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"What we measure affects what we do.
If we have the wrong measures,
we will strive for the wrong things"
(J. Stiglitz, Financial Times, 14.9.2009)

Let me say at the beginning that I am not a statistician; my approach to the problem of defining and measuring human capital will be that of an economist. In other words, I will try to see if measurements of the object and the conceptualisation of it stand consistently together and provide significant tools for understanding the working of the economic system and for deriving suggestions for policy. The aim of the present contribution is not to review all the definitions and measures, but rather to point out some aspects which may raise doubts or problems that deserve further investigation.

If the term "human capital" has to be given a proper economic meaning, it cannot fail to meet two qualifications: a) it must stand for a set of "means of production"; b) these means of production, in turn, have to be the output of a productive process. Failure to meet these requirements would imply the impossibility of classifying as "capital" whatever with this term may be meant.

1.**Human capital as a factor of production**. The fact of considering human capital as a set of means of production implies that it must be able to enter a production function. This has been done. A traditional function, with constant returns to scale, can be written:

$$Y = A K^{\alpha} H^{1-\alpha} \qquad 0 < \alpha < 1$$

Where human capital enters directly as H, physical capital as K and A is total factor productivity. This version can be considered just a specification of the more general AK model in which K stands for both physical and human capital. In this specification H stands for the number of workers L multiplied by the human capital of the representative worker, h. Lucas (1988) includes another factor in the production function: the average human capital stock in the economy, in order to take account of externalities: $Y = A K^{\alpha} H^{1-\alpha} H^{\gamma}$.

Alternatively, the contribution of human capital to aggregate production can be thought of in terms of its influence on total factor productivity. In this case it is its stock rather than its rate of accumulation that becomes relevant for growth (Benhabib and Spiegel, 2005 – Aghion and Cohen, 2004)). This role is explained, following Romer's (1990) approach, by considering technical progress as a linear function of the stock of human capital for technology creation and/or for technology diffusion.

But a good help to extract some basic problems in the definition and measurement of human capital may come from another approach. Under this approach human capital as a factor of production can be viewed as entering an input output table in a sort of production function a la Leontief.
In this view each sector will have a human capital coefficient:

$h_i = H_i / Q_i$

In this frame the human capital is a sector of production of its own, whose output H will be the inputs to all sectors. Equilibrium requires that the output of the human capital sector be equal to the sum of human capital quantities employed in all sectors:
$H = H' Q'$
So, the stock of human capital is given by the sum of all the quantities actually employed in the transaction matrix.
What in case $H' Q' < H$? In this case the quantity of human capital $H – H' Q'$ would perhaps be better considered as a consumption good rather than as a mean of production; alternatively the unbalance would show an inefficient labour market where prices are not able to equal demand and supply of skilled labour.

2. **Heterogeneity**. The first problem immediately visible in this frame is the heterogeneity of such quantities. Something which reminds of the heterogeneity of physical capital. If workers were homogeneous, the quantity of human capital would coincide with the quantity of workers, but they are not homogenous in so much as they embody different elements and qualities which are relevant for economic activity and differently contribute to the production of output.
It is exactly these elements embodied in individual workers that are referred to when the term "human capital" is used. This heterogeneity is extremely wide: it ranges from the different kinds of knowledge (scientific, practical, tacit, and so on) to the different kinds of "skills", some of which are "firm" specific and some also "task" specific.

This fits with the well known OECD definition, according to which human capital amounts to "the knowledge, skills, competences and other attributes embodied in individuals that are relevant to economic activity" (OCDE 1998). A broader definition which makes reference to the ability of human capital "to facilitate the creation of personal, social and economic well being" (OECD 2001) seems to belong rather to the field of social capital (of which human capital may be considered a

component) and to its involvement in the production of non economic benefits (for instance, quality of life, crime reduction). This definition is not far from Marshall view, who, comparing the carpenter's skill to the "tools in his workbasket", referred to "personal wealth so as to include all those energies, faculties and habits which directly contribute to making people industrially efficient" (Marshall,1890).

