ECONOMIC THEORIES OF EDUCATION

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Economic theories of education

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Abstract
This paper reviews theoretical contributions to policy-related issues discussed in the literature on the economics of education. While many authors argue that human capital accumulation has considerable positive externalities, some have pointed out reasons that may lead to overinvestment in education, such as striving for status or screening. A public school system generally helps to overcome liquidity constraints, but has its drawbacks, in particular with respect to the pupils' efforts. If schools are financed on a decentralized basis, a segregation of communities is the typical outcome. The distributional implications of subsidizing higher education are ambiguous. Several reasons have been given why human capital accumulation within firms is generally co-financed by firms and workers. Some recent papers discuss the setting of standards, the interaction between education and unemployment, the interrelation between education and redistribution, and the role of education for economic development.

Keywords: Human capital, education, endogenous growth
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1 Introduction

Education is widely seen as one of the main factors that determine economic growth and the distribution of income. Therefore, education policy receives much attention throughout the world. This paper reviews the literature on economics of education with the main focus being on recent theoretical contributions to policy-related issues.

Section 2 deals with the question of how the functions of education can be described and shows which factors determine the individuals' decisions on education. While most economists are familiar with the view that individuals invest in human capital, the consumption aspect and the screening mechanism of education are often neglected. Afterwards, possible sources for market failure in the education sector are discussed. As it is well known, external benefits of education usually justify the subsidation of schooling. While the specification of these external effects in economic models may seem somewhat ad hoc, many different arguments for positive externalities have been identified. However, theorists have also found sources for possible overinvestment in education, such as screening processes or relative income considerations. Liquidity constraints and tax policies can also induce distortions of educational choice.

Since the observation of market failures does not suffice to justify government intervention, the following sections consider the impacts of different policy measures. It is shown that the debate on the choice between private and public financing of schools is still open. While public financing may help to overcome poverty traps and thus induce higher long-run growth of per capita income, its main drawback is that a private school system leads to higher effort levels of pupils. A modified private school system with subsidies or vouchers for schooling need not yield a superior allocation in comparison to the polar alternatives. Theories that consider the political evolution of school systems show no clear tendencies. Given a public school system, one of the main questions is whether it should be financed on a local or on a centralized level. Choosing the former alternative can induce segregation and stratified schools. The literature shows that improved efficiency will generally not be reached by a centralization of financing, but by setting incentives for mixed populations.

Reforming higher education finance is on the political agenda in many countries. Aside from overcoming liquidity constraints on the students' side,
several explanations for subsidizing higher education can be given. The distributional consequences of subsidizing higher education are far from obvious. While many authors argue that income is redistributed to rich individuals, it cannot be excluded that the main beneficiaries of this policy are the unskilled. Another important branch in the education sector is training, i.e. education provided by firms. Recent contributions have identified some reasons why firms may capture gains from training that also increases the workers' productivity at alternative occupations. This can explain the observation that workers usually do not bear the full cost of such general training.

The survey proceeds with issues that have been raised in recent years, like the choice of examination standards, the interrelation between education and unemployment, the interaction between educational choices and distributional policies, and the role of education in development. The conclusion summarizes and indicates some directions for future research.

2 Functions of education

Education plays mainly three roles. First, education is an investment good. Individuals accumulate human capital in order to receive a higher income afterwards (Mincer, 1958; Schultz, 1961; Becker, 1993). The demand for education is determined by equating the marginal cost of education, consisting of direct cost, i.e. tuition fees, and opportunity cost arising from foregone income, to the marginal benefits due to a higher present value of lifetime income. As expected, the demand for education depends negatively on the interest rate and both direct and indirect cost (Ben-Porath, 1967; Bishop, 1977). Human capital investment levels decrease over the life-cycle (Ben-Porath, 1967; van Imhoff, 1989). If the return on human capital is uncertain, the expected return can turn out to be higher or lower than the interest rate in the optimum. While initial wealth has no impact on the decision on receiving education under perfect information, the corresponding demand elasticity is positive under uncertainty about future wage rates (Kodde, 1986). A positive impact of wealth on the demand for education also occurs if individuals are liquidity constrained (Kodde and Ritzen, 1985). While an unemployment rate contingent on education is associated with a positive income elasticity of demand for education (Kodde, 1988), unemployment benefits reduce human capital investment (Dellas, 1997). Empirical investigations show that both
a higher volatility of the unemployment rate and a higher volatility of GDP have a negative effect on human capital accumulation (Flug et al., 1998).

