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Human Capital as an Instrument of Analysis for the Economics of Education

JOOP HARTOG

Human Capital: the basis

Mainstream economists have at least two virtues: they think in terms of cost and benefits, but do so only marginally, and they are fond of LSD. LSD is my abbreviation for the Law of Supply and Demand. A price is determined in a market, the equilibrium price is to be found at equality of market supply and market demand. If that equality holds, at that equilibrium price everyone can sell what they intended to sell, and everyone can buy what they intended to buy. Thus, everybody is happy, there is no incentive to change anything, and the stability of equilibrium reigns. The Law of Supply and Demand says that if demand increases, a higher volume of sales will be realised at a higher equilibrium price, and if supply increases, a higher volume of sales will be realised at a lower equilibrium price. 'Supply' and 'demand' are short for supply and demand *curves*: the relation between the supplied volume of a commodity at any conceivable price and the relation between demanded volume at any conceivable price. Both the supply and the demand curves are derived from comparing costs and benefits. An individual will supply a commodity until marginal benefits from supply equate marginal cost, and the same equality holds for an individual's demand. We will elaborate on this below.

Human capital is essentially a supply side characteristic: it is an envelope concept, a valuation of people's skills. A simple definition specifies it as the value of a person's productive, marketable skills. Employing a worker is like setting an engine in motion. Capital is the value of the productive services that can be generated, it is the potential performance of the engine. There are two ways of assessing the value of the engine: calculating the cost necessary to produce it, or calculating the present value of all the services that the machine can offer, the value of all the trips that can be generated by the locomotive of a train. In equilibrium, in a smooth market, the cost of making the machine will be equal to the value of all the productive services. In a market for locomotives, you can see its value (the capital good) by the market price paid when it is sold.

The concept of human capital is one of the oldest in economics, going back to our founding father Adam, Adam Smith in this case, and to his masterpiece published in 1776. The concept was applied in the 1940s by two American economists (Friedman and Kuznets) to give a normative assessment of incomes in the professions (e.g. lawyers and doctors), but really took hold of the field of economics in the 1960s. It is now a household concept.

The concept of human capital is sometimes restricted to the value of those skills and productive capacities that people have had to acquire at a cost, as an investment. This would then exclude innate abilities that people are born with. It is also possible to use a wide concept of human capital, not necessarily considering the sales value of improved skills, but also including the private valuation of greater consumption. Schooling may not only raise your market value as an employee (or employer), but may also increase your enjoyment of literature, culture, etc. Human capital in this broad sense might then be valued as the cost of all actions taken to increase future welfare.

The Barest Model of Investment in Schooling

Figure 1 shows the barest possible analysis of investment in schooling. A person faced with the decision to embark on studies requiring s years of full-time attendance knows that after these s years he will earn an annual wage of W_s , from s until retirement at age 65, or, more generally, at time T . His alternative is not to study, go straight to work and earn W_0 from the time of decision until retirement at time T . Going to school has an annual cost for tuition and books of K . Total lifetime earnings if a person does not go to school equal W_0T and are visualised by the rectangle of that size. However, a euro earned after 20 years is not the same as a euro in hand right now. So, we will discount future wages. If a person values a euro next year at .9 euro now, the discount rate is 10%. This basic framework can be used for three types of analysis: we can analyse investment decisions, we can calculate the rate of return on an investment, and we can predict the equilibrium structure of wages by level of education.

The Investment Decision

We can analyse the decision whether or not to go to school by simply comparing the total lifetime discounted income from the two alternatives and choosing the alternative with the highest lifetime discounted income. We can also subtract income in case of no schooling from income in case of schooling and predict that

