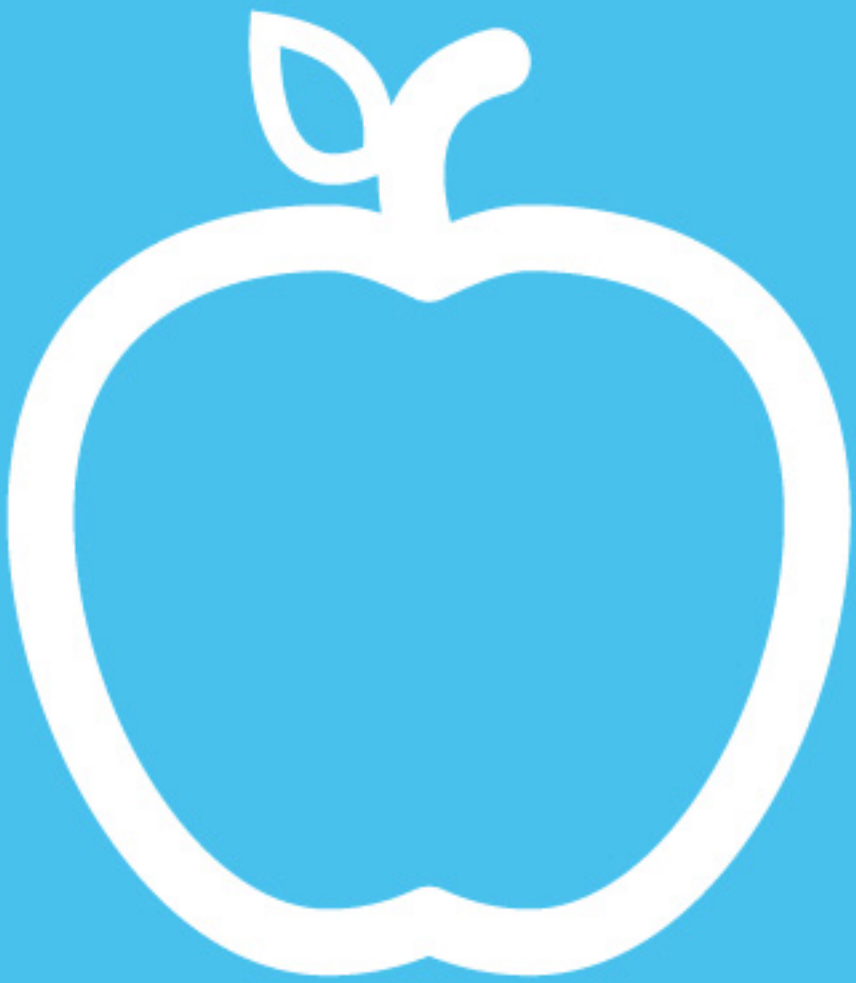
Education and Economic Development – What does empirical research show about casual inter–relationships?

Anders Björklund and Mikael Lindahl



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REGERINGSKANSLIET

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– What does empirical research show about causal relationships?

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Foreword

There is a widespread view that education is one of the vital building blocks in economic growth. The Lisbon vision of Europe as ”the world's most competitive, dynamic, knowledge-based economy” has its best chance of success in a radical expansion of the European education system. Sweden is not alone in her determination that half of all youth should enter higher education or in expanding the opportunities for citizens to take part in recurring education over their lifetime.

But is there evidence that more education for larger numbers of the population will lead to higher economic growth in society? In recent years a substantial body of research has focused on the relationship between education and economic development.

In this report to the Expert Group for Studies in the Economy (ESS), Professor Anders Björklund and Mikael Lindahl Ph.D, both working at the Swedish Institute for Social Research at Stockholm University, review the most important findings of this research. They find that the social return from education corresponds closely to the return for individuals.

Education creates a general and more flexible knowledge that facilitates both individual and societal change. In order to provide a broader social science perspective of our knowledge in macro economics, Albert Tuijnman, Professor in International Pedagogy has been invited to comment on and supplement this review of the findings.

By this means the report will contribute further input to the current debate on the relationship between education and economic growth, and create an interest in more detailed studies on education and the importance of knowledge for economic and social development.

The report has been produced in cooperation with the Swedish Ministry of Education, Research and Culture.

As with all reports to ESS, the authors are alone responsible for the contents of their reports and for the judgments and conclusions reached therein.

Stockholm in December 2005

Expert group on Economic Studies

Levi Svenningsson

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Summary

A large volume of research literature covering empirical studies from many countries shows that education leads to higher incomes. But what contribution does an expansion in education make to overall economic development, measured in terms of gross domestic product per capita? Arguments have been put forward in the debate that the contribution of education to economic development is overestimated and that the social returns are not as great as those accruing to the individual. However, there are also those arguing the opposite, namely that the contribution of education to total production in society is clearly greater than can be measured by the higher incomes of those receiving more education. In this report we examine the findings of recent empirical research on these issues.

The main argument that the contribution of education to society's production is lower than aggregate individual income effects is that education provides a signal of productive capacities valued by the labour market rather than that education provides the individual with new knowledge and skills of productive value. The value higher education signals could also create a non-productive race where young persons compete with each other to show prospective employers their excellent qualifications. Our review of the research investigating these issues leads us to the conclusion that it is improbable that a significant proportion of the higher incomes of those with education is dependent on the effects of such signals. For this reason, it is also improbable that the contribution of education to overall production is substantially underestimated by the individual income effects which the research has documented.

Is there then any basis on which the converse can be argued, namely that education provides a larger contribution to economic development other than that indicated by means of higher incomes to the educated? Our examination of the research shows that what are referred to as the external effects of education provides conclusions that are not entirely unambiguous. On the other hand, we have examined the large body of literature which used data from different countries to examine whether countries which have invested more in education have achieved higher growth of GDP or level of GDP than other countries. The best studies indicate that

the overall economic production effects correspond fairly closely with the aggregate individual income effects.

Even though the research building on the cross-country approach has developed substantially in recent years, and in particular has been able to use education data of increasingly higher quality, it is our view that the results are not entirely reliable. With this type of analysis, it is particularly difficult to determine if education leads to higher GDP, or whether it is higher GDP which leads to more education. This is the reason we have also examined research based on regional differences in educational expansion within a country, and especially the differences which have arisen due to the varying impact of policy reforms on different regions. In the report we argue that such regional analyses are more reliable from a methodological viewpoint. But the results from these studies indicate that the contribution of education to economic development essentially corresponds to the higher incomes for persons with more education.

On the other hand, there is a rapidly growing body of research studying whether education has had an impact on other economic variables, which in their turn may be expected to have a favourable impact on economic development. We have been able to identify studies - which in terms of their methods are more convincing than comparative studies between countries – that indicate a number of positive effects arising from education. A number of studies examining the relationship between parental education and children's incomes and education indicate that a part of the strongly positive ”inter-generational” relationships can be described as the effects of resources contributed by parents through their education. Similarly there is reason to believe that the strong relationship between an individual's education and their health and life expectancy is at least partially to be regarded as a direct results of education. One American study clearly indicates that higher levels of education lead to a reduction in crime, but in this case it is unclear if these results would also apply to Sweden. Finally, based on current research we believe that there is reason to believe that education leads to increased political awareness and involvement.

How can the fact that research indicates on the one hand that education has favourable effects on the children of those with education, promotes health, extends life expectancy, reduces crime and promotes democracy, be reconciled with the fact that such

effects on the other hand do not translate into higher growth in the countries and regions investing more in education? One possibility is that these positive effects are not sufficiently large to affect the economy and have an impact on GDP statistics. Obviously they can still be of importance. Another interpretation may be that variations in education between countries and regions are not sufficiently great to capture all the positive effects of education. These are major and difficult questions which future research may possibly address.

1 Introduction, background and aims

The scope of schooling in different forms has expanded continuously in the majority of countries and Sweden is no exception in this respect. Economic growth and economic development in a broad sense have thus gone hand in hand with increasingly longer education which has come to cover increasingly larger parts of the population. This ongoing expansion of education is due to many factors, but there is no doubt that policy decisions have contributed to the expansion. Over time politicians have justified educational investments in many different ways. A long time ago democratic arguments were put forward such that a democratic society to function effectively requires educated citizens. The distribution argument for more education also occurs frequently, albeit with varying degrees of strength and focus over time. An ever recurring argument has, however, been that education can be regarded as an investment which contributes to higher production in the future, or to what in somewhat simplified terms is usually referred to as economic growth.

What do we know about the real outcome from the expansion of education in general, and educational policy initiatives in particular? Will the outcome be higher production and as a result higher economic welfare in the future? Although the research concerning such issues has undoubtedly been substantial, it is nevertheless difficult to simply and concisely summarise answers to these questions. The most substantial research probably exists on the extent to which completed education affects the incomes of those with more education, or what is usually described as the individual economic return on education. Both economists and sociologists in the labour market area have contributed to this

research by using data on individual incomes, education and various personal characteristics to calculate income or salary equations to arrive at what is referred to as an income premium (or salary premium[1]) for education, i.e. effects on income levels of longer education or higher levels of education. When such studies based on Swedish data and length of education have used a simple aggregate measure of education, the results have shown that each additional year of education raises the individual's income by between 4.0 % and 8.5 %. The latter figure refers to the end of the 1960s and the former to the 1980s and 1990s.[2] A recent study by Gustavsson (2004) indicates this has risen most recently.

Can we simply aggregate individual income premiums of persons with more education and thus arrive at the overall effect of education on incomes and production levels throughout the economy? If this were the case, it would be relatively straightforward to use studies of the income effects of education to calculate the overall contribution of education to total production. However, it is evident that highly specific assumptions would have to be made for this to provide the right answer. Firstly, income effects would also have to the same as production effects. The second is that education only affects those who *de facto* participate in education and not others, i.e. there are no external effects from education. In both the scientific and general debate, objections are frequently raised to these assumptions, and arguments are put forward that the individual income effects give an incorrect picture of the total effects of education on the economy. But there are in fact researchers and debaters who come to completely different assessments on this issue. Those who argue that individual income effects overestimate the effects on production levels in the economy (GDP) usually refer to the fact that the relationship between the individual's education and income not only depends on more education raising the worker's productivity, but also that education (to a significant extent) provides a signal that the individual already possess a productive capacity which would be useful on the labour market. Alison Wolf, the British researcher is

[1] Most studies in this area use as an indicator wages per hour worked, but a number of studies have also used annual incomes. In what follows we will focus on the term income effects.

[2] A review of Swedish studies can be found in Björklund (1999). Card (1999) provides an international scientific review, and argues that the income premiums calculated may be regarded as an effect of longer education and not due to more productive individuals choosing to undergo education, i.e. the ”ability bias”.

one of those arguing in this way and her views have also featured in the Swedish debate.[3] However, especially in recent years many economists have emphasised that education has positive external effects, i.e. it contributes to higher production via channels other than those of the individual's own production and income. This view, which is emphasised strongly in more recent growth theories in macroeconomics, is presented to a broader public by Storesletten and Zilibotti (1999).[4]

Our overall purpose is to critically examine and present to a wider public current research concerning the effects of education on economic growth and economic development in a broad sense. The starting point is that there are a number of well-documented studies indicating that persons with more education obtain higher incomes purely as a consequence of education. Our examination concerns not only such income effects on the individual, but also the effects on production in the economy, as well as whether there are other effects from education which are not captured in economic returns to the individual before taxes. Since the overall body of research into these issues is very large, we concentrate on those studies of relevance to Sweden. This means that we do not take up the substantial body of research related to developing countries. Our review is also affected by the focus we put on the causal effects of education on economic growth. It is important to differentiate between general descriptive relationships – or ”correlations” – and explicit causal relationships, namely whether production really would have been lower in the absence of education. We examine whether existing empirical research can convincingly demonstrate that such a causal relationship exists between education *and* economic growth.

The report is organised as follows. In section 2, we start by classifying the different effects of education, in addition to those which are captured by the return on income to the individual. In this section, we also discuss briefly the underlying theoretical explanation for the effects of education. In section 3, we then review the results of studies using variations between countries in education, and relate these to variations in the level of GDP and growth in GDP between countries. Has a country investing more in education achieved higher growth, and in which case how much?

[3] See e.g. Wolf (2003, 2004).
[4] Fundamental contributions to this new growth theory are those of Lucas (1988) and Romer (1990). See also Aghion and Howitt (1998) for a theoretical review of this literature.

This is an attractive analytical method in the sense that ”in principle” it captures the aggregate effects of higher education in one country compared with another, the direct effects on persons with more education which leads to higher growth, as well as the indirect effects on other individuals. For the results to be reliable, they should provide a complete answer to the question we pose on the overall effects of education on economic growth and the level of production. On the other hand, non-monetary effects are not captured unless they indirectly lead to higher growth. Our conclusion, however, after having examined this literature is that comparative country studies have clear limitations and that the results are thus not entirely reliable. The fundamental problem resembles that of the ”chicken and egg” in that it is not possible to determine whether it is more education that raises GDP, or whether it is the high level of GDP that leads to a higher demand for education in society.

In addition, even if comparative country studies were to provide reliable results in terms of the overall contribution of education to economic development, such studies would only provide limited insights into the mechanisms by which education performs this. Additional research initiatives would be necessary to answer such questions.

For these reasons, we consider that it is of importance to examine in more detail what has been learnt from other studies on the effects of education. In section 4, we review the studies which have made a more direct attempt to examine if the income effects of education can also be represented as production effects. We discuss i.a. studies which have tried to determine whether education primarily functions as a signal of the individual's production capacity or represents a productive investment. Thereafter in section 5, we review studies which examine whether there are more effects on the individual (and family) other than the purely income effects. In section 6, we examine empirical studies which have tried to study the existence of the external effects of education on individuals other than those receiving the education. It is our view that, amongst these studies, are a number which have identified fairly reliable ”quasi-experimental” variations in education, which fairly convincingly show that education leads to higher life expectancy, lower rates of crime, and more active political participation. The latter are also variables which in their turn probably have an impact economic growth.

We conclude by summarising the overall effects of education in section 7, and in section 8 provide recommendations for future research.

2 Classification of different educational effects: theory and some methods

There are many reasons as to why the overall effects of more education deviate from the sum of the individual income effects. In this section, we will review the theoretical arguments for such deviations between individual income effects and overall economic production effects as a prelude to reviewing the empirical material in the following section. Our classification of different effects is illustrated in Table 1.

Table 1 Review of differens education effects

Are individual income effects of education also production effects? • Does more education signal higher productivity without causing this? • Do salary differentials correspond to differences in productivity?
Is the individual with more education and his/her family affected in ways other than by higher incomes? • Are health and life expectancy affected by education? • Are children affected by their parents' education?
Are other individuals in society affected by one person's education? • Do work colleagues also become more productive? • Do work colleagues, friends, and acquaintances become more productive? • Does more education lead to lower rates of crime? • Does political involvement increase?

Are income effects also production effects?

The first question we put is thus whether the individual income effects – which a substantial body of literature on individual data has shown – also mean that production is correspondingly higher. This follows from a simple macro economic model where the marginal cost of an additional worker (i.e. the wage) is equivalent to the value of the production created. In addition, if education is regarded as purely an investment in knowledge and skills raising

the productivity of educated persons in working life – or in human capital, the current economic term – income effects and production effects can be treated as equivalent. This is, however, a highly simplified approach which is often questioned.

One objection to this view arises from what is referred to as *signalling theory* as applied to education.[5] According to a more sophisticated version of this theory, education only functions as a signal of the productive capacity which the individual already had when starting education, but education in itself has no independent effect on this productive capacity. Nevertheless, the theory shows that an economic equilibrium can be attained when some people quite rationally choose to educate themselves and others do not. The reason is that it becomes more stressing (and perhaps more demanding timewise) for those with low productive capacity to undergo education, as a result they rationally choose not to participate, whilst highly productive individuals choose to participate. Such an economic equilibrium shows the same type of relationship between the individual's income and education as does a human capital model which considers education as an investment in higher productivity. For this reason, both theories are consistent with the individual income effects of education.

