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Human Capital Investment: The Returns from Education and Training to the Individual, the Firm and the Economy

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Abstract

This paper provides a non-technical review of the evidence on the returns to education and training for the individual, the firm and the economy at large. It begins by reviewing the empirical work that has attempted to estimate the true causal effect of education and training on individual earnings, focusing on the recent literature that has attempted to control for potential biases in the estimated returns to education and training. It then moves on to review the literature that has looked at the returns from human capital investments to employers. Lack of suitable data and methodological difficulties have resulted in a paucity of studies that have carried out sound empirical work on this issue. In the final part of the review, we look at the work that has tried to assess the contribution of human capital to national economic growth at the macroeconomic level. This work has generally involved using either a 'growth accounting' theoretical framework or 'new growth' theories. Although the empirical macroeconomic evidence that accompanies this work does not generally allow one to distinguish between the two approaches, there is a substantial body of evidence on the contribution of education to economic growth.

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I. INTRODUCTION

The aim of this review is to provide a non-technical assessment of the state of knowledge on:

- the impact of education and training on the labour market opportunities of individuals, in particular on earnings and employment probability; we also discuss the determinants of participation in education and training;
- the impact of training on firm performance: productivity, profitability and long-term competitiveness;
- the contribution of education to economic performance, through its impact on domestic output and productivity growth at the aggregate level.

The Concept of 'Human Capital'

There are three main components of 'human capital' — early ability (whether acquired or innate); qualifications and knowledge acquired through formal education; and skills, competencies and expertise acquired through training on the job.[1] The concept of human capital arose from a recognition that an individual's or a firm's decision to invest in human capital (i.e. undertake or finance more education or training) is similar to decisions about other types of investments undertaken by individuals or firms. Human capital investments involve an initial cost (tuition and training course fees, forgone earnings while at school and reduced wages and productivity during the training period) which the individual or firm hopes to gain a return on in the future (for example, through increased earnings or higher firm productivity). As with investments in physical capital, this human capital investment will only be undertaken by the wealth-maximising individual or firm if the expected return from the investment (or 'net internal rate of return')[2] is greater than the market rate of interest.

II. RETURNS TO THE INDIVIDUAL

In the standard economic model, the accumulation of human capital is seen as an investment decision, where the individual gives up some proportion of income during the period of education and training in return for increased future earnings. Individuals will only undergo additional schooling or training (i.e. invest in their human capital) if the costs (tuition and training course fees, forgone earnings while at school and reduced wages during the training period)

[1]Other labour market activities that are sometimes included in the concept of human capital include migration and search for new jobs.

[2]The return is a net figure as it takes into account the costs to the individual or firm of the human capital investment.

are compensated by sufficiently higher future earnings.[3] In a competitive labour market where wages reflect the marginal product of workers, to be able to command higher earnings, the better-educated or more-trained workers must be sufficiently more productive in employment than their less-skilled counterparts.[4] Note, however, that in the presence of imperfect competition or of barriers to entry into different occupations, wage differentials between the qualified and the unqualified may not necessarily be related to productivity differentials.

1. Measuring the Impact of Education and Training

There are several problems that arise when trying to estimate the true causal effect of education and training on individual earnings. The most discussed of these is the issue of whether the higher earnings that are observed for better-educated or more-trained workers are *caused* by their higher education or training, or whether individuals with greater earning capacity and ability choose to acquire more education or training. If the latter is true, then simple estimates of the return to education or training will be too large, as they will be unable to separate the contribution of unobserved ability from that of education and training and will ascribe them both to education and training (so-called 'ability bias'). Conversely, if education or training is measured with error, the estimates will be too small. Different methods have been developed and applied to account for some of the potential biases that may arise. Our aim is to synthesise the results found in the literature.

2. Estimates of the Returns to Education

The empirical results do suggest, in line with the theoretical literature, that education confers significant wage advantages to individuals. Most of the early studies of the returns to education ignored such things as ability and measurement error bias, whereas the more recent literature has placed much more emphasis on attempting to control for these potential problems. Most empirical studies also ignore the direct and indirect costs of education because of the difficulties involved in measuring these costs (and thus measure *gross* rather than *net* returns). Studies that have accounted for the direct and indirect costs of education show positive net rates of return as well.

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[3]The standard economic model concentrates on the quantifiable economic costs and benefits of these investments. Thus these models ignore the unquantifiable benefits an individual obtains from undertaking education — for example, the pleasure derived from learning and/or the non-financial advantages of working in a skilled profession.

[4]It should be noted that, while in the human capital approach it is the investment in education that enhances the productive potential of the individual, a competing paradigm — the 'screening hypothesis' — views educational qualifications as being simply used as a mechanism for selecting individuals who are *inherently* more productive.