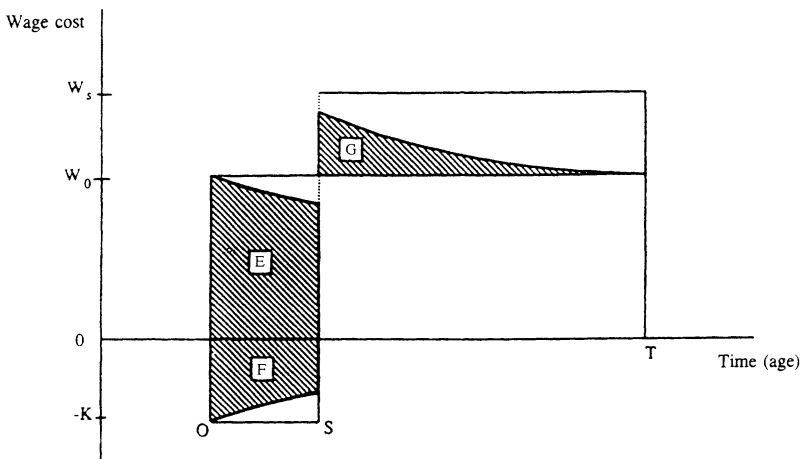


FIGURE 1 Cost and benefits of investment in schooling

the individual will go to school for s years if the balance is positive. In the first s years the gap is $-K - W_o$ per year: the individual has to pay K for tuition and books and does not enjoy the income from working W_o . The latter, W_o per year, is called the *opportunity cost*, the income forgone by choosing the other alternative. $W_o + K$ is the annual investment cost. In a lifetime perspective, after discounting, it is indicated by the shaded area in Figure 1 (E+F). After s years, the difference between the two income streams changes sign: earnings W_s surpass non-schooling earnings W_o . The difference $W_s - W_o$ is precisely the benefit from schooling, the higher annual wages due to schooling. Again, taking off the edges by discounting, we see the contribution to the lifetime earnings difference as the shaded area to the right of s (G). Now, the decision rule is simple. The person will go to school if the lifetime earnings balance from the schooling alternative is positive, or if the lifetime benefits ($W_s - W_o$, discounted) is larger than the investment cost ($K + W_o$), discounted. We should discuss a slight problem here. If people could borrow and loan for their education at one and the same rate of interest, this would be the proper discount rate. However, this is often not the case. The wage gain is usually discounted at the person's discount rate (what is, in *your* assessment, the value right now of the euro that you will receive next year). The cost of investment is often discounted at the lending rate of the bank, or if the bank is restrictive, the discount rate of parents who will have to finance the cost of the education.

This simple model has some interesting conclusions. First, we may note that investment cost, the cost of going to school, consists of direct cost K and opportunity cost W_o , the wage that might have been earned. It is often not realised that forgone earnings are by far the biggest cost component. Quite often, the direct outlay for tuition and books is no more than 10% of the opportunity cost, the wages that are lost.

Second, we can make some immediate predictions. Participation in schooling will increase if:

- the future benefits increase, i.e. at a higher wage premium for those who have completed their education
- the direct cost of education decreases, because schools lower tuition or the government subsidises schools
- the discounting rate for present wage gains decreases (or, stated otherwise, those with an orientation towards the future rather than towards the present, i.e. a lower discount rate, are more inclined to embark on schooling)
- financing education becomes easier. The banks may be more inclined to provide funds, parents may become richer and have more funds available in a process of economic growth, the bank lending rate may drop or the government may provide cheap loans, or even free scholarships.

All these predictions have been supported by empirical evidence, although magnitudes of effects may sometimes be small.

Optimal Investment in Schooling

We can mould the basic Figure 1 to apply the economists' marginal analysis. Suppose the premium for another year of schooling is not constant, but depends