Obviously, education in today's labour markets can function both as a signal and a productivity enhancing investment in the individual's knowledge and skills (human capital). It is also important to emphasise that the signalling function is also a productive function which has significant economic value. On the other hand it is possible – even though we are not aware of any systematic empirical studies of this – that the education system is an expensive means of signalling information about the individual's productivity. It should be quite possible to obtain information about a person's capacity to solve problems, patterns of work discipline etc in a cheaper way than having a person attending four years of university education. Those who believe that an important part of individual income premiums from education can be explained by signalling theory thus have reason to caution against excessive belief in educational measures to raise economic growth. Such misgivings are reinforced if we consider that young people

[5] Arrow (1973) and Spence (1973) are regarded as providing the scientific foundation for this theory. A more current review of empirical applications is provided by Riley (2001).

might take part in an economically unproductive race where the goal is to raise their education relative to others.[6]

Another objection to treating income effects and production effects as equivalent is that the Swedish *salary structure* is so ”compressed” by trade union wage policy that the relationship between the worker's productivity and salary, which applies in the simple economic model, does not correspond. If the highly educated (on the average) are not fully remunerated for their productive capacity, and those with lower levels of education are instead paid more than their productive capacity, the contribution of education to total production in the economy may actually be underestimated. This issue has special relevance in the context of the contribution of education to economic growth over different periods in Sweden. From 1968 to 1981, the average wage premium per year of education in Sweden decreased from about 8.5 % to about 4.0 %.[7] Undoubtedly, it would be strange if the contribution of education to production decreased just as much. Similarly. it can be questioned whether the contribution of education to overall production in countries with income premiums of about 10 percent (such as the USA and the UK) are twice as large as in countries with income premiums of about 5 percent (as in the Nordic countries).

Effects on the individual other than income?

But there are also arguments to the effect that education in addition to its effects on individual incomes may have other positive effects, which directly or indirectly affect economic growth. It is thus meaningful (as in Table 1) to differentiate between such effects on the persons undergoing education and the effects on other persons. Why this is an important distinction is that the individual has good reason to take account of all the effects which can accrue irrespective of whether they are incomes or something else, whilst there is no such reason for the individual to consider the effects on other people in society. The occurrence of the latter i.e. the external effects is a traditional argument that the individual in economic terms invests too little in education and

[6] This is the essence of Wolf (2002) whose contribution is examined by Card (2002) and Haveman and Wolf (2003).
[7] See e.g. Björklund (1999).

that policy measures should be taken to stimulate more education than the individual would choose without an active educational policy.

Initially a conceivable effect for the individual in addition to higher incomes is that *health* may be improved and that the individual as a result may also *live longer.* A causal effect of this kind can occur in a number of different ways. One possibility is that education enables the individual to obtain work with a lower risk element and that this leads to better health. professional Another possibility is that the higher income as a consequence of education enables the individual to receive advice about living a healthier lifestyle and use the healthcare system when necessary. It is also possible that education makes the individual more aware of different health risks, of the importance of living in a way that promotes health and access to pharmaceutical products.

The effects of education on health and life expectancy are obviously valuable in themselves. It is, however, important to emphasise that such effects also have overall economic consequences. In the first instance, it is reasonable to believe that better health raises the individual's productivity at work. It is entirely possible that a large part of the income premiums calculated are related to better health and not just to better knowledge and skills per se. The second reason is that better health and longer life expectancy enable the individual to work longer. Normally this is not taken into account in standard calculations based on individual income premiums. Such calculations normally assume that persons with high and low levels of education have equally long working lives, the income premium from education is thus aggregated (after discounting to take account of the fact that the value of future incomes is lower than current incomes) up to the time when people retire. If more education extends working life, the current value of *total* income during the additional working period is calculated as an addition to production arising from the additional education. Björklund and Kjellström (2002) show that the individual economic return – measured as the internal rate of return, a measure of an investment's profitability[8] – may be 1–2 percentage points higher if we assume a university educated person works until the age of 65, whilst a person with an upper secondary

[8] In the case of educational investments, this measure of return comes close to coinciding with the relative income premium on education, see Björklund and Kjellström (2002) for further details.

education works until the age of 62, figures which are close to reality. These calculations do not take account of differences in life expectancy.

A longer education for the individual may also have *consequences for their children.* This can happen in many ways, and different scientific disciplines have their own models for explaining such effects. We confine ourselves to pointing out that a longer education for a generation of parents may lead to higher incomes which can benefit their children in different ways. It is also possible that the knowledge obtained from different types of education is valuable in bringing up children.

Whether we should look at the effects on the children of the educated as ”private effects” within the framework of a family model, or as purely external effects on others in society is a complex issue. It is possible that people in their choice of education also take into account all possible effects on their family, and thus it is not necessarily the case that the individual in economic terms underinvests in education. It is also possible that such effects are not included in their entirety. We will not examine this difficult question any further.

External effects of education

There are a number of mechanisms which can create external effects of education, i.e. the effects on persons other than those receiving the education. Some of these mechanisms can operate within the framework of the economic production system, where persons with more education disseminate their knowledge to co-workers at their own workplace or to other persons in their surroundings. It is also possible that higher education raises innovation in the economy and in this way contributes to higher growth. Other mechanisms can operate outside the production system of the economy, but over a longer perspective still lead to higher production and growth. We will now briefly discuss the argument for such externalities of education.

External effects can occur at the individual workplace if a recently educated person can mediate new knowledge to co-workers and they then become more productive. Such transfers of knowledge can also occur outside the workplace if the educated

persons contribute new valuable knowledge to others in their social settings.

In what is called the ”new growth theory”, economists have also emphasised that innovation in the economy can be promoted by a large number of highly educated persons and especially by highly educated engineers. In particular, such effects can be achieved if points of contact are created between engineers and entrepreneurs who can transform such innovations into business settings. This theory (see Storesletten and Zilibotti 1999 for an introduction) differentiates between level externalities, which means that higher education leads to a higher *level* of production also amongst those who are not educated, and growth externalities, which means that a higher level of education raises the *rate* of long-term growth through its effects on innovation in the economy and by making it easier for a country to imitate or acquire technological innovations from other countries.

But important external effects of education can also operate outside the production system itself. In the first instance, many social scientists have claimed that higher education can lead to *lower rates of crime.* Such causal effects from education may occur for a number of reasons. From an economic perspective, the decision to commit crimes is determined by the difference between, on the one hand, the individual's perception of the expected benefits to be gained and, on the other hand, the expected benefits from legal activities. Higher education can thus raise the profitability of legal activities, the cost of loss of freedom becomes higher and thus reduces the propensity to commit crimes. It is also possible that education directly impacts the attitude to – or ”usefulness of” – criminal activities. In addition, it is possible that education influences the time-horizon of educated persons making them more prepared to wait for a return from their work input. To the extent that higher education has such favourable effects on crime, it is evident that in the long-term it can also raise the production capacity of the economy since crime by its very nature is destructive.

Secondly, there are reasons to believe that education in different ways influences *political participation* in society. A classic argument for compulsory public education is that an educated population is a prerequisite for society to function democratically. Economists usually claim and this even applies to Milton Friedman as well – otherwise known for advocating private solutions to most societal

problems – that publicly subsidised educational systems are needed so that all citizens acquire the knowledge required for democracy to be effective, as well as for establishing certain fundamental values in the population.[9]

More specifically from a general theoretical perspective, it can be argued that higher education may have an effect on political participation, both quantitatively and qualitatively. Education can thus lead to more people becoming interested in political questions and acquiring the fundamental knowledge required for participating in political decisions and political fora. In the same way, higher education can make it possible to expose weak political leaders and take appropriate political initiatives when necessary. Even though such effects from higher education are entirely possible, it may not be possible to argue that they are theoretically unambiguous. It is also possible that higher education raises the private cost of participating in political activity since the income foregone becomes higher. It is thus an empirical task to determine which effects weigh most heavily.

It is also an empirical question to determine whether increased political participation influences economic development. It is undoubtedly a reasonable hypothesis that a better functioning political system has favourable effects of this kind, but we cannot call on any empirical studies to substantiate this.

Social and individual returns from education

Our ambition in studying the effects of education, apart from those identified by the income effects obtained from studying individual data, leads us into taking a broad economic perspective on the effects of education. This means that we come close to what is usually called the social return on education, in contrast to the economic return for individuals. Similarly we wish to emphasise that we do not have the ambition of presenting new calculations of the social return. The traditional approach to such calculations is to include on the income side the whole addition to production arising from education, and on the cost side include not just production lost during studies, but also the costs of teachers and premises for providing the education. Some estimates of the social

[9] Friedman emphasises this in his classic book *Capitalism and Freedom* from 1962, which is quoted by Milligan, et al (2004).

returns usually attribute a value to the purely consumption value which education may have. For relatively recent estimates of such social returns, we refer to OECD (2003) and Psacharopoulus and Patrinos (2004). See also Björklund (1999) for a simple introduction.

Yet another central distinction is between, on the one hand, the social return from education and, on the other hand, its effect on the overall budgets of the public sector. The latter type of calculations are less common in the scientific literature and we do not intend to explore these. One recent contribution to such analysis, however, is that of de la Fuente and Jimeno (2005).

Measuring education: some methodological issues

Before we start examining the findings of empirical research, it would be appropriate to discuss a few fundamental methodological issues in this context: What do we really mean by education? And what do we mean by causal effects of education?

In a report such as this, obviously we wish to make our conclusions as relevant as possible for policy decision-making. This is the reason for focussing on the concept of causality: what would happen to economic development if education expanded in a certain direction because of educational policy measures compared with the alternative of no expansion? This means in the first instance that we are interested in the effects of education that are subject to influence. Most of the studies we review use an overall measure of educational level in different countries or different regions. On the other hand, they do not use such measures for the knowledge and skills of reading and mathematics – which are associated with schooling. This is because such knowledge and skills do not only affect education, but also other factors in society. We wish to identify the effects of education which operate via knowledge and skills, but not the overall effects of knowledge and skills on production in society, which is also related to many other factors.[10]

Secondly, it is clear that the level of education is influenced in many different ways. It is possible by using policy instruments to

[10] On the other hand, if there is a great interest in the mechanisms by which education influences production outcomes, it is necessary to have an analytical model which also contains measures of knowledge and skills acquired in school.

increase the proportion of each age group undergoing some form of university education, it is possible to extend compulsory schooling, preschooling can be made more or less comprehensive. There is also a central quality component in education, the effects of which one wishes to recognise. All these issues are well-defined, so that the list of different ”education effects” for which one would like research to provide answers becomes very long. It is hardly surprising that we emphasise that there are major knowledge gaps concerning the effects of different education orientations. Large parts of the literature have studied the effect of a general increase in the level of education which is relevant, but not in itself sufficient.

Thirdly, it is clear that the issues for which we would like answers most often concern the future. What would the effect be, if today we were to further increase the proportion studying a certain type of education, or change the length of compulsory education? Using the results from studies of historical data to make forecasts concerning the future is always complex. Our focus is on examining what can be learnt from actual empirical studies. We do not attach such great importance to the question of how we can go from this result to future assessments of various types. This may represent a shortcoming, but we do this with the conviction that it is better to try to learn from history than not to do so.

3 Empirical results: using variations between countries

In this section, we examine the relationship between educational levels of countries and level of GDP and growth. The advantage of estimating GDP as a function of education variables is that such an estimate has the potential to capture all the effects of education on economic development for a typical country. The occurrence of effects on the external *level* would also provide a relationship between the level of aggregate income and educational level in a country which exceeds the corresponding relationship obtained when the results for all individuals are aggregated. The occurrence of *growth* externalities would provide a relationship between economic growth and level of education even though GDP is a control variable at the beginning of the period.

Regression estimates between countries of economic growth as a function of many variables literally exploded during the 1990s.

They were even given a special name: Barro regressions, named after Robert J Barro at Harvard University who made many contributions to this literature.

The relationship between level of education and GDP per capita

It is well known that there is a strong positive correlation between a country's level of education and its level of GDP. In order to illustrate this, we used GDP statistics from Summers and Heston (1991) and education data from Barro and Lee (1996) for 1960 and 1990. We use the following simple model for the relationship between the logarithm of GDP – in order to obtain the relative relationship – and the level of education measured as the average number of educational years of the population:

(1) The logarithm of GDP level = a_0 + a_1 * Education level + Indicator for 1990 +random factors

For 83 countries, both rich and poor, we find that a_1 = 0.29, with a standard error of 0.02. This means that for the average country, an additional year of education is associated with approximately an increase of 29 percent in GDP per capita.[11] If we estimate the same relationship for 23 OECD countries, then a1= 0.15 with a standard error of 0.02. However, the relationship is also significant and positive for rich countries, approximately 15 percent, even though it is weaker.

Equation (1) has the same form as the standard equation in analysing individual incomes and education. With such individual data on the private return at this time about 0.10 (or about 10 percent) on average from both rich and poor countries, and about 7.5 percent in OECD countries (see Psacharopoulos and Patrinos 2004). The fact that this is 2 to 3 times greater when we estimate equation (1) with country data may be due to large external effects from education. But this may also be related to other factors.

One explanation may be that there is reverse causality, i.e. rich countries invest more in education and have longer compulsory schooling or that individuals in these countries choose to educate

[11] The percentage changes are calculated as exp(a_1)-1, which is the reason why the coefficient 0.29 essentially correspons to 34 percent. Note that the less a_1 is, the better the percentage change is approximated.

themselves longer if the demand for persons with a higher education is greater in rich countries. Another explanation may be that there are number of other factors which lead to both high GDP and a high level of education. For example, in our estimates above we have not allowed for the differences between countries in capital intensity and technological level of development. A number of studies, which we will now proceed to review, have tried to tackle the problem of variables omitted by including measures which can approximate these, or by using variations within countries over time. However, it is reasonable to argue that no study has satisfactorily solved the problem of reverse causality.

Heckman and Klenow (1997) try to allow for technological differences between countries by including life expectancy in a specification similar to that above. The argument is that countries with advanced medical technology (which is assumed to correspond to the level of technology in production) have citizens with high life expectancy. When this is done, their estimate for education decreases from 0.23–0.32 for 1985 to 0.11, depending on the specification and number of countries, i.e. they come very close to the estimated effects of education on incomes with individual data from many countries. Since the level of income in itself may influence health and life expectancy (see Pritchett and Summers 1996), it may be somewhat problematic to allow for differences in life expectancy in different countries. Heckman and Klenow also allow for differences in capital intensity between countries. However, this turns out to have little impact on the results.

If the most important factors left out when estimating equation (1) above are constant in a country over time, then, providing there is data for a number of points in time, this can be allowed for by including an indicator for each country. This is equivalent to estimating the growth of GDP as a function of the change in the level of education during the time period studied.

We use a model of this type with the same data that was used to estimate equation (1) above:

(2) Log GDP level = a_0 + a_1 * Education level + Indicator for 1990 + country indicators + random factors

We find that a_1 = 0.25 with a standard error of 0.05 for poor and rich countries and that a_1 = 0.08 with a standard error as much as 0.07 for OECD countries. It is worth noting that the longer the

time period used, the higher the estimated effect of education. This may be due to the fact that changes over longer periods correspond to real changes in education, whilst changes over shorter periods largely reflect errors in the educational measures used (see Topel 1999). It may also be due to more variables being left out and that reverse causality may have a greater impact over longer periods of time (Krueger and Lindahl 2001). The last mentioned reason indicates that the figure for education over such a long period as 30 years may overestimate the real effects.

