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Economic Impact of Education: Evidence and Relevance

Dr Kristinn Hermannsson
kristinn.hermannsson@glasgow.ac.uk
Robert Owen Centre for Educational Change,
School of Education,
University of Glasgow,
St Andrews Building
11 Eldon Street
Glasgow, G3 6NH
Tel: 0141 330 2210

Abstract
Education impacts the economy through a range of channels. The extent to which these have been analysed is inversely correlated with how difficult they are to quantify. For instance, it is thoroughly documented how the education sector impacts the economy through purchases of inputs and employing staff. Conversely, it is far less well understood how education detracts from (costly) criminal behaviour, although recent work is making impressive strides in this direction. The salient topic of how skills benefit the economy has been widely researched but arguable the implications of that evidence base are not widely understood. Analysing education's contribution to the economy is faced with two main challenges: the limitations of traditional national accounting, i.e. how to incorporate impacts that occur outside the formal marketplace; and the statistical challenge of unravelling the specific contribution of education from the various confounders.

1 Introduction

The application of economic analysis to various aspects of education dates back at least to the work of Adam Smith[1] who recognised the skills of the population[2] as one of the manifestations of an economy's capital stock. The modern literature on the economics of education as a special sub-field spans approximately half a century (De Meulemeester & Diebolt, 2004), stretching back to Schultz (1961) who argued for public intervention to facilitate human capital accumulation and Becker (1964), who presented a model of investment in human capital analogous to investment in physical capital. Since then the field has grown to include a huge literature encompassing broad topics ranging from the role of education in influencing economy-wide outcomes, such as in economic growth and development; labour market outcomes and the functioning of school systems and individual institutions[3]. How much, if any, role economic perspectives should have in shaping education policy is beyond this chapter to resolve. However, there is significant evidence to suggest that education policy will always have economic implications, whether intended or not.

The economics of education is not a unified body of knowledge, but rather one that is spread across time and several sub-disciplines of economics. For this overview I shall build on McMahon's taxonomy of identifying impacts along the two dimensions of private/public and market/non-market. The main emphasis is on the labour market impacts of qualifications. This is by far the most widely researched aspect of the economic impact of education. Then I shall examine how this translates into a macroeconomic impact in the context of human capital and signalling theories; and job queuing. Furthermore, the chapter examines the wider economic impacts of education, such as through impacts on health, crime and household production. Where appropriate I shall highlight tensions between popular perception and the evidence base and point out areas for further research.

As is common in applied research the evidence base on the economic impact of education falls short of some of the detailed requirements of the decisions facing policy makers. Empirical evidence relies primarily on observational data, which for

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[1] De Meulemeester and Diebolt (2004) suggest early precedents can be found in the work of William Petty but that Smith was the first clearly to articulate the concept of human capital.
[2] "the acquired and useful abilities of all the inhabitants or members of the society. The acquisition of such talents, by the maintenance of the acquirer during his education, study, or apprenticeship, always costs a real expense, which is a capital fixed and realized, as it were, in his person. Those talents, as they make a part of his fortune, so do they likewise of that of the society to which he belongs" (Smith, 1776, book II, ch.1, para. 17).
[3] See for example Johnes & Johnes (2004) for an overview of different strands of education economics.

causal inference requires more elaborate identification strategies such as natural experiments. Furthermore, the level of detail is often limited by the nature of the data collected and statistical power. For instance, information on the association between the level of qualifications and labour market outcomes are available for most countries. But digging deeper such as into subject of study, type of education institutions attended, regional or socioeconomic variation, evidence rapidly becomes more difficult to obtain. Conversely, many aspects of the economic impact of education that are well supported empirically do not appear to be widely accepted or understood. The aim of this chapter is to offer an accessible introduction to empirical work on the economic impact of education.

Before digging into the actual evidence it is useful to clarify what is meant, when referring to economic impact. Therefore, I shall briefly define two concepts that typically lurk in the background of any discussion of the economic implications of policy, National Accounting and its result the Gross Domestic Product, and Cost Benefit Analysis (CBA).

2   How do we define "the economy"?

It is frequently asserted in public-policy discourse that a particular course of events would be good or bad for the economy. Sometimes the direction and/or magnitude of this impact is contested, but despite the definitive article this reference to "the economy" is rarely clarified. Does it refer to a conceptual notion of the economy; a particular metric, such as GDP or employment; or perhaps the interests of a particular sub-population such as rentiers or wage earners? Furthermore, is the definition restricted to market based activity, which can be clearly attributed a monetary value or does it also account for a wider range of impacts, such as on leisure, home-production or the environment?

A clear delimitation of some of these boundaries is still a work in progress (for a comprehensive discussion see Stiglitz, Sen & Fitoussi, 2010). However, two yardsticks are often applied in the evaluation of the economic merits of public policy. One is the contribution of policy to macroeconomic aggregates (GDP, GNP, etc) as defined by national accounting. The other is the sum of total costs and total benefits as articulated in Cost Benefit Analysis (CBA).

Modern national accounting took hold in the 1940's and has evolved through successive revisions of the United Nations System of National Accounts, although

the precursors date back to the 17th century[4]. In a nutshell, the national accounts count the amount of output, income and expenditures of households, government and businesses for a particular place over a particular period at market prices. One of the results of this exercise are frequently referenced macroeconomic aggregates. Gross Domestic Product or GDP (expenditure view) is defined as the total market value of all final goods and services produced within an economy[5]. GDP (income view) can also be defined as the total factor incomes (wages and other value added) generated in the economy[6].

From the definition of GDP the limitations of the concept are clear. It is a measure based on aggregate market activity and therefore has little to offer on non-market issues or the composition of the aggregate. As Okun (1971, p. 133) points out, the "beauty of the present practice is that no sensible person could seriously mistake the GNP for [a measure of social welfare]". However, an increase in GDP or GNP is often interpreted as a proxy for much broader advancement. A comprehensive review of these issues is presented in Stiglitz, Sen & Fitoussi (2010), which bring together discussion of the "classical" measurement issues associated with GDP and GNP, in addition to environmental issues and the more philosophical of defining and measuring quality of life.

As useful as national accounting principles are when applied to their intended domain, these clearly omit important aspects of what is sought after in public policy. Public services are counted in GDP at their input costs, but not their output value. This can provide a very misleading target for establishing policy priorities as simply the most expensive policy would contribute the most to GDP[7]. Economic benefits of education, such as a skilled workforce, impact through contributing to the activity of all the sectors in the economy[8].

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[4] As Bos (1992) points out the impetus for articulating the amount of economic activity was provided by the needs of England and France to levy taxes in order to pay for war and other activities of the state.