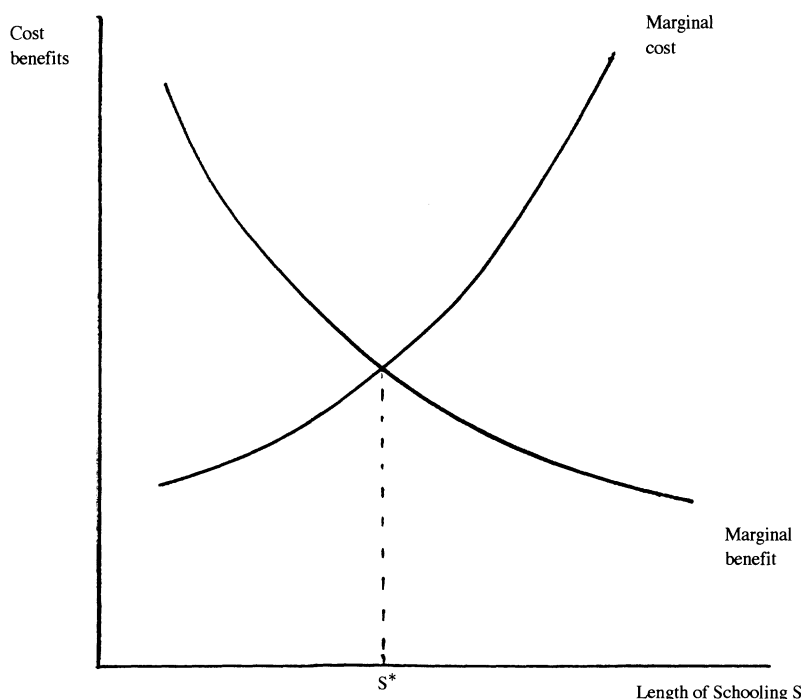


FIGURE 2 Optimum length of schooling

on the total years of schooling. In a lifetime perspective, this benefit should drop, as the remaining working life becomes shorter and shorter. Suppose also that the costs of schooling increase: the more advanced the schooling level, the higher the cost of an extra school year. An immediate reason for this increase is the higher opportunity cost. The longer one has been in school, the higher the wage one may earn with that level of schooling. We then get a picture like Figure 2. The optimum level of schooling occurs at the intersection of marginal benefit and marginal cost. Increasing beyond S^* would generate more additional cost than additional benefit, and hence would not be rational. This framework has also been used to derive some predictions, mainly by allowing the cost and benefit curves to differ between people:

- those with lower marginal cost will invest more, will study longer. One cost element is the cost of funds, the borrowing rate. Wealthier families have cheaper access to funds and send their children to school for a greater number of years. If cost includes psychological costs (or the joy of learning), those with more intrinsic interest in schooling opt for longer schooling
- those with higher marginal benefit will invest more, will study longer. Suppose family networks are important in placing you in the right job after school. Then families from the higher social strata have children who study longer. It is also conceivable that those with higher academic ability or IQ benefit more from schooling, as schooling is complementary to their talent. This would lead them to study longer. However, abler people

presumably also have higher opportunity costs (they would also earn more than those with little schooling). This prediction is not straightforward, and the evidence on the issue is mixed (Hartog, 1994).

The Rate of Return to Schooling

The framework can be used to calculate the rate of return. Given the investment during the schooling years, to what annual rate of return does the wage premium $W_s - W_o$ correspond?¹ To calculate this, one should know a person's realised earnings during his lifetime and wait until retirement. However, *ex ante*, as expected return, we can see how earlier generations fare in the labour market and we can take the evidence from a cross-section of the labour force. In practice, the rates are not calculated from information in Figure 2 but from estimated wage equations, assuming an equilibrium structure.

There are many studies that calculate the rate of return to education. On another occasion, I have put George Psacharopoulos on a pedestal as the great *collectionneur* of such studies (Psacharopoulos, 1994). There are some generalities which I have called George's Laws:

- 1 private rates of return are higher than social rates of return. Private returns relate the person's after-tax earnings gain from education to the person's cost, social returns relate gross earnings gains to true social cost, and hence, consider the real cost of schooling, without subtracting subsidies by the government
- 2 the rate of return diminishes by level of education. The highest returns relate to primary education: learning to read, write and do arithmetic are the most profitable investments. There are some signs that the relation for private returns could in fact be U-shaped, with a somewhat lower return for intermediate schooling levels
- 3 the rate of return diminishes by level of development of the nation: highest rates are found in developing countries.

In a current project funded by the EU, the available datasets in 15 European countries are used to generate an overview of private returns as they have evolved over the last two decades.²

Rates of return tend to follow shifts in supply and demand. It is often alleged that wages are set by institutional arrangements and not in open flexible labour markets. Whatever the truth of that statement, returns to education appear to fluctuate in response to supply and demand conditions. I shall illustrate this below.