Second, education can be seen as a consumption good (Schultz, 1961; Nerlove, 1972; Bös, 1980; Kodde and Ritzen, 1984). In comparison to the predictions of the human capital approach, incorporating the consumption aspect leads to longer study terms. Further, this view yields another explanation for the observable positive income effect with respect to the demand for education (Kodde and Ritzen, 1984).

Third, a high demand for education can also signal a high productivity to potential employers (Arrow, 1973; Spence, 1973; Stiglitz, 1974, 1975). The main idea starts from the premise that firms cannot observe the productivity of their workers directly. However, learning at school is less costly for talented individuals. Individuals with a high productivity may then increase their demand for education up to the point at which individuals with low productivity will refrain from imitating their behavior. This mechanism generally leads to over-investment in unproductive education. However, if different types of labor are complements in production, this screening mechanism can also have positive effects on productivity since a misallocation of the different types of individuals can be avoided (Arrow, 1973; Stiglitz, 1975; Wolpin, 1977). If the supplementary education is associated with an increased productivity, then voters who cannot assess the talent of their children will opt for a level of resources for this screening process below the social optimum (Stiglitz, 1975).

Several other functions of education are discussed in the literature. Rosenzweig (1995) posits that educated individuals are more likely to choose input combinations close to the cost minimizing level. An overview on further functions of education, for example a rising productivity in household production, is provided by Haveman and Wolfe (1984) and Hanushek (1986).

3 Efficiency of educational choice

The answer to the question whether education yields external effects is crucial when analyzing the efficiency of educational choice. In Lucas (1988), education raises the individual’s supply of labor in efficiency units. This implies internal returns on her investment in human capital, but also causes a higher productivity of all factors via the increased value of human capi-
tal per capita. The latter impact is ignored by the individual and therefore constitutes an external effect. The external effect is usually associated with increasing returns to scale. However, models can be found in which the external returns arise with a time lag due to a learning process (Torvik, 1993). If the externality is very strong in some ranges, multiple growth equilibria may occur where countries with a more educated workforce can reach an equilibrium associated with a higher growth rate of per capita income (Azariadis and Drazen, 1990).

Another view states that education stimulates growth by allowing a faster introduction and adoption of new technologies (Nelson and Phelps, 1966). This is reflected in comparatively high shares of skilled workers in research and development, and in young industries (Bartel and Lichtenberg, 1987). The complementarities between human capital and research and development imply a problem of coordination of expectations: If firms expect a small pool of educated workers, they will invest less in R & D. This leads young individuals to choose a low investment in human capital (Redding, 1996). A similar coordination problem arises if economy-wide production is subject to increasing returns to scale, where individuals will only demand education if they expect others to do the same (Eckhout, 1999). A justification for increasing returns to scale in connection with human capital accumulation has been given by Acemoglu (1996a) who considers individuals whose productivity cannot be observed ex ante. This causes firms to underinvest in physical capital. Higher levels of education increase the value of hiring a worker for any firm. Consequently, the firms choose higher stocks of physical capital. Another reason for underinvestment in human capital exists if the main source of economic growth is the stock of knowledge in the economy. The demand for education will then usually fall short of the efficient level since the selling price of knowledge is too low due to its public good characteristics (Freeman and Polasky, 1992).

Market failure may also occur in the absence of external effects. Educational choices lead to underinvestment in human capital if firms have some monopsony power such that wages are below the marginal product of labor (Acemoglu, 1996b). If employment of skilled workers is comparatively profitable for firms, posting vacancies for skilled jobs is costly, and if the matching process is inefficient, multiple equilibria with different shares of skilled workers may occur. This causes a problem of coordination of expectations, where the economy may end up in a low-skill bad-job trap (Snower, 1996). In a
screening framework, talented individuals may demand too little productive education in order to avoid imitating behavior by individuals with a lower ability (Weiss, 1985).

