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CHERRY-PICKING IN THE ECONOMICS OF EDUCATION ORCHARD: A SELECTIVE SURVEY OF RECENT DEVELOPMENTS

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ABSTRACT

A selective survey of recent developments in the economics of education is presented. The survey focuses in particular on key contributions in the areas of (i) human capital, signalling and screening, (ii) educational finance, and (iii) universities as multiproduct institutions.

Keywords: education, human capital, signalling, screening, vouchers, location, efficiency, cost function, multiproduct firms

JEL classification: I20

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Introduction

It is an honour to have been invited to present this lecture to the conference of the *Società Italiana di Economia Pubblica*. I am delighted to be here, and am delighted also that the theme of your conference this year concerns the 'Economics of Human Capital: Institutions, Incentives and Evaluation'. With such a theme, the conference promises to be a stimulating event. The conference title, indeed, hints at what is so magical about the economics of education. In an environment where institutions are complex and powerful, we are starting to learn about the power of incentives as mechanisms that can bring about change in the direction of greater social efficiency.

My task is to provide a broad survey of the field of the economics of education. It is a task that would be better suited to a series of books than to a short lecture. Indeed, two handbooks (one of which is itself a two volume edition) have been published on the economics of education in recent years.[1] So I shall need to be selective. I shall focus on a small number of papers that have excited me, and that have impacted upon my own work in this area over the last 10 years or so. I will, however, select this literature from a variety of topics within the sphere of the economics of education.

To begin with, no consideration of the economics of education would be complete without some discussion of human capital models, on the one hand, and signalling and screening models, on the other. The relationship between education and earnings has been the focus of a vast amount of empirical research, and in the last 10 years we have made gains in understanding of the roles played by ability bias, endogeneity, and dynamics in the earnings function. The microeconomic relationship between education and productivity of course has a macroeconomic counterpart in the impact of education on growth. After considering these issues, I shall devote some time to the economic analysis of educational funding models.. Finally, I shall consider both the theoretical and the empirical literature on universities, a particularly distinctive type of educational institution characterised by their multiproduct nature.

Education and earnings

The human capital model of wage determination has its origins in the work of Adam Smith (1776), but in the modern era is associated with Schultz (1961), Becker (1964) and Mincer (1974). The idea is simple; by investing in education, individuals become more productive and so reap a reward in the form of higher lifetime earnings. In a free market, individuals will invest in education up to the point where the internal rate of return on education equals the rate of return available on other investments, thereby following the 'eleventh commandment' of Mark Blaug (1970): 'thou shalt equalise rates of return in all directions'.

There are some important nuances. The private rate of return may be distinguished from the social rate of return. This distinction is important where there are differences between the private and social costs and benefits of education. Private benefits are usually thought of in terms of increased earnings potential. Since the increased earnings typically come from increased productivity, the social benefit of education is

[1] Johnes and Johnes (2004) and Hanushek and Welch (2006).

ususally considered to be similar to the private benefit – although some researchers make an income tax deduction from the latter. The big difference, however, is between private costs and social costs. Where government fully subsidises education, private costs consist only of foregone earnings (or output), while social costs include also the costs of tuition. This means that social rates of return are characteristically lower than private rates of return – and that systems where education is subsidised and not rationed can be prone to overeducation. (The social return to education, somewhat perversely, is not usually defined to include well-established positive externalities such as better health, lower crime, or responsible attitudes to the environment.)

The rate of return to education may be calculated using a variety of methods (Psacharopoulos and Patrinos, 2004). The full method involves gathering information about the (smoothed) income streams of individuals of different education levels over the life cycle, and about the costs of education. The rate of return that equates the costs to the present discounted value of the benefits of education is then found by solving a high-order polynomial equation.

A short-cut method divides the difference between the mean earnings of educated and uneducated individuals by the duration of study times the mean earnings of the educated. This is clearly much less data-hungry than the full method, and in many cases provides a good approximation. In effect it assumes that the earnings differential between individuals with different levels of education is stable over time, that the only cost attached to a year of education is foregone earnings, and that individuals discount future returns over an infinite time horizon.

