

CHAPTER 18

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**HUMAN CAPITAL AND  
PRODUCTIVITY IN  
THE IRISH CONTEXT**

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**ABSTRACT**

Human capital has long been regarded as one of the main drivers of growth and productivity in an economy. This chapter analyses and outlines the theoretical and empirical findings linking human capital to productivity growth at a macroeconomic level. There is compelling evidence in support of the view that increased human capital boosts growth, individual earnings, and firm level productivity. While the impressive gains in labour productivity experienced in Ireland since the 1990s were underpinned by a steep rise in educational attainment, educational outcomes today, while broadly in line with OECD averages, are still below the results achieved by the best performers in the OECD.

## 18.1 Introduction

One of the most important macroeconomic issues is how to improve living standards, i.e., GDP per capita, over time. It is now widely recognised that the main driver of living standards in the long term is productivity growth.

But what drives productivity? Levels and growth rates of productivity depend on many factors of which human capital – in essence, a skilled labour force – is just one, but an increasingly important one. This observation has attracted considerable recent attention not least because of the ability of policymakers to influence it through investment in education and training.

With global, demographic and technological change, it has been argued that the links between human capital and productivity are now more important than ever (Bergheim, 2005; Leitch, 2005). Product markets have become more global, increasing the elasticity of both product and labour demand. The growing availability of high-technology capital has created new products and production systems that may require workers to have greater cognitive skills and to be more adaptable and efficient learners.<sup>1</sup> Economic growth increasingly depends on the synergies between new knowledge and human capital, which is why large increases in educational and training investment have accompanied major advances in technological knowledge in all countries that have achieved significant growth over the past decade.<sup>2</sup>

Despite the consensus that human capital impacts on productivity, the extent and nature of the relationship remains unclear. There are at least three ways of defining the impact or returns to investment in human capital: (1) the productivity or growth effects – sometimes referred to as macro effects; (2) the returns to the individual; and (3) the firm level effects. The first highlights the impact of human capital investment on macroeconomic growth and productivity. The second is made up of the costs and benefits to the individual and is net of any transfers from the state and any taxes paid. The third attempts to estimate any additional externalities or spillover effects at the level of the firm.<sup>3</sup> The purpose of this chapter is to provide an insight into the literature that examines these separate effects of human capital on growth and productivity.

The chapter is structured as follows. Section 18.2 outlines the theoretical and empirical findings in the literature linking human capital to productivity and growth at the macroeconomic level. The following section reviews the basic tenets of human capital theory and provides some empirical evidence that demonstrates compelling support for positive rates of return to education and training for the individual. Section 18.4 reviews the strand of literature that links human capital and firm level productivity. A brief overview of Ireland's human capital record in a comparative context is offered in Section 18.5 and Section 18.6 provides a conclusion and some policy considerations.

## 18.2 Human Capital, National Growth and Productivity

There are many definitions of human capital in the literature. However, one of the most useful and widely used is that by the OECD (2001), which states that human capital is the “knowledge, skills, competencies and attributes embodied in individuals that facilitate the creation of personal, social and economic well-being.” Hence, the knowledge and skills that a worker has – which can be acquired or added to from education and training – generates a stock

of productive capital. Education, experience and abilities of an individual have an economic value for the individual, for employers and for the economy as a whole.

### 18.2.1 Theoretical Foundations

There are two main strands to the literature that attempt to link human capital to growth and productivity. The first is based on the seminal work of Robert Solow in 1956. Solow's model is based on a production-function approach to the economy where output (Y) depends on inputs of capital (K) and labour (L) and exogenous technological advances.<sup>4</sup> Solow shows that economic growth is driven by the improvement of productivity via technological advancement. Hence, improving the efficiency of labour, through a better skilled workforce, is an example of how growth can be generated within the Solow framework, although Solow does not specifically explain how the process of growth is determined.

The second strand is based on the new growth theories by Lucas (1988) and Romer (1986; 1990). These models emphasise the endogenous determination of growth rates which are determined within the model (and can thus be affected by government policies), instead of being driven by exogenous technical change. Human capital affects growth in at least two ways: increases in education and training have the potential to spillover to other individuals, making other workers more productive; and better educated and trained workers are more productive, have more knowledge and make better use of firms' capital investments. The approach also emphasises the higher rate of innovation that can be generated by having more educated workers generating new ideas.

