Human Capital and Economic Growth: United Kingdom, 1951–1961[1]

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In recent years, economists have been turning their exploratory energies in increasing measure towards investment in human beings, such as formal education, post-school training, health, migration and information. Of these, education and training have received most attention. Rates of return on such investment have been estimated, and its contribution to the economic growth of various countries assessed, thus accounting for part of the hitherto "unexplained residual".

This article is concerned with the contribution of the increase of education and training to the growth of national income in the UK over the decade 1951–1961. Estimates for the UK as well as for seven other West-European countries and the USA have already been made by E. F. Denison (1967). The approach used differs from that already adopted by T. W. Schultz (1961) in respect of the USA. Variants of both methods are applied in this study in respect of the UK, and it is shown that they give different results because they measure different things.

Both methods involve the classifying of labour by level of formal education, multiplying the increments in labour of different education levels by certain weights and adding the products, but they differ as to the type of weights used. The weights used in the Schultz method are rental values arrived at by multiplying the stock of human capital necessary for bringing a person up to certain levels of education by their internal rates of return. The weights associated with Denison (1962, 1967) are the differences between the average earnings of occupied persons with given levels of education, and the average earnings they would have achieved if they had no formal education.

In measuring the effect of the increase in the quality of labour on economic performance, authors[2] have applied variants of one or the other of these methods

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2. The first method has been applied by Harberger and Selowsky (1966) and by Hines *et al.* (1970); the second by Griliches (1963) and Psacharopoulos (1969).

without being precise as to what was measured. Though M. J. Bowman (1964) has very ably compared various aspects of the original contributions of Schultz and Denison, some further discussion is called for.

This paper begins with a simplified model which will help in interpreting and comparing these methods. It will be shown that if we accept the theory that on-the-job training has an opportunity cost, then the first method, to be called the "rate of return" method, could be said to measure, to an approximation, the contribution of the increase of formal education to growth. The second method, to be referred to as the "earnings" method, will then be seen to give an underestimate of the combined effect of both formal education and on-the-job training. If, however, we discarded the opportunity cost theory of on-the-job training and assumed that the observed earnings profiles are due to costless learning, then formal education is the only investment to be reckoned with, and we should have two rival methods for measuring the contribution of the increase in formal education to growth, the "earnings" method giving, under normal circumstances, by far the higher estimate. It could be shown that this method is to be preferred as being much the more accurate. It has, incidentally, the advantage of requiring a smaller amount of data. We shall adopt the opportunity cost theory of training without discussing the merits of rival explanations of earnings profiles, e.g. Lydall's (1961) theory that earning patterns reflect the growth of abilities with age and experience, and Arrow's (1962) learning by doing. It will then be shown how the accuracy of the two methods is affected by changes in the number of entrants into the labour force and in the intensity of on-the-job training, and by the rate of deterioration of human capital.

In the second part of the paper the two methods are applied to the UK in the period 1951–1961. This will bring out the problems of measurement peculiar to such enquiries. One particular difficulty is that they require knowledge of the earnings of workers who have had no formal education. There are few such workers in the UK and records of their earnings are not available. Hence we apply earning ratios borrowed from the USA. We had to make other assumptions where data are lacking, e.g., the proportion of the difference in earnings between workers of different education levels that is due to difference in ability.

On the various assumptions made, and subject to the qualifications detailed in the paper, it is found that the increase in full-time formal education alone contributed between 10 and 14 per cent of the increase in national income, and on-the-job training between 7 and 10 per cent.

Measuring the contribution of human capital to growth

The increase in national income due to an increase in human capital between two years is measured by $\Sigma w_i(b_i - a_i)$, where a_i and b_i are the numbers of occupied persons of education level i in years 1 and 2 respectively, and w_i is a weight reflecting the returns to human capital carried by labour of education level i. It is the weights w_i which differ as between the "earnings" method and the "rate of return" method.

On the "earnings" method $w_i = z_i - z_o^i$ where z_i is the average earnings of occupied persons of education level i in the base year, and z_o^i the average earnings they would have received if they had no formal education.

It should be noted that, in view of the process of selection whereby people of higher abilities tend to receive more formal education, we expect that $z_o^i > z_o$, z_o being the average earnings of workers with no formal education, and we may therefore write $w_i = z_i - z_o^i = \alpha_i(z_i - z_o)$ where $0 < \alpha_i < 1$ is a correction factor for differential ability. Estimates of the α_i's are not available even for countries where there are occupied persons who lack formal education. However, estimates of the correction factor for differential ability between primary, secondary, and higher education are available in respect of the USA.[3]

The contribution to the increase in national income, $\Sigma w_i(b_i - a_i)$, whether calculated by the "earnings" method or by the "rate of return" method could be split into two parts as follows:[4]

$$\Sigma w_i (b_i - a_i) \equiv (B - A) \cdot w_i \frac{\Sigma a_i}{A} + B w_i \Sigma \left(\frac{b_i}{B} - \frac{a_i}{A}\right) \quad (1)$$

where $A = \Sigma a_i$, $B = \Sigma b_i$.

Or alternatively,[5]

$$\Sigma w_i(b_i - a_i) \equiv Be_2 - Ae_1 \equiv (B - A)e_1 + B(e_2 - e_1) \quad (2)$$

where $e_1 = \frac{1}{A}\Sigma w_i a_i$, $e_2 = \frac{1}{B}\Sigma w_i b_i$.

The first term on the right hand side of (1) measures the effect of maintaining the relative distribution of the labour force by education level, the second term measures the effect of changes in the relative distribution of the labour force by education level. Similar interpretations apply to the two terms on the right hand side of (2).[6]

3. Becker (1964) pp. 79–88, 124–127; Denison (1964) pp. 86–100 and (1967) pp. 83–84; Morgan and David (1963).

4. Cp. Selowsky (1969) p. 451.

5. Bowman (1964) p. 452.

6. It is important to note that if our sole purpose is to estimate the effect of a change in the relative distribution of the labour force by education level by the "earnings" method, we do not need to know the earnings of uneducated labour, nor the correction coefficient for ability differential between them and labour of the lowest education level. This is of particular importance in a country where such data are not available. See Bowman (1964) p. 461. This can easily be verified by writing in the second term of the right hand side of equation (1) or (2):

$w_i \sum_h^i \beta_h(z_h - z_{h-1})$, where β_h is the adjustment coefficient for differential ability between the hth and (h–1)th education levels.