There is some evidence that success in school does not only depend on the student’s talent and on the resources per pupil spent on education, but also on average IQ in the class. This “peer group effect” is usually stronger for weaker students (Henderson et al., 1978). However, the existence of a peer group effect does not imply that mixed classes lead to preferable outcomes. Even a social planner with a distributional objective tends to choose stratified classes if human capital production is subject to increasing returns to scale (Arnott and Rowse, 1987). Given a hierarchical school system and peer group effects, the number of individuals in the higher school will exceed the income maximizing amount in the absence of admission standards (Effinger and Polborn, 1999). Other contributions stress that a positive impact of the quality of teachers on human capital production can be taken for granted (Summers and Wolfe, 1977; Hanushek, 1986).

A negative external effect of education arises if individuals aim at increasing the difference between their income and the average income of their reference group. Since the higher income induced by human capital accumulation diminishes utility of other members in the reference group, over-investment in human capital occurs (Lommerud, 1989). In contrast, if the status of a group hinges on the ratio between average human capital within the group and average human capital of other groups, striving for status can have positive implications for efficiency: Fershtman, Murphy and Weiss (1996) consider a model in which individuals may either remain workers or receive education in order to become managers. While the rise in human capital depends on the individual’s abilities, the increase in knowledge causes a higher productivity of workers. If individuals only differ either with respect to their nonwage income or with respect to their ability, striving for status induces both a higher growth rate of output and a more equal distribution of income. However, if individuals differ with respect to both characteristics, a lower growth rate due to striving for status by rich individuals with little talent cannot be excluded. Another source of a negative externality is a possible congestion effect in human capital production. Given that individuals neglect the decreasing productivity of education if the pupil-teacher ratio rises, they may demand too much education (Barthélémy, 1999).

Although theoretical arguments for overinvestment in human capital exist,
the observable employment of "overeducated" workers (Duncan and Hoffman, 1981; Tsang and Levin, 1985; Dolton et al., 1997) need not reflect efficiency losses. On the one hand, there may be no overinvestment in view of the workers' prospective careers, on the other hand formal education often replaces training on the job (Sicherman, 1991).

Educational decisions by children from poorer families can be distorted by liquidity constraints. Young individuals generally do not have access to the credit market to finance their education due to the absence of securities and existing moral hazard (Nerlove, 1972). Therefore, they have to borrow from their parents. If the parents cannot spare the desired sum, underinvestment in human capital can result. This may lead to the consequence that complete dynasties remain in poverty traps (Barham et al., 1995). A similar result turns out if the interest rate on loans exceeds the interest rate on savings (Galor and Zeira, 1993). Even if the cost of education only consists of foregone income and the credit constraint varies with the young individual's wage income, underinvestment in human capital will occur (De Gregorio, 1996). With an uneven distribution of income, the richer half of the population may choose to subsidize education in such a way that the poorer half remains credit constrained. While this mechanism will enhance growth in poorer countries since richer families will no longer underinvest, total income in richer countries will fall short of the efficient level (Fernandez and Rogerson, 1995).

Another source of distortion is the tax system. The conjecture that investment in human capital is not affected by a wage tax does not hold if returns to human capital are uncertain. On the one hand, the insurance aspect of taxation, arising from a reduction in the spread of the payoff distribution, induces higher investment levels. On the other hand, the opposite reaction may occur due to income effects (Eaton and Rosen, 1980). A general income tax with identical tax rates for all kinds of income usually distorts the choice on the use of savings in favor of investment in physical capital. This happens since depreciation on human capital as a consequence of retirement usually cannot be deducted from the tax base (Nerlove et al., 1993). While taxes on the returns of human or physical capital will reduce the accumulation of the respective factor, a consumption tax does not affect investment decisions (Rebelo, 1991).

It is obvious that educational choices need not yield efficient outcomes if the main decisions are taken by the parents. Mandatory schooling has a
positive impact on growth if parents do not take all returns of human capital investment into account when maximizing utility (Eckstein and Zilcha, 1994; Balestrino, 1997).