The Wage Structure by Level of Education

Suppose everyone had equal ability to benefit from education at any desired level and everyone was only interested in maximising lifetime earnings, then, everyone would decide to follow just the education that promised the highest lifetime net earnings (net of schooling investment cost). We would then only observe people in each and every education if the return were identical for each education. Such equality of the returns could be established by flexible wages. If too many people follow a particular education, they would invade the labour market and the wages

for those with that particular degree would drop. Similarly, if few people graduated from that education, shortage would increase their wages.

Applying simple mathematics to this line of reasoning generates very elegant formulae. A key result is that every extra *year* of education generates a specified *percentage* increase in wages. This percentage increase, say 5% or 10%, for an extra year of completed education is then the return to education. A highly simplified intuitive argument may also help. Suppose there were no discounting. Then, if you go to school for 5 years, and hence forego five years' wages, and you have 40 years to make up for the loss, raising the annual wage by $5/40 = 12.5\%$ precisely makes up for it. Discounting future earnings changes the numbers, but does not affect the essence of the arithmetic.

Of course we know that not everybody has the same ability to complete their studies, has the same interests, or wants just to maximise lifetime earnings. But these are variations on a theme. We can adjust for that, we can elaborate richer models. Such models have been developed and econometric estimates have been obtained. If we correct for individual ability and talent, the return to schooling tends to drop by about a third. A new wave of research on measuring returns, taking into account that education is not bestowed on an individual but is the result of deliberate choice, suggests that the returns are much higher than commonly measured so far. But these results have not yet settled into robust truths (see the special issue of *Labour Economics*, forthcoming this autumn).

LSD Works

Human capital is a concept that brings several labour markets together in one single underlying market. The markets for graduates of different levels of schooling are interpreted as an underlying market for homogeneous human capital. If the demand for university graduates increases and the demand for primary school graduates declines, we say that the demand for human capital has increased. We then expect the law of Supply and Demand to generate an increase in the rate of return to human capital: the wage of university graduates compared to primary school graduates should increase. And the reverse holds if relative supply of university graduates increases.

Usually, we can easily observe the supply of workers by level of education, but we do not have direct observations on the demand for workers by level of education. Ideally, we should know the relation between the demand for graduates of some type of schooling and a range of possible wages and then establish whether this demand curve has shifted. But this can only be determined from statistical analysis, and in that sense, LSD is more a framework for interpretation, and interpretations are often subject to debate.

As a first illustration of the operation of LSD, let us consider the Dutch case (Hartog, Oosterbeek & Teulings, 1993). Between the early 1960s and the early 1980s, the rate of return to education was cut in half and then flattened out: it was about 13% in 1962 and about 7% in 1995. It is not difficult to find an explanation for the drastic change in relative changes. Over that time period the labour force with university education increased about fourfold for men and sixfold for women. Supply flooded the market, and the price dropped. The greater supply can be explained by cheaper funding of the investment, by more generous government scholarships and higher parental incomes.

An interesting example is also provided by Sweden (Edin & Holmlund, 1993). The greater supply of university graduates also lowered the rate of return to education. However, after a while, students reacted to this decline in returns with a reduction in university education, and the rate of return increased again.

As already noted, it is always possible to have a different view when it comes to interpretation. Gottschalk and Smeeding (1997) argue that changes in relative supply of workers by education can explain many changes in rates of return in several countries. There is a systematic negative relationship between the size of supply shifts and the changes in education and experience premia across countries (o.c. p. 655). Blau and Kahn (1996) have argued that the difference in the wage structure between the US and Europe is not consistent with relative supply: the wage dispersion across education levels should be larger in Europe rather than smaller. They ascribe this to institutional factors (legislation, union wage control, etc.) that frustrate the free play of market forces. However, Oosterbeek and Leuven (1998) show that the observations are consistent with market forces if one acknowledges the differences in schooling quality between the US and Europe: the actual skills in the US at the lower schooling levels are much lower than in Europe, and the lower bottom in the earnings distribution reflects this. Thus, there is no need to invoke minimum wage legislation and union power to explain the higher floor in the distribution in Europe: it is simply consistent with skills measured directly rather than proxied by years of schooling.