A third method which is very commonly used is based on a regression analysis, and derives from the work of Mincer (1974). This so-called Mincerian rate of return is the coefficient on the number of years of schooling in a semi-logarithmic regression of wages on schooling and a variety of controls – usually including linear and quadratic terms in experience. This method is based upon similar assumptions to those underpinning the short-cut method.

It is important to note that it is not more generally true that the coefficient on a variable in a wage equation can be identified with a rate of return. For example, the coefficient on a binary variable indicating whether the respondent has undergone training is not a rate of return on that training experience, since there is no measure of the cost of that training. Equally, it is important to note that the Mincerian rate of return is a measure of the private rate of return under certain assumptions only. It cannot, for example, be meaningfully considered to be a measure of the rate of return to higher education in countries where students pay non-negligible tuition fees, since it assumes that foregone earnings are the only (private) costs of education.

Using one or another of these three methods, several thousand studies have calculated rates of return to education in a large variety of countries. These have been surveyed recently by Psacharopoulos and Patrinos (2004), and the findings are striking. As one would expect, social rates of return are lower than private rates of return. Typically the rates of return diminish as the education level rises, so that primary education has the highest rate of return while higher education has the lowest. Rates of return are higher, often much higher, in developing countries than they are in developed economies. This is indicative of underinvestment in education in poorer countries, and

has led the World Bank to call for universal primary education by the year 2015. As things stand, that laudable goal looks unlikely to be achieved.

Much of the recent literature on the evaluation of rates of return to education has focused upon the problem of endogeneity in earnings equations. This issue has been surveyed recently by David Card (2001). A variety of fixes is possible, and many of these rely on using institutional aspects of the educational system to generate instrumental variables that are related to the experience of education but are orthogonal to subsequent earnings. Since Card's survey provides much detail about these studies, I shall mention them only briefly here. Instruments that have been used, with some success, include: college proximity (Card, 1995); quarter of birth (Angrist and Krueger, 1991; Staiger and Stock, 1997); raising of the minimum school leaving age (Harmon and Walker, 1995; Meghir and Palme, 1999) and other educational reforms (Brunello and Miniaci, 1999); differences in educational attainment due to war (Ichino and Winter-Ebmer, 2004; Angrist and Krueger, 1995). Typically the rate of return estimates that are yielded by instrumental variables estimation exceed those provided by OLS. The conventional explanation for this (Griliches, 1977) is that ability bias (which would lead us to expect that OLS estimates of the rate of return are upwardly biased) is more than offset by the effects of measurement error. There are, however, other explanations. The instruments may be crude, there may be publication bias, or the instruments may disproportionately affect respondents who have a relatively high rate of return.

An alternative to instrumental variables estimation is to design a full structural model of education, occupational choice, and earnings. This literature, spawned by the work of Keane and Wolpin (1997) involves the construction of a theoretical model that explains an individual's educational and occupational decisions at each point in time. The parameters are then estimated using panel data and simulated maximum likelihood techniques. The explanatory variables comprise the set of decisions made by that individual in the past, and also the expected value of decisions that will be made in the future. The calculation of the latter involves the evaluation of expected variables defined over a huge state space, and so this method is computationally extremely expensive. Nonetheless, structural dynamic discrete choice models of this kind are attractive for a number of reasons. They involve the estimation of the parameters of a theoretical model, and so link empiricism more closely to theory than is otherwise possible. They also enable a variety of dynamic policy simulations to be conducted, and these would be difficult to achieve using more conventional methods.

This discussion of rates of return should not blind us to the fact that the relationship between education and earnings is not necessarily explained by the accumulation of human capital. Since the seminal contributions of Arrow (1973) and Spence (1973), it has been well understood that education might act as a screening device or a signal of an individual's innate ability, and that it might be this innate ability rather than education itself that allows productivity, and hence earnings, to be augmented (Brown and Sessions, 2004). As Lazear (1977) has argued, it is particularly difficult to disentangle the effects of human capital accumulation from those of signalling and screening because they are observationally equivalent – or nearly so.