The heterogeneity of the variety of elements which enter the human capital coefficients of production is relevant under two profiles.

First. Some of these elements are the output of a productive process and some are not. The first category, in turn, may be the output of a variety of production processes: schooling, vocational training, lifelong education, learning by doing, self education an so on, also related to different kind of knowledge (know what, know how, know why, know whom, codified knowledge, tacit knowledge, scientific knowledge, practical knowledge..). It has to be noticed that all of these production processes have different production costs. Consider the experience of Statistics Sweeden, which reveals that 90% of competence development takes place through daily work and only 10% through budgeted courses (UN Economic and Social Council, 2006). The second category encompasses elements or capabilities relevant to economic activity that are due to a wide range of factors, such as innate qualities, instincts, attitudes, parental influence, social environment, culture, and which are not created by processes of production such as schooling or training.

The question is: do we have a way of distinguishing the quantities of the two components (and the subcomponents of the first category) that make up the human capital coefficients which enter the input output table? We must be aware that every firm buys a vector of capabilities embodied in individual workers and these vectors are different, both because of the existence of firm specific skills required (demand side) and because of the different individual profiles (supply side). If we are not able to operate the above distinction, we lack the basis for giving a proper meaning to the "stock of human capital" (strictly speaking, "the non produced" capacities should not be considered as "capital", but possibly something like "natural resources") and subsequently to deal with problems such as the evaluation of its cost of production, its accumulation, not to say its rate of return. An aggregation of the heterogeneous components of human capital under whatever measure would be problematic and unfit.

The second problem is the difficulty of disentangling the role in production played by the elements which are the output of a process of production from the others. If a great role were played by "non produced" elements of human capital what sense could be given to the notion of human capital "rate of return"? We should take seriously the empirical findings reported by S. Bowles (2001) about the success in the labour market (finding a good job and earning a good pay) derived from cognitive skills and non cognitive factors. Quoting a study by Duncan and Dunform, he reports that success in the labour market, and therefore earnings, were affected by behavioural factors, such as participation in social clubs, church attendance , television viewing, newspaper reading and even "an interviewer's assessment of the cleanliness of the respondent's home". He concludes that "the unexplained variance

in the standard earnings function is due in part to individual differences in behavioural traits that are rewarded on labour markets and not captured in the usual measures of schooling, work experience and cognitive performance", and that " we are not likely to find a non cognitive behavioural or personality analogue to the common factor g underlying most measures of cognitive performance", and concludes that "understanding why individual characteristics that are not skills may be rewarded in a competitive labour market may enhance the explanatory power and policy relevance of the human capital model".
One way out of these problems would be to consider "non produced" traits and characteristics (such as innate abilities, determination, attitudes, etc.) as functionally related to produced ones, and in this way to make the whole of the elements depend on the process of production of human capital, using the output of the production process of human capital, for instance "educational attainments", as a "signal" of capabilities and capacities not created but only detected by education. ("Does education raise productivity or just reflect it?", Chevalier 2003) The set of these capacities is very large (David, 2001). But the above mentioned unexplained variance, plus some recent empirical research (Chevalier 2003) seem to weaken this interpretation. In any case, should this screening hypothesis be considered valid, a big question would remain about whether the schooling apparatus is the most effective and efficient screening device.

3. **Human capital as a produced factor of production**. The individual vector of capacities that workers embody and employers buy in the labour market is, as it has been seen, only partially the output of a production process. The part which is, though, can be represented as the output of a production function with several arguments that reflect the variety of variables influencing the process of individual accumulation of human capital.
This may be tentatively described as