Empirically, the theoretical frameworks propose the following outcomes. The first view proposes that the level of output depends on the level of human capital and this implies that output growth depends on the rate at which countries accumulate human capital over time. Hence, a one-off permanent increase in the stock of human capital (e.g. average years of education in the population) will give rise to a one-off increase in productivity growth.<sup>5</sup>

The second views human capital as enhancing the absorption and innovation of new technologies. Human capital stocks (levels of education) are thus linked to productivity growth, and a one-off permanent increase in the level of human capital is associated with a permanent increase in the growth rate of productivity.<sup>6</sup>

There is no consensus among academics about which theory most accurately describes the process of economic growth. However, there is consensus that improvements in human capital provide a boost to growth by making workers more productive and/or more flexible.

### 18.2.2 Empirical Evidence

We can summarise the following key points from the empirical literature as follows:<sup>7</sup>

- There is compelling international evidence indicating that investment in education increases growth and productivity. For example, increasing average education in the population by one year has a positive impact on productivity of between three and six per cent (and perhaps seven per cent, based on new growth theories).<sup>8</sup>
- Third level education is relatively more important for growth in OECD countries than primary or secondary education, between 1960 and the 1990s (Gemmell, 1996).

- It appears that the stage (primary, secondary, tertiary), level (are all years of education equally valuable? Does the impact of expanding a stage of education (say, higher education) depend on the initial levels of attainment in that stage?) and type (e.g. engineering versus arts degree, academic versus vocational) of education all matter for growth (Judson, 1998).
- There is some evidence (albeit small) that efficiency of educational resource allocation matters for growth (Judson, 1998).
- Human capital also contributes indirectly to growth through its positive impact on physical capital (Barro, 1991; Gemmel, 1996; Benhabib and Spiegel, 1994).
- There is evidence that the rate of technology transfer is enhanced by human capital (Griffith, Redding and Van Reenen, 2000; Cameron, Proudman and Redding, 1998; Benhabib and Spiegel, 1994).
- The effects of training on productivity growth at the national level are not addressed in the literature. The debate would benefit greatly from such research.
- There are wider social benefits associated with increased investment in human capital, such as improved health (Barro and Lee, 1994; Rose and Taubman, 1979; Fuchs, 1979; Schultz, 1963; 1981; Becker, 1993), reduced crime possibilities (Blundell et al., 1999; Johnson, 2004), greater social cohesion (Green et al., 2003), fertility (Barro, 1991 and Barro and Lee, 1994), lower infant mortality (Barro and Lee, 1994), and greater voter participation (Dee, 2003).

## 18.3 Human Capital, Productivity and Returns to the Individual

The idea that education and training constitute an investment in individuals that is analogous to investment in machinery was first espoused by Adam Smith in 1776 in his book, *The Wealth of Nations*.<sup>9</sup> However, it is the writings of Mincer (1958; 1962; 1974), Schultz (1961), and Becker (1962) that underpin the theoretical and empirical foundations of human capital.

### 18.3.1 Theoretical Foundations

Human capital theory suggests that differences in human capital lead to differences in productivity and hence to differences in earnings. The process of acquiring skills is analogous to an investment decision. Like other investment decisions, it requires the outlay of resources now (costs) for expected returns in the future (benefits), and like other investments, it is the prospect of these returns that motivates the individual to undertake such investment.

The costs to the individual of investment include psychological, social and monetary costs (e.g. difficulty with learning, costs of going to college, loss of earnings when not working, etc.). The private benefits to the individual are the expected financial rewards from work, i.e., an individual will expect higher earnings over their working life because investment in education and training equips them with skills that improve their productivity and make them more attractive to employers as a result.<sup>10</sup>

Human capital theory postulates that an individual, when deciding to invest in education and training, will perform a sort of cost-benefit analysis, considering the benefits of education

and training, net of costs. Various other factors will also influence the individual's decision: investment is more likely when the person is young, when the expected earnings are higher and when the initial investment costs are lower.<sup>11</sup>

### 18.3.2 Empirical Evidence: The Returns to Education

There is a significant amount of research indicating that education and earnings are positively linked. In all countries, including Ireland, graduates of tertiary level education earn substantially more than upper secondary and post-secondary non-tertiary graduates. In many countries, upper secondary and post-secondary non-tertiary education forms a break point beyond which additional education attracts a particularly high premium. Earnings differentials between tertiary and upper secondary education are generally more pronounced than those between upper and lower secondary or below (OECD, 2005).

