THE RETURNS TO HIGHER EDUCATION TEACHING

ARNAUD CHEVALIER
GAVAN CONLON
FERNANDO GALINDO-RUEDA
SANDRA MCNALLY

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Arnaud Chevalier
Gavan Conlon
Fernando Galindo-Rueda
Sandra McNally

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1. INTRODUCTION

This paper provides a literature review into the returns to higher education teaching in the United Kingdom as a component of the overall attempt of the Department of Education and Skills (DfES) to gather a comprehensive set of reliable information on the returns associated with higher education activities more generally. In the original proposal, there were five main areas of interest:

- The returns to students
- The returns to businesses
- The returns to regions
- The returns to the economy
- The returns to society

The evidence on returns to higher education qualifications within these five areas was to be gathered along two broad categories according to the type of qualification attained

- Undergraduate degrees and other qualifications attained during higher education
- Within the undergraduate degree category, a further distinction according to the subject of the degree level qualification.

We have undertaken a literature review of available research work in these areas, which have been published in English, giving a greater priority to those providing recent, robust and relevant information relating to the United Kingdom.

There is a wide literature in existence relating to the private returns to education generally and in particular the private returns associated with additional years of post compulsory schooling. This literature review focuses on both the private and social returns accruing to higher education teaching generally, specific higher education qualifications and degree level subjects. Due to the specificity of the topic under consideration, the volume (and sometimes the quality) of the research available is less than might be expected. The methodology and the sophistication of the econometric techniques adopted by researchers vary substantially from study to study. This depends on whether the focus of the particular research is the estimation of private or social returns and is also determined by the quality and quantity of information contained in the data sources available. Therefore, this review illustrates a broad range of estimates associated with higher education qualification attainment. Care must be taken in their comparison.

The review is set out as follows: Section 2 details some of the theoretical and methodological issues associated with estimating private returns and rates of return to qualifications. Section 3 provides information on the data sources that have been used in rate of return analysis in the United Kingdom. Section 4 provides a review of the empirical evidence on the private returns associated alternative undergraduate degree level subjects. Section 5 reviews research undertaken on the private returns to alternative higher education qualifications. Section 6 reviews the literature on the returns to business. Section 7 provides a review of the social returns to higher education. Section 8 reviews the literature on regional returns. Section 9 concludes.

2. REVIEW OF THE THEORY AND METHODOLOGICAL ISSUES

The private returns to education represent the observed equilibrium between the interaction of the supply and the demand for education and qualifications. Private returns can also be thought of as the extent to which those in possession of qualifications are rewarded in the labour market. The theoretical framework relating to human capital accumulation was developed by Becker (1964)[1] and on the empirical side; this work was extended by Mincer (1974)[2]. Walker and Zhu (2001) provide a more detailed discussion of both the theoretical and empirical framework upon which rate of return analysis is based.

The Ordinary Least Squares wage equation that is estimated is derived from standard human capital theory and can be represented by the following earnings equation:

$$\log(w_i) = X_i b + r S_i + d' x_i + g x_i^2 + u_i$$

where w_i is an earnings measure for an individual i (such as earnings per hour or week), S_i represents a measure of their schooling, x_i is an experience measure (typically age minus age left full time education), X_i is a set of other variables assumed to affect earnings, and u_i is a disturbance term representing other unobservable factors which are not be explicitly measured, which is assumed to be independent of X_i and S_i. Under these assumptions, the coefficient r can be considered the rate of return to an additional year of schooling.

The specification of the wage equation in these terms has resulted in the majority of empirical studies (especially in the US) focusing specifically on the returns to an extra year of post compulsory education, rather than a specific level of qualification attainment and this also accounts for the apparent deficiency in the literature relating to the returns to specific qualifications in the United Kingdom.

As will be discussed to a greater extent in section 4, it is only recently that there has been any recognition of the fact that the decision to undertake post compulsory schooling is not based on the number of additional years of schooling but rather the qualification that is potentially on offer. Thus, an alternative wage equation can be specified to include dummy terms corresponding to particular levels and/or types of qualification as opposed to a simple schooling term. The resulting coefficients will now provide estimates of the return (but not the rate of return) associated with the qualification in question. This is illustrated as follows:

$$\log(w_i) = X_i b + r_{j_i} Qual_{j_i} + d' x_i + g x_i^2 + u_i$$

where w_i, x_i, X_i and u_i are as before, $Qual_{j_i}$ is a dummy variable indicating the possession of qualification j by individual i and r_j represents the average return associated with qualification j[3].

[1] Becker, G.S. (1964), "Human Capital", Chicago: The University of Chicago Press, 3rd edition.
[2] Mincer, J (1974), "Schooling, Earnings and Experience", Columbia University Press.
[3] See Walker and Zhu (2001) for a detailed discussion of the theoretical framework underpinning rate of return analysis and in particular the effect of the inclusion of the direct financial costs of qualification attainment on rates of return (page1, paragraph 1). It is still generally the case that the opportunity cost of the educational investment (which is the dominant component of the costs incurred)

There are still two main difficulties in this approach; firstly, the classification of qualifications and the associated difficulty in calculating rates of return based on estimates of returns or earnings premia and secondly, the possible endogeneity of schooling and selection bias.

The coefficients estimated in a standard rate of return analysis (equation 1) indicate the additional hourly earnings (say) achieved by an individual holding an extra year of post compulsory education compared to an individual not in possession of that additional year of schooling. On the other hand, the coefficients estimated in the augmented specification (equation 2) that refer to particular qualifications are earnings premia over the reference category. For example, in an analyses dealing with degree level qualifications, the reference category is normally either those with GCE 'A' Levels or those possessing no formally recognised qualifications. To convert returns to rate of returns, it is necessary to adjust the estimated return by the time taken to complete the qualification. The difficulties associated with the conversion of returns to rates of return are highlighted in a recent paper by Dearden *et al* (2000)[4] when estimating the difference in the rate of return to academic and vocational qualifications.

The authors find that at a given level of qualification, there is a statistically significant difference in returns between the academically and vocationally trained, but that this differential is diminished when considering the time adjusted rate of return. This result occurs because the time taken to complete a vocational qualification is generally less than the time required to complete an academic qualification at a given level of qualification. However, there is a wide variety of ways in which vocational qualifications are provided (day release, sandwich courses etc.) and as such the time taken to complete vocational qualifications is substantially more varied than for academic qualifications. In this specific paper, the authors calculate a simple average of the time required to complete vocational qualifications and calculate rates of return accordingly. The authors note that the results are particularly sensitive to assumptions made regarding the time taken to complete qualifications. As such, extreme care should be taken when interpreting any estimates of the rate of return that have been derived from a model estimating simple returns.

The second difficulty relating to the classification of qualifications and other Higher Education qualifications more generally is the tendency of some authors to group several qualifications together, which are different in nature or at different levels within the NVQ classification of qualifications (for instance the joint classification of undergraduate and postgraduate degrees). This problem is sometimes further exacerbated by the fact that often there is no distinction as to whether the qualification attained at a given level is academic or vocational in nature, attained in the workplace or classroom or when the qualification is attained. However, this is not the fault of the individual researcher. In most circumstances the quality of information relating to higher education qualifications and sub-categories of degrees is poor or completely unavailable. In other studies, sample size constraints prevent an analysis of detailed

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is not included in any of the wage equations and as such, the coefficients presented still represent the returns to schooling or qualifications, rather than the rate of return.

[4] Dearden, L, McIntosh, S. Myck, M. and Vignoles, A. (2000). "The Returns to Academic and Vocational Qualifications in Britain". Centre for the Economics of Education Discussion Paper 4.

qualification groupings. The main point is that the classification and treatment of qualifications in econometric analyses is not straightforward (especially in cross country comparisons) and results should be treated with caution. Despite the fact that this methodology is adopted with the obvious intention of increasing the sample size of 'degree' holders (say) and the associated robustness of the results presented, it can have the effect of obscuring the variation in returns associated with different levels of qualification. A similar phenomenon occurs within the category for degree subject itself, with generally little differentiation made between undergraduates completing different subjects. As will be illustrated in later sections, there is sometimes a sizeable variance in returns according to degree subject, though again care should be taken to interpret results based on alternative data sets where the classification of subject groupings and the choice of the reference category of degree holders varies.

However, irrespective of the OLS specification (years of schooling or qualifications), neither explicitly takes into account the possible endogeneity of schooling and the associated biases that may ensue from this.

The Ordinary Least Squares (OLS) framework is based on the assumption that the schooling or qualification attainment decision is exogenous, although it is apparent that education is an endogenous choice. Those individuals in possession of higher levels of schooling or qualifications may have higher levels of innate ability and/or motivation than those in possession of lower levels of schooling or qualification (Conlon, 2002)[5]. Theoretically, this is illustrated in the Mincer specification where the disturbance term captures both unobservable individual effects and those individual factors, which may also influence the schooling decision. Hence there is a correlation between schooling and the error term in the earnings function. The result is that the r term in the OLS specification provides a joint return to both ability (say) and schooling. In order to minimize ability bias, several authors in the literature simply restrict the sample in question to those with 'comparable' personal characteristics. For example, in estimating the returns to a degree, some authors limit the scope of the analysis to those in possession of GCE 'A' Levels (university entrance requirements) and compare earnings between those with degrees and those who could have progressed to third level education, but did not do so.

The other main approach to deal with this methodological problem have either been to incorporate measures of ability directly into the model specification to proxy for unobserved effects or indirectly through the estimation a two-stage equation using instrumental variables as follows

$$\log(w_i) = X_i\beta + r S_i + \delta' x_i + \gamma x_i^2 + u_i \qquad \text{and} \qquad S_i = Z'_i \lambda + e_i$$

where Z_i is the vector of observed instrumental variables with the properties that the instruments are correlated with schooling term but uncorrelated with wages/earnings. Thus, e captures variation in S across individuals that arises for unobservable reasons. In other words, it is necessary to find an instrument that accounts for the variation in the level of schooling or qualification attainment but is uncorrelated with the earnings measure. Intuitively, the choice of instrument is not a straightforward process, but

[5] Conlon, G. (2002). "The determinants of undertaking academic and vocational qualifications in the United Kingdom", Centre for the Economics of Education Discussion Paper 20, *forthcoming*.

instruments for schooling that have used by researchers in the past have included birth quarter or birthday (Angrist and Kruger, 1991)[6] and changes in the minimum school leaving age (Harmon and Walker, 1995)[7]. The empirical implications of this extension to the basic theory are most clearly outlined in Card (1999)[8].

However, due to the nature of the data, the standard approach to estimating the returns to either alternative higher education qualifications or degree level subjects has relied on OLS estimation. Encouragingly, Dearden (2000) has recently illustrated that the factors that bias OLS estimates (measurement error, ability and composition bias[9]) effectively negate each other. The conclusion is that although OLS estimates are not ideal, the general consensus appears to be that OLS estimates provide acceptable estimates of the returns to qualifications

3. DATA SOURCES

In this section we briefly describe some of the data sources from which many of the estimates of the returns to higher education are derived. As previously mentioned, the comparison of estimates to alternative levels of qualification and degree subject is problematic due to the fundamentally different nature of the information contained in each of the data sets, either in terms of earnings or the classification of qualifications, and also non comparability in terms of the populations sampled, the method of data collection, response rates and where applicable, rates of attrition.

3.1 Labour Force Surveys

The first Labour Force Survey in the United Kingdom was conducted in 1973, and was carried out biennially from 1973 to 1983. Between 1984 and 1991 the survey was carried out annually and consisted of two elements:

1) A quarterly survey conducted in Great Britain throughout the year, in which each sampled address is called on five times at quarterly intervals, and which yields about 15,000 responding households in every quarter
2) A `boost' survey in the quarter March to May, which produces interviews at over 44,000 households in Great Britain and over 4,000 households in Northern Ireland.

[6] Angrist, Joshua and Krueger, Alan (1991) "Estimating the Payoff to Schooling Using the Vietnam-Era Draft Lottery", Princeton Industrial Relations Section Working Paper: 290, August 1991.
[7] Harmon, C. and Walker, I. (1995). "Estimates of the economic return to schooling for the United Kingdom", The American Economic Review, Vol 85, Issue 5, 1278-1286.
[8] Card, D. (1999) "The Causal Effect of Education on Earnings." In O. Ashenfelter and D. Card, editors, *Handbook of Labor Economics*, Volume 3b, North Holland, 1999. This work indicates that IV estimates of the returns to additional years of schooling or qualifications exceed to a substantial extent the conventional OLS estimates. Instrumental Variables seem to capture the marginal rate of return to education for individuals with high discount rates or lower preferences for education. There is a sensitivity to the choice of instruments in accordance with the interpretation of instrumental variables estimates as the average effect for some narrowly defined subgroup of the population most likely to be affected by the instrument adopted.
[9] Composition bias occurs as it is only those that are currently in employment that provide information about earnings. There may be personal characteristics that determine selection into employment and ignoring these factors leads to biased estimates.

During 1991 the survey was developed so that in spring 1992, for the first time, the data were made available quarterly, with a quarterly sample size approximately equivalent to that of the previous annual data, thus becoming the Quarterly Labour Force Survey.

Population: All persons normally resident in private households in Great Britain and Northern Ireland. (From Winter 1994/95 Northern Ireland is included in each quarter. Prior to this Northern Ireland data were only collected in the spring quarters).

Units of Observation: Individuals: Families/households

Time Dimensions: Partial Panel/cohort study: Time Series:

Sampling Procedures: Simple random sample: Four sampling frames are used

For Great Britain South of the Caledonian Canal the Post Office Address File is used, whilst North of the Caledonian Canal a random sample is drawn from the published telephone directory. The sample of residents in NHS accommodation is also drawn, unclustered, for the whole of Great Britain using a specially prepared frame. In Northern Ireland the source of the sample is the Valuation List used for rating purposes, excluding commercial units and known institutions. Households are interviewed on 5 occasions at quarterly intervals thereby introducing a panel element to the survey.

Method of Data Collection: Face-to-face interview: first interview
Telephone interview: subsequent interviews where possible

3.2 General Household Survey

The General Household Survey is a continuous national survey of people living in private households conducted on an annual basis, by the Social Survey Division of the Office for National Statistics. The series begins with data for the 1971 study. It is a multi-purpose survey, carried out for a number of government departments. It provides information for planning and policy purposes, covering aspects of housing, employment, education, health and social services, transport, population and social security, and is also used to monitor progress towards achieving targets. It is a continuous survey based on an achieved sample of about 9,000 households per year. Prior to 1988 the interviewing year was from 1st January - 31st December. In 1988 the interviewing year changed to 1st April - 31st March. Due to this data were not collected for the first quarter of 1988, i.e. the period 1st January - 31st March 1988.

There was no data collection for 1997-98.

Population: Private households in Great Britain

Number of Units: 15,853 (obtained) adults in 8636 households, 4,543 (obtained) children information.

Units of Observation: Individuals: Families/households

Time Dimensions: Repeated cross-sectional study: annual

Method of Data Collection: Face-to-face interview:

3.3 The British Household Panel Survey

The BHPS was designed as an annual survey of each adult (16+) member of a nationally representative sample of more than 5,000 households, making a total of approximately 10,000 individual interviews. The same individuals will be re-interviewed in successive waves and, if they split-off from original households, all adult members of their new households are interviewed. Children are interviewed once they reach the age of 16; there is also a special survey of 11-15 year old household members from Wave Four. The sample has remained broadly representative of the population of Britain as it changed through the 1990s.

A major development at Wave 9 was the recruitment of two additional samples to the BHPS in Scotland and Wales. There were two main aims of the extensions. First, to increase the relatively small Scottish and Welsh sample sizes (around 400-500 households in each country in the initial BHPS sample) in order to permit independent analysis of the two countries. Second, to facilitate analysis of the two countries compared to England in order to assess the impacts of the substantial public policy changes, which may be expected to follow from devolution. The target sample size in each country was 1,500 households.

Date of Fieldwork:

First Wave	3rd September 1991 to 30th January 1992
Second Wave	5th September 1992 to 30th April 1993
Third Wave	5th September 1993 to 30th April 1994
Fourth Wave	3rd September 1994 to 9th May 1995
Fifth Wave	4th September 1995 to 30th April 1996
Sixth Wave	29th August 1996 to 17th April 1997
Seventh Wave	29th August 1997 to 8th May 1998
Eighth Wave	1st September 1998 to 8th May 1999
Ninth Wave	1st September 1999 to 30th April 2000

Spatial Unit Local Authority Districts

Observation Unit Individuals; Families/households

Population keywords Adults; Households; Young people

Population Households and individual household members

Time Dimensions Longitudinal/panel/cohort

Sampling procedure Two-stage stratified systematic sample.