[5] The small qualification of 'final' is important in this context as by this GDP cancels out the double counting that occurs where the output of a sector is used as an intermediate input as products and services move between producers in the supply chain.

[6] A closely related concept is the Gross National Product (GNP), which adjusts GDP for net payments abroad. GNP therefore represents only activity attributable to the citizens of a particular country (whether home or abroad) whereas GPD counts economic activity within a particular place, whether attributable to domestic or foreign subjects.

[7] However, such boosts to economic activity can be important, particularly in a local context, and no doubt play a role in the overall policy setting. See for instance Hermannsson et al (2014) for an analysis of the contribution of higher education to the GDP of Scotland.

[8] To capture these effects research have used simulation models to estimate the impact of education outputs on the macro economy. Hermannsson et al (2014) estimate the contribution of skilled labour from higher education in Scotland and Hermannsson, Lecca & Swales (2014) estimate the contribution of a single graduation cohort from Scottish Further Education Colleges.

Arguably the most prevalent approach for establishing the economic merits of policy is Cost-Benefit Analysis (CBA). Cost-benefit analysis (CBA) is widely used to derive an estimate of the social net-benefit of public projects by enumerating and evaluating the total social costs and total social benefits. To this end a range of methods and rules are applied.

CBA is a bottom up approach which includes identifying the relevant costs and benefits (including externalities), assigning each a monetary value and applying an appropriate discount rate to derive a present value of future cost and benefit streams[9]. As with any method in applied economics each of these steps requires careful consideration and should not be treated as a mechanical exercise. Costs and benefits have to be identified so that there is neither under- nor over attribution of costs or benefits to the activity being evaluated. Various techniques are used to assign prices depending on circumstance and available information and no single discount rate is universally appropriate or accepted. However, sensitivity analyses can be applied around critical parameters to produce a range of plausible outcomes. One of the benefits of CBA is that it is a well-established approach with well know qualities and limitations. If done in a transparent way users should be reasonably able to draw their own judgements as to the validity of assessment for the valuation of individual components and adjust their interpretation of conclusions accordingly.

CBA approaches are outlined in the policy manuals of various governments and international organisations. For instance the UK's Green Book on Appraisal and Evaluation in Central Government[10]. Often in practice simplified routines are adopted for CBA, which are sanctioned by convention in the field of application. However at a more general level the methods involved raise some significant theoretical and practical challenges (for a comprehensive discussion see Layard & Glaister 1994).

Typically it is straightforward to estimate the cost of education on the basis of accounting data. However, as we shall see, valuing the benefits is more challenging.

Giesecke & Madden (2006) estimate the economy wide contribution of university research in Australia.

[9] CBA draws close parallels with investment appraisal in that the objective is to establish to what outlays are recouped over a particular time horizon. However, CBA allows for non-pecuniary benefits and costs as opposed to a sole focus on cash flow as is the case in conventional investment appraisal.

[10] For details see: https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-governent

3   Economic Impacts of Education: An overview

Education policy impacts the economy through a wide range of channels. These vary in terms of their salience, clarity and depth of understanding. In its simplest incarnation education can be viewed as any other production sector, where education institutions purchase inputs and pay wages. Similarly students can be treated like tourists, affecting the economy through consumption expenditures. This is particularly relevant for higher education where students are mobile, concentrate in a few student centres and sometimes are a source of significant export earnings, as in the UK case[11].These are referred to as demand-side or expenditure effects[12].

More fundamentally, qualified individuals directly stimulate the productive capacity (supply-side) of the economy through the skills they offer in the workplace, but also through a range of indirect effects. Furthermore, many of the benefits of education are non-pecuniary. In-order to classify these supply-side and wider impacts I follow McMahon (2009) in classifying these along two axes, private or public and market or non-market. This results in four categories (see Table 1): private market benefits, private non-market benefits, external market benefits and external non-market benefits.

Private market benefits of education are the labour market benefits enjoyed by individuals as a result of their level of education. They manifest themselves in higher earnings and lower unemployment rates, relative to less qualified individuals. Similarly, private non-market impacts of education are the benefits enjoyed by individuals outside of the labour market that are directly attributable to their level of education. These include positive effects on health, longevity, happiness and many other benefits. These effects are strongly correlated with income and other attributes, which make it challenging to identify the specific contributions of education.

Table 1 Classification of returns to education

Who benefits?	
Private	**External**

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[11] In 2013 The Department for Business Innovation and Skills announced a strategy to further increase the export of education services from the UK: https://www.gov.uk/government/news/new-push-to-grow-uks-175-billion-education-exports-industry

[12] This literature has a long tradition. For an overview see Florax (1992) and Siegfried et al (2007). The methods of these studies are revisited by Hermannsson et al (2013, 2014) who allow for the influence of public funding constraints and compare the impacts of different institutions.

Type of benefit			
	Market	Higher wages Higher employment Lower unemployment	Higher productivity of other workers (productivity spillovers) Higher Total Factor Productivity (TFP) due to knowledge spillovers
	Non-market	Better own health Longer life expectancy Improvement in happiness	Lower crime Democratisation Civic society

External impacts of education (or externalities) refer to benefits enjoyed by wider society as a result of the level of education of the general population. These externalities can be manifested in terms of higher wages and higher profits and are reflected in GDP per capita. However, they are not "internalised" by particular qualified individuals and are enjoyed by other agents in the economy. Examples would include the higher productivity and wages of non-graduates generated by working with graduates and the education system's (typically focussing on HEIs) contribution to R&D and innovation (of a public good nature).

Similarly, external non-market impacts improve quality of life, but are not necessarily directly translatable into pecuniary benefits. Examples would include any education-induced: reduction in crime levels, improvements in public health, democratisation or political stability. These are non-monetary benefits that are captured at a social level as an indirect impact of the level of education in the community. They are not captured in measures of economic output but may improve other development indicators. This category would include education's contributions to various types of social advancement, such as the quality of culture or the rule of law, as reflected in quality of life metrics, for example happiness scales (independent of the effects of income on the same metrics to avoid double counting).

It is apparent that accurately attributing these effects to their source is challenging. Often outcomes are difficult to measure, random assignment is usually not possible and there are various confounding factors that need to be taken into consideration. However, it is worthwhile attempting to clarify this inherently messy situation as the alternative of assuming these effects simply do not exist could lead to under investment in education that is harmful to society.

4   Labour market benefits of education for individuals (private-market impacts)

An extensive literature documents the labour market benefits of education (typically referred to as the returns to education) at various levels of schooling, in different countries at different times. Sometimes the results are further disaggregated by characteristics such as gender, discipline and social background. These studies reveal a clear correlation between education and income and provide rich information about the nature of this relationship. Due to an obvious inability to conduct controlled experiments in the field, verifying the causality between education and income has proven difficult. More recently a wealth of papers has been published utilising advanced statistical approaches, i.e. instrument variables, controlling for fixed effects (using samples of twins) and natural experiments, to clarify the issue.