The evidence for the UK and similar developed western economies suggests that the average estimate of the gross rate of return to a year's additional education ranges between 5 and 10 per cent.[5] One of the most recent studies for the UK[6] finds that the average annual return of undertaking an extra year of full-time education is 5.5 per cent for men and 9.3 per cent for women. These figures are only averages for the population as a whole and it would appear that these returns vary significantly by the type of qualification obtained. These estimates also ignore part-time education undertaken by a large number of individuals — for example, apprentices.

In the UK, individuals who complete schooling with some sort of formal qualification have significantly larger returns than individuals with the same number of years of schooling but who completed no formal qualifications. Men who complete five or more O levels (or equivalent qualifications) receive an average return of around 21 per cent compared with individuals who complete no qualifications before leaving school at 16. The corresponding figure for women is 26 per cent. These O-level qualifications would normally be completed by the age of 16. For those who continue on at school and complete an A-level school qualification, the additional return is around 11 per cent for women and 13 per cent for men (compared with individuals with five or more O levels) — that is, around 6 per cent per annum (see Table 1).[7] The average annual return to a first degree in terms of hourly wages (compared with just A levels) has been found to be in the range 5–8 per cent for men and around 10–13 per cent for women.[8] This difference between returns for men and returns for women is due to the earnings of women with A levels being considerably lower than those of men with a similar educational background.[9] Studies from other countries have also found that investments in women's education tend to yield higher rates of return than investments in men's education.[10]

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[5]Although this is generally true, some studies report considerably higher estimates — for example, 15 per cent by Harmon and Walker (1995) for the UK. As Card (1999) argues, this is probably due to the fact that the returns to education vary among different groups of individuals (i.e. are heterogeneous). The estimation procedure used by Harmon and Walker (1995) may only identify an estimate for a particular sub-group of the UK population (those forced to stay on at school after changes to the compulsory leaving age in the UK). There are strong economic arguments why this return may well exceed the average return to education for the population as a whole.

[6]Dearden, 1998.

[7]These A-level qualifications would normally be completed by the age of 18.

[8]Blundell et al., 1997; Dearden, 1999. This calculation assumes that, on average, a degree takes three years to complete. See Table 1 for the estimates from Dearden (1999). See also Arulampalam, Booth and Elias (1997).

[9]See Blundell et al. (1997) and Dearden (1999). As these studies use data from the 1970s and 1980s, it is likely that these returns for women are an overestimate, for although overall returns to education have not fallen back over this period, the differential between men and women by education group has fallen over time.

[10]For example, Butcher and Case (1994) find higher returns for women in the US.

TABLE 1

Private Rates of Return to Education and Formal Qualifications

Type of qualification	*Return for men*	*Return for women*
In school:		
Basic qualifications	7.2%	6.9%
	(3.3)	(7.3)
O levels	15.0%	11.2%
	(3.8)	(7.7)
5+ O levels	20.8%	25.8%
	(4.7)	(14.9)
A levels	33.6%	37.0%
	(4.8)	(14.8)
Post-school:		
Lower qualification	9.0%	6.3%
	(2.4)	(5.6)
Middle qualification	10.2%	10.5%
	(3.0)	(8.1)
Higher qualification	19.6%	26.4%
	(3.9)	(7.9)
Degree	18.2%	35.4%
	(4.4)	(10.8)
Number of observations	2,597	2,363

Notes:
Linear matching using extensive controls including family background and early test scores *and* correcting for measurement error in the qualification variables. No correction has been made for self-selection into employment which will tend to increase returns, especially for women (see Dearden (1999)).
Standard errors in parentheses.
Qualification definitions from the National Child Development Survey are given in Table A.1.
Returns for schooling examinations and post-school qualifications are total returns for highest qualification achieved. Returns for school qualifications are relative to the base group, who left school at 16 with no qualifications. Returns for post-school qualification courses should be added to basic school qualifications.
Returns are not net of costs and are measured at age 33.
Source: Dearden (1999), who used National Child Development Survey data.

As reported above, recent UK studies[11] suggest that the average annual return to an O-level qualification is greater than the average annual return to an A-level or higher-education qualification. Evidence from the US and Canada also suggests that there are decreasing returns to successive investments in human capital: the rate of return to education declines with the level of schooling.[12]

Important wage and rates-of-return differences have been found for different subjects taken in higher education. In the UK, men undertaking chemistry or

[11]For example, Dearden (1998) and Blundell et al. (1997).
[12]Hanoch, 1967; Vaillancourt, 1993.

biology degrees have much lower returns than men undertaking other types of degrees. On the other hand, women undertaking education, economics, accountancy or law subjects have significantly higher returns to their higher education than women undertaking other subjects.[13]

Individuals working in an industry experiencing rapid technological progress experience higher returns to education.[14] This could be because better-educated workers are more adept at responding to technological change and therefore are more productive in high-tech firms.