Method of Data Collection Face to face Interview
Telephone interview; Self-completion

3.4 Family Expenditure Survey

The UK Family Expenditure Survey (FES), which commenced in 1957, is a continuous survey with an annual sample of around 10,000 households about 60% of which co-operate by providing the interviewers with information about the household, household and personal incomes, certain payments that recur regularly (e.g. rent, gas and electricity bills, telephone accounts, insurance, season tickets and hire purchase payments) and in maintaining a detailed expenditure record for 14 consecutive days.

The original purpose of the survey was to provide information on spending patterns for the United Kingdom Retail Price Index (RPI). The survey is a cost efficient way of collecting a variety of related data that the government departments require to correlate with income and expenditure at the household, tax unit and person levels.

Population: Private households in the United Kingdom

Units of Observation: Families/households:

Time Dimensions: Repeated cross-sectional study: annual

Sampling Procedures: Multi-stage stratified random sample

Method of Data Collection: Face-to-face interviews; Diaries:

3.5 National Child Development Study

The National Child Development Study (NCDS) is a continuing longitudinal study which is seeking to follow the lives of all those living in Great Britain who were born between the 3rd and 9th March 1958.

It has its origins in the Perinatal Mortality Survey (PMS). This was sponsored by the National Birthday Trust Fund and designed to examine the social and obstetric factors associated with stillbirth and death in early infancy among the 17,000 children born in England, Scotland and Wales in that one week.

To date there have been five attempts to trace all members of the birth cohort in order to monitor their physical, educational and social development. The first four sweeps were carried out by the National Children's Bureau, in 1965 (when they were aged 7), in 1969 (when they were aged 11), in 1974 (when they were aged 16) in 1981 (when they were aged 23) and 1991 (aged 33). The most recent sweep was carried out in 2000 (when the remaining cohort members were aged 42).

In addition, in 1978, contact was made with the schools attended by members of the birth cohort at the time of the third follow-up in 1974 in order to obtain details of public examination entry and performance. Similar details were also sought from sixth-form colleges and FE colleges, etc where these were identified by schools. It

should also be noted that during the collection of exam data in 1978 information was obtained only from the schools and colleges by post.

For the birth survey, information was obtained from the mother and from medical records by the midwife. For the purposes of the first three NCDS surveys, information was obtained from parents (who were interviewed by health visitors), head teachers and class teachers (who completed questionnaires), the schools health service (who carried out medical examinations) and the subjects themselves (who completed tests of ability and, latterly, questionnaires). In addition, the birth cohort was augmented by including immigrants born in the relevant week in the target sample for the first three follow-ups (NCDS1, NCDS2, and NCDS3). The latter group were identified from the school registers during tracing. Since 1974 no attempt has been made to include new immigrants in the survey.

The 1981 survey differs in that information was obtained from the subject (who was interviewed by a professional survey research interviewer) and from the 1971 and 1981 Censuses (from which variables describing area of residence were taken). Similarly, the 1991 survey relied on survey research interviewers to collect information from cohort members, and also from husbands, wives, cohabitees, and children of cohort members. Extensive use was also made of self-completion questionnaires.

The fifth NCDS follow-up, carried out in 1991, was designed to obtain information from the cohort member; any husband, wife, or cohabitee; the natural or adopted children of 1 in 3 cohort families; and from the mother of these children.

Population: All children in England, Scotland and Wales born in the week 3rd-9th March 1958

Number of Units: 13,500 (target) 11,363 (obtained).

There are 18,060 schedules in each of the main data sets. The reason for this figure being higher than that given for each of the separate surveys is because all the children born 3rd - 9th March, 1958 were included in the study, and the discrepancy is due to children who were in the country at the time of the follow-up but who were not when the original perinatal survey was conducted. The target size is a rough estimation - the original cohort size was 17,500. Data collected in supplementary and emigrant surveys conducted after main fieldwork raises sample size to 11,582.

Units of Observation: Individuals, Families/households:

Time Dimensions: Longitudinal/panel/cohort:

Sampling Procedures: No sampling (total universe): The birth cohort was augmented by including immigrants born in the relevant week for the first three follow-ups

Method of Data Collection: Face-to-face interview: Self-completion:

3.6 British Cohort Survey 1970 (BCS70)

The 1970 British Cohort Study (BCS70) began in 1970 when data were collected about the births and families of babies born in England, Scotland, Wales and Northern Ireland in the week 5th-11th April 1970. The first survey, called the British Births Survey, was carried out by the National Birthday Trust Fund in association with the Royal College of Obstetricians and Gynaecologists and its aims were to look at the social and biological characteristics of the mother in relation to neonatal morbidity, and to compare the results with those of the 1958 National Child Development Study.

To date there have been five attempts to gather information from the full cohort, in 1975, 1980, 1986, 1996 and 1999-2000, at ages five years, 10 years, 16 years, 26 years and 29-30 years. The 5 year and 10 year surveys were carried out by the Department of Child Health, Bristol University, and the survey at these times was named the Child Health and Education Study (CHES). The 16-year survey was carried-out by the International Centre for Child Studies and named Youthscan. With each successive attempt, the scope of the enquiry has broadened from a strictly medical focus at birth, to encompass physical and educational development at the age of 5, physical, educational and social development at the ages of 10 and 16, and physical, educational, social and economic development at 26 years.

The Social Statistics Research Unit (SSRU) became involved with the BCS70 study at the time of the 16-year follow-up. SSRU became the Centre for Longitudinal Studies, and also conducted the National Child Development Study (NCDS). Subjects from Northern Ireland, who had been included in the birth survey, were dropped from the study in all subsequent sweeps.

In addition there have been four sub-sample surveys carried out. The first two, carried out in 1972 and 1973, named the British Births Child Survey, followed up sub-samples of the original cohort at ages 22 months and 42 months. The sub-samples consisted of all twins in the original cohort, the small-for-dates and post mature births, and a 10% random sample of the original cohort. The third sub-sample survey was carried out in 1977 when 1917 non-respondents from the 5-year survey were traced and interviewed in an attempt to assess the effect of non-response. In 1991, when the cohort were aged 21 years, a 10% sample survey was carried out which focused on adult literacy and numeracy problems as well as the transition from school to work.

3.6.1 The BCS70 Twenty-six year Follow-up

The Twenty-six year Follow-up is the fourth full national follow-up of the 1970 cohort born in Great Britain in the week of 5th-11th April 1970[10]. This follow-up was designed to review and evaluate young adults' (26 year) health, education, social and family environment throughout Britain. The comprehensive nature of the data gathered in this longitudinal study enables study of the effects on the 26-year olds education, health and general progress, of perinatal problems, serious childhood illnesses and critical episodes in the family or social environment.

[10] This is not the most recent follow up of the BCS Cohort members (which occurred in 1999/2000), but contains the most recently available data and as such is the basis for several research papers contained in this review.

Population: Subjects of the 1970 British Cohort Study - all those living in Great Britain (England, Scotland, Wales, Orkney, Shetland and the Western Isles) born 5-11 April, 1970.

Number of Units: 13,475 (target) 9,003 (obtained)

Units of Observation: Individuals:

Time Dimensions: Longitudinal/panel/cohort: Birth survey, plus 4 follow-ups and 4 sub-studies.

Sampling Procedures: BCS70 cohort members for whom a current address was available. This included those who had been in the original birth survey; those who had been in all subsequent follow-ups, including immigrants and others traced for the first time though schools and health authorities.

Method of Data Collection: Postal survey:

3.7 The Youth Cohort Study (Cohort 9)

The Youth Cohort Study of England and Wales (YCS) is a major programme of longitudinal research designed to monitor the behaviour and decisions of representative samples of young people aged sixteen upwards as they make the transition from compulsory education to further or higher education, or to the labour market. It tries to identify and explain the factors that influence post-16 transitions, for example, educational attainment, training opportunities, and experiences at school. For Cohorts one to six cohort members were contacted by post three times, at yearly intervals, when they were 16-17, 17-18 and 18-19. For Cohorts 7, 8 and 9, however, the sweeps were carried out at two yearly intervals instead of annually. A fourth sweep for Cohort 3 was subsequently carried out surveying cohort members at the age of 22-23. Thus it is possible to observe the higher education choices made by the cohort of pupils who were 16 during the academic year 1985-86.

Population: Young people who reached minimum school leaving age in the 1996/1997 school year (Cohort 9)

Number of Units: (A) 22,500 (target) (B) 14,662 (obtained) Weighted sample size.

Units of Observation: Individuals:

Time Dimensions: Longitudinal/panel/cohort:

Sampling Procedures: Multi-stage stratified random sample:

Method of Data Collection: Telephone interview: as complementary mode for non-respondents to postal survey; Postal survey:

3.8 New Earnings Survey Panel Data Set

The New Earnings Survey (NES) is an annual survey of employers, which collects data on the pay and hours of around 160,000 individual employees in employment. The NES has been conducted annually since 1970 (although it was first collected in 1968).

The sampling method is based on a 1 per cent sample of employees chosen on the basis of the last two digits of their National Insurance (NI) numbers. The survey is representative and covers the whole of Great Britain. As well as information on pay and hours worked, the NES also collects information about sector, occupation, employment status (full-time or part-time) gender and location. Unfortunately, the NES has not usually included any questions relating to qualifications held. Since the results are based on employers PAYE (pay as you earn) records and because the employer is under a statutory obligation to provide the data, they are generally more accurate than would be the case if the survey was based on individual recall. However, there are some problems with coverage of part-time workers, since the NES does not include many of those on very low hours and pay who fall below the PAYE tax threshold

Population:	All persons in employment in Great Britain in April of each year
Units of Observation:	Individuals
Data Type:	Aggregate (macro) level
Location of units of observation:	National
Time Dimensions:	Repeated cross-sectional study: annual
Sampling procedure:	Simple random sample: one per cent, comprising all those whose National Insurance numbers end with a specified pair of digits
Method of Data Collection:	Postal survey; Information relating to the employees in the sample was obtained from their employers

4. PRIVATE RETURNS TO HIGHER EDUCATION: STUDENT RETURNS TO DEGREE SUBJECTS

As previously mentioned, the literature on the returns to education originated from the Mincer and Becker human capital model and concentrated mostly on returns to the number of years of education, before it was acknowledged that individuals when deciding their educational investment used qualifications rather than years of education in their decision to undertake additional education and training[11]. Previously, studies typically assume that all qualifications and subjects of a given type are homogenous and provide identical returns. A small and growing part of the literature has been challenging this assumption and has been looking at returns to specific qualifications or subjects. In this section of the review, we concentrate on reviewing the literature on the returns to higher education in the UK by subject of degree. We interpret returns to education in a loose sense, and concentrate on three outcomes: wages, over-education and employment.

4.1 Background

Higher education is publicly funded in the United Kingdom. The system is centralised and the government sets targets on the number of places available. Institutions then compete to fill places. The funding received by each institution from the Higher Education Funding Councils is a function of the number of students and their subject of studies. From the mid-sixties, two types of institutions prevailed: universities and polytechnics, the second being more vocationally oriented and both being under the supervision of a separate administration. In 1992, the higher education sector was reformed and all institutions became universities. Concomitant to these changes, the proportion of a cohort attending higher education rose steadily from about 15% throughout the Seventies and the mid-Eighties to nearly 35 % by 1995. A current policy aim of the current government has been to promote increasing and widening participation in higher education. Due to these institutional changes and a drastic modification of the labour market, the distribution of undergraduate degree subjects has changed over-time but for differences appearing after 1992, it is impossible to differentiate between true modifications of the subject distribution and changes due to the integration of the former polytechnic institutions. We tentatively comment on the trends in subject mix over the past two decades.

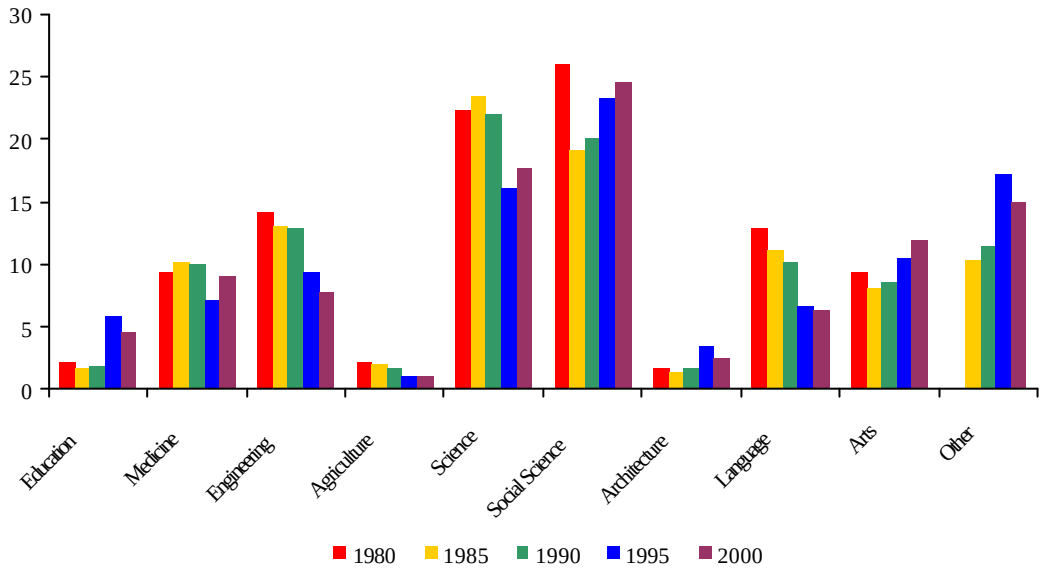
Using information from the Graduate Cohort Surveys[12], it can be seen that more than 40% of graduates are concentrated in only two disciplines: science and the social sciences. The proportion of science graduates has remained relatively stable over the period and the decline observed for the last two observations is mostly due to the introduction of the polytechnic graduates in the sample. In 1985, the social sciences appear to account for 6 percentage points fewer graduates compared to 1980, while

[11] The assumption of linearity of returns used to compute the returns to years of education is rather good, as can be seen by comparisons between returns to qualifications and returns to years of education (see Card, 1999 for the US or Chevalier and Walker, 2001 for the UK).

[12] For a fuller discussion of the Graduate Cohort Studies, C. Belfield, A. Bullock, A. Fielding, W. Siebert and H. Thomas, (1997) "Mapping Careers of Highly Qualified Workers", HEFCE Research Series M10/97.

combined subjects have proved more and more popular over the period, however, this could be mostly due to changes in the definition of the data[13]. From 1985 onwards, the proportion of social science graduates has increased from 19% to nearly 25%. A second group of disciplines representing around 10% of graduates each can be distinguished: Medical science, Engineering, Languages and Arts. Both Engineering and Languages have seen the proportion of graduates halved over the period, while the proportions in Arts and Medicine have remained relatively stable. The remaining disciplines are quite marginal, accounting for about 2% of the graduate population at the beginning of the period. Agriculture has been in constant decline over the period and only half as many students were graduating from this discipline by the end of the period compared to 1980. Architecture and Education related degrees on the other hand have become more popular over this time period. In the case of education, this is largely due to the integration of Colleges of Education and other Polytechnics.

Figure 1: Distribution of first degree by subjects (UK-selected years)



The literature on the returns to various subjects of degrees is limited by the lack of suitable data. Out of the main national surveys, two cross-sectional surveys (the General Household Survey (since 1980) and the Quarterly Labour Force Surveys) and two longitudinal surveys (the National Child Development Study and the third sweep of the Youth Cohort Study) provide information on the subject of studies. The national surveys however cover only a small population of graduates, which raises difficulties relating to small sample sizes. The GHS is representative of the whole population and thus contains graduates of different ages and various cohorts; however, evidence obtained from the GHS may not be informative on the returns to degree subject for the most recent cohorts. The QLFS samples a greater number of individuals and thus more detailed subject decomposition is possible, however, the QLFS only contains earnings information from 1992 when the survey changed from being annual to quarterly.