Numerous reviews of the microeconomic literature on returns to education have been published. Examples include Dickson & Harmon (2011), Checchi (2006), Blundell *et al* (2005), Psacharopoulos & Patrinos (2004, 2002), Harmon & Walker (2003) and Krueger & Lindahl (2001). Typically these estimates are obtained through regression analysis of cross-sectional data such as available for the UK in the Family Expenditure Survey, the General Household Survey and the Labour Force Survey (Blundell *et al*, 2005). An earning function (see Mincer 1974) is fitted where indicators for formal education, labour market experience and individual characteristics are used to explain wage income.

Typically these studies find higher returns to education in lower income countries where education levels are generally lower. This is seen as consistent with the notion of diminishing returns to education, with the return to education falling as the average education levels rise. However as noted in section 4.4 the dynamism of these diminishing returns is more complex than a simple analysis of increasing supply within a comparative static framework might suggest, as it is not only the supply of education that can change but the demand for it as well.

4.1   Returns to education in the UK

A large body of statistical work examines the labour market benefits of education in high income countries. In the remainder of this section I shall focus on the UK and UK-regions, but a wealth of evidence is available for other countries (for an overview see Psacharopoulos & Patrinos (2004, 2002)).

A key result, repeatedly found in studies of this kind is that; qualifications increase the likelihood of employment and more qualified workers generally earn higher

wages. For example, Walker & Zhu (2007ab) pool ten years of data from the Labour Force Surveys in 1996-2005 to construct a large enough sample to estimate wage premia by qualification level at a regional level within Great Britain. Their broad findings are in line with other work in the field. For both men and women they find the value of qualifications broadly similar across Great Britain. To demonstrate the stylised findings I shall focus on results for Scotland.

Walker & Zhu (2007ab) find strong wage premia effects for both vocational and academic qualifications[13]. Overall the academic qualifications yield a higher wage premia but what is also noteworthy is how the structure of the wage premium by levels of qualification differs between vocational and academic qualifications. The marginal effect of low level vocational qualifications is modest vis-á-vis low level academic qualifications, whereas the additional wage premia gained by postgraduate study is modest. From a human capital perspective these findings may not be surprising if the amount of schooling behind these education levels is examined. For example a Level 4 undergraduate degree typically takes four academic years to complete, whereas a common duration for masters degrees is 12 months[14] so the wage premia earned per effective duration of study (and therefore also the return to education) is broadly similar between Level 4 and Level 5.

Table 2 Hourly wage premium of vocational and academic qualifications in Scotland. Source: Walker & Zhu (2007b).

Vocational wage premium	Male	Male [cumulative]	Female	Female [Cumulative]
None	Base	Base	Base	Base
Level 1	9%	9%	11%	11%
Level 2	7%	16%	9%	20%
Level 3	19%	35%	9%	29%
Level 4	17%	52%	23%	52%
Above level 4	30%	82%	29%	81%

Academic wage premium	Male	Male [cumulative]	Female	Female [Cumulative]
None	Base	Base	Base	Base
Level 1	17%	17%	18%	18%
Level 2	12%	29%	12%	30%
Level 3	19%	48%	13%	43%
Level 4	31%	79%	34%	77%
Above level 4	12%	91%	13%	90%

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[13] For vocational qualifications they use standard classification from 'Level 1' (lowest) to 'Above level 4' (highest) as found in the National Vocational Qualifications (NVQ). Although an official equivalent ranking does not exist for academic qualifications labour market researchers have established conventions as to equivalent ranking of academic qualifications.

[14] Presumably respondents with masters degrees dominate the sample as the PhD graduates are less common.

Table 3 Examples of SVQ/NVQ Levels. Source: Walker & Zhu (2007b).

SVQ/NVQ level	Academic qualification	Vocations qualification
5	PhD, Masters degree	PGCE, Non-masters postgraduate quals
4	Undergraduate degree	HNC/HND
3	2+ A-levels/3+Highers	OND, ONC
2	5+ GCSEs at A-C, 'O' Grades, Credit Standard Grade	GSVQ/NVQ intermediate, RSA diploma
1	<5 GCSE, General Standard Grade	BTEC, SCOTVEC first or general cert

4.2 Returns to education by subject

A perennial question is whether the returns to education differ between subjects. Strong views on this can be found in popular perception, but a rigorous quantitative confirmation of differing returns to subjects is harder to provide. The key limitation for statistical estimates is the size of the samples available. Blundell *et al* (2000) report some individual subject findings for higher education graduates in the UK based on the National Child Development Survey, which tracks a cohort of people born in 1958. For most subjects differences were found to be insignificant. For men a significant negative effect was found for biology, chemistry, environmental sciences and geography. The returns are calculated based on comparing the earnings of university graduates, with the earnings of those with sufficient qualifications to enter university. Therefore a weak return reflects the relatively weak earnings power of a particular subject, but are also influenced by the earning power of non-graduates. For women the pattern is somewhat different, as they were found to earn higher returns in education, economics, accountancy and law, and an 'other social sciences' category. To control for the quality of the student intake into the subjects they included A-level results in their regressions. Inclusion of this variable did not alter the results qualitatively.

O'Leary & Sloan (2005) analyse returns to higher education degree subjects. To obtain a sufficiently large sample for this breakdown they pool observations from the Labour Force Survey from 1994 to 2002. Examining men, for undergraduate degrees they find the lowest wage premium accrues to holders of arts degrees, -2.5% vis-á-vis those who have completed two A-levels[15]. Based on an earnings index where earnings of Arts degree holders (including performance arts) were fixed at

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[15] The negative wage premia for men's arts degrees is striking as it suggests these individuals might have been better off in monetary terms from entering the labour market after completing secondary school. However, the converse applies to women with arts degrees who earn positive wage premia.

100 the highest wage premia accrue to accountancy, medicine, engineering and maths and computing (>130). Next in line (130>125) are law, business and finance and education, followed by geography and architecture (125>120). Lower wage premia (120>110) are earned in nursing, biology, psychology, other social sciences, English, history and languages. Interestingly no subject falls in the range between 100 and 110, implying there is a significant jump in wage premia from holding an arts degree to the next tier above.

Table 4 Index number of returns to narrow first degree subjects for men and women: Based on several waves of the Labour Force Survey (1994Q1-2002Q4). Source: O'Leary & Sloane (2005) Tables 7 & 8, pp. 82-83.