A variety of tests has been used in the literature to provide evidence that can help us judge between the human capital and the signalling and screening models. First, since

employers learn about employees' productivity over time, one would expect the magnitude of signalling and screening effects to weaken with tenure (and so, since tenure is correlated with age) also with age. Secondly, since self-employed workers presumably know something about their own abilities, we would expect signalling and screening effects to be absent for such workers. Thirdly, since rank determines earnings in a signalling and screening model, while the level of productivity determines earnings in a human capital model, an increase in the educational level of other workers (holding constant own education) should lead to a decrease of own earnings in the sorting model (Johnes, 1998). For the most part, these tests come down decisively in favour of the human capital model, and it is clear that, at least in its strong form, the signalling and screening theory has been debunked.

Once piece of evidence remains in favour of the sorting models, however. Altonji (1995) has noted that, while the number of years spent in high school significantly affects earnings, the academic composition of those years – the number of courses and the subjects studied – does not. This suggests that employers use the more readily observed years of education as a signal or screen, while failing to consider as a determinant of earnings the precise nature of the education path that the individual has followed.

In recent work, I have challenged this view. It seems to me to be important to model students' choice of curriculum in a way that makes sense of the fact that subjects are indeed studied together. The linear model advocated by Altonji does not satisfy this requirement. A more reasonable model allows for the fact that there may be (non-constant) returns to scope associated with studying various combinations of subjects together. To examine this further, I have developed a neural network model of curriculum and subsequent earnings (Johnes, 2004a). Analysis of this model reverses Altonji's finding that the academic composition of a student's high school career does not have an impact on earnings. My results therefore provide further support to the human capital model.

The microeconomic work on human capital has a macroeconomic counterpart in the literature on growth. The new growth theories, whether they are adaptations of the neoclassical model (Mankiw *et al.*, 1992) or based on the cumulative causation (Kaldor, 1966; Nelson and Phelps, 1966) models of endogenous growth (Romer, 1986; Lucas, 1988), place education centre stage. The theoretical work in this area was given empirical support by Levine and Renelt (1992). While early work focused on the quantity of schooling, more recent analyses have considered issues such as schooling quality (Hanushek and Kimko, 2000; Jamison *et al.*, 2006) and the distribution of educational opportunities (Castelló and Doménech, 2002). Recent work has also focused on the sequencing of reforms. In the least developed economies, educational investment is, along with an open economy, a fundamental prerequisite for growth. Foreign direct investment in physical capital has been a major force in regions such as east Asia because countries in these areas already have a well educated workforce capable of using the new technologies. The education has to come first (Johnes, 2006).

Education finance

The microeconomic and macroeconomic evidence that education is indeed a productivity enhancer allows us to take seriously the results of rate of return analyses. In developing countries, in particular, undereducation appears to be a problem. In these countries, as elsewhere, imperfections in capital markets prevent individuals from investing optimally in their own and their children's education, and there is a clear need for government intervention in order to offset this market failure. More generally, the question of how to finance education has generated a lot of research, although it is difficult to separate out the economics from the ideology in this area.

Much discussion about the funding of education centres around the idea of vouchers. The idea of vouchers has a long history which goes back to the 18th century English thinker Thomas Paine (1792), but modern developments of the concept originate in the work of Milton Friedman (1955). Voucher systems have been introduced in a variety of contexts, including pre-school education in England (Sparkes and West, 1998) and a variety of experiments in various states of America. Rigorous theoretical treatments of voucher systems have entered the literature only recently, however, the key contribution being that of Epple and Romano (1998).

In this model, students differ from one another across two dimensions, namely ability and household income. The model allows the presence of peer effects, so that the presence of students of high ability in a given school serves to raise the performance of all students in that school. School quality is measured by the average ability of its student body. The education system comprises both public and private schools; in the former, tuition is free, while in the latter there is a cost of tuition in the form of a fee.