Allocating Graduates to Jobs

In the basic framework, we ignore what a person does with his education after graduation. The job is considered irrelevant for reaping the benefits of being educated. No matter where you work, your education will be rewarded. This, of course, is not true. If you are trained as a dentist, your education will not pay off as a doorkeeper at the Hilton Hotel. There is a line of research that links a person's education to the requirements of his job and that ponders on the proper match and the consequences of mismatch. These are dangerous and sometimes even misleading terms. They suggest we can unequivocally determine the 'required' education (and other 'required' characteristics) for a job and then call any deviations between actual and required traits a 'mismatch'. It is the line of thought that produced the concept of 'overeducation'. The danger of the term is precisely in the normative connotation that suggests that we can determine *a priori* what is a good match and what is a poor match. There can be no doubt that jobs differ in the extent to which people can gainfully exploit their education. Essentially, this depends on the degree of freedom that workers have in performing the duties and tasks of their job. One could think that on the assembly line productivity is determined by the speed of the line and that workers simply have to adjust. Whether workers are university-trained or barely literate, the assembly line has its predetermined speed, and individual worker qualities have no effect. But this is simply not true. Even on the assembly line, workers will have an impact on the quality of the product, on the frequency of interruptions, etc. Moreover, it is the quality of the workers that determines the organisation and the speed of the assembly process: there is an interaction between worker qualities and work organisation, and even here, education and training can have an impact. More generally, in almost any job, better workers generate better products. But the

extent to which worker quality can affect product quality and productivity will differ between jobs. In this sense, job requirements can be meaningful indicators. We would generally expect the potential impact of worker qualities to be greater in more complex jobs. This is why we expect to find better workers in the more difficult jobs. Abler workers will have a comparative advantage and their productivity gain over less able workers will be greater in difficult jobs. It is this comparative advantage that makes the assignment of workers to jobs a relevant issue.

Worker quality is not a unidimensional concept, and job requirements are neither rigid standards nor fixed and well determined variables. There is a great deal of flexibility and substitutability on both sides. With these caveats in mind, we can take a look at the results of the so-called overeducation literature. In this literature, workers' education is confronted with the education 'required' in their job, and consequences of equality and gaps between the two variables are studied. We should treat it as a positive issue and not as a normative issue. We should take 'required education' not as a rigid, well-defined, normative standard, but as an indication of the nature of the job and the scope for productivity variation in relation to workers' qualities. And we should keep in mind that formal education is just one variable that can potentially be substituted for another: other worker abilities, on-the-job training, general and specific work experience, etc.

In the literature on overeducation and undereducation, required schooling has been measured in three different ways:

- i from *job analysis* (JA): systematic analysis by professional job analysts who specify the required level (and type) of education for the job titles in an occupational classification. The most elaborate example is the *United States Dictionary of Occupational Titles*
- ii from *worker self-assessment* (WA): workers specify the education required for the job or indicate whether, compared to their own education, a higher or a lower (or a different) education is needed. Such questions are sometimes included in labour market surveys
- iii from *realised matches* (RM): required education is derived from what workers in the respondent's job or occupation usually have attained, e.g., the mean or the mode of the education distribution in the job.

I favour the Job Analysis method because it aims at the technology of the job, by well-trained observers, but these data are not always easily available. Data from Worker Self-assessment are usually a cheap alternative. I do not like the Realised Matches because the result is influenced by the actual allocation process in the labour market. It is much better to have some 'external' evaluation of the nature of the job. I give some examples of measures obtained for the countries where such analyses were carried out in Table 1.

The available evidence for these countries (see Hartog, 2000) allows us to conclude that in the Netherlands, Spain and Portugal, the incidence of overeducation has increased over time and the incidence of undereducation has decreased. The development in the US seems different. While overeducation may have followed a U-shaped pattern between 1969 and 1977, there is evidence that it decreased in the subsequent period until 1984. Between 1978 and 1984, the extent of undereducation seems to have dropped.