	Men				Women			
	n	index no	SE	rank	n	index no	SE	rank
Medicine and related	336	132.06+	0.0474	5	597	127.52+	0.0305	2
Nursing	25	114.39+	0.0358	20	220	113.93+	0.0301	9
Sciences	1327	125.22+	0.0335	12	696	106.13+	0.0261	17
Biology	130	115.87+	0.0482	18	188	101.6	0.0356	22
Psychology	125	118.66+	0.0454	17	303	101.98	0.0262	21
Geography	298	123.42+	0.0477	13	261	104.34	0.0398	19
Maths and computing	975	137.23+	0.031	3	346	118.10+	0.037	7
Engineering and technology	650	131.85+	0.0313	6	97	113.54+	0.0556	12
Civil engineering	411	129.25+	0.0325	7	24	113.7	0.095	11
Mechanical engineering	524	133.71+	0.0339	4	19	113.84+	0.0286	10
Electrical engineering	682	140.73+	0.0313	2	28	119.04+	0.0233	5
Architecture and related	410	120.97+	0.0288	15	83	118.70+	0.037	6
Social sciences	132	114.20+	0.0451	21	286	113.45+	0.0313	13
Sociology	126	110.83+	0.0394	24	269	106.50+	0.0292	16
Politics	118	115.70+	0.0477	19	72	99.09	0.0508	25
Law	315	128.04+	0.041	9	302	123.97+	0.0372	3
Business and financial studies	827	126.53+	0.0266	11	691	114.34+	0.0234	8
Economics	430	128.57+	0.0445	8	110	109.68++	0.0508	14
Accountancy	193	142.15+	0.047	1	95	137.12+	0.0504	1
Arts	804	100	n.a.	25	1091	100	n.a.	24
English	213	110.84+	0.0423	23	468	106.65+	0.0322	15
History	306	111.69+	0.041	22	318	110.95	0.0365	23
Languages	110	119.22+	0.054	16	291	103.3	0.0386	20
Education	490	126.73+	0.0316	10	1283	122.40+	0.0223	4
Combined	2529	122.41+	0.0241	14	3135	105.58+	0.0187	18

Notes: All returns are measured relative to an arts degree (base = 100); return to an arts degree relative to 2+ A-levels is -3.25% (men) and 19.29% (women); + (++) denotes a statistically significant difference in returns at the 95% (90%) confidence level; na denotes not applicable

A different pattern emerges for women. Compared to those who have completed two A-levels, women earn significant wage premia on arts degrees (19.29%). Again, based on an earnings index where holders of arts degrees are set at 100, fewer of the subjects were found to earn a statistically significant wage premia vis-á-vis an arts degree. Of statistically significant differences the biggest wage premium for women is earned in accountancy (137). The next tier (130>120) is composed of

medicine, law and education. Many subjects fall on the range between 120 and 110, including nursing, maths and computing, engineering, architecture and business and financial studies. In the range closest to arts (110>100) we find sciences, sociology, economics and English.

O'Leary & Sloan (2005) base the disaggregation of the subjects on what was feasible with the available data, with popular fields allowing more disaggregation due to larger samples. In their regressions they include a control for the quality of the student intake[16]. This affects the final ranking of the subjects; where a wage premium is reduced if a subject has a relatively high quality student intake, but inflated (in relative terms) if the student intake is of a relatively low quality.

This issue is revisited by Walker & Zhu (2011) who find limited variation across subjects for women but a more pronounced effect for men, where law, economics and management offer the best financial outcome. Degree class has large effects in all subjects suggesting the possibility of large returns to effort. Similarly, postgraduate study has large effects, independently of first degree class. Chevalier (2011) argues that an overlooked aspect with regards to the economic pay-off from subject choice is the distribution of earnings around the mean. Graduates in some subjects exhibit earnings that are relatively tightly clustered around the mean. For example education and subjects allied to medicine where most graduates enter relatively centralised labour markets with formal pay-scales. Conversely, for some other subjects, outcomes are much more widely dispersed, making the subject choice more risky from an investment point of view.

4.3 Interpreting the statistical association between education and earnings

Whilst the correlation between earnings and education is a well-established fact, the presence of correlation is not sufficient to establish causality. There are two main theoretical perspecitves on this subject. The human capital school has its origins in the works of Mincer (1958), Schultz (1960) and Becker (1964). This tradition maintains that education is an investment in human capital, which in turn increases the productivity of workers. An alternative perspective is that of the signalling school. This stems from the works of Spence (1973) and Stiglitz (1975). In the most extreme version of this theory, education has no impact on productivity, but simply reveals (signals) innate ability to employers. A third alternative is the assignment approach, which explains the distribution of earnings as result of an optimising process, whereby workers are assigned to jobs in the labour market. For an overview, see Sattinger, (1993). This work has its origin in Tinbergen (1951,

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[16] Leslie's degree acceptance quality variable see: O'Leary & Sloan, 2005, p. 77.

1956) and Roy (1951). These papers offer a general equilibrium framework, where demand factors play a role in determining the distribution of wages. A fourth view is that of Thurow (1975), where labour market rigidities create job queues and where education again acts only as a signal of a worker's trainability. These models suggest that longer job queues disproportionately impact on less skilled workers, such as during a cyclical downturn, as is demonstrated by Ours & Ridder (1995).

4.3.1 Signalling and screening

An often raised concern is that education may have a value in the labour market not because of the positive effects of formal education upon productivity but for spurious reasons. Particularly it is stressed that education may act as a signal of ability or other characteristics that employers value but cannot easily observe. In the extreme case, these abilities are unaffected by education altogether. That is to say, education signals, but does not contribute to, the workers' inherent productivity. As noted by Harmon & Walker (2003) there is a fundamental difficulty in unravelling the extent to which education is a signal of existing productivity or truly enhances productivity. This is because both human capital and signalling theories suggest that there is a positive correlation between earnings and education, but for very different reasons.

Brown and Sessions (2004) refer to the theory which proclaims education 'signals' or 'screens' intrinsic productivity as the 'sorting' hypothesis. Signalling and screening refer to two related genres of models which describe this process from opposite starting points. Signalling models (Spence 1973, Arrow 1973) describe the process from the point of view of the employee obtaining a signal to enhance his labour market performance. Screening models turn the sequence around to have employers screening the labour market by setting a required signal their applicants need to obtain (Stiglitz, 1975).

