \hspace{1cm} D2 \hspace{1cm} D3

\hspace{1cm}

S1 \hspace{1cm} S2 \hspace{1cm} S3

p_{11} \hspace{1cm} p_{21} \hspace{1cm} p_{31}

\hspace{1cm}

p_{12} \hspace{1cm} p_{22} \hspace{1cm} p_{32}

\hspace{1cm}

p_{13} \hspace{1cm} p_{23} \hspace{1cm} p_{33}

O \hspace{5cm} \text{Human capital invested (dollars)}
A related extension of the model is the inclusion of consumption elements. The basic human capital model is an investment framework and doesn’t account for consumption motives, like ‘the pleasure of studying’. Schultz (1963) noted that the consumptive value of education relates both to present consumption (the joy of attending school) and to future consumption (for instance enjoying art). In the literature several examples can be found in which investment and consumption motives have been integrated in a schooling model (Lazear (1977), Kodde (1985), Oosterbeek and van Ophem (1995)). In Chapter 4 a model will be estimated including investment and consumption motives for schooling.

Another extension of the basic human capital model is the inclusion of uncertainty. An individual who decides on enrolling in education is confronted with several elements of uncertainty. For instance, the individual has to deal with the uncertainty about future earnings, the labor market developments and the probability of graduating or dropping out. Kodde (1985) analyses the impact of uncertainty in future income and unemployment expectations on the demand for education. The general approach in extending the basic model with uncertainty is to incorporate probability distributions for costs and benefits in the model.

A major assumption in the core model is that all human capital is homogeneous, ignoring many quality differences between levels and types of education. Becker (1967) shows that incorporating quality differences in education in the basic human capital framework is very straightforward. With two kinds of human capital each individual has two sets of demand and supply curves. In equilibrium, marginal benefits and marginal costs are equal for each set. The individual chooses for the kind of education with the highest life time utility. In the economic literature examples can be found of studies that deal with the quality of schooling (Venti and Wise, 1982), the choice for a particular college or university (Oosterbeek, Groot and Hartog, 1994), and the field of study (e.g. Freeman (1975), Zabalza (1979), Zarkin (1985), Dolton (1990)).

These extensions show that the basic human capital model is a very flexible framework adaptable for many insights, and not just economic insights. This flexible framework will be used in this study for analysing decisions and consequences of students in higher education. The flexibility of the basic model offers opportunities for multi-disciplinary research. Notions from other disciplines, like sociology or psychology, with more tradition in the field of educational research than economics, can be included. This study starts with an economic framework but also keeps an eye on insights from other educational disciplines. The human capital framework may be used as a bridge between the educational disciplines.

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7 Leisure has also been integrated in models of human capital and consumption (see e.g. Becker (1975)). In such models wealth maximisation is not equivalent with utility maximisation. However, the demand for leisure remains outside the scope of this study.
Empirical applications of the schooling model

The basic schooling model is being used in three types of empirical analysis:
1. estimating the returns to schooling;
2. explaining and predicting schooling decisions;
3. predicting the equilibrium wage structure.

This study deals with the first two types of analysis; most attention is given to
the second type.

Returns to schooling

The main application of the basic schooling model in the economic literature is
the estimation of the returns to schooling. The so-called Mincerian earnings func­
tion plays a central role in this research. Mincer (1974) relates education and
(realised) earnings in a quadratic earnings function:

$$\ln W_i = \beta_0 + \beta_1 s_i + \beta_2 t_i + \beta_3 t_i^2 + \varepsilon_i$$

(1.6)

where $W_i$ is individual $i$’s earnings, $s_i$ the amount of education, $t_i$ the amount of
working experience, $\varepsilon_i$ a disturbance term with expectation zero, and $\beta_j$
($j=0,1,2,3$) parameters. In this formulation $\beta_1$ is the discount rate or the rate of
return to schooling$^a$.

Since the early sixties a substantial literature has developed about the rate of re­
turn to schooling. In 30 years many studies have been published on the objective
rate of return to schooling$^b$. Despite the great diversity of these studies the con­
cclusions show a great deal of consistency. Most studies find a rate of return be­tween 5 and 10 percent. The rates of return correlate negatively with the level of
education; the rate of return is higher for lower levels of education than for
higher levels. The rates of return are higher in developing countries than in de­
veloped countries. The rates of return are higher for minority groups than for
others.

The most important drawback of the simple Mincerian model, stressed by Rosen
(1977), is that this model considers schooling as an exogenous variable rather
than a choice variable depending on, for instance, ability and social back­
ground$^c$. In Cards (1994) formulation:

"Education is not randomly assigned across the population, rather
individuals make their own schooling choices. Depending on how
these choices are made, measured earnings differences between

$^a$ The relation between (3) and (6) is straightforward, ignoring direct cost $C$ and working experience we get:
$$(dW_i/ds).1/W_i = r$$
which implies that $W_i = e^r$ leading to $\ln W_i = \beta_0 + \beta_1 s_i$.