Benhabib and Spiegel (1994) estimate growth over the period 1965–85 in a country as a function of growth in labour force participation, capital intensity and years of education, as well as initial level of GDP in 78 countries. This corresponds to the estimates of model (2) with additional control variables. They find a negative, but statistically insignificant effect from years of education on growth.

Barro and Sala-I-Martin (1997) estimate growth for nearly 100 countries over the period 1965-75 and 1975–85 as a function of changes in the level of education for men and women. At the same time, they use a number of control variables such as initial level of education at the beginning of the period, life expectancy, interaction between GDP and human capital, political instability and public spending on education. They find no statistically significant effects arising from educational changes on growth.

Krueger and Lindahl (2001) find, however, that the educational data used in these comparative country studies had very low quality. In general, under reasonable assumptions, the effect of a variable is underestimated – its estimated coefficient is closer to zero than what is correct – if the variable is badly measured. For estimates between countries, Krueger and Lindahl (2001) show that the effect of educational changes on GDP growth because of this problem have been heavily underestimated in earlier research on growth. This applies particularly to the findings of Benhabib and Spiegel (1994). When Krueger and Lindahl allow for measuring errors in education, the results indicate that education has major positive effects.

When estimating model (2), it is very important whether capital is used as a control variable. If log capital per capita is added, the effects of education decrease. At the same time the effect of capital becomes unrealistically large. Krueger and Lindahl find that if capital is assumed to have a more reasonable effect on GDP, an

increase in the average number of school years by one year would lead to GDP/per capita increasing by about 8 percent, which is statistically significant. When allowances are made for the low quality of the measure for education, then the estimated effect becomes about 7 percent. This result means that the results from comparative analysis between countries are close to those obtained when estimating individual economic effects on the basis of individual data.

Amongst other things, as a result of the findings of Krueger and Lindahl (2001) much recent research has been directed to improving the quality of educational indicators. De la Fuente and Domenech (2002) make a real effort to improve the quality of educational data in OECD countries. They carefully examine the data for each country and year, and eliminate, for instance, unrealistically large changes in level of education between two years; these may have arisen due to changes in the source of educational statistics. They then compare the improved educational measures and the results from using these with i.a. educational data used in Barro and Sala-I-Martin's (1997) study, as well as in Benhabib and Spiegel (1994). De la Fuente and Domenech (2002) consider that their data is of a higher quality than that used in the studies. Using the new data, they find a strong positive relationship between education and GDP per worker which corresponds to 10 percent for each additional year of education. This is somewhat higher than the average individual return in OECD countries during this period.

Cohen and Soto (2001) examine and improve educational data for 95 countries. Amongst the sources they use are national population censuses. They use data such as how many individuals start education at different levels each year when population census data does not exist. De la Fuente and Domenech (2002) find that the data of Cohen and Sotos is of very high quality for OECD countries. Our view is that the educational data of Cohen and Sotos is the best that exists for a large number of countries over time. They first estimate GDP per capita as a function of years of education and allow for differences in investment levels between countries, and find that the return is between 8-10 percent. When they estimate growth of GDP as a function of changes in education, they also find a return of between 8-10 percent. These

figures are very similar to the typical private return in most countries.[12]

The conclusion from these comparative country studies is that the estimated effects of the average number of education years or GDP per capita correspond closely to the average private return in these countries.

The relationship between level of education and GDP growth

We use the same data from 1960 and 1990 as above, and will now estimate the following model:

(3) GDP growth = b_0 + b_1 * Education level 1960 + random factors

where GDP growth is the difference between Log(GDP/capita) for 1990 and 1960. The result is that b_1 = 0.06 with a standard error of 0.02 for rich and poor countries. For OECD countries b_1 = -0.07 with a standard error of 0.02, i.e. countries with a higher level of education in 1960 have grown more slowly.

If it is the case that countries with different levels of education have different GDP starting points, then allowance should be made for GDP level in 1960 as in the following model:

(4) GDP growth = b_0 + b_1 * Education level 1960 +b_2 * Log GDP per capita 1960 + random factors

This changes the result somewhat: now b_1 = 0.10 with a standard error of 0.04 for all countries, b_1 = 0.00 with a standard error of 0.03 for OECD countries.

For all countries, a higher education is thus associated with higher growth over the following 30 year period. An additional year of education corresponds to 0.2-0.3 percentage points higher annual rate of growth. However, for OECD countries there is no statistically significant relationship.

[12] Portela et al (2004) make corrections for certain shortcomings in the education data Barros used. They find support for the existence of a systematic measuring error in educational data related to level of education. When they take this into account, they find that educational change (and also level of education) are important for growth. Pritchett (2001) finds similar results (to Benhabib and Spiegel 1996) for educational growth when using improved education indicators, and at the same time allow for the growth in investments.

From relationships such as (2) it is possible to calculate the long-term relationship between GDP per capita and level of education, what we refer to as b*.[13] We then find b* = 0.62 for all countries and 0.004 for OECD countries. This would mean that the effects of education on GDP in the long-term, which take account of both level and growth effects, are very large when both poor and rich countries are studied, but virtually non-existent for OECD countries. It should, however, be pointed out that the value for b* is very sensitive to the estimated value of b2, namely what the relationship between a country's initial level of GDP and growth looks like, which is very difficult to estimate correctly. The result is that the long-term relationship for all countries is clearly stronger than we found in the previous sub-section where level of GDP is related to educational level. This is discussed in greater depth in Teulings and van Rens (2003). They find that the long-term effects of education on GDP per capita is approximately twice as great as the immediate effects of education. They also find support for the idea that the effect of education on growth has increased over time.

The results above also indicate that there is a positive growth effect from level of education for countries with a low educated population, but that the opposite applies to countries with a high level of education (see Krueger and Lindahl 2001). This result was discussed by Vandenbussche et al (2004), who nevertheless find support that more university education has a positive effect on the growth of highly productive OECD countries.

The relationship between the orientation of education and educational quality and GDP growth

There are good reasons for assuming that the models we examined above are too simple to use level of education as an independent variable. In the first instance, it seems reasonable that certain types of education are of greater importance for growth than others. Murphy et al (1991) draw a distinction between university educated engineers and lawyers. They argue that engineers stimulate growth by means of entrepreneurship, whilst lawyers focus on ”rent seeking,” i.e. their salaries are paid by the profits

[13] This applies when the assumption is made that long-term growth is constant. Based on model (4) it can then be shown that in the long-term a marginal increase in education increases GDP per capita by -(b1)/(b2). In the estimate b2=-0.17 for all countries and -0.41 for OECD.

generated by entrepreneurs, without themselves contributing anything of value for economic growth. Murphy et al find some support for this when they use a simple model for 91 countries, with growth between 1970 and 1985 as a function of the proportion of engineers and lawyers out of all persons with university education, at the same time as they use GDP for 1970 as a control variable. The proportion of engineers has a statistically significant positive importance for growth. The proportion of lawyers, on the other hand, has no statistically significant effect. Interpreting the level of their estimates would mean that if about half of all lawyers were educated as engineers instead, the annual rate of growth would increase by 0.4 percentage points. When they allow for other factors, i.a. the level of investment and the proportion with compulsory schooling, the effects become statistically insignificant.[14]

Secondly, the quality of education is important. Hanushek and Kimko (2000) estimate growth between 1960–1990 as a function of average length of education and average test results in mathematics and the natural sciences during this period for 31 countries, both rich and poor. They find that the relationship between growth and education decreases from 0.55 to 0.10 when test results are used as a control variable. The test results are statistically significant, whilst education no longer is, since both variables are included simultaneously. The authors interpret the test results as an indication of the quality of the labour force. They also include direct measures of school quality, such as the number of pupils per teacher and total spending on education in the model. It turns out that these variables are not statistically significant for growth and this applies both when using and not using test results as a control variable. How should this then be interpreted? The view of the authors is that the test results have a positive causal effect on growth, but that the estimates they obtain, for reasons which are unclear, are unreasonably high. We also wish to emphasise that if test results are used as a control variable and education is included at the same time, the test results will be partly dependent on education.

[14] Murphy et al find more positive effects from the proportion of engineers, also when using control variables, if the sample is limited to the 55 countries with more than 10,000 university educated persons. This sample thus consists of countries with large populations and smaller countries with many university educated persons. It remains #? unclear as to why this sample of countries is an interesting group to study.

Discussion

In this section we reviewed the most important contributions to comparative country analysis of the contribution of education to economic development. Clearly some progress has been made, not least thanks to better data quality. Nevertheless our overall conclusion is that it is still very difficult to know how reliable the estimates are when using variation in education between countries.

The level of education between countries varies for reasons which are virtually impossible to allow for. Within countries, between regions or between individuals, on the other hand, there are sometimes examples that education varies as a result of random factors, e.g. education reform. One example which we will return to is the reform of the compulsory school in Sweden which took place over a period of 10 years when the reform was implemented step-by-step in different municipalities. This gave pupils in certain municipalities a minimum of 9 years of schooling, compared with 7 to 8 years for pupils in other municipalities. The differences in education between countries on the other hand is affected by the decisions of countries themselves, often due to varying preconditions. It is not only virtually impossible to allow for differences in all relevant factors (the problem of omitted variables), but also conceivable that if a country expects rapid growth in the economy, then investments in education will be increased (the problem of reverse causality).[15] Both these factors mean that an estimate of GDP level or GDP growth as a function of education (irrespective of whether this concerns level or change) cannot be interpreted as purely an effect of education. Bils and Klenow (1999) calibrate[16] one model and find that more than half of the relationship between the level of education and economic

[15] It is also the case that certain variables which are important in terms of explaining differences in economic development between countries have an unclear relationship to the level of education. One example of this is the stock of capital: if we do not include this, it is evident that we are omitting an important variable, but if we do include it, it probably captures a part of the educational effect we are trying to estimate.

[16] Certain economists work with calibration models. These are quantitative models of the whole economy that take into account the interaction between labour and goods markets and other factors, and take as their starting point that individuals and companies aim to optimise their activities. The parameters of the model identify the behaviour of individuals and companies. These parameters are obtained from different empirical studies, but "calibrated" so that the model generates outcomes which correspond to real outcomes. This involves advanced simulation models based to some extent on empiricism. The advantage of these models is that they can take account of highly complex interaction between markets and players, whilst their weakness is that they are not entirely empirically based.

growth was created by the effect of expected growth on the level of education, i.e. reverse causality. Another problem with many of the results from this literature is that they use sophisticated empirical models, namely dynamic panel data models, on a small sample of countries. One weakness is that these models only allow for permanent differences in growth between countries. In addition, it is unclear as to how well they function with so few observations available in comparative country studies.

Since there are such major problems with country data on education, combined with the difficulties of solving the problem of reverse causality and the omission of variables in growth estimates, Krueger and Lindahl (2001) argued that the most promising approach for future research in the area is to use variation between regions within a country instead of variation between countries. Whilst major improvements have taken place in the quality of educational data in recent years, research based on country data does not adequately deal with the problems of reverse causality and the omission of variables. For this reason, later on (in section 6.1) we will change our focus from country comparisons to studies which use more reliable data on variation in education between individuals, workplaces, towns and regions within a country. Even though such studies perhaps do not capture all types of effects which ideally occur in comparative country studies, the advantage is that the estimated effects are more reliable.

Despite these objections, it is worth reiterating that the results of the best research in the area may be said to have converged towards greater correspondence between the results obtained from individual analyses and those obtained from country analyses. Whilst the first studies in the area indicated major differences in results between both these analytical approaches, the results of the studies which could have used better data on educational changes in countries come very close to those originating from the individually based research tradition. This can be seen from the most recent studies of Cohen and Soto (2001) of poor and rich countries and De la Fuente and Domenech (2002) for OECD countries.

4 Empirical results: are income effects also production effects?

4.1 Is education primarily a signal?

Both human capital and signalling theory on purely logical grounds are reasonable and thus have a strong position amongst economists. Both theories have been developed by economists who have won the Nobel prize in economics. Gary Becker and Theodore Schultz developed human capital theory, and Kenneth Arrow and Michael Spence signalling theory. Given this background, there is no doubt that reliable empirical tests of the relative importance of both theories on choice of education would be received with great interest in the research community. Despite this, it has been difficult to carry out tests that are entirely convincing.

One attempt was made to study whether persons running their own business have income premiums from education that are just as high as those who are employees. The idea behind this strategy is that people running their own business work for themselves and thus do not need to signal their productivity to an employer. Wolpin (1977) carried out such a study on American data and found that the educational effects of salaries were in fact somewhat higher amongst those running their own businesses than among employees. But objections can in fact be directed to this strategy also. One is that certain people running their own business, such as consultants and lawyers, need to be able to signal their productivity to their customers. For this reason an impressive graduate qualification on their visiting card would be useful. Another objection is that the results for people running their own business, a smaller group of around 10 percent of the labour force, cannot necessarily be generalised to employees in general.

Another attempt to test the effects of signalling in education was based on the idea that the value of education for the employer as only a signal of productive qualities would decrease relatively quickly as employer and employee get to know each other. For this reason, the return on education decreases with the duration of employment, and perhaps over time on the labour market more generally. This pattern, however, does not normally recur in the data. Instead the opposite tends to be found, namely a (sometimes albeit weak) tendency for the return on schooling to increase

somewhat commensurate with time on the labour market. Chevalier et al (2004) report such results on British data and discuss these in terms of signalling theory. Björklund and Kjellström report Swedish results indicating that the return immediately starts increasing with entry on the labour market. Altonji and Pierrat (2001) present American results indicating that employers rapidly become familiar with the productive capacities of new employees and that the signal value of education is thus low.

Objections could be raised that tests such as these are not entirely reliable since learning at the workplace can vary greatly between individuals due to the skills they bring with them to the workplace. In other words as it is often put ”skills beget skills”. The original knowledge may in its turn reflect both what has been learnt in school (human capital theory) and inherent characteristics (signal theory). These tests are thus not entirely convincing.

A further attempt to eliminate the importance of signalling effects has been proposed by, amongst others, Card (2002) in his criticism of Wolf's (2002) argument that the effects on society are exaggerated. Card refers to the results of studies of major education reforms which extend compulsory education for a specific age group, but not for the age-group of the preceding year. One concrete example is the British school reform which meant that children born in 1956 received longer schooling than children born the previous year because of a policy reform imposing compulsory schooling up to the age of 16 instead of as earlier up to the age of 15. This reform was well known throughout the country which is why employers had no reason to interpret the increase in education of the 1956 cohort compared with the 1955 cohort as an expression of higher intrinsic productivity. The data, however, shows that the extra education resulting from the reform provided an individual economic return of about 10 percent, a figure slightly more than the average income premium for education; the results are reproduced in Harmon and Walker (1995). This argues strongly against signalling effects.

Chevalier et al (2004) develop the analysis of this education reform in order to further eliminate the signalling hypothesis. When the absolutely lowest educational level rises as a consequence of an increase in the length of compulsory schooling – based on a signal theory perspective – those who have a somewhat longer education than compulsory schooling have an incentive to extend

their education. This is to provide a signal that they have a higher capacity than those who have now received longer education as a consequence of the reform. However, they could not find such indirect effects in their analysis of British data. They interpret this as a sign that signalling effects are not strong.

In addition, one way of testing both theories has been to use the fact that signalling theory emphasises that it is relative education which is important and not the absolute level. This can be tested by studying whether it is the relative educational level within an age group which explains incomes or the absolute level of education. Both Kroch and Sjoblom (1994) and also Chevalier et al (2004) carry out such tests and find that the relative level of education has an insignificant effect on incomes whilst the absolute level has a major effect.