4 Private versus public provision of education

Policy changes within a pure system

The choice of a school system does not only involve the decision between the two polar alternatives public and private financing, but also on the extent of government intervention. Many papers focus on the impacts of changes in the government's parameters. Johnes and Johnes (1994) consider a model with a private school system in which education is not associated with external effects and free occupational choice yields an equalization of lifetime utilities. The introduction of an education subsidy financed by lump-sum taxes can then reduce output if the teacher-student ratio is high or the productivity increase by education is small. Raising the education subsidy in a private education regime has a positive impact on output growth if either the parents invest in their children in order to receive transfers during old age (Balestrino, 1997) or human capital is produced with the parents' human capital and schooling (Zhang and Casagrande, 1998). Within an endogenous growth model, an education subsidy may, by increasing the number of skilled workers, raise the share of skill-intensive goods and induce a bias for quicker technological progress in that sector (Acemoglu, 1998). In a pure public education regime an increase in the government's education spending can reduce human capital accumulation if this measure, by increasing the interest rate, leads young individuals to redistribute their time budget in favor of work (Lin, 1998).

Contrasting public and private education

The distributional implications of public and private education have received much attention. Public education is generally represented by the feature that all students receive the same resources per capita. Of course, the intuitive expectation is that public education is associated with a more even
income distribution than a private education regime. However, if marginal returns of human capital are diminishing, education is privately financed, and a positive productivity effect of human capital per capita exists, a convergence of individual income levels will result (Tamura, 1991). In contrast, under a public education regime, majority voting by individuals who do not take into account the full social benefits of education will not only lead to underinvestment in human capital, but can even increase income inequality between skilled and unskilled workers (Turrini, 1998).

The contributions discussing the choice between public and private education do not show a unified picture. Assessing the question which regime is preferable with respect to efficiency hinges both on technological conditions and the structure of individuals’ preferences.

Loury (1981) analyzes an economy in which human capital is produced with ability and schooling under diminishing returns to schooling. Altruistic parents decide on the level of schooling of their children without knowledge of their abilities, where the abilities within a family are uncorrelated. Changing from a private education regime to a public education regime with a progressive taxation increases mean income and welfare because the switch allows to insure against uncertain future incomes. Glomm and Ravikumar (1992) consider implications of the educational system choice on growth within an endogenous growth model. Individuals are altruistic towards their children in such a fashion that the human capital level of their children appears as an argument in their utility function. Human capital is produced with the parents’ human capital, time of the children and school quality, being measured by the budget per pupil. Under private financing, the parents provide their children with these resources. The time input will be higher under the private education regime since the own children benefit only marginally from the returns to human capital accumulation under a public education regime. If individuals are identical, this yields a higher output under private financing in every period. If the production function exhibits decreasing returns to scale with respect to the factors school quality and human capital, the converse result may appear should the income distribution be uneven (Glomm and Ravikumar, 1992). Family-specific preferences for education induce a persistent income inequality under private education. While implementing a regime of public education will let the income inequality vanish, the losses in human capital accumulation will be higher than under homogeneous preferences (Cardak, 1999). If parents choose the children’s time spent on...
education where the latter also work and thus contribute to the income of the family, a public education regime generally leads to a higher output growth rate than a private education regime (Glomm, 1997). Gradstein and Justman (1997) consider a model where the children's human capital depends on their talent, the amount of schooling they receive and the average schooling in the generation. The parents decide on the amount of schooling and their own leisure. Both education subsidies and public education increase the demand for education, but public education also raises the demand for leisure. Education subsidies lead to higher levels of per capita income than public education if the externality in human capital accumulation or the parents' degree of altruism is strong, the increase in demand for leisure under public education is stark, or the inequalities in income and ability are moderate.

The approach of Saint-Paul and Verdier (1993) considers the same utility function as Glomm and Ravikumar (1992), where human capital is produced with the parents' human capital, exogenous parental time and public education. They show that the growth rate of aggregate human capital increases with a rising income tax rate. Hence, the political process has positive implications for efficiency.

The determinants and consequences of democratic choice of the extent of public education have also been discussed. On the one hand, public education will be associated with overinvestment in human capital since the median voter has generally less than average income. Hence, her contribution towards the education system will be below average. On the other hand, individuals tend to underinvest if the distribution of talents has the property that median ability lies below average ability (Stiglitz, 1974).