The models[17] draw on the theoretical work on asymmetric information and market imperfections, where often a single transaction takes place between the buyer and the seller and therefore asymmetric information can be used to the sellers advantage[18].However, an employment relationship is continuous and firms can revise their employment and wage decisions. Even if firms are paying their wages purely on the basis of credentials in the short run, over time they gather their own information about the employee and can change wages, through redundancy or promotion. Therefore under longer time horizons employers should correct for a potential initial effect of signalling. Indeed, examples of signalling models with

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[17] I shall not elaborate on the models here, but refer interested readers to Brown & Sessions (2004) and Checchi (2006).
[18] See Akerlof (1970).

employer learning can be found in contemporary work, for example Lange & Topel (2006). Furthermore, for a review of empirical evidence, including studies allowing for learning, see Brown and Sessions (2004).

Figure 1 Informational feedback in the job market (Spence, 1973, figure 1, pp. 359).
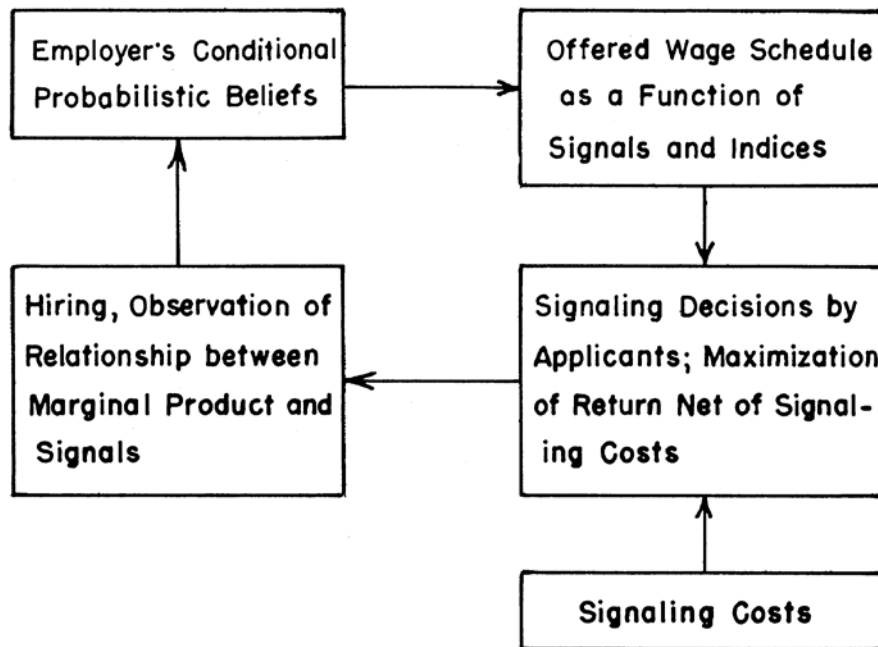
Spence (1973) gives a dynamic description of how signalling might work in that observed labour quality feeds into the value assigned to education signals in the labour market. See Figure 2. Over time therefore, the signal is not static but reflects recent observations of actual labour productivity by education level. A scenario where qualified workers are overpaid relative to their actual productivity can only occur under quite restrictive assumptions. The quality of new graduates entering the labour force has to be worse than in previous periods and the informational feedback sluggish enough not to adjust the wage premium assigned to a particular education level based on new observations of productivity. Needless to say, such overpayment relative to productivity cannot persist indefinitely. Sooner or later, market participants will discover that the quality of new graduate entrants is not the same as before and adjust the wage premia assigned to the education signals accordingly.

As summarised by Harmon & Walker (2003)[19] there are various ways of finessing the problem of estimating empirically the extent of signalling in the labour market. One of the ways suggested is to compare the wages of the employed and self-

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[19] For a further review of empirical evidence on sorting hypothese see Brown & Sessions (2004).

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employed[20]. This is predicated on the assumption that that education has no value as a signal for the self-employed as individuals know their own productivity and therefore do not need to signal it to themselves. Harmon & Walker (2003) argue, based on British Household Panel Survey data, that the rates of return to education are quite comparable between the two groups, implying that the signalling component is quite small. A weakness of this approach, however, is that self-employment is not random and that individuals with specific and often unobservable characteristics choose to be self-employed. Another approach is to directly include ability measures in the regressions. This, however, requires that the ability measures are 'uncontaminated' by the effects of education or they will pick its productivity enhancing effects and that ability measures reflect ability to make money rather than ability in an IQ sense. As (Harmon & Walker, 2003, p. 134) point out, it "seems unlikely that any ability measure would be able to satisfy both of these requirements exactly". Harmon & Walker (2003, pp. 149-150), conclude that it is possible that the returns to education reflect innate ability signalled by credentials. However, they find that the effect is small, as the inclusion of ability measures lowers the return to schooling by less than one percentage point.

As of yet there is not a widespread consensus on how best to reconcile human capital and signalling theories as explanations of graduate wage premia. However, most well informed readers of both views will conclude that these are not incompatible. Brown & Sessions (2004, p.94) argue that it is a misinterpretation of sorting (signalling and screening) that education only signals productivity and cannot cause it as such. However, a clear dichotomy is a useful modelling expediency. As Brown and Sessions (2004, p.94) point out the "pioneering theoretical work of Spence (1973), Arrow (1973) and Stiglitz (1975) only abstracted from an augmenting role for education to clarify their analysis". Indeed as Arrow (1973) states he did not believe education was unproductive; rather, that this assumption was adopted as the extreme view made the modelling process easier. Conversely, there is not a basis to reject signalling altogether. The current state of the academic debate about the value of education is not about either seeing education as productivity enhancing or just a signal, but to narrow the range for which education may have a true treatment effect on worker productivity as reflected in wages (apart from any wider impacts of course).

4.3.2 Does education drive earnings or vice-versa?

The correlation between education and wages has also been scrutinised from a more purely empirical point of view. An obvious weakness of the link drawn

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[20] Some studies compare returns to education in the public and private sectors but these have been found less credible. See Harmon & Walker (2003) p. 134.

between education and earnings is that it cannot be verified by means of a controlled experiment, where randomly selected individuals would be given different education treatments and their labour market outcomes subsequently compared. Instead we have to rely on analyses of actual observations. Therefore, it is not clear ex ante whether the causality runs from education to earnings, or the other way around, i.e. individuals with better earning capabilities seek out more education.

Various adjustments to the basic analysis of cross-sectional labour market data have been used to identify bias in estimates of the rates of return to education. These include adjustment for the anticipated growth in earnings, mortality, unemployment, taxes and innate ability. Authors of various recent surveys (Checchi 2006, Psacharopoulos 2004, Bonjour *et al* 2003, Krueger & Lindhahl 2001) have pointed out, following Card (1999), that application of a range of adjustments has led to the conclusion that the pluses and minuses effectively cancel so that the end result is a net benefit almost equal to the unadjusted one. Therefore the use of unadjusted returns has become prevalent. In his survey Checchi (2006) identifies three types of weaknesses of the estimated returns to education which could bias the results: omitted variables, measurement error and heterogeneity of returns in the population.