In the "rate of return" method, we calculate $w_i = f_i r_i C_i$ where r_i is the internal total social rate of return to investing in the lowest i levels of education;[7] C_i the investment in formal education calculated by compounding the social costs (which include both direct costs of teaching as well as indirect costs, that is forgone earnings) to the end of the education period; $f_i = 1/[1+\frac{1}{(1+r_i)^{n_i}}]$; that is the correction for the finiteness of working life, whose length for education level i is n_i years. As n_i is large, f_i is approximately unity and we could write as an approximation $w_i \doteq r_i C_i$.

To calculate r_i we need the stream of returns over working life $z_{it} - z'_{ot}$ where t is age. (Note that the z_i referred to on page 75 is the average of the z_{it} weighted by the respective age groups of occupied persons of educational level i in the base year). It will be noted that $z_{it} - z'_{ot}$ can also be expressed as $\alpha_{it}(z_{it} - z_{ot})$ where z_{ot} is the average earning of uneducated workers t years old, and α_{it} is the corresponding correction for differential ability. Of course α_{it} need not be the same for all t, and as estimates of α_{it} are even more difficult to come by than estimates of α_i, all α_{it} are usually taken to be equal.[8]

The stream $z_{it} - z'_{ot}$ is affected by on-the-job training, on which subject a few words will be said here. Training may be either general, in the sense that it increases the productivity of a worker elsewhere as much in the firm giving the training, or specific, if it increases his productivity in that firm only. Under perfectly competitive conditions, the firm charges the worker for his general training. The reduction in the worker's earnings is an investment on which he will get a rate of return assumed equal to the social rate of return on his formal education, r_i. A firm may charge the worker for part of his specific training, and in this case the worker is assumed to get the same rate of return r_i. Training is more intensive at the beginning of the working life but diminishes with age. Hence earnings are at first lower, then higher than they would be without on-the-job training. Human capital due to both formal education and training is subject to deterioration which generally causes earnings to fall later in life.[9]

The question arises, what shape the stream of returns to i levels of education would have in the absence of on-the-job training? There are probably no occupied persons who get no training throughout their working lives, though some may work for long spells at dead-end jobs. Hence the question cannot be answered from empirical observation. It may, however, be plausibly assumed that the stream of returns would rise at first owing to psycho-physiological development

7. For computation procedure, see Blaug (1965), and Blaug, Preston and Ziderman (1967).

8. However, Hines *et als* (1970) apply different correction factors based on Morgan and David (1963) to ages 18–34 and 35–74. These, however, relate to differential ability of workers of primary education level and upwards. No correction factors are applied as between primary education and no education.

9. See Becker (1964) pp. 18 ff. Both Becker (1964, pp. 45–47) and Mincer (1970, pp. 14–15) show that the opportunity cost theory of on-the-job training is not incompatible with psychological theories of learning.

occurring early in life; then decline through obsolescence of the stock of education and, in old age, to fall in productivity and working hours as well.[10] However, the hypothetical stream of returns in the absence of on-the-job training would be much flatter than the series $z_i - z_o$, and it will be represented by $r_i C_i$ as an approximation.

It should be noted that to the extent that firms pay for and get the benefit of the specific training of their employees, the series $z_i - z_o$ does not represent the marginal productivity of labour of education level i, the expression $\Sigma w_i a_i = \Sigma (z_i - z_o) a_i$ as used in the "earnings" method will understate the contribution of formal education and on-the-job training to national income. These reservations, however, do not affect the "rate of return" method.

Having associated the "rate of return" method with formal education, and the "earnings" method with the combination of both formal education and on-the-job training, let us investigate more closely what these two methods measure. We start by comparing the contribution to national income in the base year $\Sigma w_i a_i$ as calculated by the two methods. In order to concentrate on essentials, let us use a simple model. Assume there are three stages in working life, each lasting one period: stage 1 during which formal education is received, if at all; stage 2, during which school graduates enter the labour force and are subjected to *general* on-the-job training, and lastly, stage 3, when they continue to work without receiving any further training. Persons with no formal education work during all three stages, but get no on-the-job training. Educated persons join the labour force at the constant rate of n workers per period, and leave it at the end of stage 3. The cost of formal education per person, assumed to consist solely of forgone earnings, is C. We rule out differential ability and deterioration of human capital. Earnings received by educated labour exceed those of uneducated labour by y_1 in stage 2 and y_2 in stage 3. The rate of return r, assumed the same for both formal education and on-the-job training is give by $C = \frac{y_1}{1+r} + \frac{y_2}{(1+r)^2}$. The return to formal education, d per worker per period is given by $C = \frac{d}{1+r} + \frac{d}{(1+r)^2}$. Put investment in on-the-job training $d - y_1 = k$. Then $y_2 - d = k(1+r)$.

The "rate of return" method gives total contribution to national income as $2dn$, and the "earnings" method as $n(d-k) + n[d + k(1+r)] = (2d + kr)n$. Hence the "earnings" method covers the returns to on-the-job training $nk(1+r)$ but subtracts an amount nk equal to investment in that training during the base period. The full contribution of human capital should be $[2d + k(1+r)]n$, of which $nk(1+r)$ is due to on-the-job training, and the weight w should be $d + k(1+r)/2$ instead of $d + kr/2$, as given by the "earnings" method. There is thus a dissimilarity between the treatment of investment in formal education and on-the-job training, in that investment during the period is netted out in the case of the latter but not the former.

10. This seems to be consistent with the findings of psychologists. See Birren (1968) pp. 180, 184.

It is worth pointing out, in this connection, that the accepted national accounting systems accord different treatments to investment in physical assets and in human capital. Investment in human capital to the extent that it is earnings forgone while undergoing formal education or on-the-job training is not included, while to the extent that it is tuition costs, is included under public and private consumption.[11] This omission does not in itself affect the measurement of the returns to human capital, but it does affect the magnitude of the national income with which it is compared.