Mixed systems

Another topic frequently raised in the literature is the impact of political measures in a mixed system. If public and private education are perfect substitutes, an increase in government spending on education financed by taxes on the middle aged will increase demand for human capital, but may depress output growth due to a slower physical capital accumulation (Buitier and Kletzer, 1995; Bräuninger and Vidal, 1999). However, Saint-Paul (1997) stresses that public education can stimulate capital accumulation if under private education the middle aged have to repay credits for education.

If private and public schools coexist, it is generally Pareto improving to
introduce a partial deductibility of private tuition cost from the parents' tax base. The lower tax revenue will be offset by the reduction in public expenditure on education (Martinello and West, 1988). The introduction of tax-financed vouchers that can be employed to purchase private education leads to a higher fraction of students in private schools. If the introduction of these vouchers is associated with a decrease in taxes, a Pareto improvement results. Otherwise, those families lose whose children remain in the public school system (Hoyt and Lee, 1998). In the model of Epple and Romano (1998) individuals differ with respect to income and talent of their children. Utility is a function of own consumption and the children's human capital, where the accumulation of human capital is influenced by a peer group effect. Schools decide on fees and admission criteria. A strict hierarchy of private schools with respect to fees and quality emerges, with the quality of public schools being at the low end of the ladder. The introduction of education vouchers helps talented children from poor families, while those who remain in public schools lose. Kaganovich and Zilcha (1999) consider the consequences of increasing the share of education vouchers in the public budget at the expense of public education if public and private education are complements in human capital production. This measure raises the output growth rate if either the parents' altruism towards their children is very weak or very strong and the share of public education is large. In the intermediate range, the impact on growth can be negative since the education vouchers will crowd out private investment in human capital.

Given that public education can be supplemented by additional private education, a political equilibrium with a coalition of rich and poor families may turn out, where both opt for a relatively low level of public education (Epple and Romano, 1996ab). If public education is less productive than private education, a fluctuation between purely private financing and a mixed system will occur. In the opposite case, the share of public education increases over time (Gradstein and Justman, 1996). Zhang (1996) considers strictly altruistic parents and posits that human capital is produced with school quality, parental time and the average human capital of the old generation. Starting with a system of private education, the introduction of an education subsidy induces a higher growth rate of income per capita. If the initial income inequality is substantial, a public education system is chosen although it is detrimental to individuals with average income. The resulting reduction of income inequality leads to a regime change, i.e. to the choice of
5 Centralized versus decentralized financing

An important organizational issue is to assess the consequences of choosing either centralized or decentralized financing of schools. Boardway, Marceau and Marchand (1996a) consider a model of locational choice with two schools. Private returns on education depend on the chosen level of resources devoted to schooling and the total number of students. A decentralized financing by fees will then probably lead to an inefficient locational choice and, even more important, to overinvestment by the schools. The latter problem can be alleviated by employing vouchers for education (Boardway, Marceau and Marchand, 1996a). Allowing families to send their children to schools outside their own community can influence the quality of schools in receiving and sending communities in either direction. While keeping a given school quality in the receiving community becomes more expensive, the increased burden may be overcompensated by a higher share of state aid (Lee, 1997).

If school financing is basically decentralized, and if the income elasticity of demand for education is high, a segregation of communities is the typical outcome. Communities are then stratified by the income of individuals where rich communities have higher expenditures per pupil than poor communities (Bénabou, 1994, 1996a; Durlauf, 1996; Fernandez and Rogerson, 1996, 1998). Policies that lead individuals with middle incomes to move into poorer communities, as, for example, subsidies for living in poorer communities, can induce a Pareto improvement (Fernandez and Rogerson, 1996). Changing the system in favor of a more centralized financing does not have an unambiguous impact on welfare (Fernandez and Rogerson, 1996, 1998). It will reduce welfare if segregation is not offset (Bénabou, 1996a). Similar phenomena can turn out if individuals are initially identical and choose between different education levels. A modified peer group effect in such a way that the unit cost of educating an individual falls with a higher share of pupils striving for the higher education levels yields stratification (Bénabou, 1993).