Finally a more theoretical argument is normally used to make the case against the signalling function as having sufficient power to explain an important part of income differences between high and low educated persons. If it were the case that long and expensive education was only used to provide similar signals, there would be strong economic incentives to develop test methods which provide the same information about a person's intrinsic productive qualities such as education. Quite simply a market for such tests would be developed. Both employers and potential students would have a high willingness to pay for such tests. This argument is reinforced for American university education, not only because of the high costs for individual students, but also because markets for tests could be more easily established in America. But there is no sign of any company offering advanced test methods as an alternative to universities in the USA. On the other hand, private companies offer different ”test packets” which can be used to provide training for the admission tests used by American universities for selecting students. University education per se is thus given a high value. We interpret this as support for the idea that knowledge and skills and also university education are highly valued.

Overall we are inclined to the view that the effects of education on total incomes and total production are hardly lower than the effects on individual incomes because of the signalling effects. The empirical studies we referred to, and particularly those based on major educational reforms, are as strong in this respect as is the logical argument that a substantial test industry would have

developed if the signalling effect of education were very important. There are also reasons to emphasise the fact that signal effects which lead to the right person coming to the right place also have an economic value. For this reason, we believe that there are evident reasons for politicians in the educational arena to take serious note of signal effects, for example, when designing rules for grades and academic qualifications.

4.2 Is wage differences also productivity differences?

The natural approach for an economist to tackle this question is to look for more direct information about the role of the labour force with different educational qualifications in the production process itself. This means searching for empirical production functions. Such functions show what production level a company can achieve with different inputs of production factors such as capital and labour. Here it is crucial that the production function be sufficiently detailed to be capable of distinguishing between a labour force with different levels of education and also preferably different educational orientations. Despite the fact that many leading researchers – e.g. Griliches (1997) – have recommended this approach, we have not been able to find any convincing studies based on this approach.

Moretti (2004c) uses American company data to estimate such production relationships. He also finds causal effects of education on productivity. But in his analysis he is only able to differentiate between a low and highly educated labour force, and this is the reason why the result is a little too imprecise to be used for making comparisons with existing estimates of the income effects of education.

Mellander (1999), however, uses Swedish data, for 24 industries – in his study on the demand for four types of labour with different levels of education over the period 1985–1995. He finds that technical development during this period has shifted demand in favour of those with higher education, what is referred to as skill-biased technical change. The demand for labour is, however, based on the assumption that salary differences correspond to productivity differences which is why the study does not directly correspond to our question.

5 Empirical results: other effects for persons with more education

5.1 Effects on health and life expectancy

There is a very strong correlation between the individual's education and health/life expectancy. Such relationships appear to be universal and applicable to most countries and time periods. We examine the relationship between education and health in Sweden by using data from the Swedish Level of Living Survey (LNU) 1991. We estimate the following simple linear probability model:[17]

(5) Good Health = c_0 + c_1 * Years of education + date of birth indicators + gender indicator + random factors

The dependent variable, good health, takes a value of 1 if the individual considers their general health status to be good, and the value 0 if it is considered to be bad or somewhere between good and bad. We find that c_1 = 0.020, with a standard error of 0.002 for 4 274 individuals and c_1 = 0.028, with a standard error of 0.005, for 1042 older individuals born 1930 or earlier. These estimated relationships can be interpreted as showing that the probability of being in good health is 2–3 percent higher for each additional year of education.

We use the LNU data combined with data on mortality to illustrate the relationship between education and mortality in Sweden. For 2582 individuals born between 1901–1925 and still alive in 1974, the following linear probability model was estimated:

(6) Mortality = c_0 + c_1 * Years of education + date of birth indicator+ gender indicator + random factors

where mortality is a variable which assumes the value of 1 if the individual dies between 1975–1984 (which applies to approximately 20 percent of all individuals born 1901-25) and the value 0 if the individual lives to 1985 or later. We then find that c_1 = -0.006, with a standard error of 0.003. This means that mortality during this ten year period is 0.6 percentage points, or 3 percent lower for each additional year of education.

[17] The results would be very similar if instead we were to estimate a Probit model. This applies to the estimates for both equations (5) and (6).

Erikson (2001) estimates the relationship between education and mortality with a large volume of data for Sweden. He finds that the risk of mortality falls sharply with level of education. For example, the risk of dying during years 1991–96 for an individual aged 64 in 1990 is as much as 5 percentage points higher if the individual only attended elementary school as compared with having a long university education.

In purely descriptive terms, there are strong relationships between education and health/mortality. For us the main issue, however, is whether there is a causal relationship. Is it reasonable to believe that an educational reform which extends (or improves) education, or extends education for other reasons, leads to people having better health and living longer? This does not necessarily follow from the statistically significant relationships. It could instead be the case that bad health means that people educate themselves less and/or that factors we cannot observe, such as genetic factors or conditions during upbringing, determine this relationship.

In any case there are some studies showing that such relationships may also be causal. A study carried out by Lleras-Muney (2005), which in our view is not unconvincing, using American data shows that this applies to life expectancy. She estimates how the probability of dying within 10 years between 1970 and 1980 (given an individual has survived until 1970) is affected by number of years of education for individuals born in the USA during the period 1901–1925. With a fairly simple model, she finds that the probability of dying decreases by 1 percentage point for each additional year of education, a figure that is somewhat higher than we obtained for Sweden. In a more advanced analysis, she uses variations in the individual's education resulting from variations between states in legislation governing compulsory schooling and age at which children can start work. This variation cannot be influenced by the individual per se, and it can also be assumed that it is not related to non-observable factors specific to the individual. (This is an example of what is called the instrumental variable approach which we explain in greater detail in the Appendix. Later we review other studies using this technique). When this is done, education has a more powerful impact on life expectancy: about 4–6 percentage points from an additional year of education. These estimates are, however, not statistically different from the more simple estimates above.

There also a number of studies which have tried to estimate the effect of education on health using Nordic data through a methodology similar to that of Lleras-Muney (2005). Arendt (2005) studies how education influences general health in Denmark. When a simple model is used, a positive and statistically significant relationship is found between health and education. When he uses variations in the individual's education arising from two educational reforms in Denmark in 1958 and 1975, he obtains positive but statistically insignificant effects from education. The reforms have some importance on the length of education for men, but a statistically insignificant effect on general health. In a later study, Arendt (2004), information about the reform of 1958 was used, but with a much larger database: nearly 700 000 individuals born between 1943–1950 with outcomes measured for 1990–2000. First he finds that the reform has a positive effect on education, since the increase in the level of education in the reform areas is higher compared with the areas outside the reform, especially for women. In addition, he finds that an education longer than compulsory schooling is associated with a 1 percentage point lower probability of being hospitalised. This still applies if the reform is used as an instrument, but the effects are a third of the original. The effect is that education beyond compulsory school leads to a probability 1.2 percentage points lower of being hospitalised due to sickness.

Spasojevic (2003) studies the effect of education on a health index for individuals born between 1945–1955 using Swedish LNU data from 1991. Simple relationships between these measures of health and education are positive and statistically significant. Her main analysis also uses an indicator of whether the individual has completed 9 year compulsory schooling, or the shorter 7–8 year compulsory schooling that existed for these age groups. Using variations in education created by this reform was first done for Sweden in Meghir and Palme (1999, 2004). Spasojevic finds that those who went through the ”reform school”, and were thus ”forced” to attend 1–2 extra years in school, had better health in 1991. This estimate, however, is only marginally statistically significant. She also finds that if she estimates health in relation to education, and only uses variations in education produced by the reform indicator, then the relationship between good health and education is strengthened. Once again this estimate is only marginally statistically significant.

It is worth noting that the source for the construction of the reform indicator variable affects the results in Spasojevic (2003). If the individual's own report on attending the ”reform school” is used, then no statistically significant effect is found for the time spent in education. This means that this measure cannot be used in the subsequent analysis, since we cannot with statistical certainty state that the reform generates variations in education. In order to construct the reform indicator giving the results referred to, information was used on when the reform was carried out in different municipalities. Since the reform in a number of cases was introduced at different points in time in different parts of a municipality and also because sometimes it is unclear as to which age cohorts were affected by the reform, there is some degree of uncertainty concerning the results.

The conclusion appears to be that education has a causal effect on mortality. It thus seems reasonable to assume that health is also positively affected by longer education, even though so far there is a lack of convincing studies as to whether this is the case. Even though both Arendt (2005) and Spasojevic (2003) have used a good analytical strategy (using variations in years of education generated by educational reforms) which can potentially provide an estimate of the effect of education on health which can be interpreted causally, both these studies have been carried out on such a small sample that the reliability of the estimates is far too low. Their results are interesting, but must be interpreted with caution.

Let us finally discuss briefly a possible mechanism underlying the positive causal effect of education on health and mortality. Lleras-Muney and Lichtenberg (2004) have studied whether individuals with high education acquire new medical knowledge. This is measured by a variable which shows whether they are quicker to use medical products approved by the American FDA. They estimate a simple model with a number of control variables, including demographic and socio-economic variables. They find support for the hypothesis even though the effect is very small.

5.2 Inter-generational effects on children of the educated

As in the case of education and life expectancy, there is a strong relationship between parental education and their children's education and incomes. Such relationships form the core of a

substantial body of literature concerning inter-generational mobility. Particularly within sociology, there is a long-established tradition of studying such relationships in terms of class mobility between generations.[18] The role of education in this mobility has also been thoroughly studied. Within economics, there is a significantly younger literature concerning parental and their children's incomes in adult years.[19] The role of education in the relationships has also been emphasised in this literature. Both these branches of the literature have documented very strong relationships between parents and children in terms of occupation, class, income and education. As examples of these relationships, it can be mentioned that studies using American data tend to show that the elasticity of sons' incomes (long-term average) in relation to fathers' incomes (also long-term) is about 0.4, i.e. differences of 10 percent amongst fathers become on average differences of 4 percent in the next generation. Corresponding estimates for the Nordic countries produce figures of around 0.2 i.e. differences of 10 percent amongst parents become on average 2 percent in the following generation. Another way of illustrating inter-generational relationships is to relate a child's income to length of parental education. Results obtained from the Swedish data show that an additional year of education for parents is related to about 1.8 percent higher income for children, which can be compared to about 4.5 percent when relating a person's own income to their own education. If the 1.8 percent were added to the 4.5, there would undoubtedly be a significant difference in the overall return from education. However, the objection could be raised that the effects on children come significantly later than for parents, and thus these benefits should be appropriately discounted. Nevertheless, effects on children of these orders of magnitude constitute significant values.

But strong general relationships between parental and child education are not the same as causal relationships, i.e. a policy reform which raises the education of parents has direct consequences on the next generation when they reach adult age. The main purpose of inter-generational research has been to *describe* the relationship and not necessarily draw conclusions on the consequences of a reform of a certain kind, or whether the

[18] See e.g. Erikson and Jonsson (1993).
[19] See Solon (1999) for a scientific review and Björklund (2002) for a more popular publication in Swedish.

education of the parental generation would change for other reasons. It is thus highly possible that the strong relationships, wholly or partly, are related to other factors.

Recent research has looked at the question of causal effects of parental education analysed from a number of different approaches. One approach has been to use data on adopted children and their adoptive parents. The idea behind this approach has been that these relationships are unaffected by the purely genetic relationships between biological parents and their children, but focus only on the environmental relationship. The most comprehensive study using this approach was carried out using Swedish data on adopted children born in Sweden in the 1960s (Björklund, Lindahl and Plug 2004), but the methodological model comes from a number of studies using American data.[20] The results show that the inter-generational relationships are significantly weaker in adoptive families than for biological parents and children. As regards the latter, the studies show that if a parent has a university education, the probability is 15 to 20 percent higher that the child will also have a university education than otherwise, and that an additional year of education for a parent means approximately 0.15 year longer education for the next generation. In adoptive families, the corresponding relationship is less than half as strong, but is nevertheless statistically significant. These results are still valid when the analysis is limited to families where children are adopted at a very early age, and when a number of other factors are taken into account.[21]

The results of this study of Swedish data, similar to those based on American adoption data, show that about half of the inter-generational relationship between parental and children's education (and thus) incomes cannot be described as causal. Nevertheless, there are certain significant relationships even in adoptive families which indicate that the resources provided by education may have causal effects on the next generation. It is worth noting that the effect of education is approximately twice as large for fathers as for mothers.[22] The relative importance of the mother's and father's education has been discussed very much in the literature.

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[20] See Sacerdote (2002 and 2004), Plug (2004), and also Plug and Wijverberg (2003, 2005).
[21] Swedish data allows a number of the special assumptions on which this method is based to be tested. The results presented above are in all essential respects valid after such tests.
[22] The relative importance of the father's and mother's education (and other "resources" and qualities) has been extensively discussed in the literature. Some arguments indicate that fathers traditionally have a greater importance. For example it has been the father's income

Another approach to studying purely causal relationships has been to use data on parents who are identical twins. Their children i.e. cousins face very similar preconditions since one of their parents has similar preconditions, both genetically and environmentally; the latter follows from the fact that identical twins spend more time together than siblings do. Behrman and Rosenzweig (2002) using such data study whether there is a relationship between differences in parental education and differences in children's education. They find that the relationships between such differences are very weak for mothers in relation to the overall relationships between parents and their children's education. Some results are negative with little statistical significance. However, they find major effects for fathers. Antonovics and Goldberger (2005) have, however, recently examined the results of Behrman and Rosenzweig and their main finding was that the negative results for mothers are not reliable.

A third approach, similar to some of the studies mentioned above on education and mortality, has been to use variations in parental education generated by a policy reform. In a very interesting analysis of Norwegian data, Black, Devereux and Salvanes (2005) used educational differences generated by educational reform in Norway during the 1960s which had major similarities to the reform of the compulsory school in Sweden, where implementation started during the 1950s. This reform led to variations in parental education which was dependent on where parents lived during their schooling. Black et al show that this variation can be described as quasi-experimental and is not systematically related to factors other than the school reform which may have influenced their education. When they use statistical methods which focus on this variation in parental education, they obtain relationships which are positive, but very weak in relation to the general inter-generational relationships. The results from this study can also be interpreted as a warning against interpreting general relationships between parental and children's socio-economic status as direct causal relationships. The only relationship which is statistically significant is that between a

which has been most important in the household and that the father's occupation may have influenced the child's expectations and ambitions in working life. Other arguments support the mother as having greater importance, for example that the child spends more time with the mother than with the father. This is an important issue in many ways, but we do not think it is possible to state there is any consensus in the literature.

mother's and son's education indicating that an additional year of education for mothers leads to 0.15–0.20 year longer education for their sons. The researchers emphasise that they do not have any explanation as to why this relationship is statistically significant and relatively large.

Black et al emphasise in their study that these results may be due to educational effects generated by an extension of compulsory education. It is possible that changes in other parts of the distribution have other effects. A study by Currie and Moretti (2003) indicates that this would be the case for the USA. They use educational variations arising from closer access mothers have to education when new colleges are opened in their neighbourhood. They find significant effects for the children of educated mothers attending such education. The effects are particularly visible for different health indicators.

Given that Sweden during the 1950s and the 1960s implemented a compulsory school reform in the same way as Norway did somewhat later, similar studies could be expected for Sweden. However, no such study has yet been published.[23] On the other hand Meghir and Palme (2005) have used this reform for somewhat different purposes. In their work in the leading international journal on economics, *the American Economic Review,* they studied the effects of this reform on future levels of education and incomes. They find somewhat surprisingly that those who grew up in municipalities which implemented the nine-year compulsory school on average obtained longer education and higher incomes than those born the same year, but growing up in municipalities under the old school system with shorter compulsory education. However, they find significant differences between different groups in terms of the size of these effects. Above all, the results show that pupils of fathers with low levels of education benefited more from this reform than others. There is, however, another type of effect than that which is the focus of our report.