Let us now trace the effects of intensifying on-the-job training by an amount l. Assume the rate of return remains r. In the new steady state, that is, when everyone who has had the extra training l is getting the appropriate benefit, the "earnings" method registers returns to human capital of $[2d+(k+l)r]n$. However, during the period of intensification of training the returns recorded are $(2d+kr-l)n$. Since $2dn$ are attributable to formal education, the returns to training net of investment in the same period would be $(kr-l)n$. This would be negative if $l > kr$, in which case the "rate of return" method would show a higher contribution to national income than the "earnings" method. This result, which is hardly surprising, implies knowledge of the true r, which can only be calculated in a steady state. If the rate of return is estimated during the period of intensification of training, by comparing C with the returns $d-(k+l)$ in stage 2 and $d+k(l+r)$ in stage 3, an estimate $r' < r$ is obtained which would result in an estimate of the returns to formal education of $2d'n < 2dn$. However, it can be shown that the *apparent* returns to formal education, $2d'n$, do not exceed the returns calculated by the "earnings" method, $(2d+kr-l)n$.

That intensity of on-the-job training may change over time is suggested by Mincer's (1962) indirect estimates of lifetime investment in 1939, 1949 and 1958.[12] It appears that on-the-job training per American male worker decreased for all three education levels, except for college graduates between 1939 and 1949.[13] Of course a fall in the intensity of training would lead to an over-estimate of the rate of return.

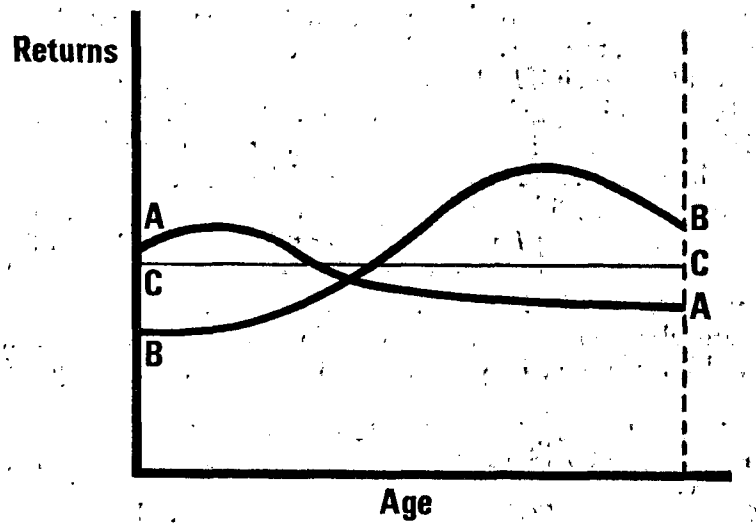
11. See Seers and Jolly (1966) for a discussion of the possibility and desirability of including investment in formal education in national income. The question of including investment in on-the-job training is more problematic. Not only is there less recognition of it, but it also involves much greater difficulties of measurement.

12. These estimates are of uncertain reliability. On-the-job training appears to end at the age of about 40, no doubt as a result of not allowing for deterioration of human capital. Moreover, no allowance is made for differential ability.

13. Mincer's estimates of lifetime investment in on-the-job training *per capita*, deflated by Consumer Price Index, show a continued increase for all education levels (Mincer, 1962, p. 55, col 5 of right hand side of table 1). This, however, does not completely eliminate the effect of the increase in earnings due to causes other than investment in education and training, such as increase in physical capital per worker. This is done by deflating col. 5 of the left hand side of the table by an index formed by the ratio of the average weekly earnings of production workers in manufacturing to the index of "labour output per man based on total days of education". The latter index is given in Denison (1962) p. 72, table 9, col. 5.

Let us now assume that investment in on-the-job training per worker remains constant, k, but that the number of school graduates joining the labour force increases at the rate p per period, r being unaffected by p. In these conditions the estimates of r and d will not be biased, but the relative magnitude of the returns calculated by the two methods will again be affected. Consider the situation when the number of educated workers at stage 3 is n. Then the "rate of return" method gives total returns to education as $n(1+p)d+nd = nd(2+p)$ and the "earnings" method $nd(2+p)+nk(r-p)$. The returns to training less investment in training during the period is $nk(r-p)$. This is smaller the higher p, and it will be negative if $p > r$.[14] It will be noted that there is investment in human capital during the period of $[(1+p)^2C+(1+p)k]n$ which goes unrecorded in national income.

Instead of assuming an increase in the number of educated entrants to the labour force, let us assume that a proportion q of educated labour drops out of the labour force at the end of stage 2, either through retirement or death. There are now two rates of return to be considered: the rate r which does not take the wastage into account, which we have been considering hitherto, and the rate of return $r < r$ which takes wastage into account. We shall continue, however, to be chiefly concerned with r,[15] since the contribution of formal education per educated



14. This is unlikely in most countries nowadays, e.g., in the UK, p is of the order of half of one per cent and r, see table 2, over 5 per cent.

15. This does not mean that r is unimportant. A low value of r may be a sign that there is excessive investment in human capital.

It should be noted that if r is the same for both formal education and on-the-job training, r which takes wastage into account, need not be the same for both.

member of the labour force is still d, calculated as hitherto, irrespective of the rate of wastage. This can be seen most clearly by assuming educated workers get no on-the-job training. The returns to education would be d per educated worker.[16] Similarly, investment in on-the-job training remains k calculated as before. Of course, the contributions to national income calculated by the two methods are smaller when there is wastage, the one calculated by the "earnings" method decreasing by the larger proportion.

We have hitherto conducted the analysis in terms of three periods, and one education level; but it could easily be generalised to many more periods and education levels. However, in discussing the deterioration of human capital due to obsolescence, lower performance and fewer working hours in old age, we require a model with more than three periods to allow for observed earnings to rise then fall. Now, if there is deterioration of human capital, then the hypothetical stream of returns to formal education must decline, and representing it by a straight line may well overstate the returns to formal education calculated by the "rate of return" method. In fig. 1, AA represents the hypothetical returns to education in the absence of on-the-job training; BB represents actual returns as affected by training, and CC a constant stream of returns whose present value is equal to that of AA or BB. If AA lies first above CC and then below it,[17] the area under CC exceeds the area under AA and hence CC exaggerates the contribution of formal education. This exaggeration is likely to be mitigated by the relatively small number of old workers. BB lies first below CC then above it. As long as it does not cross it again, then the area under BB is certain to exceed that under CC, though it may still exceed it if BB lies below CC late in working life.[18]

Our conclusions with regard to the effects of a change in the intensity of on-the-job training, and a change in the rates of entry to and exit from the labour force will not be altered under the assumption of deterioration of human capital in a multi-period working life, though they would strictly apply to the differences between the earnings profiles BB and AA rather than between BB and CC.