The theory itself gives rise to earnings functions that attempt to explain the observed differences in earnings between individuals.<sup>12</sup> There is a vast and varied literature on the internal rates of returns using these earnings functions, and some of these have been estimated with a good degree of success.<sup>13</sup> Blundell et al. (1999), Card (1999) and more recently Harmon et al. (2003) offer good summaries of this literature.

Some of the key findings are as follows.

- Education and earnings are positively linked. In all countries, including Ireland, graduates of tertiary level education earn substantially more than upper secondary and post-secondary non-tertiary graduates.
- The main measure of human capital used in the empirical literature is education, captured by the years of schooling of the individual. Analyses using this measure of human capital throw up rates of return to the individual of an additional year of education in the range five to fifteen per cent.
- Although there is wide variation in cross country studies, the most recent international evidence suggests a return to a year of schooling is in the range of seven to nine per cent for males and about eight to ten per cent for females. It is higher for Ireland: between nine to eleven per cent for males and about 14 per cent for females.<sup>14</sup> These returns for Ireland are significant and represent a high return on investment, relative to any other form of investment. They are central to any assessment of the impact of Exchequer investment on education.
- Individuals have different levels of ability and when estimates of the rate or return to schooling are adjusted for this, they are somewhat lower. Nevertheless, there is an "unambiguous positive effect on the earnings of an individual from participation in education" (Harmon et al., 2003: 150).
- Some tentative evidence suggests the return to education may not be linear; there may be a bonus for higher levels of educational attainment such as a degree (Denny and Harmon, 2001; Skalli, 2001) – this may also be true for Ireland, but further research is required.

### 18.3.3 Empirical Evidence: The Returns to Training

Training and up-skilling are just as important as initial education. In ten to fifteen years from now, the bulk of the labour force will still be composed of individuals who are currently in the labour market. Furthermore, due to population ageing and the effect of policies aimed at prolonging working life, most of these individuals will have completed their initial education many years before and rapid technological change will have made part of their competencies obsolete. The education and training they receive after they have started their working life is therefore crucial for both output growth and individual career prospects (OECD, 2003).

Although less empirical evidence exists on the impact of training on productivity, the limited data available indicates that on-the-job training is an important source of the increase in earnings that workers get as they gain experience at work. The returns of on-the-job training are commonly found to be quite high, at between five to ten per cent.

The following is a summary of the key points from the literature:

- People with higher ability and with higher educational attainment are more likely to participate in training, suggesting a strong complementarity between the components of human capital; early ability, qualifications and knowledge (acquired from formal education) and skills and competencies (acquired from training on the job) (see Blundell et al., 1999).
- Women, part-time workers and older workers are less likely to receive training than other groups. However, the returns to training for working women may be greater than for working men (see Booth, 1991; Greenlagh and Stewart, 1987).
- International evidence indicates there are significant returns to investment in formal training for the individual: higher earnings in the range of five to ten per cent have been observed (see Blundell et al., 1999; Smith, 2001; Groot, 1995). Despite the positive effects of training, there is some evidence of under provision.<sup>15</sup>
- There is very limited evidence on the returns to training in Ireland but the studies that do exist, indicate it is positive (Denny and Harmon, 2000).<sup>16</sup> Also, surveys of Irish training show that large firms train more than small firms, foreign enterprises provide more employee training than their indigenous counterparts, and training is concentrated among those who are already highly qualified.
- Individuals benefit in other ways from training, in addition to increased earnings. Training is associated with the likelihood of promotion (Bishop, 1990), reduced probability of unemployment, and reduced likelihood of quitting (Dearden et al., 1997; Lillard and Tan, 1992; Booth and Satchell, 1994; Blundell et al., 1996 for men; and Lynch, 1991 for company-provided formal on-the-job training).
- Firms are generally slow to invest in training that equips workers with transferable skills, for fear of poaching. With specific training, firms are more likely to invest as they can reap some of the benefits when the worker becomes more productive as a result of training. There is some evidence that the content of training is important; computer training seems to have a greater impact on productivity, at least in the non-manufacturing sector in the US (Black and Lynch, 1995; 1996).
- There is evidence that training also benefits the firm; in the UK a one percentage point increase in training is associated with an increase in the value-added per hour of about 0.6 per cent (Dearden et al., 2005).<sup>17</sup> However, evidence from the US and New Zealand is not as conclusive.