In what way should the results from these recently published studies on the causal effects of parental resources in relation to education (and in certain cases incomes) be summarised? A recurring result is that studies which try to capture the purely causal effects show significantly weaker relationships between generations than the more descriptive studies. No studies indicate

[23] However, such a study is being carried out within the framework of a research programme led by the authors.

that clearly more than half of the descriptive relationships are causal effects. If we also take into account Antonovic's and Goldberger's criticism of the American study on twins seriously, it can be said that there are no studies showing negative effects of parents' education (or incomes). Weak positive effects would thus appear to be a judicious assessment. The fact that different methods give different results may, however, be due to the complexity of causal relationships and perhaps vary between different education and income groups. Hopefully, future research will provide better material for assessing the different results.

6 Empirical results: external effects on others than the educated

6.1 Results from regional analyses

There are some advantages from using data concerning regions/towns instead of countries when estimating educational externalities. In the first instance, when years of education are aggregated at the regional or town level, data of high-quality is generated compared with country measures which are instead based on the proportion of persons registered at different levels in education. We mentioned in the section on country analysis that unreliable educational measures, in particular, are a problem when using data for a number of different points in time, and when using variations over time in a number of countries. Such a strategy can more easily be applied when making estimates at the regional level within a country; also towns can then constitute regional units. Secondly, it is easier to find some type of usable quasi-experimental variation in education within a country, than between countries. Earlier, we have illustrated this by means of the reform of compulsory schooling in Sweden, introduced on different occasions in Swedish municipalities, and by comparable reforms in other countries. By using this information, it is possible to just use the variations in education created by the educational reform. One disadvantage of using regional variations is, however, that not all types of externalities are obtained, namely those which are created through contacts across regional borders. This disadvantage is reinforced by the fact that mobility is greater between regions than between countries.

We illustrate this analytical strategy by making use of data from LNU 1991 and estimate the following model:

(7) Logarithm of individual's hourly wage = d_0 + d_1 * Individual's years of education + d_2 * average number of education years for other individuals in the region + demographic factors + random factors

We find that d_1 = 0.033 with a standard error of 0.002, and d_2 = 0.043 with a standard error of 0.010.[24] The results should thus be interpreted such that an increase in education for other individuals in the region by on average 1 year, with constant education for the typical individual, correspond to an increase in income for this individual of 4.3 percent. This increase is somewhat higher than if the individual were to extend education by a year, while all other individuals in the region keep the length of their education unchanged. If all individuals in the region, i.e. including this individual, were to increase their education by a year, the individual's salary would increase by d_1+d_2, here approximately 7.6 percent. Equation (7) can thus be solved where d1 is the individual economic return and d_1+d_2 is the social return; d_2 thus represents educational externalities. If the equation is calculated only using the individual's years of education, the coefficient 0.040 is obtained, which corresponds to the individual return for Sweden which we initially reported in the introduction.

Observe that if the average logarithmic salary is estimated as a function of the average number of education years, the results are approximately the same as the sum of the coefficients d1 and d2 in the model (7). Thus if the average education is raised by a year, the average salary will increase by approximately d_1+d_2 percent. It is also worth pointing out that if the number of individuals in each region is sufficiently large, then quite simply the regional average can be used for the variables and there is no need as here to first remove observations for the individual.

An early study of the external effects of education at the regional level was carried out by Rauch (1993) who estimates a model of type (7). He studies how the salaries of individual Americans co-vary with both the individual's education and the average education in the town where the individual lives, at the same time as he uses a

[24] Demographic factors were controlled for gender, age, and the square of age for the individual and as an average for all other individuals in the region.

large number of other control variables. He finds that the private return from an additional year of education is approximately 5 percent and that the return from increasing the town's education average by one year is 3–5 percent. Both Rauch's results and our own on Swedish data above thus indicate that these types of external effects are large when calculated in this way. There are, however, a number reasons for believing that the model is too simple to be able to correctly estimate the external effects of education in the region.

Firstly, no account is taken of other non-observable permanent differences between regions. It may, for example, be the case that there are differences in industrial structure. It may also be true that productive capacity differs between individuals from different regions. It is also possible to imagine that individuals with a high-capacity tend to gather in one place where the return on education is at its maximum. If there is regional data at two points in time, it is possible to allow for this by basing the analysis on changes. Researchers who have done this have found that estimated d_2 decreases to approximately half of its original size (see e.g. Acemoglu and Angrist for the USA). But approximately half of the estimated educational externalities in the model (7) can be explained by permanent differences between regions. Moretti (2004a) instead uses variations between the proportions of higher educated persons in American states. When permanent differences between states are allowed for in this way, he finds that an increase in the proportion of higher educated by 1 percentage unit is associated with a 1.1 percent higher salary for the individual, a reduction from 1.3 percent if no allowance is made for permanent differences between states.

Secondly, there may be temporary or ”transitory” differences between regions, e.g. from demand shocks impacting regions in different ways. There may also be problems with reverse causality if regions with high salary levels invest more money in education, or the individuals there educate themselves more because the return is high. In order to allow for these factors, there is a need to find one or more variables which influence average education, but which are not related to other factors influencing salaries.

In our view the study which has used the most reliable analytical strategy for rich countries is that by Acemoglu and Angrist (2000) for the USA. They make use of state rules determining how long an individual stays in school: e.g. the age a pupil starts and finishes

school and how early a pupil may start working. These rules vary between states and years. Two variables are formulated on the basis of these rules: the minimum number of years required for schooling before a pupil can leave school, and the minimum number of years in school required before a pupil can start working. They then use variations in these rules between states. They find a private return of 7 percent, whilst the external effects of education are small (about 1 percent) and not statistically significant for years 1960–1980. They find larger external effects in 1990, which they consider may be due to lower quality in the education data for his year.[25]

Thirdly, d_2 may reflect an aggregated supply effect of higher education persons. In the model above, the assumption is made that persons with low and high levels of education are perfectly substitutable in production. If this is not the case, then an increase in the number of persons with higher education (and thus an increase in the regional average for years of education) will lead to higher salaries for those with lower levels of education, since there is now a shortage of persons with such levels of education, and the result is also a lower salary for those with higher levels of education. These effects only cancel each other out if persons with lower and higher education are perfectly substitutable in production. If this is not the case, then d_2 will be overestimated even if there were no externalities. On an intuitive level this is due to the fact that the salaries of those with lower education will increase more than the reduction in salaries of the highly educated. One possible test of this is to include an interaction variable between the individual's years of education and the regional average; this means that the effect of average education varies for individuals with high and low education in a model of type(7). If no differences are found between the effect of the average number of years of education in the region for individuals with varying lengths of education, this would indicate that the assumption of substitutability in production cannot be the reason for the results found in the analyses. Moretti (2004a) finds e.g. major differences in the return between different education groups.

[25] Normally errors in measurement of a variable mean that the effects of this variable are underestimated. Acemoglu and Angrist (2000) show, however, that when using the instrumental variable method to estimate the effects of average education, the reverse applies when taking into account a person's education.

A more direct way of allowing for this is to use the method adopted by Ciccone and Peri (2004), and correct for growth in mean salaries in the region so that it corresponds to the proportion of persons with high levels of education existing at the outset. When they do this and then estimate the corrected salary growth variable as a function of the change in the average number of years of education, the result is that the externalities in Moretti (2004a) are heavily overestimated. They also replicate the analysis in Acemoglu and Angrist (2000) for 1970–1990 and find first positive externalities (which are produced by the results for 1990), but when the corrected salary growth variable is used, they find no support for the external effects of education for this period.

Our impression from the studies where variations between regions or towns have been used, as well as a reliable analytical strategy, is that the causal effects of other individuals' education on the individual's salary are small, possibly so small that they can be ignored. We note, however, that the research referred to in this section used data for the USA, and that these results cannot with any certainty be generalised to Swedish conditions. It is also worth pointing out that the best analyses concern the effects of extending the number of years in compulsory school. It is entirely possible that the external effects, for example, of education for engineers in higher education is of a different order of magnitude.

6.2 Results from analyses based on company data

Analyses similar to those on regions and towns have also been carried out using data on companies and/or workplaces. It is then possible to see how educational composition in *other* companies within a region influences salaries or productivity in a specific company. Here externalities between individuals within a company are not caught. But if such effects are taken into account when employers set salaries, these are caught in the individual's salary.

Fortunately, there is a study on Swedish data. Isacsson (2005) studies the relationship between salaries for an individual in a company and the average number of years of education in other companies in the same municipality, at the same time as he allows for the level of education for the individual and co-workers in the company where the individual is working. The last mentioned variable is included in order to allow for imperfect substitutability

between individuals with different levels of education. He can observe individuals, workplaces and counties at different points in time, i.e. an advanced type of panel data. As a result he is able to analyse changes and thus allow for permanent differences over time, for the individual and the county where the individual lives. He also includes observable variables in an attempt to allow for non-permanent differences between municipalities. Isacsson finds that the average level of education in companies other than where the individual is working is associated with salaries 6 percent higher than the individual's own return on education. If allowance is made for permanent differences between individuals and counties over time, this relationship decreases to 1 percent. If allowance is also made for imperfect substitutability, this relationship is also 1 percent and statistically insignificant. Isacsson (2005) also reports that he then replaces years of education by the proportion of university educated and obtains similar results.

When more detailed allowance is made, as is possible with the sophisticated data that Isacsson uses, the conclusion is that there is no support for any external effects between companies regarding education.

Moretti (2004c) has also used company data, but instead of salaries as the outcome, he has used measures of the company's productivity. This has the advantage that estimates are not affected by the signalling effects nor by wage ”compression” resulting from a country's labour market institutions. He estimates the production level in a company in a manufacturing industry in a town with respect to the proportion of persons with higher education in other manufacturing industries in the town, at the same time as he allows for the company's level of education, labour force and capital. His estimates thus do not capture externalities between different companies in the same branch and town. Moretti is able to observe the same company at different point in time and can thus allow for permanent differences between companies over time. He finds support for the existence of educational externalities: an increase of 1 percentage point amongst those with higher education in other manufacturing industries in the town increases productivity by close to ½ percent. He also finds that the transfer of knowledge is greater for companies that are closely related economically (Isacsson (2005) also found support for this).[26] We note that

[26] For a similar study of British data, see Galindo-Rueda (2004).

Moretti cannot allow for reverse causality when productivity growth in an industry affects changes in the proportion of persons with higher education in other industries in the same town. This could lead to an overestimate of educational externalities.

Moretti calculates that the size of the externalities corresponds closely to salary differences between towns with different proportions of persons with a higher education. This could be interpreted as support that signalling effects and also that compressed salary structures due to institutions are two factors which have little quantitative importance in the overall return from education in the USA.

At least for Sweden in general terms, it seems there is no support for major external effects between companies.

6.3 Does longer education lead to lower rates of crime?

For education and crime, there are also strong direct relationships which do not necessarily reflect the causal mechanisms we discussed above in section 2. It is well-known that young men with low levels of education and little experience of working life are strongly overrepresented among those committing crimes. But in the same way as such relationships can reflect the fact that higher education leads to a lower propensity to commit crimes, they can also reflect the fact that persons with a higher propensity to commit crimes are not interested in further education, or that impoverished upbringing leads to both crime and low education.

In analytical terms, what is evidently required is additional valuable variation in the length of education which can be related to crime in order to be able to draw the conclusion that investments in higher education really do lead to lower crime. Lochner and Moretti (2004) – as many of the other studies we have reported — use for this purpose variations in education created by different states in the USA through changes in the rules governing the length of compulsory education and its scope at different points in time during the period 1900–1960. These reforms led to a situation where large groups ”were kept” in the school system for one or more years and some also completed their upper secondary education.

When Lochner and Moretti used this variation in education and related it to crime, then we find clear indications that extending

education leads to a reduction in crime. Firstly, they find effects on the probability of a person going to prison, a variable which they can measure from American population censuses. They also find effects on the number of arrests measured at the state level. The objection can be raised against both these measures that they capture not only the propensity to commit crime, but also the propensity to be discovered and punished for crime; education could then just as well influence the propensity to be discovered and punished, as the propensity to commit crime. This is the reason they verify these results by analysing individual data where respondents report their own criminal activity, and they find that the latter results are entirely consistent with the former. In addition, they investigate whether there is any relationship between educational changes generated by school reforms and initiatives in crime prevention such as additional police resources. But they do not find any such indications, and this strengthens the interpretation that it is the extended education of the educational reforms which led to lower propensity to commit crimes.

It is always difficult to determine whether the effects estimated by statistical methods are to be regarded as ”major” or ”minor”. In order to highlight the order of magnitude of their results, Lochner and Moretti use their estimated coefficients to calculate the economic value of a reduction in crime which the educational reforms gave rise to. For this purpose, they use established calculations of the costs of crime. They find that the value of the lower rate of crime corresponds to 14–26 percent of the individual economic return from the same education. In this case, this deals with a substantial addition to the social return on education resulting from the effects of lower rates of crime.

Our assessment is that the study of Lochner and Moretti provides convincing evidence that changes in the length of compulsory schooling implemented in the USA during the first half of the 20th century led to lower crime. It is, however, very difficult to say how general their results are. One limitation is that the results for the USA and for this period cannot be generalised beyond this specific type of educational effect brought about by legislation, when compulsory schooling is extended by one or more years , thereby reducing the proportion of pupils not completing upper secondary education. Whether the expansion of American university education or investments in preschooling would have the same favourable effects is an entirely different question. Still

more difficult is whether the same results would apply to Sweden today. Nevertheless, we consider that it is very interesting that extending education under certain circumstances can lead to substantially lower crime.

6.4 Does education affect political involvement?

Our theoretical discussion led to a conclusion that higher education in many ways can influence political involvement, both qualitatively and quantitatively, but that there are also possible counteracting factors such as higher education and income which can make involvement in political activities more expensive. The literature of the social sciences emphasises, however, that there is a strong positive relationship between education and political participation. One leading political scientist Putnam (2001) writes e.g.: "Education is the variable which is most strongly correlated with civic participation in all its forms". In Swedish research and debate, the SNS Council on Democracy, amongst others, in its report from 1998 demonstrated the existence of a corresponding relationship using Swedish data.[27]

But this correlation can also reflect other relationships than those where education leads to political participation. It is entirely possible that there is a third variable such as family background and that the upbringing this results in has created interest in both education and politics. For this reason, correlations must be interpreted with caution and it becomes a challenge to find quasi-experimental variations in education which can reveal something about causal relationships.

Milligan et al (2004) carry out an interesting comparative analysis between the USA and the UK. For both countries, they emphasise that simple correlations possibly supplemented by certain control variables within the framework of a multiple regression analysis cannot convincingly solve the problem of methods. This is the reason that they use variations in education generated by policy reforms for both countries. For the USA, they used variations created by variations in the extension of compulsory schooling at different points in time and in different states. The major differences in education between two closely

[27] See Pettersson et al (1998, p 89) where 10 different indicators of active citizenship correlate positively with level of education.

related age cohorts created when compulsory schooling was extended over the whole country in 1947 and 1973 was used for the UK.

In this approach they find that the extension to compulsory education in the USA led to a higher probability of voting. On the other hand, they find no corresponding effect for the UK. One hypothesis they put forward in order to explain this difference in the results is that both countries have different practices for registering voters; In the USA the individual citizen must register, whilst in the UK it is the local authorities who are responsible for ensuring that all those entitled to vote are registered. In order to study this hypothesis, they carry out a separate analysis for the USA studying only those who are registered for voting purposes. Amongst these, they find non-existent or a minimal effect from education on the propensity to vote. It is thus conceivable that longer compulsory education in the USA led to a higher propensity to register as a voter.

Milligan et al also study whether the longer education generated by educational reforms affected political interest and participation along dimensions other than voting. For both countries, they found that education increased the propensity to become interested in politics through reading newspapers and following other media. In the same way they found that education raised the interest people reported they had in politics.

Dee (2004) has independently of Milligan et al carried out a similar study on American data. The result is essentially the same, but Dee uses other sources of data to measure political activity as well as an additional source for variation in education, apart from changes in the length of compulsory schooling. This strengthens the reliability of the results which Milligan et al obtained.