In the formula $\Sigma w_i(b_i - a_i)$ the weights w_i established in year 1, the base year, are applied to year 2. This is on the assumption that the productivity of factors, in particular labour of different education levels, is the same in the two years. Now, labour productivity undergoes both long-term changes (due to

16. We are of course abstracting from possible changes in productivity per worker following a fall in the number of experienced workers. All that interests us here is how returns to human capital are calculated.

17. AA is likely to start above CC if the improvements in performance due to psycho-physiological development in the early years of working life is not sharp and prolonged. But even if AA lies initially below CC, the area under CC may still exceed that under AA.

18. In both the UK and USA the area under BB is about twice that under CC. It is, however, possible to imagine an earnings profile with very low earnings during a protracted old age which would make the area under CC (though not that under AA) exceed the area under BB. Nevertheless, even if the area under CC exceeded that under BB, the contribution to national income measured by the "earnings" method might still exceed that measured by the "rate of return" method if there are relatively few workers in the older age-groups.

changes in technology, and in capital/labour ratio, economies of scale and other causes), and short-term cyclical changes connected with the rate of utilisation of resources.[19] The productivity of labour will also be affected by changes in the intensity of on-the-job training or in the age-structure of the working population.[20] The larger the changes in the productivity of factors between the two years, the less valid the results.

To summarise the discussion so far, the "rate of return" method tends to overstate the effect on economic growth of the increase of formal education by assuming a constant stream of returns. The estimate of the social rate of return and of the total returns to education may be biased if there is a change in the intensity of on-the-job training. The "earnings" method tends to understate the combined contribution of formal education and on-the-job training to growth because of (a) the omission of the effect of specific training paid for by the employer, (b) the understatement of the weights w_i because the method involves the deduction of investment in on-the-job training from the returns to education and training when calculating these weights,[21] (c) this understatement is aggravated by the increase in the number of entrants to the labour force and by the intensification of training.[22] The two methods will be illustrated by estimating the contribution of education and on-the-job training to UK national income growth over the decade 1951–1961.

The Data

The main sources of data are the Censuses of Population for 1951 and 1961. These allow us to classify the occupied population by age and years of full-time education. Data on earnings are taken mainly from Blaug (1965).[23]

19. See Neild (1963), Ball and St. Cyr (1966).

20. An attempt has been made to eliminate the effect of a change in the age structure when applying the "earnings" method by using age-specific weights. (Schwartzman, 1968). This however requires age-specific adjustment factors for differential ability and may not improve the estimates if intensity of training has changed between the two years.

21. To get an idea of the understatement of the contribution of human capital to growth resulting from this omission, we divide Mincer's estimate of the investment in on-the-job training of US males in 1949, $9 billion, (Mincer, 1962, p. 57) by $\Sigma w_i a_i$ for US males in 1949, computed according to the "earnings" method, on the assumption that $a_i = 1$ for all i. We get a ratio of 0·11. On the limitations of Mincer's estimate, see footnote 13.

22. Further understatement arises from the following: strictly speaking the weights used in the "earnings" method should be, earnings of workers of educational level *i less* what they would earn if they had neither formal education *nor on-the-job training*. These weights should be higher than the weights $z_i - Z_o^i$ used in the above argument; that is, earnings of workers of education level *i less* what they would earn if they had no formal education. The difference being the effect of on-the-job training on their hypothetical average earnings as illiterates. Though this point is of little practical significance in view of the crudity of data on earnings, it is as well to bear it in mind.

23. More recent earnings data than the ones used here are available in an article by Morris and Ziderman (1971). This gives average earnings (in many cases based on small sample numbers) by age and selected post-primary school educational qualifications for the year 1966–67. These cannot be utilised for the "earnings" method both because no breakdown of the population by qualification

American ratios have been used for calculating imputed earnings of labour with no formal education. Details of the occupied population in Great Britain in 1951 and 1961 by education level are given in tables A1 and A2.[24]

The major drawback of the Census data is that they give the terminal education age (TEA) rather than the number of years actually spent in full-time education. This has to be inferred from the TEA. Education in the UK generally starts at five, and we have assumed that those who have a TEA of less than 19 have undergone a continuous educational process of duration TEA minus five years. However, many of those with TEA of 19 or over have interrupted their studies, the breaks occurring usually between school and higher education, and are filled by work or military service, or some kind of education of secondary school level. Data about length of breaks and how they are used are given in the Robbins Report.[25] Such interruptions were much longer in the years immediately following the Second World War.[26] The method applied here in transforming TEA into years of education is to estimate, independently of the Census, the numbers of those members of the occupied population who, by the Census years have had some higher education, whether they succeeded in getting a degree or dropped out without getting a degree. Such estimates are arrived at by adding to the holders of qualifications in the three types of higher education (University, teacher training and advanced further education) an estimate of the wastage, that is, the drop-outs. By subtracting the number of those who have had some higher education from the total number of those with TEA over 18 given in the Census, we get an estimate of the number of those who have had non-advanced further education, that is, of secondary school level. It remains to estimate the average length of the different courses pursued by those with TEA over 18. This has been calculated in the case of the three types of higher education from data on the number of students in course of study and the number of initial entrants.[27] Such estimates have been made for different age groups whose sizes have been used as weights when calculating the average years of education shown in table A2. Of course, the average years of education cover the usually shorter periods during which those who ultimately drop out without obtaining a qualification stay at the higher education institutions.

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is available, and because they cover only a small range of qualifications. In particular, no data on primary school earnings have been collected, and when calculating the marginal rates of return which use 10 years of primary education as "base-line", it has been assumed that the "earnings of unqualified school leavers at age 15" by age, are equal to those of a sample of employees registered under the National Insurance Act (pp. xiii, xiv). Since these are a cross-section of all employees, this can hardly be a good substitute for the earnings of persons with primary school education. Moreover, no earnings for employees with TEA less than 15 years, who in 1961 constituted over half the working population are available.

24. Northern Ireland, which accounts for about two per cent of the working population, is not included as no similar data are available in respect of it for 1951.