The individual returns to education change over time due to the evolving interaction between the demand for and the supply of workers of each qualification level. With regard to the more historical evidence, it thus appears that the rates of return to education in the UK were higher than ever before prior to the Second World War, declined temporarily in the 1970s and rose again in the 1980s.[15]

Evidence from comparisons with less-developed economies shows the rate of return to education tends to be higher in low-income countries. Early US studies as well as studies from developing countries have found that the returns are largest for investments in primary education.[16]

Empirical research has also highlighted the importance of factors such as an individual's ability measured in early childhood,[17] family background[18] (family income, parental education and number of siblings) and local environment[19] (the opportunities in the local unskilled labour market, the quality of schools in the local region and the proximity to a college) in affecting educational attainment.

3. The Determinants and Effects of Training

What is Training?

In most empirical studies, training is distinguished from formal school and post-school qualifications (which are viewed as education) and is generally defined in terms of courses designed to help individuals develop skills that might be of use in their job.[20] What is clear from the studies looking at the returns to training and participation in training is that using highly-aggregated descriptions of 'training'

[13]Blundell et al., 1997.
[14]Lillard and Tan, 1992.
[15]For the UK, see, for instance, Schmitt (1993) and Moghadam (1990).
[16]For a detailed survey of cross-country evidence, see Psacharopoulos (1981 and 1994).
[17]For example, Dearden (1998) and Blackburn and Neumark (1993).
[18]For example, Dearden (1998) and Butcher and Case (1994).
[19]For example, Card and Krueger (1992) and Card (1995).
[20]This is not always true. For example, in the study by Green (1993) using data from the UK General Household Survey, training includes 'self-instruction' which includes activities such as 'teaching yourself to use a word processor over a period of time'.

misses important differences in the determinants and effects of different forms of training.[21]

The Private Returns to Individuals

The private returns from employer-provided and vocational training (variously measured) to individual workers' real earnings have consistently been found to be significant. Individuals undertaking employer-provided or vocational training earn, on average, just above 5 per cent higher real earnings than individuals who have not undertaken such training, with some studies showing higher rates. The returns are closer to 5–10 per cent if the training also results in a middle or higher vocational qualification being obtained (see Table 2).[22]

TABLE 2

Private Returns to Employer-Provided Training and Qualification Training Courses

Type of training	*Returns for men*	*Returns for women*
Current job		
On-the-job employer-provided training course(s)	3.6%	4.8%
	(1.8)	(2.5)
Off-the-job employer-provided training course(s)	6.6%	9.6%
	(1.7)	(2.5)
Previous job		
On-the-job employer-provided training course(s)	5.7%	4.6%
	(3.2)	(3.6)
Off-the-job employer-provided training course(s)	5.4%	6.2%
	(2.5)	(3.2)
Other work-related training course(s)	6.7%	6.3%
	(2.1)	(2.7)
Qualification training course(s)		
Lower	0.01%	1.1%
	(2.6)	(3.3)
Middle	4.3%	6.9%
	(2.6)	(4.9)
Higher	8.5%	10.4%
	(2.4)	(3.3)

Notes:
See Table A.1 for definitions of qualification courses.
Standard errors in parentheses.
Returns across training programmes are additive.
Source: Blundell, Dearden and Meghir (1996), who used National Child Development Survey data.

[21]See Blundell, Dearden and Meghir (1996).
[22]Blundell, Dearden and Meghir, 1996.

Some studies have found the returns from training to be larger for working women than for working men[23] and to vary among the different sources and types of training courses. In particular, employer-provided training has higher returns than off-the-job training from other sources.[24] As to training type, managerial training shows the most significant impact (18 per cent), followed by professional and technical training (13 per cent) and semi-skilled training (9.5 per cent).[25]

When we observe an earnings stream for an individual who has undergone training, there may be reasons to suppose that the observed return may be net of some contribution to the costs of training. The available data do not contain information on the actual division of costs between employer and employees.

Returns over Time: Do the Acquired Skills Depreciate?

The actual magnitudes of the estimated wage gain from training depend not only on the different samples, definitions of training and methodologies used, but also on the timing of training. In fact, several studies[26] have found strong evidence that the acquired skills considerably *depreciate* over time (within a decade or so), which results in declining returns over time. Vocational training thus needs to be renewed to retain its benefits.

Employer-provided training not only has the largest impact on earnings, but its effects are also the most long-lasting (13 years against 8–10 years for training from other sources, using US data). While the initial effects of managerial and professional or technical training are larger, the earnings effects of semi-skilled training persist over a longer period (15 years as compared with 12 and 11 years respectively, again using US data).[27]

How Portable is Training?

A number of studies have found that employer-provided training acquired in earlier jobs is quite portable.[28] In the UK, for example, the return from on-the-

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[23]Booth, 1991; Greenhalgh and Stewart, 1987.

[24]Blundell, Dearden and Meghir, 1996; Tan et al., 1992; Lillard and Tan, 1992. The last find, for instance, that the greatest quantitative effect on increasing earnings comes from employer-provided training (16 per cent), followed by training from business and vocational schools (11 per cent) and training from regular schools (8 per cent).