The case of omitted variables can apply when the researcher is unable to control for characteristics that might raise earnings independently of education, such as family background or individual ability. "A typical example is unobservable ability: more talented persons achieve more education because it is easier for them to do so, and at the same time they are more productive when working" (Checchi, 2006, p. 201). The sign of the bias is ambiguous. It could be positive since more intelligent and disciplined people also perform better as students, thus achieving longer schooling. However the bias could also be negative if better endowed individuals face a higher opportunity cost of schooling and therefore leave education earlier. Further ambiguity arises as parents may take decisions on educational investment. They may do so on basis of efficiency where more is invested in abler individuals, which should produce a positive bias. Conversely, they may be driven by equity considerations where more is invested in less able individuals to compensate for their shortcomings, resulting in a negative bias.[21]

Measurement errors are a second source of bias. It has been observed that self-reported schooling is not completely accurate and that the measurement errors do not cancel out as the least educated cannot underreport and the most educated

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[21] For details see Checchi (2006) pp. 201-202.

cannot over report. "Research in the U.S. over the past three decades has concluded that the reliability of self-reported schooling is 85-90 percent (Angrist and Krueger (1999, Table 9)), implying that the downward bias is on the order of 10-15 percent – enough to offset a modest upward ability bias" (Card, 2001, p. 1135).

The third source of bias stems from the heterogeneity of the coefficient to be estimated in the population. Card (1995) points to two potential sources of the heterogeneity – ability bias and cost bias. The first is driven by the fact that differences in abilities result in difference in productivity so that more able individuals can expect a higher payback for any level of education achieved. The second originates from financial market imperfections, where people of different family backgrounds face different marginal cost in acquiring education, so that poor families face higher cost.

> The consequence of both distortions is that the subset of the population with low educational attainment will be composed of individuals with lower returns (less able) and by individuals facing higher costs (poorer backgrounds). Since the underlying model implies that each individual will optimally select the amount of education that will equate his/her expected returns to his/her marginal cost, the population estimate of the return on education will depend on sub-group composition. If the group of less able individuals prevails, I observe a positive correlation between education and error component μ in the wage function, and therefore the OLS estimate will be upwardly biased. Otherwise when the group of individuals from poorer families prevails, the opposite situation will occur, and I will observe a downward bias (Checchi, 2006, pp. 202-203).

One way to dealing with this issue is to analyse returns to education in samples of twins. As twins share biological and social backgrounds analysing variation within twin-pairs controls for the fixed effects of genetics and the home, which is seen as (at least partial) controls for individual ability bias. As McMahon (2009, p. 332) points out, there is "wide agreement that identical twins studies offer probably the best basis for estimating the pure returns to education since they provide highly controlled conditions for the identical abilities and family backgrounds of monozygotic twins".

McMahon (2009) summarises US studies utilising within twin-pairs differences in earnings and education to estimate 'net-ability bias' in estimates of return to education. He points out these studies have found evidence of significant ability

bias, but that these are partially offset by a downward biased measurement error. Early studies found a wide range of estimates for net ability bias but McMahon (2009) argues that in more recent studies, with larger samples and methodological advancement, estimates have converged on a more narrow range from 0.9% to 13.7%[22]. Perhaps the most prominent twin study based on data from UK twins is Bonjour *et al* (2003) who corroborate findings of previous authors that there is indeed an upwards ability bias in estimates for returns to education, but that this is offset by a downwards bias caused by measurement error. They conclude that these roughly cancel out.

4.4 Skill biased technical change and the return to education over time

In cross sectional comparisons institutional features of the labour market affect wage premia. Over time, however, it is not only the relative supply of workers at different skill levels (e.g. graduates) that determines wage premia but also demand. Demand for skilled labour has been gradually increasing – a fact typically attributed to technical change[23]. Goldin & Katz (2007) use estimates of supply and demand for graduate labour to investigate the level of the graduate wage premium in the US over the 90 year period from 1915 to 2005[24]. They find that the graduate wage premium (vis-á-vis those with high school qualifications) was at a very similar value, around 65% at the beginning of the period as the end, albeit with significant intermittent fluctuations. Two troughs can be identified, around 1950 when it fell close to 30% and again in 1980 when it fell slightly below 40%[25].

Figure 2 US College and High School graduate wage premiums 1915 to 2005. Source: Goldin & Katz (2007, Figure 1, p. 32).

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[22] These are percentage (not percentage point) deviations so that if a graduate wage premia of say 50% were to be revised downwards it would become 49.55% (50/1.009) or 43.97% (50/1.137) for the lower and upper bounds respectively.

[23] For a review see: Machin (2004) and Acemoglu (2002).

[24] For some metrics they examine an even longer period from 1890 to 2005.

[25] Goldin & Katz (2007) argue that these are not fully explained by the simple supply and demand framework, but are influenced by institutional features of the labour market, such as strong unionisation in the 1940's and inflation in the 1970's inflation eroding the real value of graduate wages relative to lower skilled workers on indexed contracts. Whereas, the growth in the graduate wage premium after 1980's was driven by a slowdown in graduate attainment growth and weaker bargaining position of lower skilled workers.
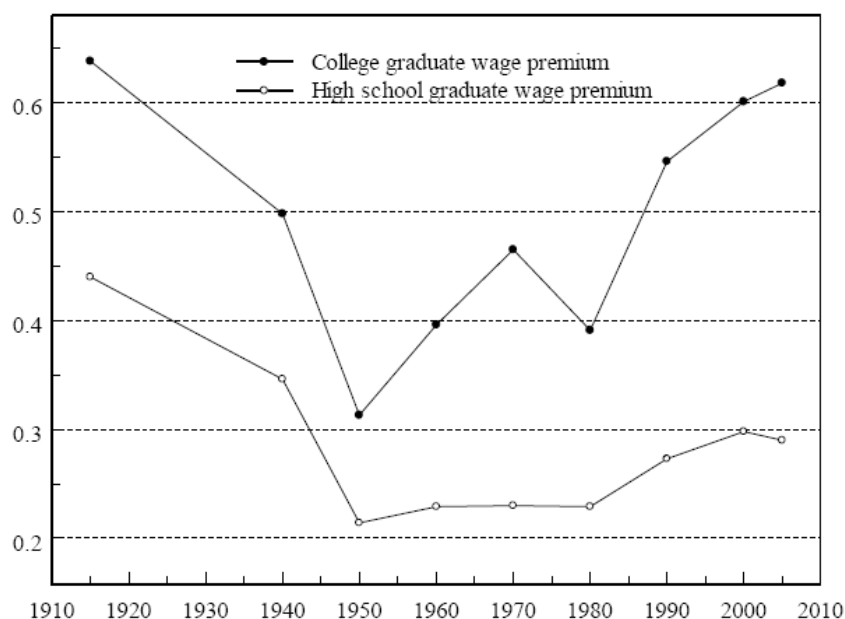
Acemoglu (2002) reviews evidence and theoretical perspectives on the links between technical change and skills premia in the labour market. He draws on economic history to argue that technological change can be skill biased (increasing the need for skilled labour) but can also be skill replacing (decreasing the need for skills). Whereas evidence from the United States in the 20th century suggests that technological change has been skill biased, counterexamples are found in 19th century Britain where industrialization made highly skilled artisans redundant as they were substituted by low skill factory workers. He argues that this dual nature of technological change can be understood if it is recognised that the development and use of technology responds to profit incentives. In circumstances where it is profitable to develop and implement technologies which complement low skill workers, technological change will tend to be skill replacing, however when technological advances requiring high skill operators are more profitable technological change will tend to be skill biased.