When Dee uses variations in education resulting from reforms in compulsory education, he finds not only a significant effect on the propensity to take part in elections, but also that education significantly increases reading of newspapers and affects attitudes to freedom of expression. He also uses the variations in education resulting from physical proximity to 2 year (short) college programs. Higher education as a consequence of its closeness to such educational opportunities leads to a significantly higher propensity to participate in elections.

7 Summing up: are results from the different studies contradictory?

Our results are potentially contradictory. On the one hand, we have shown that the best studies which used variations in education between countries and regions – here we consider recent studies to be more reliable – indicate that there are no strong external effects from education. On the other hand, we have pointed out that there is strong evidence that education leads to improved health and life expectancy, politically more active citizens, lower crime and possibly that the children of educated persons become more productive.

One explanation for these seemingly contradictory results may be that the favourable effects of education are not sufficiently strong to have an impact on economic development. It is also possible that the traditional measure of GDP is too narrow (and perhaps insufficiently stable) to capture the favourable effects.

Another explanation may be that the analyses based on variations between countries and regions are not capable of capturing all the positive effects. In order to discuss what is captured by such analyses and what is not captured, there is reason to reflect over the fact that the studies nevertheless build on data over very long periods of time. Most comparative country studies use data on economic development for the period 1960 to 1995. For this reason we consider that the possible effects of education through reduced crime and increased civic involvement should be captured by the data. On the other hand, it is more doubtful whether the favourable effects on health, life expectancy and children's development are captured in their entirety. Here we have been particularly struck by the result that the effects of education on life expectancy are not only statistically significant, but also large in their magnitude. The positive effects of education on health and life expectancy are, in addition, perfectly reasonable in theoretical terms, and this is especially true of one American study we consider to be entirely convincing in purely methodological terms.

We thus consider that it would be beneficial to study the overall economic consequences of such effects in more detail than has been done within the framework of conventional analysis of the returns from education. Even though we have not had the opportunity to carry out such an analysis in this report, we would

like to take this opportunity of highlighting certain aspects which should be taken into account. Conventional analysis of the return on education – irrespective of whether it is the individual or social return – has taken as its starting point that education is related to certain costs during the education (for the individual and society) and that there is a return in the form of higher gross incomes (for society) and net incomes (for the individual) up to and including retirement age. This is assumed to be the same for both high and low salaried persons. It is clearly evident that such assumptions are dubious. There is reason to believe that those with higher education work longer if they have better health, and live longer. How this will affect different calculations on returns remains to be determined.

There may also be reasons for attaching greater attention to cost-benefit analyses of extending education. If longer life expectancy means a longer period with incomes from the pension system, it may be worthwhile to take this into account.

8 Tasks for future research

Our review of the empirical research on education and economic development has indicated numerous gaps in knowledge. Many of the potential educational effects which on theoretical grounds should be viewed as a priority have either not been empirically studied, or the empirical data on which they are based is conspicuously weak. It would thus be a relatively simple task to conclude our report by providing a long list specifying important empirical studies to be carried out at the earliest opportunity. But hopefully it has also become apparent that producing reliable empirical results is easier said than done when it comes to complex causal relationships of the kind involved here. Basically, we consider that this problem is related to the general problem of analysis in the social sciences, namely that controlled experiments (in most cases) cannot be carried out. Instead researchers must try to find ”quasi-experimental” variations in data which can replace experimental (or randomly) generated variations. We have provided numerous examples of such studies where researchers with great imagination and perseverance have succeeded in obtaining educational data containing such valuable quasi-experimental variation.

When we consider what is particularly important for future research, there are good reasons for considering that this should deal with the total effects of education, and not just the external effects which our review has focused on. Our review indicates that the individual income effects are undoubtedly the most important when it comes to effects on incomes and production. In our assessment this view is well-founded. For this reason, it could be claimed with relative certainty that despite a number of shortcomings in the research, that education does affect salaries, incomes and level of GDP. (If our task had been to summarise the research situation in terms of how factors such as taxes, the public sector, start-up entrepreneurship or labour legislation affects long-term growth, we would have had even more reservations and the emphasis on gaps would have been even stronger.)

A shortcoming in much of the existing research – both concerning individual economic effects and the external effects on individuals other than those receiving the education – is that often there is no differentiation between different educational orientations. Differentiating between the effects of different educational orientations – whether engineers versus lawyers, such as the focus of some comparative country studies, or social sciences versus natural sciences – is, however, difficult in general terms since those completing different types of education have different preconditions for success on the labour market even before they start their education. It is thus important to be able to allow for such differences. The use of Swedish data, however, creates opportunities for such studies since information on upper secondary grades is available on upper secondary school completion from 1988 and onwards, and since these people have now reached an age greater than 30, it becomes meaningful to study the outcome of education in terms of success on the labour market. One can thus compare persons with equivalent upper secondary grades in relation to different orientations in their further education.

Another gap in the research is that we know far too little about the return on education from different types of learning institutions, for example, established and relatively large research-based universities, compared with smaller university colleges with little or no research. In the immediate future, this gap can be closed by research based on the same type of data as discussed above, namely studies which examine how outcomes for adults are related

to type of university and which take account of upper secondary grades and family background.[28] This may also be a point of entry into studying the relative importance of research components and purely educational components in higher education. Here there is also an obvious gap in the research.

Different orientations in upper secondary education can also be analysed in a similar way, but with grades in year 9 to allow for differences in preconditions. National tests can also be used in this way. As regards education up to and including year 9, it is not a question of studying the effects of different educational orientations, since course content is the same. On the other hand, it is relevant to study the effects of variations in the quality of education at this level. Such analyses are, however, made more difficult by shortcomings in early data on grades and test results. It would also be a priority to study the long-term consequences of preschool in terms of the child's future development at school and later as an adult on the labour market. This is, however, very difficult and in our view there is no obviously reliable study of the effects of the ambitious initiatives that have been taken with respect to preschooling in Sweden.

We also believe that it would be both important and possible to study in greater detail the implications that education appears to have a clear causal effect on life expectancy. Most calculations of the contribution of education to lifetime incomes take as their starting point that low and highly educated persons work for the same number of years. It is unclear how longer life expectancy for persons with higher education is distributed between longer working life and longer retirement. It should be straightforward to determine and calculate the consequences in terms of increased lifetime incomes and increased future production.

A closely related gap in the research is that the effects of education on wages per hour worked – i.e. salary adjusted for the number of hours worked – and also on the total number of hours worked, has not been properly studied. By tradition, Swedish studies have either used ”hourly wages” or ”annual incomes” as a measure of outcomes when analysing the different effects of

[28] Lindahl and Regnér (2005) study the individual economic return on different forms of higher education and take account of family background and to some extent grades. They find that "established" universities have a much higher return compared with smaller regional university colleges. In the immediate future, their analysis can be expanded to cohorts born in 1969 and onwards – for which there is data on grades – who have now reached an age where their long-term labour market outcomes can be measured.

education. The latter measure also captures some of the effects of hours worked, e.g. the effects of full-time as opposed to part-time work, and the effects of working a whole year compared with parts of a year. On the other hand, the effects on the probability of not working at all have seldom been studied. Here there are numerous opportunities to carry out new studies on Swedish data.

We will conclude by reiterating the importance of preserving the fundamental research infrastructure for education and economic development. In the first instance, we would like to emphasise the importance of better data. The weakness of the data used in the first generation of comparative country studies is surprising. The availability of much better data has led to much better studies. But there are still many problems related to measuring level of education (and quality of education) in different countries to be overcome before this analytical approach can be carried out in the best way.

As regards Sweden, there is also every reason to emphasise the value of the substantial volume of register-based material which has been increasingly used in recent years. In a number of areas, better studies can be carried out on Swedish data (and other Nordic countries) than on data from the Anglo-Saxon countries currently dominating the research. There are many advantages to such data. Firstly, samples are sufficiently large to enable ”small” effects to be studied with reasonable statistical precision. Secondly, variations in education between individuals and companies in different regions and municipalities can be studied, and this is important since education develops differently in regions and municipalities. It is also possible to study the relationship between people who are working at different workplaces. Thirdly, register data from Sweden enables unique studies of persons with different family connections to each other. Our review of the research has looked at a number of such studies.

But perhaps most important of all, however, is to underline the importance of variation in educational data which is sufficiently ”similar to experimental data” to allow analysis to differentiate between cause and effect. It is surprising and some cause for concern that studies based on the major school reforms carried out in Sweden and other Nordic countries more than 40 to 60 years ago are only now being published in leading journals. It is only now that the lifelong effects of these reforms can be studied and substantial data is available for relevant analyses. It is our view that

the philosophy underlying the quasi-experimental approach of these reforms has been virtually forgotten in Sweden. Obviously, not all policy can be carried out in experimental forms, and just as obviously politicians need answers to difficult questions faster than 40 to 60 years later. But with a greater willingness to carry out pilot activities in different parts of the country, combined with the wealth of register data which Statistics Sweden can now provide for analysis, our view is that there are good opportunities to provide better policy material for many important educational issues.

References

Acemoglu, D och J Angrist (2000), ”How large are Social Returns to Education? Evidence from Compulsory Schooling Laws”, *NBER macroeconomics annual,* vol 15, s. 9–59.

Aghion, P och P Howitt (1998), Endogenous Growth Theory, Cambridge, Ma: MIT Press.

Altonji J och C Pierrat (2001), “Employer Learning and Statistical Discrimination”, *Quarterly Journal of Economics,* vol s. 313–350.

Antonovics, K och A Goldberger (2005), ”Does Increasing Women’s Schooling Raise the Schooling of the Next Generation? Comment”, under publicering i *American Economic Review.*

Arendt, JN (2004), ”In sickness and in health – till education do us part: Education effects on hospitalization,” Working Paper, Institute of local government studies – Denmark.

Arendt JN (2005), ”Does education cause better health? A panel data analysis using school reforms for identification”, *Economics of Education Review,* vol 24, s. 149–160.

Barro, R (1991), ”Economic Growth in a Cross-Section of Countries”, *Quarterly Journal of Economics,* vol 106, s, 407–443.

Barro, RJ, och JW Lee (1993), ”International Comparisons of Educational Attainment,” *Journal of Monetary Economics,* vol 32, 363–394

Barro, RJ och JW Lee (1996), ”International Measures of Schooling Years and Schooling Quality”, *AEA Papers och Proceedings,* vol 86, s. 218–223.

Barro, R och X Sala-I-Martin (1997), *Economic Growth,* Cambridge MA: MIT Press.

Behrman J och M Rosenzweig (2002), ”Does Increasing Women’s Schooling Raise the Schooling of the Next Generation?”, *American Economic Review*, vol 92, s. 323–334.

Benhabib, J, och M Spiegel (1994), ”The Role of Human Capital in Economic Development: Evidence from Aggregate Cross-Country Data”, *Journal of Monetary Economics,* vol 34, s. 143–174.

Bils, M, och P J Klenow 2000, ”Does Schooling Cause Growth?”, *American Economic Review,* vol 90, s. 1160–1183.

Björklund A (1999), ”Utbildningspolitik och utbildningens lönsamhet”, i L Calmfors och M Persson (red), *Tillväxt och ekonomisk politik,* Studentlitteratur, Lund.

Björklund (2002), ”Inkomst och familjebakgrund”, i *SOFI 1972–2002. En jubileumsskrift.* SOFI, Stockholms universitet.

Björklund A och C Kjellström (2002), ”Estimating the return to investment in education: how useful is the standard Mincer equation?”, *Economics of Education Review,* vol 21, s. 195–210.

Björklund, A, M Lindahl och E Plug (2004), “Intergenerational effects in Sweden: What can we learn from adoption data?”, IZA DP 1194.

Black, S, P Devereux och K Salvanes (2005), “Why the Apple Deosn’t Fall Far: Understanding Intergenerational Transmission of Human Capital”, *American Economic Review,* vol 95, s. 437–449.

Card D (2002), ”Comment on Wolf”, Milken Institute Review.

Chevalier A, C Harmon, I Walker och Y Zhu (2004), ”Does education raise productivity or just reflect it?”, *Economic Journal,* vol 114, s. F499–F517.

Ciccone, A och G Peri (2004), ”Identifying Human Capital Externalities: Theory with Applications”, Mimeo.

Cohen, D och M Soto (2001), ”Growth and Human Capital: Good Data, Good Results”, OECD Development Centre, CEPR Discussion Paper 3025.

Currie J och E Moretti (2003), ”Mother’s education and the intergenerational transmission of human capital: evidence from college openings”, *Quarterly Journal of Economics,* vol XX, s. 1495–1532.

de la Fuente, A, och R Domenech (2002), ”Human Capital in Growth Regressions: How Much Difference Does Data Quality Make?” Mimeo, September 2002.

de la Fuente, A och JF Jimeno (2005), ”The Private and Fiscal Returns to Schooling and the Effect of Public Policies on Private Incentives to Invest in Education: A general framework and some results for the EU”, CESifo WP no 1392.

Dee, T (2004), ”Are there civic returns to education?”, *Journal of Public Economics,* vol 88, s. 1697–1720.

Duflo, E (2001), ”The Medium Run Effects of Educational Expansion: Evidence from a Large School Construction Program in Indonesia”, Mimeo.

Erikson R (2001) ”Why do graduates live longer? Education, occupation, family and mortality during the 1990s”, i J O. Jonsson och C Mills (red) *Cradle to Grave: Life-course change in modern Sweden,* Durham: Sociologypress.

Erikson, R och JJ Jonsson (1993), *Ursprung och utbildning. Social snedrekrytering till högre studier,* SOU 1993:85.

Friedman, M (1962), *Capitalism and Freedom,* Chicago. Chicago University Press.

Galindo-Rueda, F (2004), ”Social Returns to Human Capital and the Spatial Distribution of Productivity amongst British Firms,” Mimeo, London School of Economics.

Griliches Z (1997), ”Education, Human Capital and Growth: A Personal Perspective”, *Journal of Labor Economics,* vol 15, s. S330–S344.

Gustavsson M (2005), ”The evolution of the Swedish wage structure: new evidence for 1992–2001”, under publicering i *Applied Economics Letters.*

Hanushek, EA och DD Kimko (2000), ”Schooling, Labor-Force Quality, and the Growth of Nations,” *American Economic Review,* vol 90, s. 1184–1208.

Harmon C och I Walker (1995), ”Estimates of the economic return to schooling for the UK”, *American Economic Review,* vol 85, s. 1278–1286.

Heckman, JJ, och PJ Klenow (1997), ”Human Capital Policy”, Mimeo University of Chicago.

Isacsson, G (2005), ”External effects of education on earnings: Swedish evidence using matched employee-establishment data,” IFAU Working paper 2005:10.

Kroch E och K Sjoblom (1994), ”Schooling as Human Capital or a Signal: Some Evidence”, *Journal of Human Resources,* vol 29, s. 156–180.

Krueger, AB och M Lindahl (2001), ”Education for Growth: Why and for Whom?”, *Journal of Economic Literature,* vol 39, s. 1101–1136.

Kyriacou, G (1991), ”Level and Growth Effects of Human Capital: A Cross-Country Study of the Convergence Hypothesis”, New Yoek University C. V. Starr Center for Applied Economics Working Paper RR 9126.

Lindahl L, och H Regnér (2005), ”College choice and subsequent earnings. Results using Swedish siblings data”, Scandinavian Journal of Economics, under publicering.

Lleras-Muney, A, (2005), ”The Relationship between Education and Adult Mortality in the U.S.”, *Review of Economic Studies,* vol 72, s. 189–221.

Lleras-Muney, A och F. R. Lichtenberg (2004), ”The Effect of Education on Medical Technology Adoption: Are the more educated more likely to use new drugs, mimeo, Princeton University.