[13] In 1980, graduates from combined subjects were allocated to one category rather than to the other category, which has been the case since 1985.

Turning to the longitudinal surveys, the NCDS is a nationally representative survey of some children born in 1958 observed regularly throughout their life. Hence it is possible to obtain reasonable estimates of the returns by degree subject for students who typically graduated in the late 1970's. As mentioned in the previous section relating to data sources, the YCS tracks cohorts of students at age 16 with most YCSs including two or three waves, the last survey taking place when the cohort member is aged 18.

However, for the third cohort (aged 16 in 1987), a follow up was organised when the respondents were aged 23. Hence, it is possible to do some specific analysis of the integration into the labour market for this cohort and the returns by degree subject.

The remaining evidence come from graduate surveys. There are two types of data available for the possible estimation of private returns to higher education qualifications. The First Destination Survey (FDS) is an administrative survey organised by the Higher Education Statistical Agency (HESA), which contacts all graduates from a UK higher education institution six months after graduation (response rates range from 80% to 90%). The First Destination Survey can therefore provide an immediate snapshot on the differences in the labour market integration achieved by graduates with different degree subjects. However, it is clear that the first six months after graduation may provide biased information on lifetime achievement. The other type of graduate survey is typically less extensive; a random sample of graduates from a given cohort is surveyed a few years after graduation. This type of survey contains information on educational achievement pre and post-graduation, labour market history and some personal information. These surveys provide better understanding of the early to mid-career development of graduates and thus better information than the First Destination Survey. Despite the fact that these surveys have been run by different institutions and have slightly different populations, they remain broadly comparable over time. The drawback of these surveys is the lack of a comparison group. Returns to degrees can only be estimated in relation to another degree subject but not in relation to other qualifications (typically GCE 'A' levels).

We now review the literature according to each data source in turn.

4.2 Undergraduate Degree Subject and wages

4.2.1 Evidence Based on General surveys

Harkness and Machin (1999) use pooled cross sections of the GHS between 1980 and 1995 to calculate the wage returns to different degree subjects for full-time workers. To obtain a workable sample size, the authors group the data in 3 year periods, and in doing so achieve a sample size of around 2000 observations for men and between 700 and 1250 observations for women per time period of estimation. The authors distinguish between four broad subject groups (Arts, Science, Social Science and Other) and in a Mincer framework calculate the returns to higher education compared to individuals with at least one A-level[14]. For men, returns have increased over the period for all subjects with the exception of the 'other' category. Returns to an Arts degree among men are significantly lower than for other subjects (at least 10

[14] The specification includes age, age squared, and dummies for teacher status, region and industry.

percentage points). The results for women are slightly different compared to those presented for men. Returns to Arts and Science degrees increased by 12 to 15 percentage points over the period, while returns to social science and other degrees had a more hectic evolution, rising substantially before falling below their original levels. Harkness and Machin also calculate the changes in relative supply associated with these changes in returns and conclude that throughout the period, the relative demand for science degrees increased significantly (especially so for women) while the demand for Arts and other subjects was substantially reduced. One caveat associated with the authors' methodological approach is that only a limited number of pupils reach GCE 'A' levels without attending higher education. As a result, the comparative group is therefore highly selected which may bias the returns upwards[15].

In a more recent study, Walker and Zhu (2001) pooled 7 years of the Quarterly Labour Force Survey focussing specifically on graduates and people with at least 2 GCE 'A' levels aged between 25 and 59. The QLFS contains data on wages for individuals leaving the survey (approximately a fifth of the survey is renewed every quarter) and since 1997 for every individual entering the survey for the first time. Walker and Zhu select the 20% of respondents who are observed for the last time, which generates a sample of 18,000 men and 14,000 women. As with the approach adopted by Harkness and Machin (1999), selection into the labour force is not taken into account and the authors estimate a standard Mincer regression[16]. According to the most basic specification when degree subjects are not explicitly controlled for, the estimates indicate that the returns to a degree compared to 'A' levels have varied over time from 12% to 18% for men and from 19% to 31% for women. In addition, for each subject, returns are higher for women than for men. It is surprising to note that yearly fluctuations are quite important, which casts doubts on the robustness of the results. Turning to the more sophisticated specifications where dummies for degree subject are included (13 subjects), this instability remains and no clear trend in the returns by subject over the period is observable. However, this analysis by subject and year is constrained by the number of observations, especially in subjects with a small number of graduates like architecture. While there is variation in the estimated returns by degree subject, the ranking of returns is more stable. Health, Law, Economics and Mathematics are the subjects providing the highest returns for graduates. Arts and Education have the lowest returns, but while for men a degree in one of these subjects provides negligible or even negative returns compared to GCE 'A' levels, for women, Arts degrees had a return of 17% (respectively 22% for education) over the period.

4.2.2 Evidence based on Longitudinal Studies

Lissenburgh and Bryson (1996) use part of the 4th wave of the YCS 3 to conduct an extensive study of the returns to higher education. The authors limit the sample to pupils who achieved at least 5 'O' levels (NVQ level 2 or equivalent) leading to a sample of 1,311 graduates and 803 non-graduates. This sample has to be corrected for

[15] Pupils with A-levels who decide not to go to university may have lower academic ability, be less motivated, have higher preference for the present, or other unobservable characteristics. Whatever the determinants of their choice, this choice is not exogenous to their wage and this biases the estimated rates of return. For example, assuming that non-participants to higher education have lower ability, the rate of returns computed will include the returns to HE but also returns to ability.

[16] The list of exogenous variables includes age, age squared, and dummies for marital status, race, union status, health status, and region.

attrition as more than 70% of the 1st wave respondents did not participate in the 4th wave. In addition, the information on subject of degree is somewhat limited and only four broad categories of subjects can be used (Science, Mathematics and Computers, Engineering and others). Using a cohort rather than a cross section of the whole population has the advantage of providing a more homogenous population. The returns to degree subject for university graduates at the age 23/24 are estimated. The econometric specification includes a quadratic term in labour market experience, a linear term in unemployment, regional, personal characteristics and job characteristic dummies.

Surprisingly, the authors do not include any background information that could be used to proxy ability. The omitted subject is a combination of arts and social science subjects. This choice of reference group is unfortunate, as Walker and Zhu (2001), for example, have shown that graduates from these two subjects achieve substantially different outcomes. In addition, due to the small sample size (846 observations) the authors are forced to pool males and females, which is not ideal but unavoidable in this situation given the data limitations. It is found that graduates from Science, Maths and Engineering earn 9 % more than other graduates, however, these estimates are not extremely informative due the nature of the omitted category and the pooling of males and females.

Blundell *et al* (2000) follow an estimation strategy similar to both Harkness and Machin (1999) and Walker and Zhu (2001). The authors use information from the 5th follow up of the NCDS, when the respondents were aged 33. The NCDS has the advantage of including a substantially more detailed decomposition of degree level subjects, information relating to cohort members' innate ability (reading and mathematical test scores at the age of seven and eleven can be viewed as proxies) and GCE 'A' level scores. In order to increase the sample size, the authors include all individuals with some spell in higher education and individuals with post-graduate degrees. In this analysis the comparison group is individuals in possession of undergraduate degrees where there is no explicit information relating to the subject of the qualification, i.e. 'missing'. The choice of this base makes for tricky comparison and interpretation of the results. The authors' specification includes higher education dummies, ability test scores at age 7, region of residence, school type at age 16, family background information, demographic information when the child was 13 (from the Census) and some employers' characteristics. Surprisingly, the authors did not include any measure of labour market experience. The implication of this omission is that if some subjects are associated with a greater likelihood of time out of the labour market, then the returns to that subject will be biased downwards. Turning to the results presented, the inclusion of a measure of the GCE 'A' level scores reduces the returns as expected; the returns to degree level qualifications are considerably higher for women than for men for every subject apart from 'other sciences' with the difference reaching 15 percentage points for Engineering and 'Economics/ Accountancy/ Law' (we will refer to this subject category as 'Economics' hereafter). The subjects with the highest returns were found to be Economics and 'Mathematics/ Physics' for men and Economics and Engineering for women. Subjects that were found to have negative returns compared to the 'missing' category were Arts, 'Chemistry/ Biology' and 'Other' subjects for men and 'Chemistry/ Biology' for women. Unfortunately, the fit of this specification is quite poor and only a couple of subject dummies are statistically significant (at the standard

95% level of confidence). This is surprising, as in all the evidence presented so far, the subject of undergraduate degree was found to be highly significant. This may be due to the small number of observations and the detailed subject variable chosen. For example, the 800 women in the study are split between 10 subjects of study, which means that the cell size for each subject is rather small, leading to the imprecision of the estimates.

Table 1 reports the estimates of the subject effect on earnings for these 4 studies. We attempt to make the comparison between studies easier to understand by reporting the subject effects for three subjects (Science, Social Science and Arts) relative to Education whenever this was possible (i.e. in Walker and Zhu (2000) and Blundell *et al* (2000)) or the 'Other' category (Harkness and Machin (1999) and Lissenburgh and Bryson (1996)). A discussion of the various evidence regarding returns to subject is presented at the end of this section.

Table 1: Returns to subject in HE in the UK compared to a degree in Education

Study	Data	Method	Returns to science	Returns to social science	Returns to arts
Harkness and Machin (1999)	GHS 1980-1995 N=3,000 per period Age 16-60	Mincer, 4 subjects, returns relative to A-levels.	**1980:** Men: 0.12 Women: 0.24 **1990:** Men: 0.24 Women: 0.32 **1995:** Men: 0.18 Women: 0.37	**1980:** Men: 0.17 Women: 0.22 **1990:** Men: 0.25 Women: 0.26 **1995:** Men: 0.22 Women: 0.21	**1980:** Men: -0.02 Women: 0.11 **1990:** Men: -0.02 Women: 0.19 **1995:** Men:0.05 Women: 0.27
Walker and Zhu (2001)	QLFS 1993-1999 N=4,500 per year Age 25-59	Mincer, 13 subjects, returns relative to A-levels. Reported returns are relative to graduates from education	**1993:** Men: 0.28 Women:0.06 **1999:** Men; 0.20 Women:0.13 **All years;** Men: 0.24 Women: 0.17	**1993:** Men: 0.23 Women:0.12 **1999:** Men; 0.25 Women:0.21 **All years;** Men: 0.25 Women: 0.18	**1993:** Men: -0.03 Women:-0.04 **1999:** Men; -0.14 Women:-0.04 **All years;** Men: -0.06 Women:-0.04
Lissenburgh and Bryson (1996)	YCS cohort 3 N=846 Age 23/24	Mincer, 4 subjects, returns relative to arts and social science	All: 0.09	na	na
Blundell *et al*. (2000)	NCDS wave 5 N=1,832 Age 33	Mincer, 9 subjects, returns relative to education	Men: 0.06 Women: 0.07	Men: 0.07 Women: 0.15	Men: -0.14 Women:-0.04

Note: We define science as math and physics, social science as Economics/accountancy and law for Blundell et al (2000). From Walker and Zhu (2001) we define science as Mathematics, Social Science as Economics. It is not possible to calculate the standard errors from the original studies, as we typically do not have the matrix of variance-covariance.

4.2.3 Evidence based on graduate cohorts

Individual graduate cohort data sets exist for students graduating from United Kingdom Higher Education institutions in 1960, 1970, 1980, 1985, 1990 and 1995. These data sets include information on job history and are the most comprehensive source of information about the early careers of graduates. In this section of the review we focus on the last four cohorts. In the 1960, 1970 and 1980 data sets, the graduates were traced and questioned about the first 5, 6 or 7 years of their labour market experience following graduation. The data for the graduate cohorts 1985 and 1990 are similar to the previous ones but for both cohorts the information was collected in 1996, i.e. eleven years after graduation for the 1985 cohort and six years after graduation for the 1990 cohort. Finally, the 1995 cohort was sampled in spring 1999, three and a half years after graduation. This last survey lacks important variables such as age, marital status and region of residence so that comparisons with the previous cohorts are difficult.

Due to their relatively large sample size, it is possible to calculate the mean earnings of graduates at a very detailed level by subject (between 40 and 80 classifications for the 1980, 1985 and 1990 cohorts and 13 subject classifications for the 1995 cohort).

Table 2 reports the relative mean earnings for some specific subjects compared to graduates in possession of a degree in education. These earnings means do not correct for any observable characteristics of the graduates or their job.

Table 2: Returns to degree subject in HE in the UK (earnings means in graduate cohorts)

Study	Data	Method	Returns to Science vs. Education	Returns to Social Science vs. Education	Returns to Humanities vs. Education
Dolton *et al*. (1990)	Graduate survey 80. Pay 1986 N=5,002	Average salary in 1986	All: 0.49	All: 0.56	All: 0.18
Belfield *et al*. (1997)	Graduate survey 1985, pay 1996 N=2,417	Average salary in 1996	Men: 0.29 Women: 0.32	Men: 0.49 Women: 0.19	Men: 0.04 Women: 0.18
Belfield *et al*. (1997)	Graduate survey 1990, pay 1996 N=2,507	Average salary in 1996	Men: 0.30 Women: 0.25	Men: 0.40 Women: 0.16	Men: 0.17 Women: -0.07
Own calculation	Graduate survey 1995, pay 1998 N= 10,571	Average salary in 1998	Men: 0.29 Women: 0.19	Men: 0.06 Women: -0.02	Men: -0.08 Women: -0.07

Note: From Dolton *et al*. (1990), Belfield *et al*. (1997) we define Science as Mathematical science, Social Science as Economics and Arts as History, while the base category is education. For our own calculations on the 1995 cohort, we define Science as Mathematics and Computing while Social Sciences and Humanities cannot be decomposed. As a result of changing the omitted group compared to the published paper for ease of presentation, we cannot present the associated standard errors in this analysis.

Dolton et al. (1990) provide a complete analysis of the 1980 cohort. This cohort was surveyed in 1986 and the questionnaire and sample design is globally similar to those

used for the 1960 and 1970 cohorts; i.e. 1 in 5 graduates was randomly selected and sent a postal survey, leading to a sample of 7,141 graduates. Current earnings are presented for about 40 subjects based on 5,002 observations[17] (see Table 2). Large returns to mathematics, economics and history are observed; specifically, graduates from mathematics have a mean wage 49% greater than graduates from education. In fact, the base category (education) is the degree subject for which the earnings are the lowest. However, these results could be misleading since they are provided for all graduates and not subdivided to take into account gender pay differentials. In particular, education related and teaching professions are mostly female orientated occupations while some of the other subjects considered have a more balanced or mostly male population. Part of the subject differential observed is in fact due to the gender wage gap.

The 1985 and 1990 cohort were surveyed in the autumn of 1996, so the 1985 cohort had been in the labour market for up to eleven years, approximately five years later than all the other cohorts that have been surveyed. The sample was chosen by selecting 30 Higher Education institutions, which then contacted their alumni by postal survey and approximately 50,000 questionnaires were sent to holders of diplomas, degrees and post-graduate degrees.

The total number of valid questionnaires returned was around 15,000. Belfield *et al* (1997) provide evidence based on LFS and FDS showing that the survey was representative of the graduate population.

Belfield *et al*. (1997) report the mean annual wage for graduates in 1996 by gender for about 40 subjects (out of the 80 available in the data). It is found that there is a large dispersion of earnings by subject and that graduates from Mathematics or Economics earn more than graduates from Education. In addition, relative returns for these subjects have remained relatively stable between the two cohorts. For History graduates the results are more ambiguous; male History graduates earn more than Education graduates, especially for the 1990 cohort, while for women, Arts graduates enjoy an 18% premium for the 1985 cohort but a 7% penalty for the 1990 cohort relative to the reference category. These changes may reflect a large pay increase that took place in the teaching profession at the beginning of the nineties that affected more experienced teachers to a disproportionate extent (Chevalier *et al.*, 2001). Gender differences in the returns by subjects are also important in the Economics discipline, where returns for men are about 25 percentage points higher than for women. The authors do not provide explanations for this gender gap.

The survey of the 1995 graduates is similar in design to the 1985 and 1990 surveys. In order to obtain a nationally representative sample of about 5% of all graduates, 33 higher education institutions were contacted and their alumni records were used to contact the graduates. The response rates only reach 27% probably due to the poor quality of Alumni addresses held by most higher education institutions[18], which leads to a sample of 10,593 graduates and diploma holders. The data can only be

[17] In this survey like in the other graduate surveys, earnings were reported in categories (from 12 to 16). We use the mid-point of the band to define individual earnings while the value associated with the top band is somehow arbitrary. The various authors believe that the chosen value does not substantially affect the results.