25. Appendix 2B, pp. 25, 86, 109.

26. See PEP, *Graduate employment*, 1956.

27. The method is described in the *Robbins Report* Appendix 1, p. 153.

Table A3 which classifies occupied men by age and education level in 1961 is partly based on proportions given in the more detailed 1951 Census for men 10 years younger.

Table A4 shows male earnings by education level. The earnings of men with primary, secondary and higher education are taken from the Appendix to Blaug's article (1965). They are admittedly inaccurate. They are meant to be for the year 1963, but they understate the earnings for that year and even those for the year 1961.[28] Earnings of uneducated labour are not available for the UK, and imputed earnings for such labour have been calculated by multiplying the earnings of men with primary education by the appropriate earning ratios in the USA.

Estimating procedure and results

Table 1 shows the increase in the contribution of human capital to national income calculated by the "earnings" method. Average returns to education in 1961 by education level have been multiplied by the respective numbers of occupied persons. The same average returns could not be used for 1951 as the average years of education for the three education levels were different in that year from those in 1961, so average returns for 1951 were calculated by interpolation. In the absence of adequate data on women's earnings by education level,[29] it has been assumed that the returns to their education are half those of men who have an equal amount of education. The error involved cannot be large, both in view of their low earnings and of their relatively small number,

28. If we multiply the numbers of occupied men and women by these earnings, we get about 92 per cent of labour earnings in 1961 calculated from national income statistics. The difference is partly due to the exclusion of some labour from our data.

Our estimate of labour earnings, Great Britain, £16,149 million

Estimates for UK derived from C.S.O.

National income and expenditure:

Earnings from employment, £16,387 million

Add 0·57 (Denison, 1967 p. 354, footnote 5) of income from self-employment (£1,222 million), giving £17,609 million.

This is 9 per cent higher than our estimate. The difference is partly accounted for by difference in the amount of labour underlying the estimates:

To occupied population, table A2,

add 2·1 per cent for Northern Ireland,

3·7 per cent for certain categories of labour, such as armed forces abroad and part-time and irregular labour (1961 *Census, England and Wales, Occupation tables* (pp. xxv ff.)

Subtract 1·5 per cent for unemployed persons included in Census.

Hence labour earnings according to C.S.O. cover 4·3 per cent more labour than our estimate. It is likely, however, that the average earnings of this labour are less than the general average.

29. Woodhall (1965) shows on a graph the mean incomes of women by age and the following TEAs: 15 and under, 16 and 17, 18 or over. Arregger (1966) gives earnings of women with higher education only. The data are based on a non-random sample. These and other sources (see Thatcher (1968) pp. 138, 149. *Ministry of Labour Gazette*, 1962, p. 50, Morris and Ziderman (1971, p. xxiii)), indicate that women's earnings are about half those of men. Hence the assumption in the text.

about half that of occupied men. From table 1 we learn that the returns to human capital as estimated by the "earnings" method increased between 1951 and 1961 by £1,426 million at 1961 prices which is 28·3 per cent of the increase in national income (£5,040 million in 1961 prices). However, if we apply the adjustment

TABLE 1: *Returns to education, by "earnings" method, (unadjusted for differential ability) Great Britain, 1951, 1961*

		Men			*Women*[a]		
		Primary	*Secondary*	*Higher*	*Primary*	*Secondary*	*Higher*
1951							
Average years of education[b]		8·97	11·49	16·38	9·09	11·51	15·81
Average returns[c]	£	301	802	1,484	158	402	7,022
Total returns	£ million	4,063	1,425	574	905	403	164
Total for all education	£ million		6,062			1,471	
1961							
Average years of education[b]		9·19	11·53	16·42	9·30	11·53	15·73
Average returns[d]	£	328	808	1,490	175	404	697
Total returns	£ million	4,225	2,068	849	1,018	594	205
Total for all education	£ million		7,142			1,817	

a, Returns to women's education are assumed to be half those for men with the same education.
b, Calculated from Table A1.
c, Calculated from returns in 1961 (see note *d*) by interpolation.
d, Average earnings for the respective education levels less imputed earnings for men with no formal education computed from Tables A3 and A4.

factor for differential ability of 0·66 to all education levels,[30] we get 18·7 per cent. This estimate will undergo some refinement later.

Table 2 shows the returns to occupied men's education by the "rate of return" method. Two sets of rates of return, marginal and total, have been calculated to the nearest ½ per cent, one ignoring differential ability, and the other applying an adjustment factor of 0·66 for all ages and education levels. In calculating these rates of return, participation rates and death rates have not been taken into account (see p. 79).

It should be noted that our marginal rates in respect of secondary and higher education cover in each case some education of immediately lower level. Similarly, the total rates for primary and secondary education do not cover the full periods of education, but only averages of 9·19 years and 11·53 years respectively.

In calculating the rates of return for primary education, no forgone earnings have been imputed for the period of primary education which is compulsory in the UK. A case could be made for including such forgone earnings in the social

30. No factual evidence is available for the UK on this point, and our figure is close to those used in other studies of the returns to education in the UK.

TABLE 2: *Returns to men's education, by "rate of return" method Great Britain 1951, 1961*

		Not adjusted for differential ability			*Adjusted for differential ability*		
		Primary	*Secondary*	*Higher*	*Primary*	*Secondary*	*Higher*
Marginal social rate of return[a], per cent		15½	17½	7½	13	14	5¼
Total social rate of return[a], per cent		15½	17	11¼	13	13¾	8½
1951							
Education costs per man compounded at rate of return	£	1,018	2,583	9,908	907	2,261	8,893
Average returns per man	£	158	439	1,115	118	311	756
Total returns	£ million	2,131	781	432	1,591	553	293
Total for all education	£ million		3,344			2,417	
1961							
Education costs per man compounded at rate of return	£	1,099	2,624	10,000	970	2,295	8,923
Average returns per man	£	170	445	1,125	126	316	759
Total returns	£ million	2,204	1,140	642	1,629	807	433
Total for all education	£ million		3,986			2,869	

a, Calculated from 1961 data, see Tables A4 and A5.

costs of education at least as an alternative computation, but the requisite data are not available.