TABLE I. Examples of Measurement of Over- and Undereducation (percentages)

Country	Netherlands		Spain		Portugal		UK		US	
Year	1960	1995	1985	1990	1985	1992	1986	1991	1969	1984
Overeducation	7	24	17	15	18	33	31	13	35	33
Proper match	58	63	60	69	63	29	52	70	na	47
Undereducation	36	12	23	15	19	38	17	17	na	20
Method	JA	WA	WA	RM	RM	JA	WA	RM	WA	WA

Source: Hartog (2000)

We can expand the standard human capital earnings function discussed above and consider earnings consequences of over- and undereducation. We then get what I call the ORU specification, an earnings function that distinguishes earnings effects of over- and undereducation from returns to required education. In a survey to be published in the year 2000 I have collected the results from five countries for different years, amounting to a set of 45 regression equations. They point to four regularities:

- 1 *If you relate individual earnings to required education in the job, the returns to education are higher than if you relate them to attained education.*
This shows that it helps to get a job where your education matches the education required in the job.
- 2 *The returns to overeducation are positive, but smaller than for required education.*
This indicates that overeducation is not wasted. If a person has a better education than the job requires, this gives additional earnings. Typically, the returns to overeducation are about half to two-thirds of the returns of required education. Returns to overeducation are substantial.
- 3 *The returns to undereducation are negative.*
The penalty for undereducation is always smaller than the returns to required education. This means that if a person obtains a job for which he is underqualified, the earnings are higher than if he gets a job that matches his education.
- 4 These three results are not sensitive to the method of measuring required education.

A typical illustration of earnings in relation to over-, under-, and required education is given in Figure 3. Earnings in a job with specified required education for individuals with just that education ('proper match') are given by the solid line. If we focus on some job with specified required education, at some point on the solid line, returns for overeducation are given by moving up the line to the right, for undereducation by moving down the line to the left.

We can conclude that overeducation is not a cause for concern. Overeducation as measured has a substantial return and is not a waste. Moreover, there is evidence that it is a temporary phenomenon, more frequent among youth who are still finding their way in the labour market. There is also evidence that attained education is simply an incomplete measure of a person's human capital. With job proficiency depending on other variables as well, often easily substitutable,

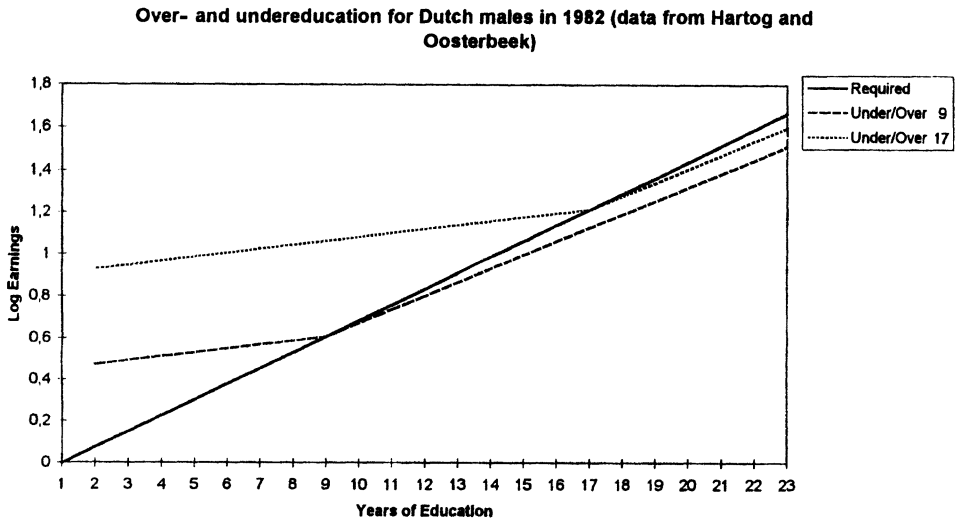


FIGURE 3 ORU earnings functions for several countries

Source: Hartog (1994)

focusing exclusively on schooling is incorrect, as it ignores the role of variables such as experience and on-the-job training.

Risk

All the analyses and models discussed above are based on perfect information and the absence of uncertainty. People know what an education is like, know what they will earn after graduation, have no doubts about graduation itself, and take their decisions knowing perfectly well what the future will bring under various alternative options. Clearly, this assumption is absurd, but analysis of schooling decisions under uncertainty, in a situation of imperfect information, is surprisingly underdeveloped. Only a few studies consider what happens in an uncertain environment.