[25]Lillard and Tan, 1992. Similarly, Bartel (1995) finds that 'core' training (teaching managers how to evaluate and improve employee performance, how to manage time effectively, how to be an efficient leader and how to implement change) has the largest impact on wages, followed by employee development training (problem-solving, decision-making, written and oral communication, improvement of job performance and stress management) and technical training.

[26]Greenhalgh and Stewart, 1987; Lillard and Tan, 1992; Mincer, 1994; Arulampalam, Booth and Elias, 1997; Blundell, Dearden and Meghir, 1996.

[27]Lillard and Tan, 1992.

[28]Blundell, Dearden and Meghir, 1996; Lillard and Tan, 1992; Booth, 1993.

job training undertaken with a previous employer is similar to the return from on-the-job training undertaken with the current employer.[29] A US study found, however, that transferability of training from most sources is diminished when new jobs are found in industries characterised by high rates of technological change.[30]

Other Benefits of Training

Part of the benefits from training investments in the firm derive from their positive influence on subsequent occupational status[31] and likelihood of promotion.[32] Also, trained workers are much less likely to change or quit their jobs or to be made redundant.[33] Trained workers are also much less likely to experience spells of unemployment.

The Relationship between Education and Training

Given that the benefits of work-related training are quite large, it is of interest to establish what sorts of individuals receive this training. What is clear from almost all of the studies looking at the determinants of training is that individuals with higher ability (as measured by aptitude scores), with higher educational attainment, who have undertaken training in a previous period (with the current or even a former employer) or with higher occupational status and skills are significantly more likely to participate in training.

A picture emerges of a strong complementarity between the three main components of human capital — early ability; qualifications and knowledge acquired through formal education; and skills, competencies and expertise acquired through training on the job. The current accumulated stock of human capital provides both strong incentives and more opportunities for further investments in human capital formation, thus highlighting the self-sustaining nature of individual human capital growth.

The observed patterns of provision of and participation in training therefore tend to amplify the skills gap rather than compensating for the low levels of educational attainment of many workers when they first enter the labour market. A number of studies point to the potential importance of early intervention even at nursery-education level: early achievement and qualifications appear to be key determinants of future educational attainment and wages.[34] This results in a

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[29]Blundell, Dearden and Meghir, 1996.
[30]Lillard and Tan, 1992.
[31]Greenhalgh and Stewart, 1987.
[32]Bishop, 1990.
[33]Dearden et al. (1997); Lillard and Tan (1992); Booth and Satchell (1994); Elias (1994); Winkelmann (1994); Blundell, Dearden and Meghir (1996) for men; Lynch (1991) for company-provided formal on-the-job training.
[34]Dearden, Ferri and Meghir, 1998; Heckman, 1998.

vicious circle for those who fail to acquire initial qualifications and who may subsequently lag further and further behind in the labour market.

It has been shown that those with no or intermediate-level educational qualifications and those with low social and economic status have high returns from training but low participation in it.[35] This result, however, tells us very little about the effectiveness of increasing training for individuals with low levels of formal education. The outcome could simply be due to the potentially higher costs of training lower-educated people: higher costs require higher returns to justify the investment in training. Also, if returns to training differ across individuals, as has been shown to be the case,[36] then the ones observed training may be the ones who can command the highest returns from it. Expanding training may not provide such large, or indeed any, returns to new participants. This question needs to be addressed in future research.

A qualification to the preceding discussion concerns the possibility that companies may sometimes offer *remedial training* to those employees whose previous training and educational qualifications are deemed insufficient. An econometric study investigating the determinants of three types of training offered by a large US manufacturing firm to its professional employees[37] offers some interesting (although obviously not generalisable) evidence in this regard. The results in the cases of 'core' training[38] and of technical training indicate that these types of training are considered by the firm as career-advancement measures to be awarded to those who stand out relative to their peers. By contrast, employee development training programmes[39] appear to be remedial, being targeted at individuals in relatively unskilled low-status jobs.

Other Determinants of Training

Most empirical studies have found that women, particularly those with children, are less likely to receive training than men.[40] Part-time workers and older workers are also less likely to receive or undertake training. This is in part due to the fact that such individuals will have less time in the labour market in which to make the training investment worth while. This means that the returns to such training will have to be relatively high, compared with those for other workers taking or being offered similar courses. Indeed, this could explain why higher returns to training (and indeed education) have been found for women in some studies.

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[35]Blundell, Dearden and Meghir, 1996; Arulampalam, Booth and Elias, 1997; Ashenfelter and Rouse, 1998.
[36]Heckman, LaLonde and Smith, 1999.
[37]Bartel, 1995.
[38]Teaching managers how to evaluate and improve employee performance, how to manage time effectively, how to be an efficient leader and how to implement change.
[39]Problem-solving, decision-making, written and oral communication, improvement of job performance and stress management.
[40]Blundell, Dearden and Meghir (1996) and references therein.