[18] No difference in the response rate by type of institution is noticeable.

decomposed into 13 subjects but for the calculations reported in Table 2, we attempt to maintain consistency with the subject classifications used in the previous two cohorts.

However, there are some differences, the main discrepancy being that we cannot distinguish between the various components of either Social Science or Humanities. For all subjects, the relative returns compared to the Education reference category are higher for men than for women. Specifically, relative returns to Mathematics are the highest (29% for men, 19% for women). As in the previous cohorts, relative returns to Humanities are low and sometimes negative. In sharp contrast with the previous cohorts, returns to Social Sciences are especially low for the 1995 cohort, and this could be due in part to the differences in the classification of degree subjects between cohorts[19] (i.e. Social Science rather than Economics).

These results are not directly comparable with those obtained from nationally representative dataset. We now report estimates that account for some personal or job characteristics. Despite the large volume of work done on the 1980 graduates, we could not find any estimates of the effect of subjects on earnings. We thus present our own estimates in a framework that is as close as possible to the studies presented in the first part of this survey. We estimate the log of annual earnings and our independent variables include GCE 'A' level score, class of degree, post-graduate qualification, a quadratic term in employment, month of unemployment, marital status and number of children, a dummy for residence in London and five broad subject dummies. The omitted subject category is 'Other' degree level subject, which mostly contains graduates from Education. The estimates of the subject effects are all statistically significant for males but for females only a degree in Social Science affects earnings positively compared to an individual in possession of an Education degree (Table 3).

Battu et al. (1999) estimate the determinants of pay using information from the 1985 and 1990 cohort using a non-traditional methodology. Rather than using a Mincer equation framework, they do not account for experience and estimate a model including class of degree, whether a degree was a requirement for the job, some job characteristics, whether the individual's spouse has a degree and 8 dummies for the subject of degree. The sample considered is diploma, undergraduate degree and postgraduate degree holders but the estimates do not differentiate between the specific levels of qualification obtained. This specification leads to controversial results where graduates from Education are among the largest earners.

These results may be due to the model specification or the careless pooling of the various qualification holders in the survey. Chevalier (2000), using the same dataset, estimates a Mincerian earnings equation (but pooling cohorts and genders). The results indicate that graduates from Mathematics, Social Science and Humanities earn respectively 6%, 2% and –12% more (less) than graduates from Education. This specification also controls for pre-university ability (through the inclusion of GCE 'A' level score), various controls for educational achievement and job characteristics and thus is similar to the specification used to estimate subject effects on the 1980 cohort.

[19] For example from while male who graduated in 1985 from economics had earnings of £34,971 in 1996, the average earnings were £25,269 and £20,973 for graduates from politics and sociology respectively.

Table 3: Estimates of subject effects on earnings

Study	Data	Method	Returns to Science vs. other	Returns to Social Science vs. other	Returns to Humanities vs. other
Own calculation	Graduate 1980, Pay 1996 N=1818 (female) 3097 (male)	Mincer, 5 subjects, returns relative to other (education)	Men: 0.084 Women:0.034	Men: 0.116 Women:0.096	Men: 0.068 Women: -0.018
Battu et al. (1999)	Graduate survey 1985, pay 1991 N=3,693	Regression, 8 subjects, returns relative to education	Men: - 0.01 Women: 0.00	Men: -0.04 Women: -0.12	Men:-0.20 Women: -0.13
Battu et al. (1999)	Graduate survey 1990, pay 1996 N=6,253	Regression, 8 subjects, returns relative to education	Men: -0.08 Women: -0.02	Men: -0.20 Women: -0.09	Men: -0.29 Women: -0.17
Chevalier (2000)	Graduate survey 1985 & 1990 N= 5,552	Mincer, 12 subjects, returns relative to education	All: 0.06	All: 0.02	All: -0.12
Own calculations	Graduate 1995, Pay 1999 N=4,563 (female) 3,701 (male)	Mincer, 5 subjects, returns relative to other (education)	Men: 0.179 Women:0.184	Men: 0.168 Women:0.093	Men:0.054 Women:0.091
Chevalier et al. (2001)	Graduates 1960 -1990	Mincer, 5 subjects, returns relative to other (education)	Teacher: 0.08 Non-T:0.002	Teacher:0.09 Non-T:0.02	Teacher: 0.037 Non-T:-0.09
Naylor et al. (2000)	FDS 1993, Occupational earnings	Regression, 21 subjects	Men: 0.02 Women: -0.10	Men: 0.01 Women: -0.14	Men: -0.09 Women: -0.20

For the 1995 cohort, estimates using a specification similar to the 1980 cohort (marital status and number of children were dropped) are reproduced in Table 3. For men, Science and Social Science degree subjects are associated with substantial relative returns (around 17%) while Arts subjects have a relative return of 5.4 % compared to Education degrees. For women, the relative returns to Science are similar to the ones obtained by men while returns to the Social Sciences and arts are around 9% relative to the reference category.

Chevalier et al. (2001) pool 5 graduate cohorts (1960, 1970, 1980, 1985 and 1990) to examine the decision to become a teacher. The authors estimate the determinants of current earnings (about 6 years after graduation and 11 years for the 1985 cohort). This specification includes broad subject categories and the authors find that graduates with degrees in Education were paid less than any other graduates from

other subjects in a teaching job. In non-teaching occupations, Language and Arts graduates suffered significant pay penalties compared to all other graduates. One explanation for this might be the fact that it is possible that graduates from Education backgrounds become teachers in the primary sector while graduates from non-education degree subjects become secondary teachers. For non-teaching occupations, the subject of degree does not appear to be statistically significant and this contradicts evidence based on the individual cohorts. Given the fact that the composition of the graduate population has changed widely over the period, the pooling of various cohorts hides some of the variation in pay that is observable at the individual cohort level. This piece of work substantiates evidence that the returns to subjects are not homogenous (see below).

Naylor *et al*. (2000) use the First Destination Survey matched to information from the individual student's records to analyse this question. However, the FDS does not include any earnings information so the authors impute occupational earnings based on the New Earnings Survey (NES). This method has the advantage of using a measure of life time earnings rather than earnings immediately after graduation but has the disadvantage of wiping out all individual effects and is based on the assumption that the occupation graduates are in six months after graduation represents their life-time career choice. On the other hand, research from the DfES (1999) provides some evidence that this is (at least partially) the case, for early career choice, based on the 1995 cohort. Accepting this assumption relating to lifetime occupation and imputing earnings for all graduates using the New Earnings Survey, the authors regress the log of occupational earnings on controls for academic background, degree class, age and paternal social class as well as subject of degree[20]. The disparity in earnings is large, with medics and lawyers' earnings at the top of the earnings distribution and graduates from Agriculture and Humanities being at the bottom of the distribution.

Despite all the evidence presented it remains difficult to reach a consensus regarding the effect of subjects of graduation on earnings. The difficulties primarily come from variations in the definition of subject used and possible cohort or sample effects. However, we now tentatively summarise our findings according to the subject of degree level qualification. Table 1 summarises the evidence based on samples representative of the entire population. Studies based on the GHS and YCS suffer from the imprecision of the subject variables and in the case of GHS leads to surprising results where graduates from the 'missing' subject classification have the highest returns to their investment. The choice of this category makes comparison difficult.

From the graduate evidence, the discrepancy between the results of the various studies is also great, but we will put more weight on studies using a Mincer regression framework. The Naylor *et al* (2000) paper should also be read with caution as the results are based on the projected earnings of graduates in the occupation rather than observed earnings.

[20] This analysis uses a single graduate cohort, so any variation in pay for individual cohorts, which might be hidden as a result of pooling, does not arise.

The remaining studies find

- Higher returns for males than for females
- Large relative returns to Science and Social Science compared to Education
- Mixed evidence concerning the relative returns to Arts degree.

No obvious trend is discernable and the estimated returns are quite sensitive to the specification used. Evidence based on salaries or estimates using Mincer regressions on large surveys of graduates are consistent with these conclusions. Focussing on the studies with the highest level of subject decomposition, the point estimates of relative returns to Mathematics, Economics, or Humanities degrees (as opposed to Education degrees) range for men from 6% (Blundell *et al*, 2000) to 28% (Walker and Zhu, 2001), 7% (Blundell *et al*, 2000) to 25% (Walker and Zhu, 2001) and –14% (Walker and Zhu, 2001) to 7% (Chevalier, 1980 Cohort) respectively.

For women, the relative returns are 3% (Chevalier, 1980 Cohort) to 18% (Chevalier, 1995 Cohort), 9% (Chevalier, 1995 Cohort) to 21% (Walker and Zhu) and –4% (Walker and Zhu) to 9% (Chevalier, 1995 Cohort) respectively. The variation in estimated returns is important between different studies but it is impossible to conclude whether these differences stem from the type of data used, cohort, age, or specification effects.

However, the previous estimates of the subject effects may be biased, as subjects are not allocated randomly. This is due to the fact that prospective students tend to apply for subjects for which they have a strong preference, a better chance of success or subjects that will provide them with the highest returns. More explicitly, the OLS estimates will be biased upwards if the covariance between subject (S) and unobservable (e) is positive.

$$\ln y = b_s S + b_x X + e$$

$$\hat{b_s} = b_s + \frac{\text{cov}(S,e)}{Var(S)}$$

The first equation reports the relationship between earnings and choice of subject; this is a variation on the Mincer model as presented in section 2. When estimated by OLS, b_s is an estimate of the returns to higher education degree subject relative to a base category. However, as explained in section 2, this estimate will be biased if the determinants of choice of subject are correlated with some unobservable characteristics that also determine earnings. The size of the bias is in relation with this correlation (*cov* (S,ε)).

We assume the bias will be upward if for example, students with better numeric skills choose to graduate with Mathematics degrees rather than Arts degrees, and if the labour market rewards numerical skills to a significant extent. In this case, the calculated returns to a Mathematics degree will also include the returns to numerical skills. The effect of the bias is likely to be different by subject. As in the above example, the bias is likely to be upward for subjects in high demand. Alternatively, if less talented pupils choose to graduate from subjects for whom the demand is lower, then the estimated effect of these subjects is likely to be biased downward. To purge the subject estimates of this selection bias, one would have to rely on strategies

(Instrumental Variables or Heckman selection models) requiring an exclusion variable, i.e. a variable that explains the choice of subject independently of earnings. In the absence of a suitable instrument, it therefore may be the case that the estimates presented of the returns to degree subject are biased.

4.3 Subjects and over-education

The previous calculations represent the average returns to degree subject but do not take account of the possible disparity within subjects in labour market achievement. In this section, we focus on the outcomes associated with obtaining a graduate job. There is substantial evidence indicating that United Kingdom graduates are over-educated and in particular between 15% and 30% of graduates are thought to be in non-graduate occupations (Chevalier, 2000; Dolton and Vignoles, 2000). Over-education is a difficult concept to measure and various measures have been proposed. To summarize, a comparison is made between the education of an individual and the education required to do the job. This education required can be defined by various methods (expert judgement, own employee's judgement or statistical methods). All these solutions suffer from caveats[21]. The existence of over-education will negatively affect the earnings of the affected graduates. The estimates of the pay penalty for over-education range from 10% to 30%. As indicated in the previous section relating to the heterogeneity of returns according to degree subject, over-education is not randomly distributed across subject areas. Chevalier (2000) estimates the determinants of over-education for two cohorts of UK graduates. The author splits the population of graduates in three categories: professionals and managers are defined as graduate occupations; all other occupations are traditionally viewed as non-graduate and therefore are defined as over-educated occupations. Chevalier splits the over-educated population based on the assessment of the match between their education and job. Over-educated graduates who are satisfied with the match are in jobs whose requirements include some graduates skills while other graduates can be viewed as genuinely over-educated. The basic model specifications include GCE 'A' level score, class of degree, gender and cohort dummies as well as 12 subject dummies (Table 4).

Table 4: Graduate over-education by subject (marginal effects)

	Apparent over-education	Genuine over-education
Medical	-0.062 (0.036)	-0.110 (0.028)
Biology	0.039 (0.018)	-0.004 (0.011)
Agriculture	0.066 (0.027)	0.001 (0.015)
Physics	0.016 (0.014)	-0.004 (0.010)
Mathematics	-0.067 (0.026)	-0.048 (0.016)
Engineering	-0.010 (0.016)	-0.040 (0.014)
Architecture	0.025 (0.023)	-0.029 (0.015)
Administration	0.018 (0.024)	-0.013 (0.009)
Languages	0.034 (0.018)	0.021 (0.007)
Humanities	0.046 (0.020)	0.022 (0.006)
Education	-0.190 (0.043)	-0.054 (0.013)

Source: Chevalier (2000)- Standard errors in parentheses. Omitted category: graduates from Economics

[21] See Green *et al* (1999) for a comprehensive discussion

Compared to economists, graduates from medical science, mathematics, engineering, architecture and education are less likely to be genuinely over-educated, while those in possession of languages and humanities degrees are at higher risk of over-education. These effects can be quite large: for example a graduate from medical science is 11 percentage points less likely to be genuinely over-educated than a graduate from economics. Mason (1996) also supports these findings of large heterogeneity in the over-education experience of graduates. He surveyed the recruitment of graduates in two industries (steel and the financial services) and found that while over-education was almost non-existent in the steel industry, about 45% of graduates employed in the financial sector had positions at a sub-graduate level. Hence the average effects presented in section 4.2 may hide variations in the returns to subjects[22].

The 1995 cohort is also useful for assessing other dimensions of the quality of jobs obtained by graduates. In Table 4, we report the proportion of graduates who agree with the statement that the subject of their degree was a determinant of them obtaining a job. The more vocational subjects such as Law, Medicine, Engineering and Education score highly (between 50% to 76%). Degrees in Mathematics and Computing are also associated with high relevance levels for current jobs. On the other hand academic degrees are generally associated with low levels of relevance. Less than 25% of men graduating from Humanities think that the discipline of their undergraduate degree had any effect on their job prospects.

Some gender differences in the relevance of the subjects are difficult to explain. For example, women with a medical degree are 10 percentage points less likely to answer that their subject was an important factor in obtaining their job. In the last column of Table 5, we report another measure of the assessment of job quality. DfES (1999) research reports an index of job quality based on the respondent evaluation of the following six categories:

- Competitive salary
- Continual skill development
- Interesting and challenging work
- Opportunity to reach managerial level
- Long-term security
- Dynamic organisation.

Each category is given a score of one when the respondent agrees with the statement concerning their current job. For example, 36% of graduates indicate that the most important characteristic of their job is that it is interesting and challenging. The index of job quality is constructed by adding the scores regarding the six statements together. The relevance of such an index is debatable as some of its components may be more important to graduate preferences than others. However, this DfES research provides evidence that this index is well correlated with graduate entry jobs. At the bottom of the quality index we find Social Sciences, Arts and Humanities but also Education (penalised by salary and reduced opportunity of reaching managerial level), whereas the top three positions are taken by Mathematics, Law and Business degrees.

[22] See also, the effect of occupation on the returns to subject of graduation.

Table 5: Relevance of subjects and quality of job- 1995 Cohort

	Subject relevant for obtaining job?		Quality index
	Men	**Women**	**All**
Arts	30.30	35.16	2.98
Humanities	23.53	27.35	2.88
Languages	38.55	36.56	3.11
Law	54.49	55.06	3.35
Social sciences	31.19	35.84	3.06
Maths & computing	58.09	57.42	3.43
Natural science	50.11	52.67	3.11
Medicine & related	76.82	66.32	3.30
Engineering	64.13	70.27	3.31
Business studies	34.77	39.53	3.32
Education	73.91	71.13	2.87
Other vocational	48.76	53.03	3.27
Interdisciplinary	40.79	41.67	3.09
Total	47.95	47.14	

Note: Graduate cohort 95- relevance of subject (own calculation)- index of quality (DfES, 1999)

4.4 Education and employment

The evidence presented so far has concentrated on working graduates, however the return to a degree subject will be affected by the probability of employment and unemployment. Using information from an international survey of graduates funded by the European Union that took place in the autumn of 1998 among 1994/5 graduates, Brennan *et al*. (2001) present some evidence that UK graduates have the highest probability of employment in Europe. They find that this probability has remained stable over time; however, the probability of employment and unemployment may vary largely by subject studied.