$h_t = f (h_{t-1}, s_t, la_t, w_t, eg_t, f_t, so_t, \text{etc.})$

Where
h_{t-1} = the human capital possessed at previous period, St= schooling in current period; la_t = other learning activities in current period; w = work experience in current period, eg educational goods and services purchased in current period (such as books, newspapers, records, theatre, travels, etc), f = family experience, so = social experience. Knowledge of coefficients an the elasticity of substitution among the different factors, together with their unit costs. is necessary in order to calculate the efficient combination in the production of human capital. Something rather difficult to acquire, given also the ambiguities of measuring the left side of the equation.
In the frame of endogenous growth, the per capita accumulation of human capital (according to Lucas model) is:
$dh/dt = \beta (1 - u) h,$

where (1-u) is the fraction of working time subtracted to work and devoted to formal education, so the growth of human capital is a positive function of the existing stock of human capital, but this holds true under the assumption that human capital accumulates only through formal education.

Once the cost of production to the individual and the price paid by employers (at their present values) are know, the profit, or the rate of return on the individual expenditure in capital formation can be determined. But this may have nothing to do with the productivity, or marginal productivity, of human capital. Like in the case of Keynes marginal efficiency of capital, market conditions, scarcity, new competitions, structural changes in demand could change the return even with unchanged physical productivity.

The well known Mincerian wage equation, where the natural logarithm of real wages is seen as a linear function of the year of schooling, the years of labour experience and a quadratic in terms of the years of labour market experience (Mincer, 1974), does not escape these limits. In addition, the parameter associated with the years of schooling can be considered as the private return to schooling, but just to schooling; it's inappropriate to consider it as a rate of return to investment in schooling because the costs of schooling, both direct and indirect, are not accounted for.

Considering the rate of return to investment in schooling, and still more to investment in education and training in general, brings to the fore the problem of how the costs are (or should be) shared between the individuals (both workers and employers) and the State. Something that implies a calculation of the social rate of return to education; which, in turn implies the adoption of some kind of a Mincerian aggregate production function in which years of schooling stand for human capital, and unavoidably some kind of "total factor productivity" element appears. Total factor productivity is notoriously a term which is not directly observable; nor is directly measurable the term human capital, and that's why the years of schooling are used instead.

4. **Measuring human capital: by schooling**. Here comes the problem of how to give a quantitative expression to human capital in a way consistent with its conceptual definition. An appropriate quantitative expression is necessary in order to measure the impact of human capital on productivity and earnings at the micro-level or on output and growth at the macro-level. We do not intend to deal with these impacts here, but just to raise some question on the ways of quantifying the human capital concept.

The simplest and raw measure of the human capital stock is straightforward, and has been mentioned above: years of schooling. This can be found both at a micro level in the Mincerian wage equation, and at the macro level, for instance, in models a la Benhabib, which measure the stock of human capital as the proportion of adults with tertiary education in the total adult population.

The simplest measure of the stock of human capital at time t is

$H = \Sigma\ Xe_i \times h_i$

Where Xe_i is the amount of workers with educational level i and h_i is the years of education of workers with educational level i. Following the input-output approach, only actual workers are considered and not the entire population, as only they enter the actual productive system and are used as input.

Still the problem of taking account of the educational level of the entire population is relevant, since investment is made on it through private and public expenditure and since some benefits to society can derive from it. But the point is whether, from the point of view of measuring the stock of capital, goods which are not used in production can be treated in the same way as those which are inputs in productive processes. Borrowing the term from Clower and Keynes, an aggregate stock of capital which includes also knowledge, skills, capacities and capabilities that are not used in production should more appropriately be considered as a sort of "notional" capital while "effective" capital would be made up only of those knowledge and skills actually exchanged and paid for in the market. On the other hand the difference between human capital embodied in workers and human capital embodied in unemployed is a problem. Would it be correct to admit that the stock of capital of a country may change merely as a consequence of a change in employment? Can the "non utilised" human capital be considered as the non utilized productive capacity of a plant? But, differently, the non utilised human capital has not been paid for by the firm. Would this divergence of some use in dealing with the problems of "overeducation" or mismatching? Alternatively it could be accounted for as "social capital", impacting on law and order, social cohesion, trust and the like.