Union members have been found to participate in training more than non-union workers, while ethnic-minority male employees have a lower training incidence (such racial differences have not been found for women). Moreover, public sector firms and larger firms appear to provide more training than private sector and smaller establishments.

The training probability is lower when unemployment is high, and the likelihood of receiving firm and informal on-the-job training is greater in industries experiencing rapid technological change, especially for the most-educated workers. In fact, many job-relevant skills are technology-specific and are acquired through working with specialised production technologies. To the extent that few of these skills are easily available outside the firm, the incidence of on-the-job training was indeed found to increase with the industry rate of technical change.[41]

III. RETURNS TO THE EMPLOYER

Employers fully or partially fund the training of workers in the hope of gaining a return on this investment in terms of being a more productive, more competitive and consequently more profitable firm in the future. In practice, however, it is very difficult to measure this return. We saw in the previous section that training results in workers receiving higher real wages. These real wage increases have to be paid out of productivity gains and therefore should provide a lower bound on the likely size of productivity increases. In practice, the productivity gains are likely to be higher than this. For instance, when training has a large firm-specific component (i.e. training providing firm-specific knowledge and skills that have little or no value when an employee leaves the firm that provided the training) and, more generally, when labour mobility is effectively restricted, there may be productivity gains from training that are not passed on to the employee in terms of wages but are only reflected in direct measures of competitiveness, productivity and profitability.[42]

There are numerous difficulties in measuring the returns to education and training for firms. In the first instance, it is extremely difficult to obtain data on firm productivity, competitiveness and profitability. Furthermore, there are problems in identifying empirical counterparts to the concepts of general and specific training, and in identifying whether and how much of the costs are borne

[41]Lillard and Tan, 1992.

[42]Standard economic theory distinguishes training according to its portability between firms. The two polar forms are specific training and general training, the latter generating extremely versatile skills, equally usable or saleable in any other firm that might employ the worker concerned. A standard result based on the general–specific distinction concerns training finance. General training will not be financed by the firm due to the risk of its training investment being poached away by other firms; hence it is the workers receiving general training who will bear the cost of it, either directly or in the form of reduced wages during the training period. As for firm-specific training, the firm may be willing to fund part of its costs, while reaping part of its benefits.

by workers and by employers. Finally, there are difficult questions regarding causality (does company training cause the firm to improve its performance or does a better (poorer) firm performance foster (require) expenditure on training?). Because of these difficulties, there is a paucity of studies that have directly assessed the effects of education and firm training on company performance.

1. Impact on Firm Productivity

Some interesting evidence on the links between the skill composition of the work-force of a firm and labour productivity is provided by researchers at the National Institute of Economic and Social Research. In their work, they take a number of UK manufacturing firms and match them with continental firms producing similar products. This allows them to carry out direct productivity comparisons of these matched samples of manufacturing plants.[43] All these studies have found that, in all of the examined sectors, the higher average levels of labour productivity in continental plants were closely related to the greater skills and knowledge of their work-forces. By contrast, in the UK, the lower level of manpower skills was found to affect negatively labour productivity, the types of machinery chosen, the ways in which machinery was modified for the firm's particular needs, the smooth running of machinery and the introduction of new technology. The relationship between workers' productivity and subsequent firm *profitability* is, however, a complex one.[44]

As to the empirical literature aiming to quantify directly the contribution of training to worker or firm productivity, several studies (none of them carried out for Britain) show that training does indeed have a positive impact on productivity. The estimates range from very large effects[45] to little[46] or no[47]

[43]A range of different industries was covered: engineering (metal-working) — Daly, Hitchens and Wagner (1985) and Mason and van Ark (1994); wood furniture — Steedman and Wagner (1987); clothing manufacture — Steedman and Wagner (1989); food manufacture — Mason, van Ark and Wagner (1994); and a service sector (hotels) — Prais, Jarvis and Wagner (1989).

[44]An important qualification is, in fact, that the results of these studies may indeed point to an overall lower productivity of the British plants studied, but not necessarily lower profitability. Lower-skilled workers in the UK are not generally paid as much as their continental counterparts (because of relatively low unemployment benefits and the absence of a minimum wage). It may thus be far more profitable and efficient for British firms to employ more of these lower-skilled workers. Furthermore, if high-technology equipment is complementary with highly-skilled labour, it being easier for more-educated workers to adapt to new technological capital equipment efficiently, and if the average skill level of hires is too low, firms in the UK may simply find it not optimal to train workers to a high enough level to allow them to use the new capital equipment profitably. The ensuing socially inefficient low-skill, low-technology equilibrium may thus be optimal from the firm's point of view.

[45]Bartel, 1991 and 1995; Barron, Black and Loewenstein, 1989.

[46]de Koning, 1994.

[47]Black and Lynch, 1996 and 1997.

effect. Some studies[48] have found a positive effect of a *bundle* of human resource practices (including training) on firm productivity.