In the model of Bénabou (1996b) the production of human capital depends on the parents’ human capital, time spent on education of their children, resources spent on education, and a stochastic shock. Wages are deter-
mined both by the individual level of human capital and the average human capital in the economy. While the advantage of segregation lies in the feature that human capital is bequeathable, the complementarity of inputs in the production process indicates that centralized financing is preferable. Typically, short-term growth of output is higher under segregation, while central financing is associated with a higher long-term growth rate.

If human capital accumulation is positively influenced by the share of talented children in the class, and if this peer group effect is stronger for less talented children, an inefficient uneven distribution of talented children can turn out (de Bartolome, 1990). Enhancing efficiency will then not be reached by taxation according to the parents' residence, but by an equalization of school budgets.

Important insights have also been gained from migration theory where the results are applied to competition between countries or regions. If skilled individuals move in one direction between two jurisdictions, this brain drain causes inefficient low education subsidies in both regions (Webb, 1985). Similarly, the budget for public education will fall short of the efficient level if there is a positive probability of outmigration of skilled workers (Justman and Thisse, 1997). Given that brain drain is detrimental for growth in the sending country, a policy of reducing these losses may consist in improving the country's stock of human capital per skilled worker by increasing the teacher-student ratio (Wong and Yip, 1999). If physical and human capital are complements in production and education financing is decentralized, the chosen level of education subsidies will be too high since each region tries to attract mobile physical capital (Gradstein and Justman, 1995).

6 Problems of higher education

Subsidies for higher education are frequently met throughout the world. However, the terms of payment are very heterogeneous. In some countries students do not have to repay the subsidies. Others choose loans which are either organized like a mortgage or which have to be paid back according to the individual's income situation (Barr, 1993). In Australia, for example, tuition fees cover about 20-25% of the costs of education; the interest rate on the loan is equal to the inflation rate, and repayment does not start before the income of the recipient exceeds the average wage income in the economy.
(Chapman, 1997).

The repayment of the study loan by an increased income tax need not reduce the demand for education. On the one hand, the rate of return on investment in human capital declines, but on the other hand the opportunity cost of a longer study is lowered (Clarke, 1992). If subsidy grants to students are conditioned on the income or wealth of their parents, the savings of the parents to cover the costs of education and their own old age provision will decline (Feldstein, 1995).

Of course, the justification of education subsidies for tertiary education follows the general arguments. The interesting point lies in explaining a subsidy where the beneficiaries usually constitute a minority of the electorate. A possible reason for granting such subsidies is that due to complementarities in production between skilled and unskilled labor a higher share of skilled labor raises the remuneration of unskilled labor. The increase in wages may overcompensate the contribution of unskilled workers to finance the university system. Johnson (1984) considers a model with three types of labor where medium skilled labor and high skilled labor are perfect substitutes. Only talented individuals have to decide whether to acquire education in order to become a high skilled worker. It is shown that only individuals with low abilities benefit from an education subsidy. Another possible rationalization is that individuals who like both income and education may be willing to play fair lotteries. These lotteries are organized by the government that sets taxes, education subsidies and admission rules for universities (Garratt and Marshall, 1994).

According to Creedy and François (1990, 1992a,b, 1993), who consider a model with external effects of human capital accumulation, the subsidy for higher education is chosen in such a fashion as to maximize the lifetime income of the median voter. While the subsidation rate increases with the strength of the external effect, the respective impacts of the other types of public expenditure and of the private returns on education are ambiguous (Creedy and François, 1993).

The claim of Hansen and Weisbrod (1969) that tax-financed education subsidies lead to a redistribution in favor of rich families, whose children are disproportionately represented as students at universities, has been disputed in the literature. A comprehensive assessment would need to consider distributional impacts both between and among generations and would have to employ a life-cycle perspective with respect to both aspects (Crean, 1975;
McGuire, 1976; Conlisk, 1977). If liquidity constraints are substantial and individuals differ with respect to endowments, subsidies for higher education financed by income taxes have to be chosen above the efficient level in order to achieve equality of opportunity (Garcia-Penalosa and Wälde, 1997). While government loans at the market interest rate will generally not restore efficiency under uncertainty on returns to education, the efficiency goal can be achieved through subsidies financed by a graduate tax (Garcia-Penalosa and Wälde, 1997).