The First Destination Survey provides information on the speed of integration to the labour market. Graduates in Education have high rates of integration to the labour market, however, due to the nature of the qualification, there are two clear explanations for this fact, namely, education degrees are highly vocational and most teacher jobs commence in September. Over this period, teaching demand has been regularly higher than teaching supply (Chevalier *et al*, 2001) so it is not surprising to find that education graduates have high rates of employment. Other graduates have a much slower integration to the labour market: six months after graduation between 50% and 70% of mathematics and social science graduates are in employment while this proportion is between 40% and 50% for humanities graduates. Unemployment is also the highest for humanities graduates; however, no strong gender differences are found. The results illustrate that labour market trends are rather different according to degree subject. Mathematics graduates have seen their employability decrease over time, reaching its lowest level in 1995 at 53% before recovering during the economic upturn in the late 1990s. Social science graduates achieved their lowest rate of employment in 1990 but the highest rate of unemployment was reached in 1995. At the end of the period, male social scientists are 15 percentage points more likely than in 1986 to be employed within six months of graduation. Graduates from Humanities and Education have seen little variation in their employability. These variations reflect

macroeconomic changes in the demand for graduates as the British economy went through the business cycle and re-oriented itself towards the service industry.

Table 6: Employment (unemployment) by HE subject 6 months after graduation

Study	Data	Year	Maths (% employed)	Social Science (% employed)	Humanities (% employed)	Education (% employed)
Own calculations	First destination survey	1986	Men: 0.73 (0.08) Women:0.72 (0.06)	Men: 0.52 (0.13) Women:0.47 (0.11)	Men: 0.55 (0.17) Women:0.53 (0.15)	Men: 0.85 (0.08) Women:0.86 (0.08)
Own calculations	First destination survey	1990	Men: 0.65 (0.14) Women:0.62 (0.13)	Men: 0.46 (0.17) Women: 0.42 (0.15)	Men: 0.49 (0.21) Women:0.49 (0.20)	Men: 0.86 (0.06) Women:0.90 (0.06)
Own calculations	First destination survey	1995	Men: 0.53 (0.15) Women: 0.58 (0.10)	Men: 0.60 (0.20) Women: 0.62 (0.16)	Men: 0.51 (0.19) Women: 0.52 (0.17)	Men: 0.82 (0.11) Women: 0.88 0.10
Own calculations	First destination survey	2000	Men: 0.62 (0.13) Women: 0.64 (0.11)	Men: 0.67 (0.15) Women:0.69 (0.13)	Men: 0.53 (0.16) Women: 0.58 (0.13)	Men: 0.85 (0.07) Women: 0.91 (0.05)

Finally, using the 1995 data provides another snapshot of labour market outcomes three and half years after graduation. Table 7 reports the proportion of graduates who have been unemployed for more than six months over this period[23]. The conclusions are rather similar to those previously presented with graduates from Arts, Humanities, Natural Sciences and interdisciplinary degrees being at least 50% more likely than other graduates to have experienced a spell of unemployment greater than six months. Medics and graduates from the Education fields are substantially less at risk of unemployment (3.4%). The case of interdisciplinary graduates is interesting as one could assume that an interdisciplinary subject will increase the choice of possible jobs, however, it may be the case that employers are suspicious about the specific knowledge of graduates from these subjects. Hence, graduates with interdisciplinary degrees are more at risk than any others to suffer from spells of unemployment of at least six months.

[23] This is a self-reported measure of unemployment, and may not be easily comparable with more standard measures such as ILO.

Table 7: Proportion of graduates with a spell of unemployment greater than 6months (cohort 95-observed in 1998)

	Mean
Arts	11.7
Humanities	10.3
Languages	7.1
Law	6.8
Social sciences	8.4
Maths & computing	8.4
Natural science	10.2
Medicine & related	3.4
Engineering	4.7
Business studies	6.0
Education	3.4
Other vocational	6.8
Interdisciplinary	15.6
Total	8.1

Source: DfES (1999)

The previous results may be crude. A few studies have estimated the determinants of unemployment for graduates accounting for subject of graduation. Smith *et al.* (2000) found substantially similar results to those presented above by enriching the FDS with the personal records of students. This allows the authors to include measures of ability pre and post graduation as well as controlling for age at graduation and social class of the individual's father. Their measure of unemployment includes all graduates who six months after graduation were not working or in further studies. They use the cohort of 1993/94 graduates and report that education graduates have the lowest probability of unemployment. Compared with social scientists, the probability of unemployment for education graduates is 7 percentage points less, where mean unemployment is 19%. In table 8 we report the relative probability of unemployment compared to education graduates for some selected subjects. Mathematics and social science degree holders and especially humanities graduates are more at risk of unemployment than graduates in Education with the gap reaching 11 percentage points for males graduating from Humanities. However, this analysis suffers from the drawbacks of using FDS data, since graduates are observed only 6 months after graduation and as such these results may provide a biased picture of the long-term unemployment risk faced by graduates.

Lissenburgh and Bryson (1996), using the YCS, estimate the determinants of the number of months spent in a full-time employment in 1993 at the age of 23; i.e. about 2 years after graduation. Their analysis is limited by the sample size available, however, using a parsimonious specification they estimate that graduates from Science, Mathematics and Engineering incurred longer spells of employment in 1993 than other graduates (by 2 or 3 months). The unemployment rates six or eleven years after graduation are calculated for the cohort of 1985 and 1990.

These sample means confirm the Brennan *et al* (2001) statement that graduates are at low risk of unemployment since employment rates are all similar between subjects and range from 94% to 99% (for the 1990 and 1995 cohorts). More importantly, rather than unemployment at a given point in time, it may be more useful to look at the length of unemployment.

Using, the 1985, 1990 cohort, we estimate a Tobit model the determinants of the total length of unemployment since graduation[24]. The model is as close as possible to the Smith *et al* (2000) specification and includes GCE 'A' level score, family background variables, age of graduation, class of degree, type of institution, post graduate qualifications, marital status, number of children and subject of degree. On the other hand, the interpretation of the results is different. While Smith *et al* (2000) estimate the probability of being unemployed at a specific point in time, we estimate the length of unemployment up to a given point in time. We find that superior academic credentials, coming from a more favoured family background, being married and having children are all associated with less unemployment. A PGCE or a professional qualification reduces the length of unemployment while a PhD increases it. Marked differences by subject are also observed. Graduates from Medical Science, Mathematics and Education experienced less unemployment than those from Economics while graduates from Architecture, Languages and Humanities were more at risk.

Table 8: Estimates of the determinants of unemployment

Study	Data	Year	Maths (% employed)	Social Science (% employed)	Humanities (% employed)
Smith et al. (2000)	FDS + University record N=62,018	1993	Men:+6.4 Women:+5.65	Men;+7.3 Women:+7.6	Men:+11 Women:+7.2
Own estimates	Graduate survey 1985 –1990 N=5739	1996	1985 Men:1.43 Women1.12 1990 Men:0.61 Women:-0.85	1985 Men:2.61 Women1.70 1990 Men:1.10 Women:0.54	1985 Men:3.08 Women:2.19 1990 Men:1.90 Women:0.94

Note: Education is the base category.

Males experienced longer spells of unemployment than women, however, this could be due to women opting to exit the labour market when facing long period of unemployment. With the exception of women graduating in Mathematics in 1990, statistically, all other graduates have experienced more unemployment than Education graduates; men graduating from Humanities for example suffer approximately three extra months of unemployment over their first 11 years of labour market integration compared with Education graduates.

[24] OLS requires the underlying distribution to be normally distributed. This assumption is not valid in the case of length of unemployment, as a large proportion of the population will not have experienced any unemployment. The distribution of the length of unemployment over a period of time is said to be censored at 0 (there is also censoring at the top, since the maximum unemployment period is limited by the period for which data was collected). Censored outcomes have to be estimated by Maximum Likelihood. The tobit model accounts for the probability of being censored and therefore provide unbiased estimates of the effect of degree subject on the length time spent in unemployment.

All the evidence on unemployment suggests that graduates with an Education degree are less at risk of unemployment. Graduates from Mathematics and Social Sciences have about the same risk of unemployment while graduates from Humanities are substantially more likely to experience unemployment throughout the initial years following graduation.

4.5 Subject of graduation and continuing studies

Due to the disparities in the graduate labour market, it is possible that graduates from some subjects may continue in higher education in order to augment their position when joining the labour market either by graduating in a joint subject degree or more likely by undertaking some post-graduate degree course. This will be more likely to be the case if students lack information about their prospects when joining university but learn more about possible outcomes during their studies. Betts (1996) and Brunello *et al* (2001) provide evidence that students have higher expected returns than is observed and that the gap between expectations and observed outcomes falls for final year students. Brunello *et al*. (2001) compare a selection of European countries, and show that the gap between expected and realised returns is among the largest in the United Kingdom. Unfortunately both studies have a limited choice of subjects so we cannot shed light on whether students from a given subject are more likely to be disappointed on the completion of their degree.

To further assess this issue we rely on the 1996 survey of the 1985 and 1990 graduate cohorts. The number of months spent in full time education since graduation is provided in this sample, however, due to the distribution of this variable, we recode the variable into 3 categories: "None or less than 12 months in full time education" (80% of observations), "12-23 months in full time education" (12% of observations) and "More than 24 months in full time education" (8% of observations). We estimate an ordered probit model where we include the subject of degree as well as a quadratic in age at graduation, degree grades, cohort, type of university and some family background variables (living in council estate and paternal occupation when 14).

Graduates from the 1990 cohort with better grades and a lower age on graduation are more likely to have had a spell in full time education since graduation compared to other graduates. There is no family background effect, which means that all other things being equal, graduates from poorer background are neither more financially constrained nor have relatively higher discount rates compared to other graduates. These two characteristics would be associated with a greater probability of joining the labour market rather than staying or returning to higher education.

The effect of the choice of subject on the educational choice made after graduation are reported in Table 9. As the coefficients from an ordered probit are difficult to interpret, we also report the marginal effects for the three categories. Compared to graduates from the Social Sciences (the omitted category), graduates from more vocational degrees (Medics, Engineering and Education) tend not go back to higher education. Graduates with Business and Administration degrees are also 11% less likely to have any further spell in education.

Table 9: Subject effects on staying on in Higher Education (ordered probit)

	Coefficient	Marginal effects		
		No education	1 year	More than 2 years
Medic	-0.482	0.095	-0.059	-0.036
	(4.04)	(5.52)	(4.80)	(6.50)
Biology	0.141	-0.037	0.021	0.016
	(1.33)	(1.26)	(1.31)	(1.20)
Agriculture	-0.329	0.069	-0.042	-0.027
	(2.60)	(3.24)	(2.99)	(3.65)
Physics	0.076	-0.019	0.011	0.008
	(1.11)	(1.08)	(1.11)	(1.04)
Maths	-0.447	0.090	-0.056	-0.035
	(4.39)	(5.57)	(4.97)	(6.09)
Engineering	-0.549	0.110	-0.068	-0.042
	(7.17)	(8.88)	(7.00)	(11.29)
Architecture	0.086	-0.022	0.012	0.010
	(0.64)	(0.61)	(0.62)	(0.59)
Business Administration	-0.549	0.109	-0.067	-0.041
	(6.80)	(9.24)	(7.47)	(11.15)
Language	-0.014	0.003	-0.002	-0.001
	(0.20)	(0.20)	(0.20)	(0.20)
Humanities	0.035	-0.009	0.005	0.004
	(0.51)	(0.50)	(0.51)	(0.50)
Education	-1.198	0.163	-0.107	-0.056
	(7.97)	(15.88)	(15.64)	(10.15)
Missing	-0.234	0.051	-0.031	-0.020
	(1.34)	(1.54)	(1.44)	(1.72)
Observation		7753		
Pseudo R^2		0.084		

Note: The model also includes controls for cohort, age, degree results, paternal occupation and type of accommodation when 14. The omitted subject is social science (t-stat). Marginal effects computed at the sample mean.

4.6 Conclusions

This section has reviewed various aspects of the effect of degree subject on labour market outcomes and has highlighted the fact that graduates cannot be considered a homogenous population. The subject choice substantially affects earnings, the propensity of obtaining a "graduate" job and unemployment. The section has generally focused on four subject categories: Mathematics, Social Sciences, Humanities and Education.

Graduates from Maths and Social Sciences have higher returns to their degree subject but are more at risk of unemployment than Education graduates and in the case of social scientists they may experience over-education. Graduates from Education backgrounds have lower returns but do not face much risk of unemployment. Finally, graduates from Humanities are the worst off financially following graduation and are more at risk than other graduates to experience unemployment and over-education.

However, one should keep in mind that none of these results account for the selection of subject. Researchers have so far had to assume that the choice of subject is a random event. This is an obvious simplification that may bias the results substantially.

These findings are nevertheless of importance in the current debate about the financing of higher education (Greenaway and Hanes, 2000). Advocates of fee differentiation by subject would probably argue that students in mathematics and social science should be charged more due to their potential earning power. But this does not take into account the risk of over-education and unemployment associated with these subjects, which could lead to more risk adverse individuals not enrolling or graduating from these subjects. In addition, reducing the fees for humanities students may push more students to graduate from these subjects when it already appears that there is an excess supply. Finally, subjects with higher returns may also have a larger dispersion, and thus higher returns compensate for the additional risk incurred. These questions remain of interest and should be explored in further research.

4.7 Section References

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5. The Returns to Higher Education Qualifications

5.1 Empirical evidence for the United Kingdom

There are a large number of papers that investigate the economic returns of education to students in the United Kingdom, however, not all of these papers actually provide a clear picture of the specific returns to alternative higher education qualifications. As previously mentioned, the literature on the returns to education originated from the standard human capital model and concentrated mostly on the return to years of education, before it was acknowledged that individuals, when deciding their educational investment, used qualifications rather than years of education as the key determinant in the decision making process.

It was typically assumed that each year of higher education provided an equivalent return irrespective of the qualification and that expected log earnings is a linear function of years of education. This property is known in the literature as the absence of so called "sheepskin effects", which basically means that earnings, after conditioning on the number of years of schooling, are higher for those individuals who have obtained the qualification in question compared to those who did not.

The debate on the existence of such effects reflects the theoretical issue of whether skills are adequately controlled for in earnings equations with the inclusion of a measure of educational input, i.e. years spent in education, rather than a measure of educational output, such as having obtained a degree[25].

Previously, studies typically assumed that all qualifications of a given type were homogenous and provided identical returns. Thus an analysis of the rate of return to additional years of post compulsory education was deemed an entirely satisfactory proxy of the returns to specific levels and types of qualification. A small (and more recent) component of the literature has been challenging the assumption of homogeneous returns and focused on estimating returns to specific school and post-school academic and vocational qualifications instead. A substantial amount of the research that has been undertaken in this area has looked at the returns associated with degree level qualifications, although evidence distinguishing between different types of qualification at degree level (or any HEI qualification) is sparser. One of the primary reasons for the traditional emphasis on the years of education rather than specific qualifications stems from the standard theoretical model, as developed by Mincer (see section 2). The other lies in the lack of suitable data, especially in the US. In almost all data sets containing information on an individual's education, there is generally more information relating to the number of years of post compulsory education received compared to the highest level of qualification attained. As mentioned earlier, the fact that the number of years of post compulsory education can be treated as an integer value and the associated rates of return can be derived relatively easily, there are legitimate reasons for this focus in existing research. In order to convert a return into a rate of return, an assumption about the time taken to

[25]Unfortunately, it is too often argued that evidence supporting sheepskin effects confirms the empirical relevance of signalling theories of education. However, if ability is perfectly observable by the employer it is still possible to find sheepskin effects when more able individuals have the capacity to obtain the same qualifications using fewer years of schooling. In this case, no signalling investment can ever take place but sheepskin effects cannot be dismissed.

complete the qualification must be made. In addition, there are relatively small sample sizes associated with degree level (and especially alternative HE) qualifications. These factors have all contributed to the prior focus on returns to years of post compulsory schooling.