Lochner, L och E Moretti (2004), ”The Effect of Education on Criminal Activity: Evidence from Prison Inmates, Arrests and Self-Reports”, *American Economic Review,* vol 94, s. 155–189.

Lucas, RE, (1988), ”On the Mechanisms of Development Planning”, *Journal of Monetary Economics,* vol 22, s. 3–42.

Meghir, C och M Palme (1999), ”Assessing the effect of schooling on earnings using a social experiment” IFS working paper W99/10.

Meghir, C och M Palme (2005), ”Educational reform, ability and family background” *American Economic Review* vol 95, s. 414–424.

Mellander E (1999), ”The Multi-dimensional Nature of Labor Demand and Skill-Biased Technical Change”, IFAU working paper 1999:9.

Milligan K, E Moretti och P Oreopoulos (2004), ”Does Education Improve Citizenship? Evidence from the U.S. and the U.K.”, *Journal of Public Economics* vol 88, s. 1667–1695.

Moretti, E (2004a), ”Estimating the Social Returns to Higher Education: Evidence from Longitudinal and Repeated Cross-Sectional Data”, *Journal of Econometrics* vol 121, s. 175–212.

Moretti, E (2004b), ”Human Capital Externalities in Cities”, *Handbook of Regional and Urban Economics,* North-Holland Elsevier.

Moretti, E (2004c), ”Workers’ Education, Spillovers, and Productivity: Evidence from Plant-Level Production Functions”, *American Economic Review,* vol 94, s. 656–690.

Murphy, K. M., A. Shleifer och R. W. Vishny (1991), ”The Allocation of Talent: Implications for Growth,” *Quarterly Journal of Economics,* vol 106, s. 503–530.

Nelson, R, och E Phelps (1966), ”Investment in Humans, Technological Diffusion, and Economic Growth”, *American Economic Review,* vol 56, s. 69–75.

OECD (2003), *Education at a Glance.* OECD, Paris.

Petersson, O (red) (1998), *Demokrati och medborgarskap,* Demokratirådets rapport 1998, SNS Stockholm.

Plug E och W Vijverberg (2003), “Schooling, Family Background and Adoption: Is it Nature or is it Nurture?, *Journal of Political Economy* vol 111, s. 611–641.

Plug E och W Vijverberg (2005), ”Does Family Income Matter For Schooling Outcomes? Using Adoptin As a Natural Experiment?”, under publicering i *Economic Journal*

Plug E (2004), ”Estimating the Effect of Mother’s Schooling on Children’s Schooling Using a Sample of Adoptees”, *American Economic Review*, vol 94, s. 358–368.

Portela, M, R Alessie och C Teulings (2004), ”Measurement Error in Education and Growth Regressions”, Tinbergen Discussion Paper 04-040/3.

Pritchett, L och LH Summers (1996), ”Wealthier is Healthier,” *Journal of Human Resources,* vol 31, s. 841–868.

Psacharopoulos, G och H Patrinos (2004), ”Returns to Investment in Education: A Further Update”, *Education Economics,* vol 12, s. 111–134.

Putnam RD (2001), ”Tuning in, tuning out: the strange disappearance of social capital in America”, i RG Niemi och HF Weisberg (red), *Controversies in Voting Behavior.* CQ Press, Washington DC.

Pritchett, L, (2001), ”Where Has All the Education Gone?”, *World Bank Economic Review* vol 15, 367–391.

Pritchett, L (2005), ”Does Learning to Add up Add Up”, forthcoming Handbook of Education Economics, North Holland.

Rauch, J (1993), ”Productivity Gains from Geographic Concentration of Human Capital: Evidence from Cities”, *Journal of Urban Economics,* vol 34, s. 380–400.

Romer, P (1990), ”Endogenous Technological Change”, *Journal of Political Economy,* vol 98, s. 71–102.
Sacerdote B (2002), ”The Nature and Nurture of Economic Outcomes”, *American Economic Review,* vol 92, s. 344–348.
Sacerdote B (2004), ”What Happens When We Randomly Assign Children to Families?”, NBER WP 10894.
Sianesi, B, och J Van Reenen (2003), ”The Returns to Education: Macroeconomics”, *Journal of Economic Surveys,* vol 17, s. 157–200.
Solon G (1999), ”Intergenerational Mobility in the Labor Market”, i O Ashenfelter och D Card (red), *Handbook of Labor Economics.*
Spasojevic, J (2003), ”Effects of Education on Adult Health in Sweden: Results from a Natural Experiment,” Ph.D. Thesis The City University of New York.
Storesletten K och F Zilibotti (1999), ”Utbildning, utbildningspolitik och tillväxt”, i L Calmfors och M Persson (red), *Tillväxt och ekonomisk politik,* Studentlitteratur, Lund.
Summers, R och A Heston (1991) ”The Penn world table (Mark 5): An Expanded Set of International Comparisons, 1950–1988”, *Quarterly Journal of Economics* vol 106, s. 327–368.
Teulings, C, och T Van Rens (2003), ”Education, Growth and Income Inequality”, Mimeo Tinbergen Institute.
Topel, R (1999), ”Labor Markets and Economic Growth”, i O Ashenfelter och D Card, *Handbook of labor economics.* Handbooks in Economics, vol. 5. Amsterdam; New York and Oxford: Elsevier Science North-Holland.
Vandenbussche J, P Aghion och C Meghir (2004), ”Growth, Distance to Frontier and Composition of Human Capital”, mimeo, Harvard University.
Wolf A (2003), DN-debatt.
Wolf Alison (2004), Education and Economic Performance: Simplistic Theories and Their Policy Consequences, *Oxford Review of Economic Policy* vol 20, s. 315–333.

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The Effects of Education and Skills on Wage Returns and Economic Growth – comments on Education and Economic Development[1]

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1 Introduction

The economic impact of education can be measured in two ways. In the microeconomic approach the focus is on the individual wage returns to schooling while the macroeconomic approach examines primarily the relationship between the human capital stock of nations and growth rates. The informative overview paper prepared by Anders Björklund and Mikael Lindahl (2005) deals mostly with macroeconomic issues, including externalities and second-order effects of education, such as the impact on health, labour force participation rates and criminality.

In this contribution I will seek to complement the picture by examining three mainly microeconomic issues. First, I will discuss the presence of measurement error in the estimation of returns to human capital measured by indicators of initial schooling as opposed to more accurate measures of the stock of knowledge, skills and other attributes of individuals that are relevant for productive activity. Second, cross-country evidence is presented of the relationship between schooling and wage returns while controlling for the effects of directly assessed skill as well as the intermediating effects of further education and training received in the years beyond the completion of initial schooling. Finally, some cross-country evidence is presented about the differences and

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similarities between the private and social rates of return to schooling.

2 Decomposing Errors in Measures of Schooling

Björklund and Lindahl (2005) briefly discuss issues concerning the accuracy of measures of schooling and educational attainment commonly used in econometric research on the economic returns to education. They acknowledge that the measures derived from common databases collected and maintained by organisations such as the OECD and UNESCO suffer from measurement error. Such errors occur partly because of inconsistency in reporting mechanisms and also because national systems of education are reformed over time. International classifications of education systems are also updated on occasion, and this has implications for the consistency of historical trend data. Moreover, the average years of schooling obtained by EU populations has increased significantly over the past several decades. Obviously this variation poses challenges for the estimation of economic returns to education over time. Problems in the comparative measurement of educational attainment are reviewed in Tuijnman (1998).

Bjorklund and Lindahl (2005) review several recent econometric studies in which the authors have attempted to improve the quality of the education measures specified in human capital growth equations. These studies include Barro (1997), Barro and Lee (1996), Hanushek and Kimko (2000), and De la Fuente and Doménech (2002). These studies tend to show not only that significant error is indeed present in the data, but also that the use of cleaned and improved data sets yields more consistent analytical results.

An issue Björklund and Lindahl (2005) do not address explicitly is that measurement error is understood to consist of several components. Lack of *reliability* constitutes only one, albeit important, component of error. Social scientists commonly distinguish and factor in other error components as well. Besides issues of data reliability and accuracy, analysts are also interested in errors associated with the *validity* of the measures used. Errors of validity are not normally considered in ordinary econometric estimation methods, although the effects of omitted variables can be modelled using instrumental variables.

Measures of schooling and educational attainment suffer from an important conceptual drawback. Conceptually, human capital, as an economic concept, is understood to refer to knowledge, skills, competence, experience and other desirable individual attributes that are relevant for labour productivity and hence thought to have economic value. Variables such as initial schooling and educational attainment are believed to relate to knowledge and productivity, yet as indicators they measure such phenomena at best only indirectly. Knowledge and skills are thought to relate to the quantity of schooling an individual has received over a given period of time, but they are not one and the same thing. In the research literature on education economics a distinction is commonly made between aspects of education quantity and education quality. Measures of schooling and education attainment, as used in most of the research studies reviewed by Anders Björklund and Mikael Lindahl, are built on quantity but have little if anything to say about differences in education quality and how this may relate to possible variation in the productivity of human capital stock and the effects on economic growth.

From an economic perspective, human capital is an intermediate quality produced by allocating scarce resources to an individual learning process that is designed to yield sought after competences and attitudes. This process can be represented in an educational production function, which is a mathematical expression that relates inputs to outputs. Many factors can be included in such a function. For example, financial, human and physical capital items are usually included among the input factors, whereas educational attainment and different skills, values and attitudes are among the commonly measured outputs. The challenge of making the skill formation process cost-effective thus refers to the search for efficient ways of converting or substituting resources. Life-long learning is advocated by organisations such as the European Commission, OECD and the World Bank because it is believed to offer a flexible and efficient way of organising the skill formation process and so developing the requisite human, cultural and social capital for the nation. There are several problems, however, and an important one is that it usually takes a long time before the conversion of financial capital into intangibles such as human or social capital pays off (Coleman, 1988), for example, in terms of increased employment, productivity and economic growth.

Another issue is that, in the absence of direct observations on the human capital stock of nations as measured by an aggregate of the knowledge and skills possessed by the labour force at a given point in time, economists commonly use years of schooling as a proxy indicator. This may be admissible in so far as actually possessed competence correlates highly with measures of obtained schooling. However, a serious threat to validity arises if competence and schooling are only modestly related. Such a situation could occur for several reasons. For example, people who enter the labour market with similar educational qualifications have not necessarily acquired the same level of proficiency in productivity relevant skills such as solving problems or managing interpersonal relations. Second, discrepancies will arise because people do not stop learning upon leaving school. Because opportunity to learn varies depending on a host of personal, situational and economic factors, the strength of the relationship between schooling and the actual skills possessed by the labour force decreases with increasing experience.

Accordingly, information about average years of schooling or educational attainment is at best an imperfect indicator of human capital stock. The skills acquired at work and elsewhere are not normally reflected in conventional measures of educational attainment. In discerning the full extent of the effects of education on earnings account must be taken of the fact that learning is a defining characteristic of all human activity across the life span. Because people learn on the job and develop new roles in the community and every day life, relying on a measure of nominal schooling is certain to misrepresent the stock of human capital that ought to be specified in earnings or growth equations. The inability to take account of this discrepancy results in price distortions and market failures, such that the premiums paid to skill are socially or individually inefficient.

Key to solving the conceptual and measurement problems is to devise a methodology for the direct assessment of economically important knowledge and skills. At the international level three avenues of work on the direct measurement of skills have been explored in recent years. The first line of work has been the International Adult Literacy Survey (IALS), conducted between 1994 and 1998, through which data were collected on the literacy profiles of adult populations aged 16–65 in 22 countries (OECD and Statistics Canada, 1995; 2000). The second approach has been

to collect comparative data on student achievement in mathematics, science and reading literacy among 10 and 14-year-olds as part of a cycle of surveys conducted under the auspices of the International Association for the Evaluation of Educational Achievement (Mullis *et al.,* 1997; NCES, 2004). New IEA surveys have been launched recently. A third line of work has been to assess the reading literacy, mathematical literacy and scientific literacy skills of 15-year-old students as part of the Programme for International Student Assessment (OECD, 2001; 2004a).

3 Decomposing the Effects of Schooling and Skills on Growth

The surveys mentioned above have provided a wealth of new data, and subsequent secondary analysis has yielded a number of new insights. For the purpose of my argument I will focus on studies that have used the IALS data set. Two interesting studies that have attempted to estimate the effects of education on income and growth while controlling for the mediating contributions of variables such as recurrent training and literacy skills are Boudard (2001) and Desjardins (2004). Both studies found that much of the direct effect of initial education on earnings disappears once measures of directly observed skills are introduced in the wage equations. The effect of schooling on income remains strong during the first 10 years of labour force experience, but subsides gradually thereafter. The effect of skill on earnings, in contrast, is weak in early career but grows stronger thereafter. These results provide support for the screening hypothesis rather than the productivity thesis proposed by human capital theory.

The most comprehensive econometric analysis of the effects of education and literacy on earnings and cross-country growth using the IALS data set is Coulombe, Tremblay and Marchand (2004). This study derives synthetic time series over the 1960–95 period on the literacy level of labour market entrants from the age structure of the 1994 IALS data. This information is then used as a measure of investment in education in a panel data analysis of cross-country growth for a set of 14 OECD countries. The study is of immediate interest to Krueger and Lindahl's (2001) observation that the microeconomic effects of human capital appear to be significantly higher than the macroeconomic effects of schooling on aggregate

GDP growth. Krueger and Lindahl (2003) assume that the poor quality of human capital measures employed in macroeconomic growth models provide a part of the explanation. This hypothesis is supported by the findings of studies undertaken by de la Fuente and Doménech (2002) and Coulombe *et al.* (2004).

Table 1 presents the results of the analysis undertaken by Coulombe *et al.* (2004) which specifies an improved log GDP per capita time series provided by the OECD as dependent variable and two human capital measures among the independent variables. It is of interest to note that the latter include the improved schooling measure developed by de la Fuente (2002) and a direct measure of literacy skills derived from the IALS. The results show that the six independent variables specified explain between 54 and 67 per cent of the variance in GDP growth. The effect of schooling on GDP per capita (0.06) is statistically significant (Column 1). But once the measure of literacy is introduced and regressed simultaneously (Column 2), the effect of schooling becomes insignificant (0.02) while the literacy variable (0.09) picks up the explanatory variance associated with human capital in the model.

It is acknowledged that criticism has been levelled against the methodology applied by Coulombe *et al.* (2004). To the extent education and literacy are highly correlated, the simultaneous modelling of the two constructs may introduce estimation error associated with multicollinearity. The presence of multicollinearity bias in the parameter estimates associated with the regressed effects of schooling and literacy on earnings has been studied, among others, by Tuijnman (2000) and Boudard (2001). The evidence does not support the notion that multicollinearity would pose a major problem. First, the relationship between years of schooling and adult literacy is strong but not overwhelmingly so, and does not pose estimation difficulties in linear structural equation models that specifically allow for residual correlations between constructs to be taken into account. Second, the effects of education on earnings while controlling for literacy differ between countries. While the education effect may disappear in pooled between country data sets of the type used by Coulombe *et al.* (2004), this finding masks the fact that the model effects are different in different countries. In some, such as in Switzerland, the education effect remains strong, mediated by factors such as occupational status and work experience, while literacy adds little explanatory power. In others, particularly Canada and the United States,

education exerts little effect once experience and literacy are held constant in the model. In Italy, Hungary and Poland, in contrast, the effects of education and literacy on earnings are very different depending on whether the model is specified for men or for women.

Table 1 Conditional convergence of GDP per capita and GDP per worker, 1960–1995

Average years of schooling of the population aged 25 and over taken from the De la Fuente and Doménech dataset and literacy measured by average test scores of the population aged 17–25 derived from the IALS dataset.