Some very interesting conclusions can be drawn from the evidence concerning the impact on productivity of training undertaken with a *previous* employer. A US study shows that previous on-the-job training increases a worker's initial productivity by 9.5 per cent but has no lasting effect. Previous off-the-job training has more long-lasting benefits and increases current productivity by 16 per cent.[49] This finding is consistent with the earlier finding that employer-provided training was transferable across employers, suggesting that such courses may provide relatively general skills.

2. Impact on Firm Profitability

Comparing the impact of training (or education) on wage rates with its impact on productivity allows us to shed some light on the links between the returns to the individual and the returns to the firm, and thus on the impact of training (or education) on firm profitability.

The few studies available that have addressed this issue tend to confirm that not all the productivity gains resulting from training are compensated through a corresponding increase in individual remuneration, so that investment in training remains profitable for firms. In particular, two studies using very different data and approaches suggest that the productivity increase is over twice the size of the wage increase caused by training.[50]

Further interesting results relate to the existence of profitability returns to the firm from training sponsored by another employer. This suggests that on-the-job employer-provided training sometimes generates considerable third-party externalities (benefits that are not appropriated by either the trainee or the trainer) when trainees do not stay with the employer who trained them. Formal off-the-job training is found to generate substantial long-lasting externalities, while informal training appears to generate externalities only in the first year of a worker's tenure at a firm.[51]

Formal education is the typical example of the accumulation of general skills: the positive impact on current productivity is closely matched by a commensurately higher wage, leaving firm profitability unaffected.[52]

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[48]Ichniowski, 1990; Arthur, 1994.

[49]Bishop, 1994.

[50]Barron, Black and Loewenstein, 1989; Blakemore and Hoffman, 1988.

[51]Formal training received on the job from a previous employer has no effect on the starting wage but increases initial productivity by 9.5 per cent of the wage while at the same time reducing training requirements by 17 per cent. Formal off-the-job training sponsored by a previous employer does not increase current wage rates but boosts productivity, thus increasing profitability by 14 per cent of the wage at six months of tenure and by 18.6 per cent of the wage at the time of the survey interview — Bishop (1994).

[52]Bishop, 1994.

3. Impact on Firm Long-Term Competitiveness

The matched-plant studies confirm that the rapid and effective introduction of new technology requires managers to be well supported by highly-qualified technical staff, and the continental plants were found to enjoy a decisive advantage over their British counterparts in this respect. The available skills of a firm's work-force were shown to affect not only the type, variety and quality of the product manufactured, but also flexibility and the speed of the production process. In contrast with their British counterparts, the relative abundance of craft-skilled workers in continental machine shops enhanced flexibility in switching workers from one type of machine and product to another to meet rapidly changing production needs. Finally, the differences between the British and the continental engineering plants in the proportions of technicians with appropriate qualifications had visible consequences for both new product innovation and adapting the production process to take advantage of developments in new technology.

Some empirical studies directly confirm these general findings, suggesting strong links between the employment of graduates, including professional scientists and engineers, and the adoption and use of high-level technologies in the firm, and between the extent of investment in worker training and the speed and successful adaptation of new technology.[53] More-highly-educated and more-highly-skilled workers have been found not only to be able to adapt more rapidly and efficiently to new tasks and technologies, but also to be a direct source of innovation. In fact, education and even previous informal training have been found to increase substantially a worker's ability to be innovative on the job.[54]

IV. RETURNS TO THE ECONOMY

The existence of high rates of private returns to education and training provides an incentive for individuals to invest in human capital. However, the benefits of education and training may not be restricted to the individual, but could spill over to others as well so that the gains to the economy as a whole (the social return) could exceed the returns obtained by the individual investing in human capital (the private return). When justifying public support for education or training, the distinction between the private and the social return becomes crucial.

A number of spillovers or 'externalities' have been suggested in the literature. At the most basic level, there are obvious benefits to society from having an educated and literate population, including increased participation in democratic

[53]Bosworth and Wilson, 1993; Chapman and Tan, 1990.

[54]Number of years of schooling has a significant positive impact (7.8 per cent) on a measure of innovation on the job (index of suggestions). Ten years of previous relevant experience (a proxy for previous informal training) result in a 43 per cent increase in such a measure — Bishop (1994).

institutions and social cohesion. Education and training may also provide positive production externalities; for example, it has been argued that educated individuals in a firm may improve not only their own productivity but also those of the less-well-educated individuals with whom they work.[55] A number of other spillover effects have also been postulated.[56]

While the existence of these positive economy-wide educational spillovers is an important economic justification for the public support of education, the difficulties of actually verifying their size and thus calculating true social returns are formidable. Most attempts to quantify the social returns to education and training do not quantify spillover effects and simply make an adjustment to the private returns by including all of the direct costs of schooling and use *gross* rather than *net* earnings.[57] The most direct evidence on education externalities comes from comparisons of macro- and micro-estimates. The very few available estimates of the rates of return to education at the aggregate level do not, however, suggest that allowing for an externality effect adds very much to private rates of return based on earnings differences.[58]