Household utility is an increasing function of income net of any contribution to the costs of the child's schooling, net also of proportional income tax which is raised to fund public schooling, and utility rises also with the child's achievement (which in turn depends on her own ability and that of others attending the same school). Schools face costs that are defined by the sum of a fixed and a variable component; the latter increases at an increasing rate with the roll, ensuring that returns to scale may be positive or negative.

Preference for one school over another depends on the ability of the peer group and the level of tuition fees. In the public sector there are no tuition fees, and in equilibrium migration of pupils between schools will ensure that all schools in this sector are identical in terms of the average ability of their students. The size of schools in this sector is determined by cost minimisation. It is assumed that the public sector schools do not engage in strategic behaviour.

Private schools, on the other hand, do behave strategically. They are assumed to maximise profits and operate in a market where there is freedom of entry and exit, with schools continuing to enter while expected profits exceed zero.

The set of assumptions that I have described here allow a model to be constructed which satisfies household utility maximisation, private school profit maximisation, a zero profit constraint for private schools, public sector policy rules, and market clearing. The solution of the model implies that schools are arranged into a hierarchy,

with heterogeneous private schools admitting pupils with the highest average ability, and homogeneous public schools admitting those with the lowest average ability. In short, this is due to the fact that no household would be willing to pay for private education if the peer group in private schools is of lower quality than that which is obtainable for free in the public schools. The private schools choose to distinguish themselves from one another because product differentiation allows greater profits to be earned. So in equilibrium, albeit a zero profit equilibrium, these schools are heterogeneous.

Under various conditions, the pricing policy of private schools can depend on quality of the peer group or household income. Epple and Romano show that where public and private sector schools co-exist, neither the number of schools nor the allocation of students between the schools is efficient. This should not be surprising: since there is a discontinuity between the price charged for private education and the (zero) price charged for public education, a reallocation of students at the margin would yield an efficiency gain.

Under a voucher system, an amount equal to the value of the voucher is added to the net income of all households that send their child to a private school. The budget constraint of the government must also be amended to reflect the increased costs associated with a voucher scheme. By reducing the cost to the user of private schooling, the vouchers increase the demand for education within this sector. As the size of the private sector increases, the heterogeneity of schools increases. At the top end the quality of the peer group improves, and so the introduction of vouchers leads to a gain for high ability students. Meanwhile, at the bottom end of the hierarchy, as students move from public to private sector schools, the quality of the peer group (and therefore of the experience of a give pupil) in the public sector falls. It is possible therefore to regard vouchers as divisive, even though the competition that they encourage might lead to gains on average.

Epple and Romano calibrate their model on US data – an important step in their analysis because it ensures that their results are driven by empiricism rather than ideology. They find some interesting results. While on average there are indeed gains attached to the adoption of a voucher, a minority of pupils gain significantly while the majority of pupils lose out (albeit to a small extent). This is an important result, not least because it may explain why electoral support for vouchers has often not been forthcoming.

Of course the debate over vouchers represents only one part of the broader debate on educational finance. Within Europe, moves to develop cost sharing schemes for the funding of higher education have generated considerable controversy in many countries. In some of the transition economies of eastern Europe, private higher education has flourished, aided by the underdeveloped nature of policy in this area in the years immediately following the change in regime. Meanwhile, in these countries, traditional universities in the state sector that have wanted to expand have exploited loopholes in policy that allow them to charge high tuition fees to some of their students. In the United Kindgom, legislation has narrowly been passed that now allows higher education institutions to charge domestic undergraduates up to £3000 per year in tuition fees. Market forces ensure that not all institutions charge this much for all of their provision, and a plethora of scholarships and bursaries is available.

(Institutions have, for many years, been free to choose the level of tuition fee that they charge both to overseas students and to all postgraduates.) In many other western European countries, however, tuition fees are still a live issue, and in many countries the state funding of universities is based on a model that does not provide sharp incentives.