This section reviews the most relevant papers that address the effect of alternative levels of higher education qualifications on various labour market outcomes in the United Kingdom. This analysis is structured according to the broad category of dataset used in the various analyses, namely, cross sectional data (General Surveys), cohort data (Longitudinal Data), panel data and graduate surveys. We will primarily focus on earnings but will also look at some evidence on employment outcomes by alternative higher education qualifications.

5.1.1 Evidence based on cross sectional and household surveys

General Household Survey (GHS)
Family Expenditure Survey (FES)
Quarterly Labour Force Surveys (QLFS)

In one of the most influential papers estimating the returns to schooling using both Ordinary Least Squares and Instrumental Variable approaches based on UK data, Harmon and Walker (1995) use the FES to estimate returns to years of schooling for men[26]. This article in the economics of education literature is highly important as for the first time using UK data, the authors instrument for schooling exploiting policy changes in the minimum school leaving age. In addition, the authors also take into account the fact that education is coded as an integer by means of a selection model with an ordered probit. The findings are that IV estimates of the returns to additional years of schooling (16 percent) exceed to a substantial extent the conventional OLS estimates (6 percent) in what seems to capture the marginal rate of return to education for individuals with high discount rates or a lower taste for education.

The paper by Schmitt (1993) is probably one of the first pieces of academic research to directly consider qualifications instead of years of schooling using information contained in the General Household Survey[27]. The main aim of this paper is to examine changes in the structure of weekly earnings for full time male employees during the seventies and the eighties. Schmitt finds evidence of rising returns to skills in the face of a large increase in the supply of skilled labour, suggesting a substantial shift in labour demand in favour of skilled workers. Table 10 illustrates how university graduates perform much better than those with only GCE 'A' levels in the late 1980s compared to the 1970s.

[26] See Chapter 2 for a discussion of the alternative educational measures used in estimating the returns to schooling. Previous work on the FES on the returns to education had been undertaken by Moghadam (1990). This paper, although not focusing specifically on the returns to HE qualifications, is included because of its methodological significance.

[27] Unfortunately, the classification of educational categories has not been constant over time in the GHS. More detail about qualifications is only available in the latest cross sections. A more detailed discussion of the classification of academic qualifications is discussed in Conlon (2000).

Table 10: Wage differential and Estimated Unemployment Rates by Qualification

	Wage differential 16-30 years old			Estimated unemployment rate		
	74-76	**78-80**	**86-88**	**74-76**	**78-80**	**86-88**
University	.622	.526	.744	.014	.013	.027
Voc-High	.447	.375	.578	.010	.009	.028
A-level	.237	.333	.405	.020	.014	.050

Note: Schmitt (1993). Baseline in wage differential: No qualifications. Wage differentials (OLS) evaluated at 5 years of experience. Estimating equation includes experience interacted with qualifications. Unemployment rates (probit estimates) evaluated at age 40. Equation includes age polynomial. Both include regional dummies.

With a very similar aim, Harkness and Machin (1999) have also used the GHS to report changes in qualification levels and related educational wage premia in the UK labour force since the 1970s, but improving on Schmitt (1993) by including additional data from the early nineties. Among other findings, they argue that there has been a bigger relative demand shift in favour of the more educated. This is valid for the successive cohorts of more recent labour market entrants, as Table 11 illustrates.

Table 11: Estimated Wage Premia by Qualification

Period	**1979-81**	**1984-6**	**1989-91**	**1993-5**
		Men		
Degree/non degree	.357 (.010)	.385 (.012)	.415 (.012)	.431 (.014)
Degree/ A levels	.142 (.019)	.188 (.021)	.230 (.021)	.201 (.024)
Degree/ No qualifications	.494 (.011)	.574 (.012)	.658 (.014)	.681 (.017)
		Women		
Degree/non degree	.295 (.020)	.349 (.019)	.393 (.018)	.413 (.019)
Degree/ A levels	.205 (.029)	.267 (.026)	.259 (.024)	.262 (.030)
Degree/ No qualifications	.601 (.027)	.663 (.023)	.792 (.021)	.777 (.029)

Note: Dependent variable is log earnings. Control variables include age, region and industry dummy variables, among others. Standard errors are expressed between parentheses. Reported values indicate regression coefficients on the relevant qualification dummy unless otherwise specified.[28]

In a more recent article using a similar econometric approach, Harmon and Walker (1999) distinguish between years of pre and post-18 year old schooling using data from the FES to account for non-linearity in the returns to schooling. The set of instruments is divided in two groups according to the levels of schooling at which they are likely to affect participation. Specifically, for lower levels of educational attainment, changes in minimum school leaving ages and relative wages achieved in the youth labour market are used. For higher levels of educational attainment, the

[28] The displayed coefficient b is an estimate for E[log earnings| x=1]-E[log earnings|x=0]. The expected proportional wage premium can be calculated from E(Premium)=exp(b). E[exp(error)]-1, although in practice b is usually taken as a first order approximation to this value.

authors define a series of variables intended to capture the opportunity cost of undertaking additional schooling and the effect of rationing higher education. This latter point is illustrated through the award of grants to entrants and the proportion of university students in the relevant age cohort and in the population generally.

Estimates of the rate of return to years of post-18 schooling range from 13 percent for the former set of instruments to 30 percent for the latter. This marked sensitivity to the choice of instruments seems to be in accordance with the interpretation of instrumental variables estimates as the average effect for some narrowly defined subgroup of the population more likely to be affected by the intervention considered (i.e. the instrument), as has been theoretically demonstrated by Angrist and Inbens (1995).

Chevalier and Lanot (2001) use an alternative method to estimate returns. Rather than providing point estimates they estimate bounds[29]. This strategy allows them to relax the stringent hypothesis needed to apply instrumental variables. To calculate meaningful bounds, the authors make two assumptions. First, that individuals with more education have significantly higher levels of ability and therefore can be expected to earn more than an individual with less ability, at each education level considered. Second, that more education cannot have a negative effect on earnings. Pooling various cross sections of the GHS (1984-1996) they estimate the return to a degree compared to GCE 'A' levels is at most 35% and 40% for men and women respectively.

Labour Force Surveys

In more recent work using the Quarterly Labour Force Surveys, Robinson (1997) and Conlon (2001) adopt a slightly different approach and analyse the difference in earnings between the academically and vocationally trained, holding the level of qualification constant. They find that the academically trained earn a premium over their vocational counterparts at all levels of qualification according to the NVQ classification of qualifications. In the latter analysis, despite the fact that several qualifications are grouped together in order to increase the robustness of the estimating procedure, it is found that those males with degree level qualifications earn approximately 60% more than males possessing no formally recognised qualification (in terms of hourly earnings according to OLS estimates) while the figure for higher degree holders stands at 66%. For males in possession of a Higher National Certificate or Diploma (or equivalent) the premium over the formally unqualified stands at 44%. The equivalent IV estimates are 62.5%, 70.7% and 43.8% respectively. These estimates are derived for pooled quarterly data sets with the inclusion of seasonal and yearly dummies[30]. It is also noted that the returns estimated for each individual year appear to be reasonably constant over the period in question (1993-1998).

However, considering these returns in excess of the returns associated with the completion of more than one GCE 'A' level provide relatively low estimates of the

[29] See Manski and Pepper (2000) for details

[30] In the Instrumental Variable approach, a variety of factors are used as instruments, depending on the data source. In the QLFS, instruments such as birth month and quarter and changes to the minimum school leaving age are used, while for the NCDS, a variety of family characteristics are used.

rewards to higher education qualifications. In particular, the earnings premium associated with more than one GCE 'A' level stands at approximately 47% relative to those possessing no qualifications, implying that the earnings effect associated with degree level qualifications is approximately 13 percentage points.

The most recent and comprehensive work using information from the Labour Force Surveys has been undertaken by Walker and Zhu (2001). This paper estimates the returns to years of schooling, specific levels of qualification, degree level subjects and the variance of return over time. In this section we will look only at the second category.

For women, attaining GCSE level qualifications (or GCE 'O' level or CSE (1) standard) yields a premium of approximately 8% (relative to those possessing no qualifications). Being in possession of 2 or more GCE 'A' levels yields a further 17%, and an undergraduate degree yields a further 19%. Since GCE 'A' levels take two years to acquire, the estimated 'A' level effect broadly reflects an annual average return of approximately 8%. In the analysis where the sample is restricted to those who were in possession of university entry requirements, the effects of degree level qualifications relative to two or more GCE 'A'-levels suggest an annualised return of around 6%. The final note to make about the effect of qualifications on women's earnings is that the possession of a university postgraduate degree adds approximately 10% to earnings.

For men, using an identical analysis, the returns to GCSEs are approximately 10% greater than those possessing no qualifications; 2 or more 'A' levels add a further 23% to earnings (relative to GCSE qualifications), and a degree adds a further 15%. The implication is that the average annual economic return to completing a degree is approximately 5%. A postgraduate university degree adds only 5% to male earnings in excess of that achieved by undergraduate degree holders.

Table 12: Marginal Returns to qualifications (Relative to GCSE)

	Men	Women
2+ GCE A levels	23	17
University Degree	15	19

Source: Walker and Zhu (2001). Dependent variable: log hourly wages. Dummy coefficients reported. These can be converted to expected percentage wage premium by calculating exp(coef.)-1.[31]

5.1.2. Estimates based on Cohort Longitudinal Studies

The National Child Development Survey (NCDS) is one of the most detailed sources of information on qualifications in the United Kingdom. As previously mentioned in the theoretical and methodological sections, the NCDS is a continuing longitudinal survey of people living in Great Britain who were born between the third and the ninth of March, 1958 and provides a rich set of ability and family background variables that are often unavailable in other datasets. Information on reading and mathematical test score performance at the ages of seven and eleven allows researchers to control (to an extent) for ability and therefore selection into alternative levels of schooling or qualifications.

[31] Unless otherwise specified, the tables shown report qualification dummy coefficients.

Blundell *et al* (2000) estimate the premium to higher education from a sample of individuals in the NCDS with GCE 'A' level qualifications. The reason for restricting this sample is to estimate the additional impact of different higher education qualifications by comparing the outcomes of individuals with a higher education qualification to those who had the requisite qualifications to enter higher education but did not. This methodology is adopted in an attempt to remove potential ability bias from the analysis. Some of the pertinent results can be summarised as follows:

Table 13: Returns to Higher Education

	Specification 1		Specification 2	
	Men	**Women**	**Men**	**Women**
Non Degree HE	0.13	0.21	0.14	0.20
First Degree	0.12	0.24	0.10	0.29
Higher Degree	0.08	0.32	0.08	0.30

Source: Blundell et al (2000). Dependent variable is real (Jan 95 prices) log hourly wages in 1991. Baseline: Individuals with GCE 'A' level and no post-school qualifications.

In particular, the first specification includes a wide range of regressors including ability, family background and other demographic information as well as employer's characteristics and the individual's UCCA score. The second specification also includes information on the subject studied and whether the individual obtained the qualification as an adult learner. The results indicate that the returns associated with an undergraduate degree range from 12% for men and 24% for women, the implication being that the annualised return to a three-year degree over GCE 'A' levels is approximately 4% for men and 8% for women. Interestingly this paper suggests that for men, the average return to non-degree HE qualification exceeds the returns associated with degree level qualifications (according to the broad classification of qualifications in the first specification).

Observed premia associated with previously specified degree levels might appear difficult to reconcile with estimates obtained from the Labour Force Survey. Two key reasons can be found for this. First, the NCDS provides much more accurate information on an individual's education and innate ability, therefore reducing the problem of missing variables with respect to ability and the problem of measurement error associated with education variables. A standard econometric result shows that measurement error in the education variable tends to produce a downward bias in the estimates of the returns. In addition to this, the omission of ability variables in the standard econometric model specification leads to the overestimation of returns to education. Second, the comparability between estimates produced by different datasets can be questioned, as data from a single cohort does not allow the exploration of the effects of experience or age in the same way a repeated cross section analysis does.

In a similar study, Dearden (1999) examines those cohort members in the NCDS in possession of at least one GCE 'A' level and examines the probability of continuing on to higher education and employment probabilities across groups. The focus of this work is on two key issues:

- The size of bias when estimating the returns to school and post school qualifications resulting from the measurement error of the education variable, compositional problems due to selection of workers into employment and the association between higher levels of education and unobserved ability and family background variables.

- The existence of heterogeneous returns to education.

Table 14 illustrates the returns associated with different types of post schooling qualifications where the comparison group consists of individuals with no formally recognised qualifications.

Table 14: Returns to Post-Schooling Qualifications[32]

	OLS		Corrected for measurement error		Corrected for composition bias	
	Women	**Men**	**Women**	**Men**	**Women**	**Men**
Low vocational	8	4	9	6	10	6
Mid vocational	9	7	10	13	14	14
High vocational	18	23	20	32	25	33
Degree	16	32	18	38	21	42

Source: Dearden (1999). Dependent variable: log hourly wages.

The research finds that the conventional OLS estimates obtained from a typical dataset can be reasonably good approximations of the bias corrected estimates of the effect of post-schooling qualifications on earnings. The OLS specification results presented in the table above have the distinctive feature of taking into account a range of individual information on family background characteristics and ability through test score performance. The correction for measurement error explores the fact that individuals in 1991 report their education in 1981, assuming that reporting errors made in 1991 are independent of errors made in 1981. In the absence of a suitable identifying restriction that explains labour market participation but is independent of unobserved earnings potential, Dearden chooses to estimate the size of the bias under different parametric assumptions. The results reported above correspond to a correlation between unobservable components of wage and participation models of 0.66, which is consistent with other studies on participation selection.[33]

In particular, Dearden finds that the returns to undergraduate degrees range between 16 and 21% for men and between 32 and 42% for women. Considering the specificity of the academic qualifications, these results are informative. However, the extremely broad classification of vocational qualifications may abstract for the return associated with the vocational path of qualification attainment. This point again illustrates the

[32] High vocational includes: Prof qualification, Pol Diploma, CNAA or Univ. Diploma or Certificate, HNC, HNC, BEC/TEC Higher , Guilds Full Tech Cert. Mid vocational: Guilds Adv. Or final, ONC, OND, other BEC/TEC. Low voc: Other City and Guilds, RSA1 to 3, others. Degree: First degree, postgraduate diploma or higher degree.

[33] The original paper actually evaluates the estimation impact of different degrees of association between an individual's propensity to participate in the labour market and his/her earnings potential.

fact that the importance of the classification of qualifications, especially when using data from the NCDS, as the sample sizes are generally quite small.

This paper also finds evidence of heterogeneity in the returns to education in Britain. Individuals with a lower preference for education, proxied by levels of parental education, have significantly higher marginal returns to certain educational qualifications. In particular, degree qualifications play an important role in reducing gender wage differentials, as can be noticed from Table 14.

Using information from the NCDS, Conlon (2001) also estimates the returns to categories of academic and vocational qualifications. In particular, a variety of estimating techniques are used including OLS, IV and Heckman selection models with a wide variety of model specifications. The estimates (for men only) indicate that there is a small positive return to degree level qualifications over those in possession of GCE 'A' level qualifications. However, this analysis is not comparable to those previously referred to as the issue of ability and selection bias was dealt with by using alternative econometric techniques[34] as opposed to restricting the sample simply to those holding university entry level requirements. Even so, the results presented do represent very low estimates of the returns to degree level qualifications over those with GCE 'A' levels.

In more recent work, Blundell, Dearden and Sianesi (2001) estimate a multiple treatment model on the NCDS and compare estimates of the returns to alternative qualifications[35] for men to avoid the composition bias more frequently found for women. The econometric techniques used involve standard ordinary least squares, instrumental variables, selection into education with a control function method and matching methods. The OLS estimates of returns to higher education appear to be very sensitive to the introduction of additional controls such as ability, personal and family background characteristics. The premium to a higher education degree for males is estimated to lie somewhere between 17 and 20% compared to individuals who completed their studies at GCE 'A' level.

As with previously cited methodological papers, instrumental variables provide much larger estimates of the returns to higher education (approximately 22%) as they are more likely to capture some local average affect of higher education for a group with higher returns than that which we might expect from the average male population. The authors argue that the control function estimate of the return to higher education, which stands at 15%, is a more reliable estimate of the average effect (as opposed to the local average effect captured by IV, which is approximately 20%). Finally, the authors also provide a wide range of matching estimates under different calculation methods to derive an empirical counterfactual[36]. The main conclusion from this research is that the estimates of the effect of higher education seem to be higher for

[34] OLS, Instrumental Variables and Heckman Selection models with correction terms into employment, level of qualification attained and the type of qualification attained.