Yet, Adam Smith (1776), who is always quoted in explanations of human capital theory with his metaphor of education as erecting an expensive machine, made reference to the uncertainty of success in an occupation and the need for compensating people for this risk. Just as people only invest in stocks if they can anticipate higher returns than if they put their money in a savings account, they will only invest in an education-occupation line with greater risk of recouping their investment cost if the expected rate of return is higher. In a research project that we have just begun, we find clear evidence that risk is indeed compensated. We used data for Spain, Portugal, the Netherlands and Germany, and we considered the earnings variability in the occupations that people take up after their education.

Indeed, if the earnings variability is higher, the average earnings are higher: there is a positive compensation for risk. What I like about these results is the effect of asymmetry in the earnings variability. If the probability distribution is

positively skewed, with an extended upper tail, towards the higher incomes, people seem to appreciate this. They attach a positive utility to small probabilities of having a very high income: the more skewed the earnings distribution, the lower the mean earnings. That is, people are willing to give up a little income to get access to a positively skewed earnings distribution (Hartog *et al.*, 1999).

Educational decisions under risk need much more analysis. Lack of information about education, about people's abilities, about their potential performance in school and in jobs is all-pervasive. We cannot simply ignore this in our analyses. In the Netherlands, for decades, one third of the students left the school they last attended without a diploma. In addition to their 'highest completed schooling level' they have one or more years of additional schooling that do not lead to graduation. In recent years, this drop-out ratio increased. Such clear signs of uncertainty about eventual graduation cannot be ignored in our analyses.

Measuring Human Capital and its Heterogeneity

Human capital is a fascinating concept, and economists are drawn to it like a moth to a flame. But it is intangible, cannot be directly observed, is not sold and priced on the market and hence can only be inferred: in fact, it is like a secret lover. And why do economists love it? Because it is fruitful, because it fits basic economic concepts so well, and perhaps above all, because it is susceptible to all kinds of calculations. The standard Mincer earnings function is a canonical specification that is seldom subject to serious debate.

Human capital can seldom be measured, as people have not been sold on the market since the abolition of slavery. The exception is in some professional sports, most notably football, where players are sold from one team to another. But, as far as I know, information from that particular market has never been used to test predictions from human capital theory.

As noted in the beginning of the article, in an equilibrium market structure, the expected discounted future earnings stream generated by a capital good is equal to the cost of producing the capital good. In the absence of a price that can be observed when a capital good is sold, there are two alternatives for calculating the capital value: producer cost and value of future discounted earnings. Actually, the value of the capital is seldom calculated, except perhaps in forensic applications. Thus, we know returns, but the asset itself is eclipsed. With the recent advent of 'human resources management' and many businessmen claiming that the most valuable business asset is the firm's human capital, there are suggestions, and perhaps even attempts, to calculate the firm's human capital as an entry on its balance sheet. For analytical purposes, if sound rules were applied, this would be valuable, not so much for analysing investment in formal schooling, but rather for investment in on-the-job-training. It would also be interesting for analysing 'transfers' of workers between firms.

With human capital conceived as something produced in school, it is only natural that economists envisaged applying their concept of a production function. In a business operation, inputs such as labour and capital are combined to produce the firm's output. Similarly, in a school, we may envisage the combination of inputs, such as student time, teacher time and other school resources, to produce human capital. But we do not know many of the properties of the process. If we

analyse students' allocation of time, we call time spent on studying investment in their human capital and we specify parameters that indicate the efficiency in producing capital and then combine this with returns on human capital to end up with the person's wage rate. We may perhaps, in econometric work, identify the parameters of this process, but the intermediate concept of the person's human capital is unobservable. There are several applications of such models, but there is no set of empirical regularities as with rate-of-return studies, no generally accepted range of values for key parameters of the production process. In fact, the key parameters are not even defined.