Cost sharing – the idea that the costs of higher education should be shared between the state and private individuals – is an idea that has been promoted by many international agencies, including the World Bank. But remarkably little work has been done on the optimal mix of public and private funding. The prior belief of many economists seems to be that the 'user pays' principle should hold, but in a model where education influences subsequent incomes and where the distribution of income is an argument in the social welfare function, this belief might be mistaken. I have shown (Johnes, 2004b) that private funding of higher education is optimal under utilitarianism (and indeed under a Rawlsian social welfare function), but in more general cases public funding can yield welfare gains. These are due to the tension between private optimality and social efficiency that arises when the impact of education on the income distribution is considered. Similar considerations have been addressed also by Gianni Di Fraja (2002).

Concerns about cost sharing have focused on higher education because, unlike primary and (at least lower) secondary education, attendance at university is not compulsory. Tertiary education is in this manner distinctive.

Universities as multiproduct institutions

Another area in which universities are distinctive concerns their multiproduct character. For universities are not, like other educational institutions, engaged only in the delivery of knowledge, but also in its creation. Research sits alongside teaching as a major output of the university sector. Recent work has led to an improved understanding of the way in which institutions of higher education make decisions about the mix of teaching and research that they will provide.

Elena del Rey (2001) presents a model of competition between universities that are funded by a block grant and a per-student allocation made by the state. With this funding, universities employ teaching and research staff. By admitting only the best students, institutions can ensure that less teaching resource is needed in order to achieve a predetermined quality threshold and that more resource can therefore be devoted to research.

A game is played between universities located in different places. The universities compete for students that are distributed evenly across both geographical and ability space. The utility to each student of studying at each university depends (positively) on the quality threshold set by that institution and (negatively) on the distance between that university and the student's home. This defines the first choice demand for each student, and, in a two university model, means that a point in geographical space can be defined which separates students that express a preference for one university from those that prefer the other. Call this point x*. Nevertheless, even though they have a clear preference, students may apply to both universities.

Universities impose limits on student numbers. Suppose that university 1 is the more selective institution, and that it offers places to all applicants whose ability level exceeds a_1. Since university 2 is less selective, all of these applicants are sure to be offered a place also at this university. Admissions to university 1 are therefore given by the number of students whose ability exceeds a_1 and who live between university 1 and point x*. Meanwhile, admissions to university 2 will equal those students who live between university 2 and point x*, plus those who meet university 2's ability threshold but not that of university 1.

The quality of graduates of each university is determined by the ability of its intake and by the financial resources devoted to teaching each student. Funds that are not used for teaching are employed in research. Each university seeks to maximise a weighted average of measures of its research and of its teaching output (the latter being the product of graduate numbers and graduate quality). The universities' problem is thus to maximise this subject to a production function constraint and a funding constraint.

The problem is solved as a two stage game. In the first stage, the universities simultaneously choose their quality thresholds. Once this information is published, students can determine their first choice demand schedules. Then in the second stage, the institutions choose the number of students that they wish to admit.

Depending on the parameters of the model, the Nash solution of the game can lead to one of four outcomes. First, universities may be selective in their recruitment of students and active in pursuing research. Secondly, they may provide mass education (wholly satisfying demand) and also pursue research. Thirdly, they may provide mass education without providing research. Fourthly, they may specialise entirely in the provision of research services. In each case, since the universities in the model are identical *ex ante*, and since the value added by each university is supposed identical, the solution is symmetric and both institutions arrive at a similar outcome.

Since the outcome of this model is determined by the parameters, and since some of these parameters define the operation of the funding mechanism faced by the universities, it follows that the outcome is – in some circumstances at least – affected by the funding rule. Del Rey's paper therefore provides a neat link between the literature on educational finance and that on universities as multiproduct institutions, and provides a guide for policy-makers wishing to influence university behaviour by tweaking the funding mechanism.