$^b$ According to Manski (1993) "perhaps hundreds of published studies". Psacharopoulos (1985) is
an often cited survey for these studies.

$^c$ Becker (1967) already pointed at this drawback and suggested a simultaneous equations model.
workers with different levels of schooling may over-state or under-state the causal effect of education."

This implies that the schooling variable in the Mincerian earnings function should be treated as endogenous and its coefficient should be estimated using simultaneous equations methods. Moreover, the estimation of the Mincerian earnings function can be biased because of measurement errors in the schooling variable and ability bias (unobserved heterogeneity).

Below we only give a short overview of the literature which tries to handle these estimation problems because this topic doesn’t belong to the core topic of this thesis and there are some good reviews available.

Willis (1986) and Oosterbeek (1992) give an overview of attempts to estimate the causal effect of earnings with endogenous schooling in the eighties. The standard approach in most of this literature is to model the educational decision explicitly and applying estimation methods which take account of self-selectivity bias. In recent years a new wave of studies emerges using two new approaches (Card, 1994). The first new approach applies instrumental variable methods. The basic idea of this method is to find a new (set of) variable(s) that only contain the exogenous component of schooling and thus is not correlated with unobserved earnings. Regressing earnings on the new schooling variable gives the causal effect of education on earnings. The second approach employs fixed effects models on samples of twins. In these studies the estimated returns from schooling are not biased by ability or family background variables. The results from this new wave of studies indicate that the causal effect of education on earnings is understated in the traditional Mincerian equation. However, the results, especially with instrumental variable methods, are very unstable.

**Explaining and predicting schooling decisions**

The second application of the schooling model, the schooling decision function, is very important in this study. In the economic literature there is a wide variety of empirical models analysing educational choices from a human capital perspective. The seminal paper in this field is Willis and Rosen (1979). In that paper the choice whether or not to attend college is analysed with a probit model. For those who went to college and for those who did not, separate earnings equations and earnings growth equations are estimated to impute the expected earnings gain from college as an explanatory variable in the college choice equation. It is found that a larger expected earnings gain leads to a higher probability to attend college. Instead of analysing the dichotomous choice of whether or not to attend college, Garen (1984) estimates a model where education is a continuous variable measured by the number of years of schooling. More involving is the sequential choice (logit) model developed by Hartog, Pfann and Ridder (1989). At each level of schooling, students can choose between the options of stopping,
graduating from the next level or dropping out from the next level. A common feature of these models is that information about expected earnings is based on realised earnings; implicitly these models therefore operate on the strong assumption that students’ expectations about future earnings are unbiased ex post. In Chapter 11 of this thesis the validity of this assumption is analysed by comparing students earnings expectations with the realised earnings four years later. A different approach is followed by Kodde (1985) who asked respondents about their earnings expectations with and without further schooling. Although the source of earnings information is very different, Kodde also finds that a higher expected earnings gain from further schooling is associated with higher probabilities to stay on in school. This approach will be replicated in Chapter 4.

In all the studies mentioned more or less the same dimension of education has been measured, namely its level. Other relevant dimensions of education that may in principle be subject to individual choices are: the quality of schooling, the choice for a particular college or university, and the field of study. Examples of these studies were already mentioned and will be further elaborated in Chapter 6 and 7.

The so-called ‘student demand studies’ analyse the effects of price, that is direct and indirect costs (tuition fees, student aid and forgone earnings), on the schooling decisions. Leslie and Brinkman (1987) conclude in their review of 25 empirical studies that direct cost have a significant but small effect on the decision to follow education. By constructing a student price-response coefficient (SPRC) they compare the outcomes of these studies. They find that in almost all studies the SPRC lies in a range between -0.6 and -0.8, that means a 100 $ increase in price leads to a decline in enrolment between -0.6 and -0.8 percentage points. Most of the studies use tuition as price variable but in some studies student aid or forgone earnings are used. The effects of these price measures differ. In the earliest empirical studies, changes in tuition had a much larger impact on enrolment than changes in student aid. A possible explanation for this difference is that tuition is a very visible price and a student often does not know the exact amount of student aid at the moment of the decision. In later studies this difference disappears. Manski and Wise (1983) find identical coefficients for different cost variables. In a more recent study St. John (1990) finds that the effect of changes in student aid on enrolment are larger than the effect of changes in tuition.

In the next chapters this basic theoretical framework will be the starting point for the analysis. Each separate chapter will present the empirical evidence for the specific topics that will be analysed.

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11 Other versions are the tobit model applied by Kenny et al (1979) and the ordered probit model applied by Harmon and Walker (1995).
12 In 1982 US $.