Dependent variable:	*Log difference of GDP per capita*				*Log difference of GDP per worker*			
Initial GDP	-0.076	***	-0.068	***	-0.037	**	-0.041	***
	(0.014)		(0.014)		(0.014)		(0.012)	
Average years of schooling	0.057	*	0.019		-0.011		-0.57	
	(0.029		(0.034)		(0.039)		(0.035)	
Literacy			0.085	**			0.146	***
			(0.040)				(0.035)	
Investment rate	0.032	***	0.038	***	0.024	**	0.033	***
	(0.009)		(0.008)		(0.010)		(0.008)	
Fertility rate	-0.015		-0.016		-0.006		0.004	
	(0.010)		(0.010)		(0.009)		(0.009)	
Openness ratio	0.018	**	0.021	***	0.031	***	0.033	***
	(0.007)		(0.007)		(0.009)		(0.005)	
R^2	0.54		0.56		0.59		0.67	
Elasticities (K, H)	(0.42; 0.75				(0.65; -0.30)			

Notes: The regressions include country fixed effects. There are 95 and 90 observations for GDP per capita and GDP per worker, respectively. White heteroskedasticity standard errors are shown in parentheses below the estimated coefficients. *: significant at 10 % level; ** at 5 5 level; *** at 1 % level. The regressionof GDP per worker excludes Germany. No significant serial correlation in either regression.

Source: Coulombe *et al.* (2004), page 32.

The central result of the Coulombe *et al.* (2004) study is that direct measures of human capital based on literacy scores outperform measures based on years of schooling in growth regressions, even when improved measures of schooling are specified. The results indicate that, overall, human capital indicators based on literacy scores have a positive and significant effect on the transitory growth path, and on the long-term levels of GDP per capita and labour productivity in all countries studied. According to the

authors, the key economic policy implication that follows from this result is that, in contrast to previous findings – with the notable exception of De la Fuente and Doménech (2002) – human capital accumulation markedly matters for the long run well being of developed countries. It might have been helpful for Björklund and Lindahl (2005) to reflect on the implications of these and other recent studies that have attempted to factor in the mediating effects of skill in the growth equation. Work experience and gender are additional factors that ought to be considered.

4 Decomposing the Private and Social Rates of Returns to Schooling

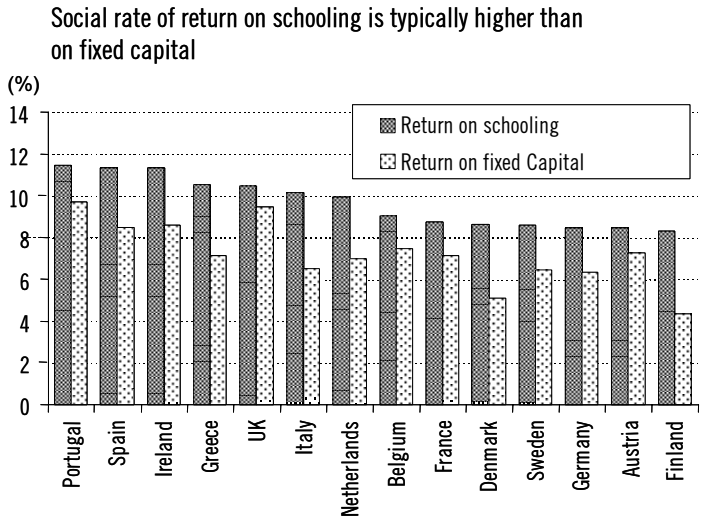
The microeconomic evidence about the wage returns of schooling is quite established. The findings reviewed above suggest, however, that the observed individual wage returns to schooling are partly attributable to omitted variables, particularly literacy skill (OECD and Statistics Canada, 2000; Coulombe *et al.*, 2004; Desjardins, 2004) as well as further education and recurrent training (Tuijnman, 1989; Boudard, 2001).

These caveats notwithstanding, the research literature on the microeconomic benefits of education provides a further set of insights that are only tangentially discussed by Björklund and Lindahl (2005). Here I refer to the branch of education economics that works on the conceptualisation and estimation of the wider benefits of learning. In this literature a distinction is commonly made between the monetary and non-monetary benefits accruing to education investments (McMahon, 1998). Both the monetary and non-monetary components are, in turn, broken down into yields falling to individuals (private returns) and yields for society (social returns). The rate of return to education can be estimated both for the individual and for a society as a whole. The private rate of return can differ from the social rate of return because the total costs incurred by individuals and society differ and also because the revenue streams and externalities are influenced by differential rates of taxation and conditioning factors such as the rate of technological progress. There is no scope to develop this classification further in this paper, but interested readers may wish to consult contributions by McMahon (1998) and Desjardins (2004).

There exists a substantive literature on the private and social rates of return to education. The European Commission recently commissioned two new studies with a focus on the EU countries (De la Fuente and Ciccone, 2002; De la Fuente, 2003). The returns are calculated relative to a one-year increase in schooling, without taking into account possible quality differences in education or the incremental effects due to on-the-job training or informal learning during the years beyond initial schooling. The private rate of return on education is the most easily measured. The benefits are the direct after-tax returns to the individual. The costs can be calculated from the direct costs borne by the student and the income foregone because of the studies. The social rate of return on education is calculated based on the total cost of education to society and the total economic gains in terms of output. This rate is more difficult to estimate correctly, since optimally it should also include external effects such as the impact of education on labour force participation and the rate of technological progress. De la Fuente (2003) describes the applied methodologies and their limitations more fully.

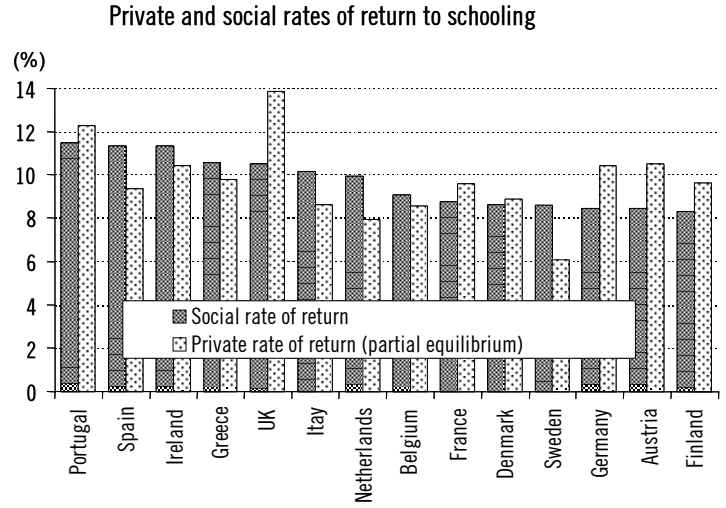
Methodological difficulties notwithstanding, the results are quite interesting. The average private rate of return to education for the EU-15 as a whole is close to 10 per cent. The private return to schooling is comparatively low in Sweden. The results reflect, to a large extent, differences in wage-related benefits and opportunity costs. According to De la Fuente and Ciccone (2002), the social rate of return ranges from 8.3 % in Finland to 11.5 % in Portugal, with an EU average of 9.7 %. The lowest returns are found in German-speaking countries (due to relative high opportunity costs) and in Nordic countries (due to compressed wage scales). De la Fuente (2003) further shows that the social rate of return on schooling typically exceeds the return to fixed capital investments in stocks and bonds (Figure 1).

Figure 1 Social rate of return to schooling, mid-1990s



Estimates of the private and social rates of return are broadly similar. Private individuals would therefore seem to have incentives to acquire a level of schooling that is also socially efficient at current rates of private and social expenditure. Exceptions are the United Kingdom, where private returns but also private costs are much above the average, and Sweden, where the private rate of return is estimated to fall below the social rate (Figure 2).

Figure 2 Private and Social Rates of Schooling Compared, mid-1990s



The microeconomic evidence presented in this section suggests that schooling is indeed a profitable investment both for the individual and for society. Direct comparisons between the private and social rates of return may be misleading, however, because they do not reflect the general equilibrium. For example, increasing the proportion of social subsidies for education in Sweden may not necessarily increase private yields while such a policy would most likely lower the social return. Estimates of the social rate of return may also underestimate various social externalities that derive from education investments. Björklund and Lindahl (2005) present a comprehensive overview of recent research findings with respect to these externalities, and these are therefore not further considered here.

De la Fuente and Jimeno (2005) present an update of the private and fiscal returns to schooling and the effects of public policies on private incentives to invest in education for a range of European countries. Interestingly, the study attempts to factor in differences in education costs, public subsidies for education, pension contributions and income tax regimes. Doing so is important because differences in private and social rates of return to education can in part be attributed to between country differences

in public policies vis-à-vis education subsidies and income tax. The results obtained by De la Fuente and Jimeno (2005) demonstrate very clearly the atypical orientation of public policies in Sweden and how they impact on private and social returns to education. Cumulative expenditure per student is higher in Sweden compared with most other European countries (OECD, 2004b). Public subsidies for education are higher too while the private direct costs are low. Taking these factors into account further reduces the after-tax private rate of return on education, which is lower in Sweden than in any other comparison country. The average premium on schooling is 4.75 per cent across the EU-14 (excluding Luxembourg) but only 0.33 per cent in Sweden. Once consumption tax and pension contributions are accounted for in addition to income tax, the fiscal recovery rate on education expenditure in Sweden turns out to be negative. Given the highly subsidised costs of education to Swedish society this is a remarkable finding that needs to be explored further.

Conclusion

The micro- and macroeconomic literature produces reasonably consistent estimates of the impact of schooling on wages and economic growth. De la Fuente (2003) concludes that an additional year of schooling increases individual wages by around 6.5 per cent across the EU-15 countries and by as much as 9 per cent in countries with less regulated labour markets. Social rates of return are of a similar order of magnitude. The macroeconomic evidence suggests productivity effects of around 5 per cent on impact, with the mediated effects of other factors such as technology estimated to yield up to another 5 per cent over the long term. These results are curiously consistent with those obtained by Coulombe *et al.* (2004), who find an aggregate effect of human capital on GDP growth of 8.5 per cent while controlling for the variance associated with other factors including differences in fertility rates and the openness of labour markets. However, it should be noted, in conclusion, that both years of schooling and literacy scores are specified as indicators of human capital, and that the magnitude of the schooling effect falls to close to zero once literacy skills have been entered into the growth equation.

It is understood that the brief given by the Swedish government to the authors of the report was to write a non-technical overview of the current state of the art of research on the relationship between education and mainly macro-economic growth. This is precisely what the authors have accomplished. As a next step, the government might wish to consider broadening the remit to include not only initial schooling but also lifelong learning, and knowledge and skills, among the independent and intermediate variables, and also to capture better the wider benefits of learning. For such an extension it would be necessary to embark on conceptual work about what constitutes these wider benefits. In the OECD Centre for Educational Research and Innovation a new study is being launched to map and investigate these wider social outcomes of education and positive and negative learning externalities. It will be of interest to see the eventual results of this new study, and particularly, to discuss the implications for education and labour market policies. The evidence presented in this paper about the distribution of private and social rates of return to education suggests that, at least compared with other European nations, Swedish society has certain special characteristics related to how its welfare state raises and distributes resources. Better understanding the nature of these special features and whether they make the country more competitive in the long run is a necessity. It would be of interest, therefore, to initiate further conceptual and empirical studies of the wider economic and social outcomes of learning.

References

Barro, R.J. (1997). *Determinants of economic growth: A cross-country empirical study.* Cambridge: MIT Press.

Barro, R.J. and Lee, J.W. (1996). International measures of schooling years and schooling quality. *American Economic Review,* Vol. 86(2): 218-223.

Björklund, A. and Lindahl, M. (2005). *Utbildning och ekonomisk utveckling: Vad visar den empiriska forskningen om orsakssambanden?* Draft 2005-04-25. Stockholm: Expertgruppen för studier i samhällsekonomi, Finansdepartementet.

Boudard, E. (2001). *Literacy proficiency, earnings, and recurrent training: A ten country comparative study.* Stockholm: Institute of International Education, Stockholm University.

Coleman, J.S. (1988). Social capital in the creation of human capital, *American Journal of Sociology*, Vol. 94 (Supplement): S95-S120.

Coulombe, S., Tremblay, J.F. and Marchand, S. (2004). *Literacy scores, human capital and growth across fourteen OECD countries.* Ottawa: Statistics Canada and Ministry of Industry.

De la Fuente, A. and Ciccone, A. (2002) *Human capital in a global and knowledge-based economy: Final Report.* Brussels: European Commission, DG Economic Affairs.

De la Fuente, A. (2003). *Human capital in a global and knowledge-based economy, Part II.* Brussels: European Commission, DG Economic Affairs.

De la Fuente, A. and Doménech, R. (2002). Human capital growth regressions: How much differences does data quality make? An update and further results. Manuscript. Valencia: Instituto de Análisis Económico, Universidad de Valencia.

De la Fuente, A. and Jimeno, J.F. (2005). *The private and fiscal returns to schooling and the effect of public policies on private incentives to invest in education: A general framework and some results for the EU.* Documentos de Trabajo, No. 509. Madrid: Banco de Espana.

Desjardins, R. (2004). Learning for well being: *Studies using the International Adult Literacy Survey.* Stockholm: Institute of International Education, Stockholm University.

Hanushek, E.A. and Kimko, D.D. (2000). Schooling, labor force quality, and the growth of nations. *American Economic Review,* Vol. 90(5): 1184-1208.

Krueger, A. and Lindahl, M. (2001). Education for growth: Why and for whom? *Journal of Economic Literature,* Vol. 39(4): 1101-1136.

McMahon, W. (1998). The monetary and non-monetary effects of lifelong learning. *Education Economics*, Vol. 6(3).

Mullis, I.V.S., Martin, M.O., Beaton, A.E., Gonzalez, E.J., Kelly, D.L. and Smith, T.A. (1997). *Mathematics achievement in the primary school years.* Boston College: TIMSS International Study Center and IEA.

NCES (2004). *Highlights from the trends in international mathematics and science study 2003.* Washington, DC: National

Center for Education Statistics, United States Department of Education.
OECD (2001). *Knowledge and skills for life: First results from PISA 2000.* Paris: OECD.
OECD (2004a). *Learning for tomorrow's world: First results from PISA 2003.* Paris: OECD.
OECD (2004b). *Education at a Glance: OECD Indicators. 2004 Edition.* Paris: OECD.
OECD (2005, April). Social outcomes of learning project. Draft background paper. Paris: Centre for Educational Research and Innovation, OECD.
OECD and Statistics Canada (1995). *Literacy, economy and society.* Paris and Ottawa: Authors.
OECD and Statistics Canada (2000). *Literacy in the information age: Final report of the International Adult Literacy Survey.* Paris and Ottawa: Authors.
Portela, M., Alessie, R. and Teulings, C. (2004). Measurement error in education and growth regressions. *Tinbergen Institute Discussion Paper TI-2004-040/3.* Rotterdam: Tinbergen Institute, Erasmus University.
Tuijnman, A.C. (1989). *Recurrent education, earnings and well being: A 50-year longitudinal study of a cohort of Swedish men.* Acta Universitatis Stockholmiensis. Stockholm: Almqvist & Wiksell International.
Tuijnman, A.C. (1998). International indicators of educational attainment. *Human Development Report 1999 (Annex).* New York: Human Development Report Office, UNDP.
Tuijnman, A.C. (2000). Education, literacy and wages in Poland in comparative perspective. *Yellow Paper Series No. 110.* Stockholm: Institute of International Education, Stockholm University.

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In recent years a substantial volume of research has been carried out into the relationship between education and economic development. In this report for The Expert Group on Economic Studies (ESS) Anders Björklund, Professor in Economics and Mikael Lindahl Ph.D. in Economics present the most important findings from this research. Albert Tuijnman, Professor in International Pedagogy has been invited to comment on and supplement the state of current knowledge.

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