The contribution of human capital to national economic growth at the macroeconomic level, as revealed by actual economic performance, has been the focus of a considerable body of both theoretical and empirical research. Two major theoretical frameworks try to model and analyse the contribution of human capital to economic performance — the 'growth accounting' literature and the 'new growth' theories.[59]

The Growth Accounting Model

In the growth accounting exercises, the proportion of real income per capita growth that could not be attributed to growth in the quantity of capital and labour inputs was termed the 'residual'.[60] Even if it was relabelled as 'technical change' or 'efficiency', much of the observed economic growth still remained unexplained. Successive developments have thus increasingly focused on the role of the *quality* of these inputs, including human capital, in the growth process.[61] Initial studies assumed that the quality of inputs remains unchanged.

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[55]Gemmell (1997) gives a number of examples of production externalities.

[56]See Gemmell (1997) and Redding (1996).

[57]When looking at the returns to individuals, earnings net of tax is the relevant measure as this is what the individual actually receives. When looking at the returns to society, gross earnings is the relevant measure as taxes are used for the benefit of society.

[58]See Jenkins (1995) for the UK and the discussion in Gemmell (1997).

[59]Note that, in a 'screening hypothesis' framework, which in its purest form claims that education makes no direct contribution to individual productivity (see footnote 4), from the point of view of society as a whole, an increase in the educational and qualificational level of the work-force would not raise productivity and thus would not contribute to economic growth.

[60]Solow, 1957.

[61]Schultz, 1960; Denison, 1962; Jorgenson and Griliches, 1967.

More recent studies claim to have shown that a significant proportion of the 'residual factor' can be accounted for by substitution from lower- to higher-quality inputs. The problem with these studies is that there are considerable difficulties in the definition, measurement and comparison of skills and competencies. There are also problems establishing the direction of causality: does more education lead to higher growth or can richer countries afford to spend more on education? Nevertheless, the studies still provide some useful bench-marks for the contribution of education to economic growth. The findings of this empirical research are discussed in more detail below.

The New Growth Literature

The recently emerged new growth literature explicitly considers the spillover effects from education and training activities and places such effects at the heart of self-sustaining growth. Two major strands of thought have emerged.[62] The first one sees human capital just as an ordinary input in production: the level of output depends on the level of human capital. This implies that the growth rate of output depends on the *rate* at which countries accumulate human capital over time.[63]

The other idea views human capital as the primary source of innovation, increasing individuals' capacity both to produce technical change and to adapt to it. Education *levels* (human capital stocks) are thus linked to productivity *growth*, and the returns to human capital accumulation are justified by the separate and crucial role human capital plays in the successful introduction of and the effective adaptation to technological and organisational changes.[64]

The Empirical Evidence

The available macroeconomic evidence does not allow one to distinguish between the two approaches. For instance, aggregate (or per capita) output growth is predicted to be a function of the rate of growth of human capital in both the growth accounting and the new growth literature.

A recent summary of the main findings of the growth accounting body of research concludes that the changing education of the labour force during the last 50 years has accounted for a significant proportion (around one-third) of overall productivity growth in the US.[65] More recent evidence from the UK covering the period 1971–92 suggests that a one-percentage-point increase in the proportion of workers with higher qualifications raises annual output by between 0.42 and

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[62]For a detailed and comprehensive review, see Aghion and Howitt (1998).

[63]Lucas (1988) offered the seminal contribution; recent extensions within this framework include Azariadis and Drazen (1990), Glomm and Ravikumar (1992) and Benabou (1996).

[64]This approach, initiated by Nelson and Phelps (1966), has recently been revived by the Schumpeterian growth literature (reviewed in Aghion and Howitt (1998)); see also Romer (1990) and Redding (1996).

[65]Griliches, 1997.

0.63 per cent.[66] These results, however, are extremely sensitive to the measure of educational quality that is used.

Evidence from OECD countries suggests that those that expanded their higher education more rapidly during the 1960s experienced faster growth.[67] It appears that, while primary and secondary education skills are related to growth in developing countries, tertiary education skills are most important for growth in OECD countries.[68]

A common finding[69] in cross-country studies is that there is a positive contribution to growth of the initial average *level* of schooling (stock of human capital), measured by literacy rates or primary and secondary school enrolment ratios.[70]

The Indirect Contribution of Human Capital to Economic Growth

There is increasing evidence that R&D activities contribute significantly to productivity growth and that some of these gains spill over to other firms and countries.[71] The growth accounting models have shown that accumulation of physical capital also plays an important role in determining the rate of economic growth. Education and training may therefore indirectly contribute to growth if they can be shown to encourage investment in capital equipment and R&D.