We now compare our marginal social rates of return with estimates obtained by others in respect of the UK bearing in mind that the rates compared do not mean the same thing. Our rate for higher education (adjusted for differential ability) is 5¾ per cent. Blaug (1965, 'Appendix) has 6½ per cent. The difference arises mainly from the fact that the rate of 6½ per cent assumes the difference in education between men with TEA 16–18 and over 18 to be 3 years of higher education, whereas we consider it to be 1·47 years of secondary education and 3·42 years of higher education. (See table 1). Maglen and Layard (1970, p. 62) give rates of return in respect of full-time higher education in engineering of 3·7, 5·4 and 6·1 per cent which are closer to our rate. Morris and Ziderman have 9·2 per cent for first degree (excluding certain occupations such as teachers) compared with "A" level, and negative rates for Master's and Doctorate degrees compared with first degree.

As to secondary education, we have an adjusted rate of 14 per cent. Blaug has 12·5 per cent. Here again, the difference is due mainly to the difference in the cost base. As table 1 shows, the difference in years of education is not 3 years of secondary education, but 1·53 years of secondary education and 0·81 years of primary education, for which no forgone earnings are imputed. Morris and

Ziderman have rates for secondary education ranging between 7 and 13 per cent No estimates in respect of primary education in the UK are available for comparison, but estimates for the USA are close to ours.[31]

In calculating the returns to education, costs including forgone earnings have been compounded at the appropriate total social rates of return and the resulting capital stocks have been multiplied by the rates of return to get the returns to the stock of education. The rates of return obtained from the 1961 data have been used in respect of 1951 on the assumption that a small difference in average years of education would make a negligible difference to the rate of return.[32]

For lack of suitable data we do not apply the "rate of return" method to women's education, but assume that the ratio of the returns calculated by the

TABLE 3: *Contribution of the increase of human capital to national income growth UK 1951–1961 (per cent)*

	Without allowing for differential ability		*Allowing for differential ability*	
	"earnings" method	*"rate of return" method*	*"earnings" method*	*"rate of return" method*
Estimate a	28·3	16·8	18·7	11·8
Estimate b	22·6	13·4	15·0	9·4
Estimate c	24·0		15·8	

a. All working population given in Table A1 included.

b. Excludes persons in respect of whom comparisons of output are made on the basis of employment or the equivalent, such as persons employed in public administration, the armed forces and the professional services. The Central Statistical Office gives the proportion of GNP at factor cost for which output comparisons are made on the basis of employment or the equivalent as 15 per cent (*National Accounts Statistics* 1968, p. 50). According to Denison, "the percentage of total labour earnings originating in such activities is typically two-fifths higher than the percentage of GNP at factor cost originating in these activities". (p. 188). We should therefore reduce estimates a by 21 per cent. We reduce them, however, by 20 per cent to allow for the fact that the C.S.O. estimate covers armed forces abroad and seamen at sea wh oare not included in the Census estimates.

c. As in b, but allowing for the increase in primary and secondary school attendance of 2·6 per cent for men and 1·5 per cent for women. These percentages are given by Denison (1967, p. 397) in respect of compulsory (that is, primary) education. One per cent increase in attendance is considered to increase returns to education by half of one per cent.

31. See Hines *et al*, (1970) p. 330, and Hansen (1963) p. 134.

32. This approximation corresponds to the interpolation used in connection with the "earnings" method. It should be clear, however, that the two methods of approximation are based upon different assumptions. Interpolation assumes that for small changes in education period average returns are proportional to education period, which is different from the assumption used here. The two assumptions become particularly inconsistent if we aggregate over a number of courses having different costs, and presumably different returns, per year of education when the proportion of people having studied these courses changes over time. This is the case with higher education (see tables A2 and A5). However, similar approximations are tacitly implied in the estimating procedures used in similar studies.

two methods is the same for women as for men. The contribution of the increase in education to national income growth is found to be 11·8 per cent when differential ability is allowed for and 16·8 per cent when it is not allowed for.

Following Denison, two adjustments are applied to the above estimates. The first allows for the fact that output comparisons in respect of a part of national product are made on the basis of employment or the equivalent. The resulting estimates *b* in Table 3 are 20 per cent below estimates *a*.[33] The second adjustment is in respect of the increase in school attendance. We assume that an increase in attendance of one per cent causes an increase in returns to education of half of one per cent.[34] The returns for 1951 calculated by the "earnings" method have been reduced accordingly, and the contribution to national income growth recalculated. These are shown as estimates *c* in table 3. The adjustment cannot be applied as easily to the "rate of return" estimates.

It was noted on p. 82 that low estimates of earnings and of the labour force have been used in our computations. On certain assumptions, the estimates by the "rate of return" method given in Table 3 should be multiplied by 1·09, but the estimates by the "rate of return" method should be raised by a lower factor.[35]

Denison, who uses a variant of the "earnings" method finds that the increase in quality of the UK labour force between 1950 and 1962 contributed 12 per cent of the increase in national income.[36] However, Denison takes into account only the increase in education *per capita*. To make our results comparable with his, we used identity 2, p. 75 to split estimates *c* into two parts as follows:

$$\frac{Be_2-Ae_1}{\triangle \text{N.I.}} \equiv \frac{(B-A)e_1}{\triangle \text{N.I.}} + \frac{B(e_2-e_1)}{\triangle \text{N.I.}}$$

$$15{\cdot}8 \text{ per cent} \equiv 3{\cdot}5 \text{ per cent} + 12{\cdot}3 \text{ per cent}$$

33. The allowance may be somewhat excessive as in certain cases the indicators of change in output are weighted indexes of employment based on rank or salary, and these are likely to be correlated with education. See C.S.O. *National income statistics*, 1956, pp. 359–370 and *National accounts statistics*, 1968, pp. 91–98.

34. Cp. Denison's adjustment (1967, p. 383): one per cent increase in attendance is equivalent to about half of one per cent increase in years of education.

35. The contribution to growth is Be_2-Ae_1. Assume that all earnings have been understated in the same proportion $s/(1+s)$, while owing to the omission of part of the working population, returns to education in both years have been understated in the proportion $n/(1+n)$. Then the true contribution to growth by the earnings method should be $(Be_2-Ae_1)(1+s)(1+n)$, where $(1+s)(1+n) = 1{\cdot}09$.

As to the "rate of return" method, calculation shows that raising all earnings (including forgone earnings that form part of costs) by a small proportion would increase the contribution of education to growth by a smaller proportion. Hence the contribution of education to growth should be raised by a factor smaller than 1·09.