The construction of optimal higher education systems is a neglected subject in the literature. Under lump-sum taxation the maximization of a utilitarian welfare function generally leads to the result that more talented individuals will be provided with a higher amount of education and have to pay a higher tax (Ulph, 1977). If public and private education are perfect substitutes and the government’s budget is fixed, the share of public education falls with increasing talent (Hare and Ulph, 1979). Another feature of an optimal educational system is that groups with higher “mortality” rates, i.e. probabilities of dropping out of the workforce for any reason, should receive less public education than others (Manning, 1976).

The problem of setting tuition fees need not be viewed as reflecting that universities sell the produced human capital. Rather, the students who constitute inputs in the production process are taxed. Net tuition fees, i.e. gross tuition fees minus fellowships, represent the difference between the output price and the students’ renumeration (Rothschild and White, 1995). It should be noted that research and education of graduate students often show characteristics of joint production. Hence, subsidies for research will generally induce an increased supply of courses (Nerlove, 1972).

7 Training

Education is often supplied by firms, in particular through apprenticeships and other training programs. Becker (1993) introduced the distinction between general training and specific training. The former raises the workers’ productivity at different occupations while the latter only raises the productivity in the respective firm. Since workers can quit, Becker (1993) concluded that firms cannot capture gains of general training. Therefore, general training will be supplied only if the worker bears the full cost by a reduction of
his current wage. This result does not hold if the worker would not receive wage offers equal to his marginal product from other firms. This may happen due to asymmetric information across firms with respect to the worker’s abilities. While the current employer observes the worker’s ability at the end of the training program, outside firms cannot infer from an observed split whether the cause was a low ability of the worker or an exogenous reason. Firms then have an incentive to provide general training since they can capture part of the gains (Acemoglu and Pischke, 1998, 1999). Another scenario states that firms have some market power in the labor market. Since outside firms will receive benefits from general training due to some exogenous splits, underinvestment in human capital is the typical outcome (Stevens, 1996).

In principle, a firm can capture the rents of specific training. However, in general a sharing rule of costs and benefits between worker and firm is used in order to reduce the probability of an inefficient split (Hashimoto, 1981).

8 Standards, unemployment, redistribution, and development

Standards

Some recent papers deal with setting examination standards. If the students differ with respect to their preference for leisure, standards under an egalitarian welfare function will fall short of those derived from the goal of income maximization (Costrell, 1994). If individuals differ with respect to their abilities and if education is productive, the opposite result may hold (Betts, 1998). Standards will be higher if schools set them before pupils enter the school than in the opposite case (Effinger and Polborn, 1999). A decentralization of standard setting generally leads to lower standards. This result turns out since a region will not receive the whole returns from the increased human capital stock due to outmigration. In addition, the students cannot capture the full returns of their human capital investment due to wages reflecting average human capital in a group. Therefore, many of them may choose not to fulfill the standard. Conversely, a centralization of standards will lower standards if the weakest region has a high weight in the social welfare function (Costrell, 1997).

Somanathan (1998) considers a model in which schools are heterogeneous
with respect to quality. While school quality is not observable for firms, they can assess the productivity of college graduates. In such a setting an increase in the heterogeneity of schools or technological progress increases the number of college students and reduces the wages of those leaving school. Introducing exams in school increases welfare since overinvestment in human capital can be avoided. Judson (1998) considers a model in which individual abilities can only be imperfectly observed, where the degree of uncertainty, expressed by the variance of the pupil’s signal, declines over time. Decisions on admission rates for primary education and the cutoff level for secondary education are taken by the government aiming at maximizing the total return to education subject to a fixed budget. Lowering the return on primary education or increasing its price reduces the admission rate, and public resources are shifted towards secondary education.

**Education and unemployment**

The observable higher unemployment rate of low skilled workers, which mainly reflects a higher number of unemployment spells (Ashenfelter and Ham, 1979; Nickell, 1979), can be explained by matching models. Since high skilled workers usually can also perform the tasks of low skilled workers, the job pool for the former type is larger (McKenna, 1996). If firing restrictions exist and a firm’s profit from employing a skilled worker exceeds the rent from employing an unskilled worker, firms tend to keep vacancies due to a positive option value of waiting for a skilled applicant (Saint-Paul, 1996b). Another view states that high-skilled workers are more likely to receive specific training by their firms. These training costs are sunk and the firm captures parts of the benefits. Therefore, skilled workers will generally not be dismissed during a downswing (Becker, 1993). If individuals differ with respect to their cost of education and if wages depend on the group-specific unemployment rate, an equilibrium will be established in which the educated exhibit both a higher wage and a lower unemployment rate than the unskilled. Decreasing the private cost of education results in higher unemployment rates in both groups. However, the aggregate unemployment rate may decline, and the income of capital owners rises (Saint-Paul, 1994, 1996a).