- More highly skilled workers are more likely to adapt to change and are more likely to be a direct source of innovation (Bosworth and Wilson, 1993; Chapman and Tan, 1990).

## 18.4 Human Capital and Firm Level Productivity

Investigation of how human capital impacts on business-level productivity has proceeded apace with the compilation of new datasets, initially across Northern Europe and in more recent times in the US and in the European Union. The need and use of these new datasets is implicitly based on the view that “the productivity of a country is ultimately set by the productivity of its companies” (Porter, 2005: 45). Furthermore to understand the impact of human capital development and the role of policy therein, firm-level research is required that facilitates focus on both individual firm and worker characteristics.

Such analyses is important for economies moving from an investment-led stage of economic growth towards an innovation-driven phase, such as Ireland, where the scope for economic growth generated from capital accumulation have largely been relatively exhausted (notwithstanding the remaining work required to bring transport infrastructures, in particular, up to international standards).

In the context of this research, databases of linked employer-employee data create the potential for comprehensive investigation of relationships between human capital and productivity at the level of firms. Specific questions that have been addressed based on the approach include (as highlighted by Abowd et al., 2002) the following:

1. How has the allocation and distribution of human capital changed in the economy? Are aggregate changes indicative of broad trends or are specific industries or specific firms within industries driving observed results?
2. How do changes occur? Do new firms with different levels of human capital replace old firms or do current firms adjust their workforce? Do high-tech firms increase employment and crowd out employment in low-tech firms?
3. What causes changes? Which changes in technology are associated with changes in human capital? How are skill intensity and skill dispersion affected by technological changes?

However, research on Ireland is limited by the absence of such data.

### 18.4.1 Some Evidence from Firm-Level Data

There are several additional benefits from using this type of firm-level data. The new datasets permit a better understanding of the role and degree of structural change on labour productivity (see Haltiwanger, 1998 for an example). This issue is often not explicitly addressed in the macroeconomic discussions of sources of productivity growth. Also, it has been shown that once researchers control for both individual and firm heterogeneity, approximately 90 per cent of wage rate variation can be explained. This is over twice what could be explained using alternative methods (see for example, Abowd et al., 2002).

Early firm-level studies provide evidence of a positive impact of computers/technology on productivity that macroeconomic studies were unable to identify, but the latter now also indicate the association between ICT usage, particularly, and macroeconomic growth.

The technology/productivity link is a crunch issue for Europe. Much is made of Europe's problem in converting ICT investment into productivity gains at macro level due to less effective ICT use, although Ireland rates relatively well here - along with Ireland, the US recorded the biggest increases in ICT contribution to labour productivity growth, from 1996 to 2002 (EIU, 2004).

Some of the key findings from the literature (Stiroh, 2001; Oliner and Sichel, 2000; O'Mahoney and Van Ark, 2003; Turcotte and Rennison, 2004; Black and Lynch 1995; 1996a; 1996b; Entorf and Kramarz, 1997; Abowd et al., 2002) are as follows:

- The most productive firms appear more likely to use advanced technology/ICT than the less productive.
- In the absence of longitudinal data, computer users possess unobserved skills that affect wages.
- Computer use, university education and computer skills development are associated with higher productivity, however, computer use is correlated with productivity benefits irrespective of whether workers have university degrees.
- The impact of education and technology on productivity is evident in both manufacturing and non-manufacturing sectors.
- Productivity improvements from employing a greater share of university graduates and using computers are larger for smaller firms (less than 20 employees).
- Businesses that upgraded their technology were also observed to upgrade their skills.
- In the US, firms in non-manufacturing industries that provided computer training to their workers had significantly higher productivity than competitors.