36. Denison (1967) p. 315. Denison's method and sources differ from the ones used here in many respects, important among which are the following. He applies a quality of labour index to labour's share in national income, (see Bowman, 1964, p. 457). In this index the earning weights are derived from French data. He does not use the 1961 distribution of the labour force by TEA as given in the 1961 Census, but calculates the mean years of education in 1961 applying the cohort method to the 1951 distribution.

where ΔN.I. is the increase in national income. Thus our result, 12·3 per cent, is very close to Denison's,[37] a remarkable coincidence, considering the differences in method and sources.

Before concluding this section, it may be of interest to compare the rate of increase of the stock of human capital with that of the stock of physical capital. The gross stock of physical capital (excluding inventories) was £68,500 million in 1951 and £90,800 million in 1961, at 1958 replacement cost,[38] an increase of 31 per cent. If we measure human capital by its return, then the rate of increase of the variants corresponding to estimates *b* and *c* of Table 3 is of the order of 20 per cent. By contrast, the annual rate of growth of educational capital in the American labour force was double that of reproducible tangible wealth, (Schultz, 1963, p. 51). It is Schultz's view (1968, p. 339) that the higher rate of increase of human capital compared with non-human capital is "an important part of the explanation of the observed reductions in the inequality of distribution of personal income", since property income is distributed much less equally than earnings from labour. It seems that Schultz is implicity assuming that the incremental property income and the incremental earnings due to the increase of human capital have the same distribution as the existing property income and labour earnings, though this is not the only assumption that would validate his proposition. Some similar assumption has to be made if we are to infer that the lower rate of increase of human capital compared with physical capital in the U.K. has tended to aggravate income inequality.

Conclusion

We have endeavoured to reconcile the two methods used in measuring the contribution of education to growth, by means of a systematic application of the opportunity cost theory of on-the-job training. Without this theory, earning differentials would be wholly attributed to schooling and the "earnings" method would appear to capture all the returns.[39] As our results for the UK show, the "rate of return" method would understate the contribution of the increase of education to growth by about one-third. The theory, however, indicates that what was attributed to education is partly due to on-the-job training. What the "rate of return" method measures is roughly the effect of the increase in formal education, whereas the "earnings" method covers this plus part, possibly the major part, of the effect of training. With the present data and techniques of measurement available, it is not possible to put an estimate on the missing part. It has also

37. We have to multiply our result by 1·09 to take into account the underestimation of the earnings and working population, (see p. 13, footnote 2). This makes our estimate about 10 per cent higher than his. On the other hand, he uses an adjustment coefficient for ability differential of 0·60, while our coefficient is 0·66. This would again make the two estimates practically the same.

38. C.S.O., *National Income and Expenditure*, 1967, p. 80.

39. Presumably formal on-the-job training would be credited with some effect on earnings.

been shown that a consistent treatment of the subject requires the inclusion of investment in human beings (both direct costs and forgone earnings) in national income.

This enquiry has been restricted in several respects. We have been solely concerned with education and training as investment and have completely disregarded the consumption aspects. Moreover, part-time education has not been considered, and the only human capital taken into account was that carried by the labour force. This simplifies a great deal the application of the "rate of return" method in particular. It is obvious that the education capital of women who are not in the labour force helps in rearing and educating children who will join the labour force in the future and enables other members of the family to work longer hours.

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TABLE A1: *Working population by education level: Great Britain 1951, 1961 (thousands)*

Period of education (years)	*1951*		*1961*	
	Men	*Women*	*Men*	*Women*
Less than 8	404	88	196	53
8	1,443	409	874	325
9	10,007	4,131	8,190	3,369
10	1,630	1,098	3,707	2,224
Primary education total	13,485	5,726	12,967	5,971
11	1,137	616	1,544	868
12	418	258	682	423
13	223	127	332	178
Secondary education, total	1,778	1,001	2,558	1,469
Higher education, total	387	234	571	294
Total	15,650	6,960	16,095	7,735

Sources: Census 1951. Census 1961.

TABLE A2: *Working population with higher education, by type of course and average length of full-time education*

Type of Course	*1951*		*1961*	
	Men	*Women*	*Men*	*Women*
University (thousands)	289	99	424	110
average number of years	16·55	16·27	16·65	16·36
Teacher training (thousands)	68	128	87	169
average number of years	15·92	15·50	15·70	15·40
Advanced further education (thousands)	30	7	60	15
average number of years	15·80	14·90	15·80	14·90
Total (thousands)	387	234	571	294
average number of years	16·38	15·81	16·42	15·73

Sources: *Census 1951*, *Census 1961*.
Robbins Report.
Reports of the University Grants Committee, of the Ministry of Education, and of the Secretary of State for Scotland.

TABLE A3: *Occupied men, by age and education level Great Britain, 1961 (thousands)*

Age	*Education level*			
	primary	*secondary*	*higher*	*total*
16—17	753	—	—	753[a]
18—19	311	286	—	597[a]
20—24	1,041	373	54	1,468
25—34	2,298	680	186	3,164
35—44	2,834	493	103	3,430
45—54	2,745	443	138	3,326
55—64	2,375	233	71	2,679
65 and over	610	50	18	678
Total	12,967	2,558	571	16,095

[a]Allocation between the two age groups is in accordance with the age distribution of male employees given in *Ministry of Labour Gazette*, 1962, p. 217.

Sources: *Census 1951*.
Census 1961.

TABLE A4: *Male Earnings by Level of Education Great Britain 1961 (£'s)*

Age	*Education level*			
	Nil	*Primary*	*Secondary*	*Higher*
16—17	316	284	—	—
18—19	321	466	466	—
20—24	360	685	880	1,075
25—34	360	730	1,122	1,514
35—44	380	775	1,452	2,130
45—54	367	715	1,452	2,190
55—64	350	665	1,430	2,190

Sources and method of estimation

All the data are from Blaug (1965), *Appendix*, except for the following:

Col. (1): the earnings of men with no education have been estimated by multiplying the earnings of men with primary education by the ratios in the USA of the earnings of men with no formal education to the earnings of men with the same average amount of education (9·19 years), calculated by interpolation. The USA data are taken from Hansen (1963). Earnings for ages 16—17: see table A5. Earnings for ages 18—19: the figure in Thatcher (1968) p. 149 is deflated by the rise in wage level.