Before moving on from this topic, however, I should note that Vanhaecht and Pauwels (2005) have produced an important variant of the Del Rey model. By relaxing an assumption that students' innate ability does not affect their preference for one university over another, and assuming a different form for the teaching cost function, these authors reverse Del Rey's conclusion that the outcome is symmetric across universities. They find that different universities might choose to locate at different points in the quality dimension. Clearly these models are very sensitive to initial assumptions. The recent development, by Chen and Riordan (2007) of the spokes model, which relaxes some of the restrictions of the Hotelling (1929) type models discussed by Del Rey and Vanhaecht and Pauwels, suggests that there is

opportunity to do much more work in this area. Nevertheless, the fragility of the results obtained so far suggests that theory has limitations, and that a substantial investment in empirical work is also warranted.

Fortunately the multiproduct nature of universities is an area where empirical research abounds. Much of this has involved the estimation of cost functions, and filling this literature is a task to which I have devoted considerable energy. The state of the art models in this area estimate true multiproduct cost functions in the sense of Baumol *et al.* (1982), using the appropriate stochastic frontier estimation methodologies developed by Aigner *et al*. (1977), Jondrow *et al.* (1982), and the panel data methods pioneered by Tsionas (2002) and Greene (2005). Over the last year or so, several papers have appeared that provide estimates of average incremental costs, returns to scale, and returns to scope within higher education institutions, all within a parametric framework that nonetheless allows the cost function to differ across universities while also providing information about each institution's technical efficiency (Johnes and Johnes, 2006; Agasisti and Johnes, 2006; Johnes and Salas-Velasco, 2006). Here I shall discuss in a little more detail the results obtained in just one of these studies – one that I conducted with my friend and colleague Tommaso Agasisti and which concerns the universities of Italy.

The random parameters specification of our frontier model suggests that cost differences between universities are particularly pronounced for two of the outputs that we consider, namely non-science students and research activity. Non-science students add a relatively large amount to costs in Genova, Messina, Siena, Trieste and Pavia, while research activity is relatively costly in Milano, Pisa, Siena and Torino. The relatively high costs in these institutions does not (necessarily) reflect inefficiency. For example, Siena appears in both lists, presumably because it is an ancient university. Such institutions typically incur high expenditures which are partly due to the high costs of maintaining property, and which also reflect the atypical nature of much of the teaching and research activity that goes on there. The measures of technical efficiency that are yielded by our analysis suggest that such efficiency in Italian institutions is for the most part quite high, though there are exceptions.

The results of our analysis provide information also about the average incremental costs associated with the production of each type of output in a typical university. Amongst students on taught courses (undergraduates and the Laurea), costs are typically higher for specialists in science (at about €4000) than for other students (for whom costs are about €3300). Costs associated with doctoral students are very high in comparison, at over €13000.

Our findings suggest that ray economies of scale are exhausted in Italian universities and that diseconomies of scale have set in. The same is true of product-specific economies of scale, with the exception of non-science students. Some global economies of scope remain, however. These results are quite startling; overall they suggest that Italian universities are typically too big, and that the overall costs of higher education in Italy could be reduced by divestment.

Conclusion

In drawing to a close, I wish to emphasise that understanding the process of education involves the full toolkit of modern economics. Education takes time, and its benefits are realised over many years. The relationship between education and other choices that individuals make over the life cycle is therefore a dynamic one, the analysis of which requires sophisticated theoretical and empirical tools. By definition, education is about a transition from ignorance to knowledge. The economics of information and models of the behaviour of principals and agents sit naturally alongside the concept of learning. Likewise, as an investment, education responds to uncertainty about the future. Educational institutions are amongst the most interesting and complex of the economic agents that we can analyse. Moreover, modern models of economic growth place education at centre stage. Nations that learn well earn well (Johnes, 2006). The problem posed by the observational equivalence between various models of growth has led to the development of new approaches to quantitative theory – the marriage of empirical analysis and theoretical work – that has had profound implications for economic practice that go way beyond the confines of the economics of education. All this being so, it is not surprising that the economics of education has become an area in which many of the best minds in economics now engage. There has consequently been a flourishing of quality research in the field that makes this a vibrant area in which it is exciting, and indeed a privilege, to work. In this conference we shall see plenty of evidence of that. Once again, let me thank you for inviting me to share with you in this exciting event.

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