[35] In this paper, a model is developed which captures the sequential nature of educational qualifications. Individuals are grouped into three categories: those who stopped after completing O-levels, those who went on but stopped after completing A-levels or equivalent, and finally those who also completed some stage of higher education. This sequential pattern is exploited with the help of an ordered probit model.

[36] Nearest neighbour with and without calliper and kernel density methods.

individuals whose actual qualifications are GCE 'A' levels (approximately 30%) than for those with higher education (15% to 17%). This suggests that the effect of treatment on the non-treated may be higher, indicating a potential rate of return to a year of higher education up to 10 percent for individuals who have actually ended up not pursuing such a career path.

Table 15: Returns to qualifications by specification

Methodology	HE Premium (relative to A-levels)
OLS	0.20
OLS with additional controls	0.17
IV	0.15
Control function	0.20
Matching. HE premium for HE individuals	0.15-0.17
Matching. HE premium for A-level individuals	0.30

Note: Blundell *et al*. (2000). Dependent variable is log of hourly wage.

Using a marginally different methodology, Dearden *et al* (2000) measure the impact of each qualification held by an individual on their earnings, as opposed to simply including the individual's highest qualification in the estimated equation. This approach allows the investigation of the financial gain associated with different profiles or paths of qualification attainment. In a comprehensive study, the authors compare estimates of the returns to specific named qualifications using the NCDS, the International Adult Literacy Survey (IALS) and Quarterly Labour Force Survey (QLFS). Their findings regarding the returns to higher education qualifications can be summarised as follows:

Table 16: Estimates of Returns to Qualifications

	Males			Females		
Qualifications	**NCDS**	**IALS**	**LFS**	**NCDS**	**IALS**	**LFS**
A Levels	0.154 (0.027)	0.177 (0.06)	0.168 (0.01)	0.175 (0.027)	0.225 (0.061)	0.185 (0.008)
Other HE Qualifications	NA	0.022 (0.128)	0.055 (0.028)	NA	-0.017 (0.196)	0.111 (0.025)
Sub Degree/ HE Diploma	0.14 (0.046)	0.264 (0.154)	0.078 (0.026)	0.177 (0.048)	-0.104 (0.094)	0.156 (0.017)
First Degree	0.100 (0.028)	0.156 (0.084)	0.277 (0.011)	0.262 (0.033)	0.207 (0.079)	0.254 (0.011)
Higher Degree	-0.052 (0.040)	0.203 (0.080)	0.076 (0.018)	0.049 (0.048)	0.335 (0.127)	0.177 (0.021)

Note: Dearden et al (2000). Estimates of additional log wage associated to each qualification category, with largest possible set of controls for each dataset. Standard errors within parentheses.

Extreme care should be taken when comparisons are being made between the NCDS and the two other data sets due to the fundamentally different nature of the data, the types of variables included, the detail of the information relating to personal and family characteristics, as well as the age profile of the respondents. Standard biases are also likely to be lower in the NCDS sample because of the richer set of background and ability variables, which are generally absent from the other datasets.[37]

[37] This point was thoroughly discussed in the methodology section.

Finally in this section, Lissenburgh and Bryson (1996) use data from the third cohort of the Youth Cohort Study to identify the effect of alternative higher education qualifications on reducing the probability of being unemployed. The authors do not find evidence to support any hypothesis linking alternative higher education qualifications with different probabilities of being unemployed. However, this finding is mainly due to the fact that more educated individuals are more likely to be observed at the beginning of their careers so that the unemployment they experience is often an initial spell on first entry to the labour market. The picture is very similar in terms of earnings, with individuals with a first or a higher degree not earning significantly more than individuals with a vocational qualification at NVQ Level 4.

5.1.3 Evidence based on Panel Data

Panel data are not particularly well suited for measuring returns to education as in general, the education variable undergoes little variation over the period for which wages can be observed. An interesting exception to this is the case of panel data where a sufficiently large number of individuals undertake some type of adult learning. Alternatively, panel data can be and often is used as a repeated cross section like the GHS or the FES. For example, Chevalier and Walker (2001) estimate the returns to qualifications from the British Household Panel Survey (BHPS). Their OLS estimates are reproduced in the following table:

Table 17: BHPS: The Returns to Education Qualifications (Selected)

Qualification	Men	Women
Higher Degree	.773 (.032)	.929 (.039)
Degree	.660 (.018)	.824 (.018)
A Level	.379 (.017)	.345 (.021)

Note: Chevalier and Walker (2001). Robust standard errors in parentheses. Models include year dummies, marital status, children, region dummies and regional unemployment rates. The omitted category is 'no qualifications'.

These results seem to indicate that the approximate rate of return to a year studying for a degree is smaller for men than for women, approximating 10 percent for men and 15 percent for women. The same authors estimate equivalent models using data from the GHS and find very similar estimates (see Table 18)

Table 18: GHS: The Returns to Education Qualifications (Selected)

Qualification	Men	Women
Higher Degree	.648 (.023)	.836 (.045)
Degree	.598 (.012)	.770 (.014)
A Level	.323 (.043)	.366 (.016)

Note: Chevalier and Walker (2001). Robust standard errors in parentheses. Models include year dummies, marital status, children, region dummies and regional unemployment rates. The omitted category is no qualifications.

Ermisch and Francesconi (2000) use a special sample from the BHPS 1991-1995, which matches mothers and their children at the age of sixteen. The authors treat education as an endogenous variable and distinguish between average and marginal returns to higher education.

Table 19: Returns to Higher Education from the BHPS

	Men				Women			
	Exog. Education		Endog. Education		Exog. Education		Endog. Education	
	All	Workers	All	Workers	All	Workers	All	Workers
HE Returns	18	18	22	31	67	69	81	84
A level returns	3	3	6	14	50	52	62	65
HE marginal returns	14	14	15	14	12	11	12	11

Source: Ermisch and Francesconi (2000) Returns are relative to no qualification and have been computed for individuals of age 25. Marginal returns represent percentage gain in earnings from HE relative to GCE A level qualification

By considering education as an endogenous variable, the results illustrate how an instrumental variable estimator delivers higher estimates than equivalent OLS estimates. The key assumption made in order to control for endogenous education is that parental information can control for sibling differences in education, and these differences will provide endogeneity corrected estimates of their effect on earnings.

These IV estimates are also likely to be less biased than OLS estimates but in the particular case that returns to education are heterogeneous across the population, there might be some exaggeration of the average effect of higher education. This is due to the fact that the instrumental variable can be expressed as the average effect defined on the narrower group of individuals who are more likely to be affected by the intervention considered. The fact that the sorts of interventions used as instruments by the authors vary considerably across gender may well explain the substantial differences in returns to education for males and females. It is also important to recall that compositional biases are more likely to affect female estimates.

5.1.4 Twins Studies

Much of the existing research that investigates the causal effects of education on earnings using twin data [38] depends on information relating to the number of years of post compulsory education. There are just two studies in the UK that make any use of twins' data. The study by Blanchflower and Elias (1999), which was based on a sample of 23 identical twins from the NCDS study, was affected by minimal variation in the education variable in such a very small sample. This did not allow the authors to estimate any effect of education on labour market outcomes.

The study by Bonjour *et al* (2000) focuses on a list of 4,500 pairs of identical and non-identical twins, mostly females, which has been built by the Twins Research Unit at St. Thomas's Hospital, London. Among other contributions, this study provides

[38] See for example Ashenfelter and Krueger (1994), Ashenfelter and Rouse (1998) and Ashenfelter and Zimmerman (1997) for the US and Miller *et al* (1995) for a US/Australian comparison.

empirical evidence on the existence of heterogeneous returns to years of education by estimating returns to qualifications.

Their methodology follows the study previously reviewed by Dearden (1999) in separating pre and post-school qualifications. The estimated OLS returns associated to the latter are reported in the following table. Unfortunately, the sample used does not contain a sufficient number of twin pairs for each qualification group and so pooled estimates are presented instead. [39]

Table 20: Returns to post-school qualifications

	Working identical twins/ all (inc. singletons)	Working identical twins/ pairs
Low vocational	-.050 (.064)	-.140 (.085)
Middle vocational	.091 (.079)	.083 (.103)
Higher vocational	.130 (.07)	.039 (.089)
Degree	.160 (.07)	.097 (.091)

Source: Bonjour *et al* (2000)

The coefficients of post school qualifications are lower compared to those obtained by Dearden, suggesting an annual rate of return for a degree of approximately 5-6 percent, two percentage points below the estimated rate of return for a homogeneous year of schooling. A much stronger premium is found in individuals who decide to continue from O levels to A levels (20.6 percent), which translates into an annual rate of return of approximately 10 percent per annum.

5.1.5. Evidence Based on Graduate Cohorts

Dolton and Silles (2001) analyse data from the Newcastle Alumni Survey. Although the main focus of their paper is the analysis of overeducation, their dataset provides information on the type of higher education received by students at University, the degree subject as well as the grade of degree obtained. This data can be used to compare the labour market outcomes achieved by university graduates with different types of qualification. They find that postgraduate qualifications help improve prospects of being adequately matched to a job (by between 5 and 10 percent probability points). Significant earnings effects of postgraduate degree attainment are also found in this study (approximately 18 percent) and assuming that the average duration of a postgraduate degree is two years we can infer an annualised rate of return to postgraduate study of 9 percent.

The 1995 Survey of the Career Paths of Graduates and Diplomates was designed in order to provide an event history within which respondents recorded details of their main activities since graduating. This study also recorded valuable information on the type of education obtained, the institution attended as well as earnings and other workplace characteristics. Unfortunately, it does not provide information on higher

[39] The authors show that pooled estimates are quite accurate as measurement and ability biases appear to offset each other. This evidence is based on within-pair estimates using years of education only.

degrees and qualification levels can only be distinguished between those with an undergraduate degree and other sub-degree categories. Unfortunately, the report by the DfES (1999) is not very specific about either employment and earnings effects associated with the completion of each one of these qualifications.

The First Destination Survey is probably the most frequently cited reference in terms of Graduate Surveys. This survey is of little use for the purpose of estimating returns to specific qualifications as it contains a very small number of observations reporting qualifications above the level of first degree.

5.2. Evidence from other countries: North America

Most of the work undertaken on estimating the returns to education in the United States has concentrated on the effect of years of education on employment and earnings outcomes. This element of research is not the prime focus of this section of the literature review, however, the results indicate that estimated rates of returns to schooling appear to be higher in the US than elsewhere, as the meta-analysis by Ashenfelter *et al*. (1999) indicates. The authors also argue that returns to education have increased in the U.S. in the last two decades.

In their work, the estimated return to years of schooling across a series of 41 studies is related to a range of other variables that may influence the estimated return. They find that estimates produced from twins samples or using instrumental variables techniques provide larger estimates (around three percentage points more) than conventional OLS estimates of the return to a year of schooling. The inclusion of ability controls reduces the estimates by five points approximately. The hypothesis of increasing returns to schooling over time is confirmed by the finding that the estimated return grows each year by approximately 0.2 percentage points.

The sparsity of the studies on the returns to higher education qualifications is reflected by the on-going debate on which is the correct measure of education, years of completed education or actual qualification attainment. The 'years of schooling' method of analysis has substantial backing in the U.S. education system, but as Card (1999) points out, is not influential in western European countries with multiple education streams. In addition, there is substantial controversy in the US about the existence of wage premia associated with the fulfilment of the final year of each schooling level, previously referred to as "sheepskin effects".

The procedure of augmenting standard earnings functions to explore non-linearities is followed by Hungerford and Solon (1987) and Belman and Heywood (1991). These investigations present evidence of non-linearity particularly concentrated around the 16^{th} year of schooling, which corresponds to college graduation. Following these considerations, the U.S. Census Bureau opted to shift towards a qualification-based system of measuring post-high-school education in the Census and the Current Population Survey. The new coding scheme implies that, instead of the number of years of school completed, the highest level of school completed or the highest qualification received will be recorded.

This change, according to Park (1994), provided researchers with a new source of data for estimating sheepskin effects. An accurate measure of these effects associated

with a degree would be the wage differential between individuals with and without such a qualification, conditional on having the same number of reported years of schooling. Park indicates that conventional sheepskin estimates, which only consider non-linear effects of years of education, produce results that are very sensitive to the chosen specification (namely, the choice of discontinuity points in the range of years of schooling) but are particularly significant with respect to schooling for more than 12 years.

Using both years of schooling and qualifications, Park finds that both are significant in order to explain wage differences between individuals. The following table summarises some of the results.

Table 20: Wage Differential by Selected levels of Schooling and Degree

Years of schooling	Some college	Associate	Bachelors Degree	Masters Degree	Profes-sional	Doctorate
12	.109					
	(.023)					
16	.248	.387	.458			
	(.059)	(.054)	(.014)			
18+			.560	.612	.850	.741
			(.042)	(.020)	(.047)	(.044)

Note: The dependent variable is the log of hourly wage. Standard errors are in parenthesis. OLS regressions also include experience polynomial and dummies for females and nonwhites. (Relative to those with 12 years of schooling and high school diploma)

It is apparent that conditional on the number of years spent in schooling, obtaining a degree qualification produces substantial earnings gains. These are especially noticeable if one compares those with 16 years schooling with a bachelor's degree and those completing 16 years schooling with just 'some college'. Comparing cells vertically, it is also possible to see how additional years of education, even when they do not contribute to additional qualifications, provide significant wage increments.

The conclusion from this study seems to be that both years of education and explicit qualifications matter. Unfortunately, since 1992 the CPS has no longer recorded both pieces of information on individual education, and more recent estimates of the returns to years of schooling require converting degree dummies into yearly returns with the associated difficulties. Nevertheless, this does not seem to be a substantial problem as both Park (1994, 1996) and Jaeger *et al.* (1996) suggest.

The previous results on the combined effects of years of schooling and degrees seem to coincide with the results obtained by Kane and Rouse (1995). They investigate the economic rationale for undertaking community-college education, which has been widely criticised in the US by many authors. They find that the estimated returns to a credit at a two-year or four-year college are both positive and remarkably similar (between 4 and 6 percent for every two semesters, i.e. 30 completed credits). They also present some estimates for different levels of higher education attainment. These values are summarised below:

Table 22: Returns to Higher Education

	NLSY72				NLSY			
	Hourly wages		Annual earnings		Hourly wages		Annual earnings	
	Men	Women	Men	Women	Men	Women	Men	Women
Associate	0.04	0.07	0.07	0.26	0.21	0.18	0.24	0.31
BA	0.23	0.23	0.28	0.39	0.34	0.33	0.42	0.51
Graduate	0.03	0.29	0.37	0.61	0.44	0.43	0.67	0.57
Other deg.	NA	NA	NA	NA	0.08	0.31	0.18	0.35

Note: Kane and Rouse (1995). OLS results. Regressions for NLS72 include race, parental income, rank in high school, experience polynomial, dummies for region, part time employment, and city of residence size, number of credits for two and four year college. The comparison group is white non-Hispanic individuals with high school. NLSY regressions also include parental education and AFQT score. The coefficients presented represent the earnings premia achieved over those with a high school education only.

Finally, in this section, Heckman *et al* (2000) estimate the different effects of completing at least 13 years of schooling using data from the National Longitudinal Survey of Youth (NLSY). Their estimating technique accounts for the possibility that unobservable differences in potential earnings with and without higher education might be correlated with unobservable factors that determine the final schooling decision. The results show that the receipt of some form of college education tends to raise the hourly wage of a randomly selected person by 6 to 9 percent. For those who actually select into college, the results are lower, ranging from 2.8 to 4 percent. Their main empirical finding is that marginal entrants get lower returns than those who precede them in attending college.

5.3 Evidence from other countries: Europe

The vast majority of the empirical evidence available that attempts to compare returns to education across European countries refers to the return to years of schooling. This is in part due to the extreme differences between educational institutions and practices across countries.

Table 26 (see appendix) presents an overall picture of relative earnings across educational groups for OECD countries. The table indicates that both the UK and the US are characterised by having more educated individuals earning more than the overall mean for all countries relative to individuals with only upper secondary education. This sharp average earnings differential is not only found at the top of the education distribution. If we look at the earnings differential between those with upper secondary and the least educated, the UK and US earnings premia are also found to be larger. These figures, however, are merely a simple description of the statistical association between qualifications and earnings, which may not be robust to the inclusion of additional variables such as experience.