## 18.5 How Does Ireland's Human Capital Record Compare?

We have seen that there is compelling evidence in support of the view that increased human capital boosts growth, individual earnings, and firm level productivity. It is insightful therefore to examine Ireland's educational attainments in a comparative context.

Impressive gains in labour productivity have boosted economic growth since the early 1990s (OECD, 2006). However, they were underpinned by a steep rise in the educational attainment of the working-age population. As a result, educational outcomes, while broadly in line with the OECD average, are still below the results achieved by the best performers in the OECD. The most recent available data reveals the following:<sup>18</sup>

- **Attainment of Upper Secondary Level Qualification:** Of the population aged 25-64 in Ireland, 62 per cent have attained at least upper secondary education; this is below the OECD average of 66 per cent and well below the leader countries of Korea, Norway, Sweden, Canada, Finland and US, and Japan, for example. Even if we restrict the sample to the proportion of the population between 25-34 years, Ireland's performance (at 78 per cent) is still ranked below these leader countries, although slightly above the country mean of 75 per cent.



- **Attainment of Third Level Qualification:** At third level, Ireland's performance is somewhat better: approximately 26 per cent of the population aged 25-64 have attained some form of tertiary level qualification, compared to a country mean of 24 per cent and the figure is higher for the sample 25-34 and 35-44, at 37 per cent and 27 per cent respectively. Nevertheless, these figures are still below the average population attainment levels for Finland, Norway, Sweden, US and Canada, and also, the UK.
- **Graduation Rates – 2nd Level:** Rising skill demands in OECD countries have made qualifications at the upper secondary level of education the minimum credential for successful labour market entry. Upper secondary level education also serves at the foundation for advanced learning and training opportunities, as well as preparation for direct entry into the labour market. Hence, these graduation rates give one signal of the extent to which educational systems succeed in preparing students to meet the minimum requirements of the labour market. In terms of graduation rates, at second level, Ireland's performance at 91 per cent is at the top end of the ranking, along with Germany, Greece, Norway, Japan and Switzerland.
- **Graduation Rates – 3rd Level:** Tertiary graduation rates show the rate at which each country's education system produces advanced knowledge. Countries with high graduation rates at the tertiary level are also the ones most likely to be developing or maintaining a highly skilled labour force. For tertiary graduation rates of Type A, Ireland is ranked 8<sup>th</sup> out of 21 countries, and for tertiary graduation rates of Type B, Ireland is ranked second out of 18 countries.<sup>19</sup>
- **Advanced Research Degrees:** Ireland is well below the country mean for advanced research type of degrees. Out of 27 countries, Ireland is ranked 13.
- **Public Expenditure on Education:** In terms of public expenditure on education, total public expenditure on education, as a proportion of GDP fell from 5.1 per cent in 1995 to 4.4 per cent in 2002, which is lower than the OECD average of 5.4 per cent of GDP in 2002. This is in contrast to other countries, such as Denmark, Sweden and New Zealand, where there have been significant shifts in public funding in favour of education.
- **Skills Profiles of Recent Immigrants:** It is also interesting to examine the skills profiles of immigrants to Ireland. The ESRI (2005: 29) have shown that many recent immigrants have high educational attainment levels relative to the native population. They note "while 27.3 per cent of the native population have third level qualifications, the corresponding figure for immigrants is 54.2 per cent. At the other end of the educational distribution, while 32.9 per cent of the native population have only lower secondary qualifications or less, only 15.1 per cent of the immigrant population have this low level of attainment".

In summary, we can see that Ireland lags behind in several key areas and there is room for improvement.

## 18.6 Conclusions and Key Policy Issues for Ireland

### 18.6.1 Some Observations and Challenges Going Forward

A well educated and well-trained population is important for the social and economic well-being of countries and individuals. In addition to providing individuals with the knowledge, skills and competencies to participate actively in society, education also contributes to economic growth, and to the expansion of scientific and cultural knowledge. Since Ireland is a small open economy, it will continue to be strongly affected by globalisation. In this context, it is important to be able to respond rapidly to economic change. This requires workers to be flexible; as they will need to change occupations and industries as traditional sectors decline and new sectors (mainly services) emerge.