There is much more research on schools as factories that produce human capital. Schooling as a production process is not framed in terms of producing additions to a person's human capital value. One usually uses test scores and measures of student achievements and relates these to the inputs, such as teacher/student ratios, teacher quality and other school inputs. The key result here is that schools make a big difference to student achievement (schools have strong 'fixed effects') but it is very hard to pin down specific variables that can explain the differences between the schools (Hanushek, 1986). Family background is very important for student achievement, but teacher/student ratios (or class size), teacher education and teacher experience have no well-established effect on a measured student performance. So, while we perceive schools as producing human capital, we cannot nail down the properties of the process and we cannot find more precise indicators of a person's human capital than years of schooling. It has long been considered unsatisfactory. As Welch noted in 1975: 'Frankly, I find it hard to conceive of a poorer measure of the marketable skills a person requires in schools than the number of years he has been able to endure a classroom environment. My only justification for such a crude measure is that I can find nothing better' (Welch, 1975, p. 67).

The Structure of the School System

To my mind, one of the most interesting issues in education is the optimal design of a school system. There are large differences between national school systems, except at the basic level. Virtually all countries have a uniform elementary school, where up to ages between 12 and 14 every child gets the same instruction, organised in successive grades. But whereas in some countries every child automatically moves to the next grade at the end of the year, in others there is a minimum achievement level. In secondary education, national school systems can differ. There may be an undifferentiated school, with a standard curriculum for all students, or there may be differentiation by student ability and interest, i.e. schools may be differentiated *vertically* by the intellectual level of the students, with selective entry (or compulsory expulsion for insufficient performance), and *horizontally*, with a different type of curriculum for the students of the same intellectual ability. In addition, higher vocational and university education may have open or selective entry. Open entry tends to create a more substantial drop-out problem in the early years of tertiary education.

The analytical tools of economic theory lend themselves perfectly well to these issues. Essential concepts are comparative advantage, scale efficiencies and coordination with labour market conditions. Scale efficiencies appear because of group education. Conceptually, individualised education could develop a person's

skills to the optimum, but it would be very costly. Subjecting groups of students to the same curriculum reduces the cost by exploiting economies of scale. The optimal nature of grouping in curriculum sets and school types depends on the heterogeneity of the student population, the rewards for different skills in the labour market, and the learning technology. Schools may cater to differences in individual capabilities by exploiting comparative advantage in learning, but only if the rewards in the labour market make this a profitable undertaking. If it is sufficiently rewarding, schools can have a homogeneous student population and curriculum. If it does not pay, schools may cater to rather heterogeneous sets of students. I have developed this analysis in another publication (Hartog, 1992). Economic theory has useful tools for this purpose. The challenge is to link up with a good theory of learning and to apply the theory empirically.

The issues are intimately related to the issue of equity. Developing people's skills to the full increases inequalities between people. In fact, this is how the school system works, as we showed for the Netherlands (Hartog, Pfann & Ridder, 1989). We predicted for a sample of Dutch people the earnings they could have obtained for any education they might complete. Had everyone completed university education, the earnings differentials would be much greater than if they had only completed basic education. Giving most education to those with the greatest abilities further increases the differences between them. And this is just what the school system does. Of course, a deliberate compensating strategy, spending more resources on the less gifted is also conceivable. But it would only slightly reduce the inequality increasing effect of education within intervals of modest size rather than across the entire spectre.

On the Demand Side of the Labour Market

Human capital is essentially a supply side concept and it is difficult to see what really makes up the skills learned in school. There is a much more developed body of data on job requirements. We already introduced the notion of education required in the job. But the notion has a much wider carriage. Job requirements have been defined in many dimensions, with the DOT mentioned above as an outstanding example. The DOT distinguishes between several types of variables. General Education Development specifies an intellectual level and eleven separate aptitudes are distinguished (intelligence, spatial aptitude, form perception, etc.) and the nature of the activities performed is described with many separate variables. The dataset has been analysed by Hartog (1980), but much more research can be carried out. The ultimate challenge is to match up these data with information on personal characteristics and see how education and other variables relate to the type of job that people hold.

Conclusion

Human capital is a very valuable concept to interpret individual behaviour in relation to education and the labour market. But the measurement is quite crude and far less detailed than the characterisation of the demand side of the labour market. Exploring further the relation between heterogeneous human capital and these demand-side variables is challenging, and no doubt, rewarding.

NOTE

- 1 A more precise definition of the internal rate of return is the discount rate that exactly equates the present value of the two alternatives, i.e. lifetime investment cost and lifetime wage gains.
- 2 First results have just become available (Asplund & Pereira, 1999).

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