The statistical techniques adopted for giving an aggregate measurement of the above mentioned stock of HC in terms of aggregate years of schooling are various, some make use of census data, some make deductions from past enrolments (Nehru 1995, Barro and Lee 1993, Psacharopoulos 1986) but it is the very point of using the aggregate unweighted sum of schooling years which is open to critiques (Wossmann 2000).

Assuming different and decreasing marginal productivity of years of schooling, the average measure does not make much sense (the productivity of a worker with 18 years of schooling cannot be assumed to be equivalent to the sum of productivity of two workers with 9 year of schooling or of 18 workers with one year of schooling) and, besides, this measure does not take account of the quality of years of schooling and might not reflect the actual acquisition of cognitive contents and skills.

In addition, and more fundamentally, this approach of adopting years of formal education as a measure of human capital is meaningful only on the assumptions that wages reflect labour productivity and that the contents of formal education enhance productivity. But if we admit market imperfections and a link between wage levels and scarcity we could have a paradox: that an increase in the number of people with high level of education would depress their wages.

5. **Measuring human capital: by other proxies**. Being made of knowledge and skills embodied in the individuals "human capital is harder to measure than physical capital as it has to be measured by indirect means" (Wei 2008), so, proxies are needed. The proxies currently used are of two different kinds: some are concerned with the causes of accumulation of such embodied qualities (allowing to make regression against earnings, against per capita income, against rate of innovation, against rate of growth and the like), and some are concerned with their effects (like labour market earnings). Years of schooling belong to the first group. To the same group belong other proxies, such as expenditure on education (private and Public) (or educational resources). Although they may be indicative of policy, and particularly of educational policy, it seems doubtful that they can be a measure of the accumulation of knowledge and skills. The problem of "high cost of low performance" and the comparisons made between the actual acquisition of cognitive skills among different groups with same educational level, or year of schooling, seem to deny this possibility.(OECD 2010). Nor can the amount of educational resources (such as class size, or pupil/teacher ratios, or teacher salaries) be considered indicative of the amount of accumulated cognitive knowledge, since there is not univocal empirical evidence in this matter (Catterall 1997).

Therefore it is easy to turn to another indicator which has the flavour of being an adequate proxy, and consists in measuring directly the content of knowledge and skills actually embodied in individuals. There are in the literature examples of this direct measurement: international tests of cognitive skills in mathematics and science (Hanushek and Kimko 2000); literacy scores from the International Literacy Survey (Coulombe 2004), the PISA project. Surely regressions can be calculated to establish the relationship between the quantity of scientific knowledge embodied in individuals and earnings or rate of growth, although the bias in favour of "scientific" knowledge doesn't seem fully justified. Why not include a test of, say, philosophical knowledge, or of historical knowledge? Who says these are not "relevant to economic activity"?

Anyway the problem still remains of quantifying the value to this cognitive stock. One way could be to consider what employers pay for buying the services provided by individuals with such cognitive skills, and this could be obtained by introducing prices in the input-output table, but then we come back to the problems that we saw faced by Bowles: employers buy a vector which is not made up only of cognitive skills. In fact Bowles (2001) emphasizes the unexplained variance in earnings when only cognitive skills are considered. On the other hand Hendricks (2002) shows that measured skills do not explain cross country income differentials. But even if they did, still unresolved would remain the question whether such differences are due to the cognitive skills learned and measured or to other factors detected by the skill learned, or, still worse, to some unexplained factor such as total factor productivity.