Some recent contributions stress that unemployment of the unskilled caused by a minimum wage leads individuals to raise their human capital investment levels. This may have positive effects on income, employment and
growth in the medium run (Cahuc and Michel, 1996; Davis and Reeve, 1997; Cubitt and Hargreaves Heap, 1999).

Education and redistribution

In an economy in which multiple growth equilibria exist due to threshold externalities of human capital accumulation, a government aiming at maximizing the long-run growth rate may choose a redistribution towards the rich in early stages of development in order to avoid an underdevelopment trap (Galor and Tzidou, 1997). If the government follows a distributional objective and if the incomes of individuals depend both on their talent and investment in human capital, a problem of time inconsistency arises. The government would prefer to commit to lower tax rates than it will choose ex post. This leads to underinvestment in human capital and can therefore justify a minimum level of mandatory schooling (Bodway, Marceau and Marchand, 1996b). Although in a private education regime moderate income-transfer policies may increase growth, implementing high tax rates will decrease the children's efforts at school to such an extent that all dynasties will lose (Orazem and Tesfatsion, 1997). If only two types of workers exist, a redistributive policy leads individuals to decrease their efforts in school, resulting in a lower graduation rate, a lower share of skilled workers, and a lower growth rate of output (Long and Shimomura, 1999).

Education and development

A country in which liquidity constraints reduce the demand for education will generally exhibit a comparative advantage for goods produced by low skilled workers. Reducing barriers to trade will depress the price of goods produced by high skilled workers and their wage. Since high skilled workers can choose to become teachers, the trade liberalization reduces the cost of education and can therefore initiate the growth of a high-tech sector (Cartiglia, 1997). Even if the cost of education remains constant, higher wages for the low skilled due to higher demand for labor-intensive commodities will reduce liquidity constraints (Owen, 1999). The possibility of brain drain, i.e. outmigration of high skilled workers, can increase growth in developing countries if migration is partially restricted and a higher share of high skilled in the economy is associated with a positive externality. In such a situation,
the chance of receiving high wages abroad provides incentives for human capital accumulation (Mountford, 1997). Economies in which the occupational choice between worker, entrepreneur and rent-seeker is distorted to the disadvantage of the entrepreneurship will experience lower output growth (Murphy, Shleifer and Vishny, 1991).

During the development process the inequality of the individuals’ education levels usually first increases and then decreases (Ram, 1990). Such a phenomenon occurs if the production of human capital depends on the parents’ human capital and the child’s effort and if, in addition, the production of human capital is associated with increasing returns to scale (Glomm and Ravikumar, 1998). It can also arise if human capital is produced with the parents’ human capital and physical resources where a positive externality of the average human capital of the previous generation is present (Galor and Tsiddon, 1997).

9 Concluding comments

Many insights regarding the economic theory of education have been gained during the last decades. We have arrived at a comprehensive understanding of the different factors that determine educational decisions. Three main reasons for government intervention have been identified, namely overcoming poverty traps, internalizing positive externalities, and avoiding coordination failure. However, noting that the models usually neglect the consumption function and the signaling function, assessing the impacts of education subsidies and the provision of public education may often exaggerate the benefits. While the literature on public intervention in the education sector does still not allow a clear-cut judgement with respect to the efficiency aspects of several measures, we are now in a position to identify some important determinants. More research is certainly needed in the field of distributional implications of education subsidies, in particular with respect to subsidies for higher education. The divergence of educational policies indicates that the uncertainty concerning this subject is considerable. Another topic in the future is to integrate the literature on setting examination standards with the construction of efficient educational systems. Due to its enormous practical relevance, the most important task is, however, to further develop the theory of the interactions between education and unemployment.
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