As we have already seen, there is some microeconomic evidence that links the ability to innovate and adopt new technology with the stock of highly-educated workers.[72] This evidence does not tell us which way the causation runs. While the presence of a large stock of educated workers may itself be a cause of productivity-enhancing technological change, the introduction of new technologies is likely to require the employment of a more-highly-educated and more-highly-skilled work-force. There is, however, substantial evidence that education and training have strong positive effects on the accumulation of physical capital.[73]

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[66]Jenkins, 1995.
[67]See, for example, Mankiw, Romer and Weil (1992).
[68]Gemmell, 1995 and 1996.
[69]Krueger and Lindhal (1998), however, show that such a finding results from imposing strong restrictions on the data.
[70]For example, the increase in average OECD enrolment rates from 70 per cent in 1960 to 95 per cent in 1985 is associated with about 0.6 percentage point per year faster productivity growth, which is in the range of possible effects based on micro-estimates for the effects of increased education (Englander and Gurney, 1994).
[71]Gemmell, 1997.
[72]Lillard and Tan, 1986 and 1992.
[73]See, for example, Benhabib and Spiegel (1994) and Gemmell (1996).

V. CONCLUSION

The available evidence has shown that human capital is an important factor in individual, firm and national economic growth.

In particular, positive economic returns to education at the individual level have been consistently found, with such returns varying by the type and level of the qualification obtained, by subject area for higher education and over time. Training, too, was shown to result in significant wage returns for the individual, and, again, the returns were found to vary among the different sources and types of training courses. Training appears to offer further benefits in terms of higher employment stability and to be quite portable among jobs. The acquired skills have, however, been found to depreciate considerably over time.

A robust finding is one of a strong complementarity between the various types of human capital investments: early achievement and qualifications are important determinants of future educational attainment, individuals with higher educational attainment in turn undertake more training on the job, and those who have undertaken training in a previous period — with the current, but even with a former, employer — are more likely to participate in further training.

There is some indication that workers and employers tend to share the returns from training — and thus possibly its costs.

Although still insufficient and scattered, the available evidence points to some positive contribution of training, and more generally of the level of manpower qualifications and skills, to firm productivity and competitiveness. As to the latter contribution, strong links have been found between the human capital of the work-force and its innovative capacity, as well as the adoption and adaptation of new technologies. In view of the increasing evidence that R&D activities and the accumulation of physical capital are important factors in national economic growth, the complementarity of human capital with R&D and physical capital investments can also be viewed as an indirect contribution of education to macroeconomic growth.

More direct evidence on the importance of human capital for national productivity growth is provided by growth regressions, where the education measures have been found to be significant explanatory variables, with higher education being the most relevant education variable for more developed countries.

Overall, a considerable amount of knowledge and consensus has been gathered on the private economic returns to education and training for the individual, and, to a lesser extent, on the contribution of education to national economic growth. By contrast, lack of suitable data and methodological difficulties have, to date, prevented adequate assessment of the impact of human capital accumulation on firm performance. The contribution of the education level of the work-force to productivity and firm profitability has remained largely unexplored, while the estimates of the impact of training on productivity

are subject to wide margins of uncertainty. Another area manifestly neglected is the cost side of training, which has prevented an accurate calculation of the rate of return to training, both for the individual and for the firm. Finally, the aggregate measures used to proxy human capital in the growth regressions have not been able to capture participation in training, so that no evidence has been gathered on the impact of training investments on economic growth.

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TABLE A.1

Description of Educational Qualification Variables in the National Child Development Survey

Variable	*Description*
Highest post-school qualification in 1981:	
Degree	University or CNAA first degree CNAA Postgraduate Diploma University or CNAA higher degree
Higher vocational	Full professional qualification Part of a professional qualification Polytechnic Diploma or Certificate (not CNAA validated) University or CNAA Diploma or Certificate Nursing qualification including nursery qualification Non-graduate teaching qualification Higher National Certificate (HNC) or Diploma (HND) BEC/TEC Higher Certificate or Higher Diploma City and Guilds Full Technological Certificate
Middle vocational	City and Guilds Advanced or Final Certificate Ordinary National Certificate (ONC) or Diploma (OND) BEC/TEC National, General or Ordinary Certificate or Diploma
Lower vocational	City and Guilds Craft or Ordinary Certificate Royal Society of Arts (RSA) awards, stage 1, 2 or 3 Other commercial or clerical qualification and all other courses leading to some sort of qualification that are not identified above, including miscellaneous apprenticeship qualifications
Highest school qualification in 1981:	
A levels	At least one: GCE A level or Scottish Leaving Certificate (SLC) or Scottish Certificate of Education (SCE) or Scottish University Preliminary Examination (SUPE) at Higher Grade or Certificate of Sixth Year Studies
5+ O levels	At least five: GCE O level passes or Grades A–C or CSEs Grade 1 or equivalent
O levels	One to four: GCE O level passes or Grades A–C or CSEs Grade 1 or equivalent
Basic qualifications	At least one: CSE Grade 2–5 or equivalent
None	No school qualification, including individuals with no formal schooling

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