It may be useful to remember that, at the macroeconomic level, the effect of improvement in education attainment on the growth of output per worker is nil according to some studies (Benhabib and Spiegel 1994, Pritchett 2001), while it shows a positive relation according to others (Temple, 2001, De La Fuente and Domenech 2006)

6. **Measuring human capital: by its effect**, **or return**. In order to overcome the drawbacks of the simple indicator of years of schooling in the evaluation of human capital, income differentials can be used to weigh the average years of schooling. This is what Sala I Martin (1997) does. He uses an efficiency parameter like the following:

$$\theta_i (t,s) = \frac{w_i (t,s)}{w_i (t, 0)}$$

where w_i (t,s) is the wage in year t of a individual with s years of schooling and w_i (t,0) is the wage of an individual with zero years of schooling, assumed as numeraire. Then by applying this coefficient to the share of labour force η_i (t,s) with different school levels he gets the average human capital per worker.
Of course this version either does not consider the possibility that same years of schooling may earn different wages, or has to adopt a sort of average wage for groups of same level of schooling. Besides, the acquired stock of knowledge and skills would show a significant change if only shocks of demand were to change the wage rate.

More straightforward, the stock of human capital can be measured by the present value of the expected stream of future earnings.
Basically, in this way the amount of human capital existing at a certain point in a country is given by the actual return that it is expected to achieve in the labour market.

$$H = \Sigma \frac{E_t}{(1 + i)^{t-p}}$$

where E stand for earnings, i is the interest rate, t is time and p is the present

On these lines is the approach of Graham - Webb (1979) and Jorgenson – Fraumeni (1989 and 1992), on the basis of which various sophisticated methods are suggested and applied.
According to this approach each individual's human capital is given by its current labour income plus the present value of the expected labour income of the expected years of his working life. Each individual belongs to a particular level of educational attainment, and the aggregation of individuals by age and level of educational attainments allows for the total value being established.
In its simplest version:

$h_a^{ei} = W_a^{ei} Y_a^{ei} + S_{a,a+1}^{ei} h_{a+1}^{ei} d$

where $d = \frac{(1+g)}{(1+r)}$, g = rate of growth of income; r = discount rate;

h_a^{ei} = average human capital of individuals of age a and educational level ^{ei}
W = probability of having a paid job; Y = current annual labour income of workers;
$S_{a,a+1}^{ei}$ = probability of surviving one more year

As it is well known, different views exist about two problems.

- The first is whether to consider the whole population or only the people who are actually employed. The first choice would overstate the stock of capital and probably should not be preferred unless some relevance should be given to a kind of "notional", or "potential", rather than effective capital and unless the overall impact of the "whole human capital" on the quality of life and also on the productive activity via the impact of "social capital" should be considered. The second is whether to evaluate the non market activities; this choice is generally ruled out on the ground of its complexity and scarce availability of data, but it also raises some serious theoretical criticism (for instance, it would be strange to evaluate the time spent in gardening by a workman differently from that spent by an academic (Rothschild, 1992).
- As it can be seen, in a world of perfectly competitive markets and of perfect information the value of the discounted income stream would be equal to the cost of production (investment) of human capital (with the rate of discount being the rate of interest). But since these conditions do not obtain and since the valuation of the human capital is made at a point in time very distant (depending on the age group) from that of the decision to invest, the two values may diverge, and the first measure appears to better reflect the actual value of human capital.
- Nevertheless, some more fundamental questions remain open. If wages (and income stream) are influenced by scarcity, the link between extra years of education and extra earnings and also between physical productivity and earnings would collapse, and the same quantity of human capital would take a different value either as a consequence of demand shocks or as a consequence of other factors such as wage setting procedures or even some mysterious "total factor productivity" change. Drastically Bowles (2001) says: "The estimated coefficient of a cognitive score in an earnings equation is at most a measure of the scarcity of the measured skill,…it says nothing about the contribution of cognitive skills to production in general".

In fact the relationship could also turn to have a reversal in the sign. An increase in average level of schooling could cause a decrease in the income stream, and therefore in the value of capital, if the individual fall in lifetime earnings were stronger than the increase in the number of individuals with that level of years of schooling.

- The model can surely be adjusted to take account of further formal education and training during the working life but it is doubtful whether it can take account of those

components of human capital which are not cognitive skills obtained in the educational processes and therefore are not proportional to their length although influencing the lifetime labour income which, meanwhile, is stratified by educational levels (in addition to age and sex).