> I suggest that the early nineteenth century was characterized by skill-replacing developments because the increased supply of unskilled workers in the English cities (resulting from migration from rural areas and from Ireland) made the introduction of these technologies profitable. In contrast, the twentieth century has been characterized by skill-biased technical change because the rapid increase in the supply of skilled workers has induced the development of skill-complementary technologies (Acemoglu, 2002, pp. 9).

Furthermore, Acemoglu (2002) argues that the acceleration of skill biased technical change is likely to have been a response to the increased supply of skilled workers,

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which made skill-intensive production methods more competitive. However, that point does not have to imply that the overall rate of technical change has increased, but rather that the types of technologies being developed has shifted.

In addition to technical change, wage premia attributed to qualifications have been affected by other factors such as changes in labour market structure, i.e. union power, changes in firm organisation and increasing trade between high skill and low skill countries. McMahon (2009) points out that the rise in the wage premium of high-skill workers in the US since 1980 can partially be explained by negative real term growth in the wages of unskilled labour. He attributes this fact to a relative abundance of unskilled labour, in part due to an effective increase in the supply of unskilled labour through increased integration of developing countries in the World economy. Furthermore, he suggests that automation has replaced many low-skill jobs and therefore reduced the demand for uneducated workers. Acemoglu (2002) suggests that all of these factors have amplified the effect of technical change upon the graduate wage premium and are likely causes for the real wage decline of low skill workers observed in the US.

Historical data reflects the average outcomes of all people with a particular level of qualification. More recently, labour market researchers have begun focussing on the variability within those averages. Walker & Zhu (2008) point out that at a UK level, although the average return to higher education has remained stable the distribution has widened with increased participation, where higher ability people are earning further beyond the average and lower ability people are falling farther behind the average. They argue that this might be the joint effect of increasing demand for skilled workers and growing heterogeneity in the HEIs' student intake. They argue that strong candidates (high unobserved abilities) are earning a greater wage premium than people of similar abilities in previous generations. However, the number of graduates with relatively lesser abilities has increased and these individuals are earning below average wage premia. Some work argues for falling wage premia. See for example McGuinness & Bennet (2005). However, the overall effects are modest.

5 Wider impacts of education

Most of the academic effort hitherto has focused on the more direct impacts of education for the economy; in particular institutional demand-side impacts and private returns to education. However, these only constitute a part of the overall impact of education for the economy. As outlined in Table 1 each effect within the overall impacts can be attributed to one of four quadrangles. So far, only the first of these has been discussed, the private market impacts. In this chapter I shall

provide a brief overview of the three remaining fields of impact: private non-market benefits and public benefits — market and non-market.

In relation to the labour market impacts surveyed in the previous chapter, where much has been published over several decades, systematic analysis of the wider impacts of education is underdeveloped. There is a substantial literature analysing specific, often quite narrow, effects. However, this evidence base is fragmented. McMahon (2004, 2009 Ch. 4) summarises the relevant existing literature and uses it to estimate the economic impact of wider effects of education. Furthermore, Haveman & Wolfe (1984) and Oreopolous & Salvanes (2011) provide a review of the non-pecuniary impacts of education accruing to individuals. Furthermore, much evidence relating to the wider benefits of higher education is summarised in BIS (2011, Ch. 3).

McMahon (2004, 2009) argues that the economic contribution of these wider impacts can be significant but measurement problems make them difficult to pin down. Many of these impacts only reveal themselves with long time lags and there is an inherent difficulty in disentangling the impact of education per se from the impact of other developments. For example, education increases income and socioeconomic advancement, but rising income also has a beneficial impact on many socioeconomic metrics. Determining causation is therefore difficult, as is attributing outcomes to particular actions or developments. Many of these effects are particularly relevant for developing countries, i.e. birth rates, political stability, rule of law. But potentially very significant benefits can be reaped by developed economies as well, such as through educations' impacts on health and crime rates.

5.1 Private non-market benefits

Private non-market benefits are the various non-monetary benefits that accrue to a particular educated individual. Probably the most important of these is improved own health, but a range of effects have been explored in the literature, i.e longevity; child health; child education; husband's health; fertility; happiness; consumption and saving; job and location amenities; lifelong learning; consumption benefits. For an overview see Oreopoulos & Salvanes (2011) and McMahon (2009, ch 4). These effects are strongly correlated with income, which is typically controlled for.

A number of studies show statistical association between children's educational attainment and that of their parents. See BIS (2011, Ch. 5) for a summary of some of the UK evidence and Wolfe & Haveman (2001) for international summary. What mechanism might explain this transmission? It is highly likely that selection issues

play a role in the statistics. That is to say that unobservable characteristics that facilitate success in education attainment also facilitate success in parenting. .. However, there may be additional transmission channels. For instance Bynner et al. (2003) point out that graduate parents read more to their children and own more books than non-graduates. Other channels include income, as income is correlated with education more higher income can be used to purchase goods and experiences that enhance childhood development However, as Oreopolous and Salvanes (2011) pont out, conditioning on income does not eliminate these effects. BIS (2011, p. 57) concludes that there is "no clear-cut evidence as to what underlies the parenting results".

McMahon (2009) details methods and sources for a range of non-market private benefits (including only studies that have income and education in the equation, so that income-equivalent benefits can be computed). He estimates that in the case of higher education the non-market benefits to the individual are 122% of the earnings increase. This is huge, with obvious implications for the incentive for individuals to invest in HE provided they have access to the relevant information.

5.2 Public benefits of education

Education is associated with a number of public benefits. Some are clearly market-based and are likely to be picked up in national accounting. Others are non-pecuniary and likely to impact the economy through much more indirect channels.