TABLE A5: *Annual Cost of Full-time Education per Man 1961 Prices (£'s)*

	Direct Costs	*Forgone earnings*
Primary education		
Age: under 15	59	—
15	150	—
Secondary education	214	284
Higher education		
University	712	600
Teacher training	346	540
Advanced further education	668	540

Sources:

Teaching costs, under 15: Department of Education and Science, *Education in 1964*, Cmnd. 2612 p. 103.

Age 15 and secondary education: Blaug, Peston and Ziderman (1967), pp. 90–91.

Higher education: *Robbins Report*, App. 4, pp. 113, 142, 152.

Forgone earnings, Ages 16—17: *Employment and Productivity Gazette*, May 1969, p. 411, gives the median full-time weekly earnings for boys aged 15—17 in 1968 as £7·2. Multiply by 1·1 to get the average by 0·718 to eliminate the rise in wages between 1961 and 1968 (p. 495) and by 50 weeks.

Higher education: *Robbins Report*, App. 4, p. 153, Earnings as students have been deducted.

REFERENCES

Books and Articles

C. E. Arregger, (ed.) *Graduate women at work*, Oriel Press, Ltd., Newcastle-upon-Tyne, 1966.

K. J. Arrow, "The economic implications of learning by doing", *Review of Economic Studies*, June 1960, pp. 155–173.

R. J. Ball and E. B. A. St. Cyr, "Short term employment functions in British manufacturing industry", *Review of Economic Studies*, 1966, pp. 79–197.

G. S. Becker, *Human Capital*, National Bureau of Economic Research, New York, Columbia University Press, 1964.

Y. Ben-Porath, "The production of human capital and the life cycle of earnings", *Journal of Political Economy*, 1967, pp. 352–365.

J. E. Birren, "Psychological aspects of ageing", in *International Encyclopaedia of the Social Sciences*, Vol. I, 1968, pp. 176–186.

M. Blaug, M. Peston, A. Ziderman, *The utilisation of educated manpower in industry*, Oliver and Boyd, London, 1967.

M. Blaug, "The rate of return on investment in education in Great Britain" with Appendix by Henderson-Stewart, *The Manchester School*, 1965, pp. 205–261.

M. J. Bowman, "Schultz, Denison, and the contribution of 'Eds' to national income growth", *Journal of Political Economy*, 1964, pp. 450–464.

E. F. Denison, "Measuring the contribution of education (and the residual) to economic growth", in O.E.C.D., *The residual factor and economic growth*, J. Vaizey, ed., 1965, pp. 32–100.

——, *The sources of economic growth in the United States and the alternatives before us*, Committee for Economic Development, New York, 1962.

—— (assisted by J. P. Poullier), *Why Growth rates differ*, The Brookings Institution, Washington, 1967.

Z. Griliches, "The sources of measured productivity growth: United States agriculture, 1940–60", *Journal of Political Economy*, 1963, pp. 331–346.

W. L. Hansen, "Total and private rates of return to investment in schooling", *Journal of Political Economy*, 1963, pp. 128–141.

A. C. Harberger and M. Selowsky, *Key factors in the economic growth of Chile; An analysis of the sources of past growth and of prospects for 1965–70*, University of Chicago, 1966 (mimeo).

F. Hines, L. Tweeten, M. Redfern, "Social and private rates of return to investment in schooling, by race-sex groups and regions", *Journal of Human Resources*, 1970, pp. 318–340.

H. Lydall, *The structure of earnings*, Oxford University Press, 1968.

L. Maglen and R. Layard, "How profitable is engineering education?" *Higher Education Review*, Spring 1970, pp. 51–67.

J. Mincer, "On-the-job training: costs, returns, and some implications", *Journal of Political Economy*, Supplement, 1962, pp. 50–79.

——, "The distribution of labour income; a survey with special reference to the human capital approach", *Journal of Economic Literature*, March 1970, pp. 1–26.

J. Morgan and M. David, "Education and income", *Quarterly Journal of Economics*, 1963, pp. 423–437.

R. R. Neild, *Pricing and employment in the trade cycle*, National Institute of Economic and Social Research, Cambridge University Press, 1963.

PEP, *Graduate employment*, London, 1956.

G. Psacharopoulos, *The anatomy of a rate of growth: the case of Hawaii, 1950–1960*, Economic Research Center, University of Hawaii, 1969. (mimeo.)

T. W. Schultz, "Education and economic growth", H. G. Richey (ed.) National Society for the Study of Education, *Social forces influencing American Education*, Chicago, 1961.

——, *The economic value of education*, Columbia University Press, New York and London, 1963.

——, "Resources for higher education: an economist's view", *Journal of Political Economy*, 1968, pp. 327–343.

D. Schwartzman, "The contribution of education to the quality of labor", *American Economic Review*, June 1968, pp. 508–514.
D. Seers and R. Jolly, "The treatment of education in national accounting", *The Review of Income and Wealth*, September 1966, pp. 195–210.
M. Selowsky, "On the measurement of education's contribution to growth," *Quarterly Journal of Economics*, 1969, pp. 449–463.
A. R. Thatcher, "The distribution of earnings of employees in Great Britain", *Journal of the Royal Statistical Society*, series A, part 2, 1968, pp. 133–181.
Maureen Woodhall, "It is worth educating women", *New Society*, 19th August 1965, pp. 21–22.
Vera Morris and A. Ziderman, "The economic return on investment in higher education in England and Wales", *Economic Trends*, No. 211, May 1971, pp. xx-xxxi.

UK Official Publications

Central Statistical Office:
National Income and Expenditure
National income statistics, sources and methods, 1956
National accounts statistics, sources and methods, (Rita Maurice, ed.) 1968.
Committee on Higher Education (Chairman Lord Robbins) *Higher Education*, 1963, Cmd. 2154.
General Register Office:
Census 1951, England and Wales, General tables
Census 1961, England and Wales,
Education tables,
Occupation tables
General Registry Office, Edinburgh:
Census 1951 Scotland, Vol. IV, Occupations and Industries
Census 1961 Scotland, Terminal education age
Ministry of Education:
Report
Statistics of Education
Ministry of Labour:
Ministry of Labour Gazette
Employment and Productivity Gazette
Scottish Education Department:
Education in Scotland, Report of the Secretary of State for Scotland
University Grants Committee:
Returns from Universities and University Colleges in receipt of Treasury Grants