- It is clear that using this approach the stock of human capital in aggregate terms becomes homogeneous in terms of value. It is in fact:

$H = \Sigma\ L_{age}^{ed}\ ly_{age}^{ed}$

(L = work force by education and age; ly = lifetime income by education and age)

As such it could enter the traditional production function $Y = A\ K^{\alpha}\ H^{1-\alpha}$. But here is a paradox: the share of labour in Y should be determined by the coefficient α (through the derivative with respect to H) but the factor H already reflects the share of labour, therefore the value of H is needed in order to determine the share of labour, but at the same time the share of labour is implied in the value of H. This is a clear drawback (not to say a crucial flaw) in using a fraction of GDP as a measure of the stock of human capital.

The last Turin OECD report says that there has been "agreement that the approach based on incremental earnings and discounted lifetime income provided the best conceptual basis for measuring the output of the education sector". This can surely be accepted if wages reflected labour productivity and productivity reflected education levels. Out of these assumptions an increase in lifetime earnings would not be a measure of the increase in human capital, unless we defined human capital itself as the discounted lifetime labour income. But in this case it would be very close to the labour share in income, which may be considered in traditional growth accounting indicative of labour productivity, which in turn is influenced by that unidentified residual dressed as "total factor productivity". Whose relationship with human capital we still don't know, unless we end up by defining human capital itself as total factor productivity. Neither we know yet what exactly causes differences in total factor productivity.

- Finally, the total stock of human capital can be disaggregated by distinguishing the average per capita lifetime labour income and the workforce for each educational level, and the aggregate change is the combined result of the changes in the two. This allows to see how much of a change is due to a larger (or smaller) work force and how much is due to a rise (or a fall) in real wages. Of course the directions of the change could also be opposite to each other, and there could be full compensation: in this case the stock of human capital would remain the same no matter how big the changes in its internal composition. Nevertheless, when cross countries or time series comparisons are made it is possible to detect what has happened internally. What seems to remain strange is that supposing nothing has changed in the numbers and in the educational structure of the workforce, the stock of human capital could undergo a change just because per capita lifetime earnings have changed, and we are left with no answers about what that means. A change in the stock of cognitive knowledge? a change in schooling resources? A change in wage setting procedures? A change in distribution? A change in innovation? A change, again, in total factor productivity?

7, **A short conclusion**. One could see a contrast between the OECD statement that "the approach based on incremental earnings and discounted lifetime income provides the best conceptual basis for measuring the output of the education sector" (2010) and another OECD statement that "measures of human capital that have been based on completed years ad level of schooling and on the return deriving from higher earnings of those with more education are far from sufficient in relation to a broad definition of human skills and other attributes" (1998)
Perhaps this is due to the complexity and to the multifaceted character of the concept of human capital. If measurement was sought just for the sake of measuring, it would be probably easier to converge on a unique universally accepted measure, but if measurement is sought in order to build a basis for choices about growth policy, or educational policy, or public expenditure policy, or distributional policy, then it becomes crucial to verify that measures are appropriate and such as to avoid leading the choices in wrong directions.
Although progresses are being made and more work is needed to this end, one could wonder whether it is really possible to have a unique measure of human capital, comprehensive of all dimensions, that may enter any algorithm for such different purposes. Probably, waiting for this to happen, it could be reasonable to work on a combination of different specific statistical indicators that may serve as guide for specific decision in the different fields of policy concerned with "human capital". We can compare, for instance, statistical data about expenditure on education, or about educational test scores, but that doesn't mean comparing "human capital" stocks, and not even human capital accumulation. Therefore it's perhaps time to admit that while it is possible to elaborate statistics on relevant aspects of human capital which may be useful for policy guidance it is nearly impossible to give a unique synthetic measure of human capital. The complexity of this concept perhaps does not allow this operation.