Perhaps the most clearly market-based public benefits of education are productivity externalities (Heurman 2011, Moretti, 2004, Battu *et al* 2003). More indirectly there are externalities that feed back to economic growth, especially over longer time horizons, e.g. effects that arise via more investment in physical capital, more investment in education, adoption of technology, improved R&D & innovation and slower population (particularly relevant for less developed economies, see Kravdal 2002).

Public non-market benefits of education are non-monetary benefits that are captured at a social level as an indirect impact of the level of education in the community. These are not captured in measures of economic output but may improve other development indicators. This category would include education's contributions to various types of social advancement, such as public health (Feinstein *et al*, 2006), strengthening of civic institutions and social engagement (Campbell, 2006), lower crime rates (Machin *et al*, 2011) and environmental effects (Appiah & McMahon, 2002). McMahon (2004) lists 13 examples of effects that contribute to non-market aspects of economic development (see Table 6.1, pp.

218). Many of these are seen as particularly relevant at earlier stages of economic development.

There is a small but growing literature on the crime reducing effect of education (Haveman and Wolfe, 1984; Lochner and Moretti, 2001; Lochner, 2004; Machin et al, 2011). The authors identify several factors that explain the negative relationship between the level of education and criminal activity. Firstly, education increases opportunity cost of criminal activity by both increasing the returns from legal work and increasing the cost of potential incarceration. Secondly, time spent in education reduces time available for participation in criminal activity. Thirdly, education may reduce the chances of involvement in criminal activity by increasing patience and risk aversion.

Machin et al (2011) estimate a causal education impact on crime exploiting as a natural experiment the rise in the compulsory school leaving age from 15 to 16 in England and Wales in 1972. This law generated a discontinuity in the average age left school and proportion with no qualification for men aged 18-40 who were born 1950-1965 . Simultaneously they observe a drop in the conviction rates for men leaving school after the school leaving reform. Similarly, Lochner (2004) finds that education reduces criminal behaviour and estimates that the social value of this is equivalent to between 14 and 26 percent of the private return to schooling.

5.3   Overall magnitude of wider impacts

To estimate the impact of wider benefits of education, cross-country macro regressions can be used. However, these are limited in that they include various controls for development indicators that are themselves influenced by education (i.e. political stability, fixed effect dummies) and therefore pick up some of the educational benefits. Furthermore if these include time dummies or are conducted over a short time horizon many of the effects will not be picked up as they occur with long time lags of at least 10-20 years. These highly controlled regressions therefore risk underestimating the wider impacts of education. If these controls are relaxed, researchers potentially overstate impacts as education starts to pick up the beneficial impacts of other closely related socioeconomic developments. Researchers have attempted to engage with this problem by applying different specifications, in which each has its potential positive or negative biases. These recent studies have provided a range of results which give an indication of the plausible magnitude of the wider impacts of education.

McMahon (2004) combines a variety of estimates for the social rate of return to education as found in macroeconometric studies and broad findings for private rates of return to provide a possible range for the magnitude of the wider impacts

of education. Based on recent literature he argues a plausible social rate of return of education may vary from approximately 10% to 30%. The lower bound implies the returns to education are almost solely based on private market returns with limited or no wider impacts. The result is based on tightly controlled static regressions, which McMahon (2004) argues fail to attribute wider impacts to education, and therefore understate education's impact. The upper bound is based on dynamic, more loosely controlled specifications, which he conversely argues is probably overstated as the lack of controls means that the education variable picks up effects from other economic developments. Drawing on a number of empirical studies and simulations he presents "educated guesses" by economic development and education level.

Figure 3 Estimates of social returns to education in the OECD countries. Source: McMahon (2004), Table 6.5, p. 244.

	Conventional monetary social rates of return (A1+B1)	Non-market private returns (A2+B2)	Non-market education externalities (B-3)	Total social rates of return (includes non-monetary)
Primary	8.5	6.8	2.5	**17.8**
Secondary	9.4	7.5	2.8	**19.7**
Higher	8.5	6.8	2.5	**17.8**

These estimates reveal that the typically un-measured impacts of education are at least as big as the frequently estimated private returns to education. However most of these wider impacts are in fact non-market benefits accruing to the educated individual himself. The externalities, although significant, are relatively small. As for education levels their economic impacts seem to be broadly of the same order of magnitude, which implies that expansion of education at any level will have a high social rate of return[26].

6   Conclusions

Available evidence on the economic impact of education is broad-brush in nature and shaped by the availability of data. Aspects of education that have been tracked in large scale secondary data sets, such as labour market outcomes, have been thoroughly researched. Much less is known about how particular details shape outcomes.

Repeated cross-sectional analysis across the world reveals that formal qualifications provide positive wage premia and increase the likelihood of being in employment. In the UK each increment of attainment, as captured in the National

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[26] McMahon (2004) makes similar estimates for developing countries were social returns are sometimes twice as large, in particular for primary education.

Vocational Qualifications scale, provides a positive benefit on average, although the impact of some of these is quite small.

A sizeable literature has grown around how to interpret these cross-sectional observations. There is the obvious problem of ability bias that occurs as more gifted students self-select into education, thereby inflating perceived wage premia. However, there are also counteracting biases through measurement issues and cost-bias, which pushes gifted students out of education. Through careful analysis of natural experiments and twin-studies a consensus has emerged that qualifications provide a treatment effect and are not simply a reflection of selection or a signal of underlying ability. However, several authors have argued that around 10-15% of the effect could be spurious.

There is a growing interest in moving beyond such broad aggregate measures and look in more depth at different sub-groups. This is particularly urgent as in recent years the dispersion of outcomes for highly skilled workers has increased.

There is much less understanding of the magnitude of the wider benefits of education, but it is clear that education provides multiple benefits in addition to its labour market impact. Education is associated with various non-monetary benefits, such as success in marital and family life, happiness, health and longevity. However, the private non-market effects are also closely associated with for instance income, making the relationship difficult to disentangle. Furthermore, education is associated with a number of public benefits, such as innovation, public health and reduced crime rates. The challenge is to disentangle the role of education from other socioeconomic causes.

The strength of using large scale social surveys to conduct research into the economic impact of education is that these can often produce robust results. However, as of yet the outputs from such analysis are disappointingly aggregate for many policy makers. In the day to day decision the issues are often quite nuanced, such as cutting a particular programme to fund another one, or vice versa. There is still much work to be done utilising large scale data investments such as Understanding Society, but also leveraging a wealth of administrative data. However, future policy analysis is most likely to benefit from enhanced efforts to collaborate through mixed methods, combining the scaffolding of statistical with the rich impression of case studies and observations.

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