It is likely that labour productivity growth will be a key determinant of future economic performance since the extent to which employment can continue to grow is constrained by supply factors; there is probably limited scope to improve participation rates, there is a declining number of young people flowing into the workforce and any future requirements for expanding the labour supply, if required, must be met by immigration.

Labour productivity can be increased in several ways: by improving the quality of labour used in production; by increasing the use of capital per worker and improving its quality; or by attaining greater overall efficiency in how these factors or production are used together (which economists call Multifactor Productivity, MFP). MFP can therefore include many types of efficiency improvements such as improved managerial practices, organisational change, and innovations leading to more valuable output being produced with a given amount of capital and labour. However, the evidence indicates that the skills and competencies of the labour force play a critical role in raising labour productivity. Increases in the level of post-educational skills may be even more important in the future – this is particularly so given the greater emphasis on knowledge, innovation and Research and Development (R&D) in order to compete globally in the 21<sup>st</sup> century.

### 18.6.2 Key Policy Issues for Ireland

- **Financing of Education is Justified:** The evidence suggests that investing in the education of individuals raises their productivity in working life and thus contributes to productivity an output growth in the economy. This strengthening of the national economy justifies governmental involvement in the production and financing of education.
- **Education May Reduce Wage Inequality:** Evidence indicates that education contributes significantly to the wage differences observed in labour markets. Hence, improving the educational attainment level of the less educated is likely to reduce wage inequality.
- **Need to Improve Educational Attainment Levels:** It is widely acknowledged that the lack of educational attainment remains a critical factor in the risk and persistence of unemployment. This, together with an increasing demand for a higher skilled workforce, makes it imperative to improve upon educational attainment at all levels. Policymakers need to examine the factors relating to the low attainment of third level qualification (Type A). Also, there appears to be significant scope for improvement at the level of advanced

research. In order to raise the education attainments levels of the Irish population, it is likely that both structural reforms and the allocation of more resources to the education sector are required.

- **Up-skilling and Training is Vital:** It has been shown that training, especially up-skilling, increases workers' productivity, output growth, individual wages and employability. Research shows that training is unequally distributed with workers who are in a better position in the labour market having more opportunities and incentives to acquire new skills. FÁS have significantly increased its expenditure on training of employed workers since 2005, in particular, with the launch of the One-Step-Up Initiative that arose in response to the Enterprise Strategy Group recommendations. However, as noted by FÁS, it is imperative that the under-represented and least qualified are targeted in all such initiatives.
- **Need to Utilise More Effectively the Skills of Immigrants:** It appears recent Irish immigrants are in occupations that are not commensurate with their educational qualifications. As noted by the ESRI (2005), failure to employ immigrants in a way that fully captures their higher educational levels means Ireland is losing out. Policy should aim to improve this matching process so that better use is made of the skills and competencies of highly qualified immigrants.
- **Subsidising the Creation of New Ideas:** Evidence indicates that human capital is an important input in the creation of new ideas. This fact should further inform policy debate on, for example, the balance between direct support for R&D, and/or subsidisation of certain kinds of education, (perhaps those who could go on to work in R&D, such as PhD students and research masters students, etc.).

### 18.6.3 Further Research

There is still some uncertainty in the education-growth research. It is still unclear whether education (and increases in the stock of human capital implied by more education) increases the level or the growth rate of GDP.

Further research is required to inform other policy relevant questions such as: how is growth affected by investment in different states of education (from pre-school to advanced tertiary education and work-related training)? How is growth affected by investment in different types of education, such as engineering disciplines and the arts? How is growth affected by the quality of education? How, if at all, are growth effects from the expansion of one stage of education affected by the level of attainment achieved at an earlier stage?

The emergence of new firm level databases has created the potential for comprehensive investigation of relationships between human capital and productivity at the level of firms in the US and elsewhere. Research in Ireland of this kind is limited due to the absence of data. Such research would be extremely worthwhile.