References

Aghion P., Cohen E. (2004), *Education et croissance*, Conseil d'Analyse Economique, Paris, La Documentation Francaise

Benhabib, J, Spiegel, M. (2005), *Human Capital and Technology Diffusion*, in: Aghion P, Durlauf (eds), *Handbook of Economic Growth*, Elsevier

Bowles S., Gintis H., Osborne M., (2001) - *The Determinants of Earnings: a Behavioural Approach*, in Journal of Economic Literature, n. 4

Catterall J. (1997) *Economic Analysis of Education Policy*, in Educational Evaluation and Policy Analysis, n. 4

Chevalier A., Harmon C., Walker J., Zhu Y., (2003), *Does Education Raise Productivity or just Reflect it ?*, CEPR Discussion Paper Series, 3993

Coulombe S., Tremblay J., Marchand S., (2004). *Literacy scores, Human Capital and Growth across fourteen OECD Countries*, Statistics Canada

David P., Lopez J. (2001), *Knowledge, capabilities and human capital formation in economic growth*, NZ Treasury working paper n. 13

De La Fuente A., Ciccone A. (2003), *Human Capital in a global and Knowledge based Economy*, European Commission, Luxenbourg

De La Fuente A., Domenech R. (2006), *Human Capital in Growth Regressions : how Much Difference does Data Quality Make?*, in: Journal of the European Economic Association, n. 1

Graham J., Webb R. (1979) *Stocks and Depreciation of Human Capital: New evidence from a Present Value Perspective*, in: Review of Income and Wealth, n. 2

Hanushek E., Kimko D. (2000), *Schooling, Labor force Quality and the growth of Nations*, American Economic Review n. 5

Hendricks K. (2002), *How Important is Human Capital for Development? Evidence from Immigrant Earnings*, in: American Economic Review, n. 1

Jorgenson D. W., Fraumeni B. M. (1989), *The accumulation of Human and Non-Human Capital, 1948 – 1984*, in: Lipsey R.E., Tice H. S. (eds) *The Measurement,of Savings, Investment and Wealth*, University of Chicago Press

Jorgenson D. W., Fraumeni B. M. (1992), *The Output of the Education Sector*, in: Griliches Z. (ed.) *Output Measures in the Service Sectors*, The University of Chicago Press

Lucas (1988), *On the Mechanics of Economic Development*, in: Journal of Monetary Rconomics, n. 1

Marshall, A. (1890), *Principles of economics*, MacMillan

Mincer J. (1974) *Schooling, experience and earnings*, New York, NBER

Mulligan C., Sala-I-Martin X. (1997), *A Labour Income- Based Measure of the Value of Human Capital: an Application to the States of the United States, Japan and the World Economy*, n. 2 , or 2001 Measuring aggregate Human Capital, in Journal of Economic Growth, n.3

Nehru V., Swanson E., Dubey A. (1995), *A new Database on Human Capital Stock in Developing and Industrial Countries: Sources, Methodology and Results*, in: Journal Of Development Economics, n.2

OECD (1998) – *"Human Capital" investment: an international comparison*, Paris

OECD (2001) - *The well-being of Nations: the Role of Human and Social Capital*, Paris

OECD (2010) – *The High Cost of Low Educational Performance*, Paris

Pritchett L. (1999) – *Where has All the Education Gone*, World Bank

Romer P. (1990) *Endogenous technological change*, in: Journal of Political Economy, n. 5

Rothschild M. (1992), *Comment on the Output of the Education Sector*, in: Griliches Z. (ed.), Output Measurement in the Service Sector, University of Chicago Press

Temple J. (2001), *Growth Effects of Education and Social Capital in the OECD countries*, OECD Economic Studies, n. 33

UN Economic and Social Council. Statistical Commission (2006), *Seminar on human resources and training*, Paris13- 15 June 2006, paper submitted by Statistics Sweeden

Wei H. (2007*), Measuring Australia's Human Capital Development : the role of post school education and the Impact of Population Ageing*", in: Statistical Journal of International Association of Official Statistics, n. 3

Wossmann L. (2001), *Specifying human capital: A review and some extensions*, Kiel Institute of World Economics