## Notes

- 1 See Murnane et al. (1995) and Cawley et al. (2000) for a discussion of the importance of greater cognitive skills on the earnings of workers.
- 2 South Korea, Spain, Taiwan and India are examples of countries that have invested significantly in human capital in recent times. See Bergheim (2005) for a discussion in particular, of the success stories of Spain and South Korea.
- 3 A fourth version, known as the social rate of return to education, builds on the second approach. It attempts to calculate the social internal return of educational investments, as the rate of return that balances individual and tax benefits with social costs, although in practice, it does not include all the costs and benefits to society. The aim is then to compare this social rate of return to other relevant rates (e.g. rate of other investments, interest paid on borrowed funds, social discount rates, etc.), to identify if the investment was worthwhile. Estimation of this rate of return is new to the literature and very little empirical evidence exists, given the difficulty with measurement. See OECD (2004) for evidence of the social rate of return for a sample of selected countries.
- 4 Solow's (1956) theory is also referred to as the neoclassical growth theory.
- 5 In empirical work, this approach is similar to the neoclassical approach. Lucas (1988) offered the influential contribution, which in turn related to previous work by Uzawa (1965).
- 6 This view emerges from the work of Romer (1986, 1990) and Redding (1996).
- 7 Sianesi and Van Reenan (2003) provide an excellent review of this literature. We draw on their research here.
- 8 Either augmented production functions (augmented with human capital) or cross-country growth regressions are standard methods of analysing human capital in the context of macro-economic growth. Most of the literature focuses on estimating cross-country macro growth regressions. Models based on the Solow growth theory typically use a measure of human capital in an augmented aggregate production function (for example, Mankiw et al., 1992, for the US) as follows:  $Y = K^a H^b (AL)^{1-a-b}$ . Here, H is the stock of human capital and A is labour-augmenting technical change.
- 9 Although Smith never used the term human capital, it is clear he was referring to the stock of knowledge, skills and experience of individuals.
- 10 A good discussion of the costs and benefits of human capital investment is offered by Elliott (1991).
- 11 It is worth noting that the screening/signalling approach offers a different view to human capital theory that has important policy implications. It suggests that education serves as a signal to employers who screen potential workers based on their educational record. In this view, education does not increase workers' productivity. Although it has proven difficult to disentangle the two approaches empirically, on balance, it appears that there is *more* support for the human capital approach. Hence, we conclude that education does increase workers' productivity and is not just a signalling device.
- 12 A general form of the model is:  $\text{Log } W/P_i = a_1 + a_2 I_i + a_3 X_i + e_i$ . Here, W/P is the real wage, I the investment in education (usually measured by years of schooling), X is a vector of variables capturing a range of individual and workplace characteristics and e is the error term. Here,  $a_2$  measures the proportionate effect of an extra year of schooling on earnings.

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- 13 Education consistently emerges as the prime human capital investment for empirical analysis. Human capital is also perceived to contribute to health and nutrition (Schultz 1963, 1981), but education in the form of schooling is generally used in analysis because it can be measured in quantitative costs and years of tenure. Recent studies have also pointed to the importance of friends, ethnic affiliation, and neighbourhoods in the choice of human capital decisions of individuals, even after controlling for the effects of parental income or education (see for example, Charles and Luoh, 2003 and Gang and Zimmerman, 2000).
  - 14 These results are based on research by Harmon et al. (2001) derived from Public Funding and Private Returns to Education (PURE), These rates of return are based on national surveys rather than a single source such as the ISSP. Earlier work for Ireland suggested the return to an extra year of schooling to be approximately eight per cent (see Callan and Harmon, 1999 and Callan and Wren, 1992). Research has indicated that it is important to distinguish between returns to males and females.
  - 15 OECD (2003) argues that public policy may therefore have a role to play to improve individuals' and employers' incentives to invest in human capital. Also, fiscal incentives should be focused on those groups who are most at risk in the labour market and who are most in need of training, such as, part-time workers, older workers, low-skilled workers, etc.
  - 16 The study examines the impact on earnings of the Vocational Preparation and Training Programme which can be taken following the Junior Certificate and Leaving Certificate. It therefore does not focus on work related training as such.
  - 17 Similar positive effects have been found by Almeida and Carneiro (2005).
  - 18 Latest available data is for 2002 from OECD (2005) *Education at a Glance*, OECD, Paris.
  - 19 The OECD distinguishes between three different tertiary education levels: ISCED 5A, ISCED 5B and ISCED6. The former refers to a traditional university type qualification, type ISCEDB generally refers to shorter and often vocationally oriented courses, while ISCED 6 relates to advanced research qualifications at the doctorate level.

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