Walker and Woolley (1999) use internationally comparable data (ISSP Data), which finds large returns to education for Great Britain and Northern Ireland. Their results are summarised in the table below for a few selected countries:

Table 23. OLS Estimates of the Returns to Years of Education: ISSP Data

Country	Male	Female
Great Britain	.1299	.1466
	(.0057)	(.0069)
N Ireland	.1766	.1681
	(.0111)	(.0127)
Republic of Ireland	.1023	.1164
	(.0051)	(.0081)
West Germany	.0353	.0441
	(.0020)	(.0036)
Sweden	.0367	.0416
	(.0047)	(.0047)
Spain	.0518	.0468
	(.0071)	(.0099)
Italy	.0398	.0568
	(.0025)	(.0036)
USA	.0783	.0979
	(.0045)	(.0058)

Walker and Woolley (1999). Various years estimates. Standard errors in parenthesis. Regressions include year dummies, age polynomial and union status. Table reproduced from Chevalier and Walker (2001)

In the absence of comparative studies in terms of qualifications, this section presents some preliminary results on the returns to higher education for a set of European countries. The European Community Household Panel provides a rather unique dataset because of its implementation at a relatively large scale across a number of different countries. Comparisons need to be drawn with caution as some differences have been found in the implementation of the questionnaire, which adds to the substantial differences in terms of educational systems.

The education information is condensed under relatively coarse categories, probably with the aim of making cross-country comparisons easier. Thus, individuals can only be categorised in three different educational attainment groups: 1) Possession of a tertiary degree qualification. 2) Secondary school qualifications. 3) Primary or no qualifications at all.

The exercise carried out is particularly simple. It consists of ordinary least squares regressions of log hourly wages on a set of variables including dummies for educational attainment. The sample consists of male employees', aged between 21 and 64, which at this preliminary stage is just intended to reduce the problem of endogenous labour supply. In order to present a clearer picture of the effect of tertiary education, those with no or only primary qualifications are dropped from the sample too. In the absence of selection into education and other econometric problems, the estimates for the dummy "tertiary education" would be expected to recover the average return to tertiary education.

Table 27 (see appendix) provides the estimated coefficients with their associated robust standard errors for the available set of countries according to four different specifications. As noted previously, comparisons have to be made very cautiously. The ranking across countries in terms of the returns to tertiary qualifications is fairly robust to the specification chosen and the UK appears to be one of the countries achieving above average returns to higher education. If one takes into account that

these qualifications have a much shorter duration in the UK than for most European countries, the rank in terms of the rate of return associated with the study of tertiary qualifications is even higher. This seems to confirm the conclusions in Walker and Woolley (1999) and Trostel *et al* (2001).

5.4. Education and Employment

In a labour market, the success of an education system can manifest itself among other things in the success of an individual in finding and holding a job, not only on the employer's willingness to pay a premium for the individual's additional skills.

As reported by Steel and Sausman (1997) for the United Kingdom, two key stylised facts can found in the data on unemployment and qualifications. Firstly, women are generally less likely to be in employment than men, particularly after the age of 25. Secondly, employment rates for men do not differ substantially between graduates and non-graduates after their early 20s until they are aged over 40. By contrast, employment rates for women differ considerably between graduates and non-graduates in the 25-29 year age band.

In recent decades, OECD countries have been witnessing an increasing demand for individuals with upper secondary and tertiary qualifications. In most countries, education policy seeks to encourage young people to complete at least upper secondary education. This development acknowledges an increasing risk of exclusion for those individuals who have lower qualification attainment, as the OECD acknowledges.

It has been suggested that the reason why recent increases in the wage premium experienced by the more educated in the US and UK cannot be generalised to other European countries reflects the different role played by institutions such as unions, minimum wages, labour taxation, etc. across countries. It is argued that these institutions tend to compress wages and accordingly reduce the magnitude of the premium to higher education, but on the other hand fail to enhance employment levels and reduce unemployment rate differentials. Tables 28 and 29 (see appendix) shed some light on this issue by examining labour force participation rates and unemployment rates of groups with different levels of education.

These tables seem to confirm the extent of the advantages associated with higher education in the UK compared to other countries. The difference in labour market outcomes for individuals in the UK with tertiary education relative to those below upper secondary is more acute than for the average of countries considered. This is found to be true both in terms of participation probabilities and unemployment risk and thus strengthens the results relating to earnings. This work also suggests that policy decisions based purely on earnings differentials would underestimate the expected return of higher education, as a considerable part of it is embedded in a higher probability of accessing a job[40].

[40] The expected wage premium to higher education should actually be computed as follows: Prob(empl| HE) * logwage(HE) - Prob(empl| less than HE) * logwage(less than HE) .

5.5 Section References

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6. Business Returns

6.1. Theoretical issues: General and specific human capital. The case of higher education.

Under classical assumptions about the functioning of markets, all economic returns to different kinds of investments in human capital should reflect themselves in differences in wages. However, wages need not coincide with the marginal productivity of workers for a large number of reasons. For example, it is costly for individuals to acquire information about job opportunities and it is also difficult for firms to acquire accurate information regarding a candidate's real productivity. In these situations, incumbent firms enjoy some degree of monopsonistic power over their employees and can indeed offer wages below productivity. As a result of this, wages will end up failing to reflect the full extent of the positive effect of certain skills, such as those acquired by means of pursuing higher education.

To elaborate further on this point, it is helpful to examine the nature of investments in human capital. Becker (1964) drew a distinction between different types of human capital depending on whether skills were or were not transferable to other firms. In the case of general skills, as some would categorise higher education, there would be no incentive for firms to invest in them and it would be up to the individual to bear the full cost of such an investment, which, in the absence of any spill-over effects and informational asymmetries, would be optimal and wages would fully reflect the resulting added value. Regarding firm specific investments, it is easy to realise that firms would follow the strategy of paying less than full productivity as long as the worker cannot find an alternative employer that can fully reward such skills.[41] In anticipation of this type of employer behaviour, workers will never optimally invest in firm specific skills because they will just receive part of the return. It follows that, under some circumstances, it might be optimal for firms to contribute themselves to their workers' skill upgrading. These two extreme conceptions of investment in human capital mark the boundaries for a continuum of intermediate combinations.

A more recent result that has been outlined by authors such as Stevens (1994), Acemoglu (1997) and Acemoglu and Pischke (1999) indicates that even some types of human capital investment that would be described as general in Becker's terminology may not be fully rewarded by employers through wages. This is explained by the fact that human capital becomes firm-specific when the prevailing labour market conditions gives monopsonistic power to incumbent firms, which is often driven by a privileged knowledge of the worker's productivity. Put in other words, we could talk about the existence of endogenous firm-specific skills: skills become specific because other firms are not able to value them properly as a result of, for instance, uncertainty about the extent of such skills. Information is an important good in practice and it is obviously not equally distributed across all economic agents. This informational asymmetry captures a key aspect of the way real labour markets operate in practice. From this point of view, the skills provided by higher education qualifications, which are frequently thought of as general human capital, could fall under the category of firm-specific human capital. Moreover, very specific

[41] This turns out to be the case if the skills are only valuable to the incumbent firm. If the firm has all the bargaining power then it is free to fix a wage marginally above the highest wage that the worker could obtain elsewhere and remain immune to competition from other firms.

qualifications could have a very limited number of potential employers requiring such skills. This would reduce the level of competition between the few existing potential employers and therefore provide them with more bargaining power than in a standard competitive setting. Thus, it is theoretically possible that wages fail to reflect the full extent of the benefits firms enjoy when their workers have a higher education degree.

6.2. Methodological issues.

There are several empirical implications about the measurement of the returns to higher education accruing only to employers following from these theoretical considerations. First, the existence of firm sponsored education will be a good indication of returns to the employers that would go unmeasured if only returns to employees were considered.[42] As said before, some types of worker training reflect the presence of specific human capital and theory tells us that wages will fail in general to reflect the productivity value of such skills. Second, by realising the incompleteness of wage figures as a means to capture the full value of skills, a natural way of pursuing this kind of study would involve looking at firm performance measures.

There are obvious problems regarding the choice of alternative performance indicators, as it is very difficult to attribute a certain and consistent amount of output to a given worker's efforts. This type of analysis involves the estimation of some type of outcome function where higher education enters as an input. Given that the unit of analysis is the firm, it is necessary to reconsider this input as the number or proportion of employees with higher education.[43]

Most research has concentrated on the effects of training on profitability, sales and innovation success. However, higher education is rarely included as an input. As Blundell *et al* (1999)[44] point out, there are several problems in measuring any type of return to qualifications to firms because of the lack of adequate data on firm productivity, competitiveness and profitability. Even under the assumption that such data has been properly measured, it is extremely hard to establish any type of causal relationship as it is not clear whether it is firms with a better endowment of human capital that perform better or it is actually the case that firms performing better are led to choose a more skilled workforce.

In some cases, training variables embed the presence of current workers that attend some type of higher education course.[45] Incumbent firms may provide incentives for

[42] There are obviously alternative reasons why employers would provide education for reasons unrelated with productivity. We find these reasons, however, less relevant in practice. If firm sponsored learning were considered merely as an alternative source of worker compensation (asides from wages) and this were the only explanation, we would expected to find a wage penalty. The empirical evidence seems to suggest the opposite.

[43] The standard practice in the literature that estimates production functions only distinguishes between blue and white-collar workers, which is more of a functional than educational classification. See for example Levinsohn and Petrin (2000). See also Griliches (1970) for a discussion of the role of education in production and its aggregate effect on the economy.

[44] Their survey provides a brief survey of empirical studies on the impact of training on a) worker productivity, b) firm profitability and c) long-term competitiveness.

[45] This would be the case of surveys that only inquire on firm sponsored training and/or education or aggregate financial investment in worker's human capital, without going into further detail.

this type of behaviour by sharing part of the costs or by compensating the employee with less working hours. There is a possibility that firms do not benefit at all from this human capital investment when workers invest in education in order to improve their employability prospects in a different (and better) firm. Machin and Vignoles (2001) provide a detailed account of the empirical evidence in the UK on the economic benefits of training to the firm.

An alternative approach is to examine a firm's demand for workers with higher education qualifications and assess their performance in relation to these hiring practices. The complexity of the problem is obvious as an econometrician would find it difficult to find variables that affect demand for skilled workers but not market performance and vice versa, i.e. variables that influence performance but not demand. In practice, at most one of these instruments can be found and the standard practice is to assume the existence of a triangular system. For example, it will be easier to estimate a production or profit function where the number of educated workers, although endogenous, does not depend on the actual performance of the firm. The empirical strategy towards identifying and estimating the responsiveness of the performance measure to the skilled labour input will consist in finding in the data some type of instrument that affects the demand for this type of labour but bears no consequences on the firm's performance.

6.3. Empirical evidence.

Using French and British[46] establishment level data, Caroli and Van Reenen (1999) show that the share of skilled workers (defined as being those workers above compulsory education) has a positive effect on the incidence of organisational change taking place. Bishop (1994) indicates that more educated workers tend to make more suggestions about work processes and be more innovative on the job in general.

Duguet and Greenen (1997) find that a larger proportion of skilled labour leads to a higher probability of innovation taking place in French firms, even after controlling for the possible endogeneity of skill composition. Using French data, Goux and Maurin (1999) argue that after controlling for the selectivity of firms' training practices, the estimated impact of post school training on wages becomes negligible. However, they also find that training is mainly beneficial to employers, partially by reducing the probability that employees switch firms.

The statistical associations between education and profitability are also studied by Leiponen (2000). Using a panel of Finnish manufacturing firms it is found that innovation is correlated with educational measures of competence. This correlation appears to depend on the presence of a sufficient share of employees with general skills acquired in higher education, which is consistent with the view that these skills enable workers to adapt faster and better to a firm's needs to become more competitive. This study, however, does not clearly establish a sound causal relationship between education and performance.

According to Green (1999), most UK employers believe that training is beneficial to their firms and that training creates a more productive work force. However, this

[46] Workplace Industrial Relations Survey for the UK and REPONSE for France.

measure of training is not particularly detailed or elaborated upon so it is not possible to identify the role played by higher education in increasing productivity. Another caveat associated with this strand of research relates to the discrepancies of employers' responses to these types of questionnaires, as the comparison with the research by Keep and Mayhew (1996) and Keep (1999) seems to suggest. Additionally, the work that has investigated the link between training and firm performance has generally looked at the impact of training on intermediate indicators such as labour productivity, employment growth and labour turnover rather than overall firm profitability (Green, 1997). This does not apply to all the existing literature, for example, Ashton and Green (1996) summarise comparison between plants and find a positive correlation between workforce skills and productivity.

Dearden, Reed and Van Reenen (2000) have constructed industry-level data on training and productivity levels and found sizable correlations between higher productivity and higher industry rates of training. The overall effect of training on productivity is around twice as high as the wage effect. These authors clearly recognise the problem of potential endogeneity of training. The benefits of training to firms that have actually undertaken the training of their own workers may not be easy to extrapolate to representative firms in the economy. Otherwise, it would be difficult to understand why some firms do not train their workers at all. Despite this criticism, the economic benefits of skills on performance appear to be significant and should be used as a first approximation to the indicator that should guide future policies.

The evidence for the US is mixed. Black and Lynch (1995) use firm level data to show that the equivalent of an extra year of educational attainment amongst workers raised productivity by a figure between 5 and 12 percent. Their results were however mixed when they investigated the impact of different training measures on firm productivity.

Finally, there exists a vast literature that estimates conditional educated labour demand functions from firm-level data. This is an alternative approach to estimating demand equations from worker data, where the dependent variable is the cost or employment share of educated workers (according to differing definitions). Under certain conditions, estimates can recover part of the structure of the underlying production functions and are particularly relevant in the estimation of the elasticity of substitution between different kinds of labour as well as determining the relative complementarity with physical capital and technology. Most of these research efforts have been aimed at determining the underlying causes of recent patterns of increased demand for skilled workers and testing competing explanations such as skill-biased organisational changes, skilled-biased technical progress, etc.[47] This framework, however, does not render itself as suitable for determining returns to higher education as the standard wage equation approach but can in turn provide very useful information about the role of skills in production.

[47] See for example the survey by Caroli and Van Reenen (1999).

6.4. Conclusions.

The previous discussions emphasises the importance in empirical analysis of having access to a sufficiently rich dataset. Given the substantial importance of multiple causality relationships, the most promising results have been derived from using matched employer-employee panel datasets, which are sufficiently representative for the whole economy. The creation of matched datasets would have the advantage of providing a much better scope for comparing firm and worker outcome variables and the panel dimension would allow researchers to look at the causality problem from a dynamic point of view as well as being able to control for firm and worker time invariant fixed effects.

This recommendation of the creation and usage of matched employee-employer datasets can also be found in Machin and Vignoles' (2001) survey, who indicate the existence of such datasets for the US and France. This is also the case for Germany, based on the matching of Social Security records and the IAB establishment panel survey.[48]

Despite this not being an assessment of UK data availability for carrying out studies on the effect of skills usage on a firm's performance, it might be useful to make a brief comment on this issue. The Workplace Employee Relations Survey (WERS98) is a national survey of British workplaces. It contains information on a firm's performance as well as data on employees' education obtained through questionnaires delivered to workers of firms that agreed to this. This data provides a useful tool to assess the effect of workers skills on a firm's performance because the education variable indicates whether an employee has a degree or not. It is also possible to investigate the effect of qualifications above the degree level. It is expected that new research will be soon available that will shed some light on the effect of higher education on firms' performance.

The available empirical evidence seems to confirm the hypothesis that wages are not a sufficient measure of a worker's productivity. This indicates that firms perceive significant returns from their worker's qualifications that are normally not taken into account when evaluating the benefits of skill accumulation. However, there is no evidence on the relative importance of higher education in shaping this productivity-wage gap. Nevertheless, it would be wrong to conclude that the pure returns to higher education to firms are negligible. What this review reflects is the need to proceed with further research into this issue, as suggested above.

[48] No trace was found of empirical studies based on these datasets that estimate a structural model of workforce qualifications' effect on firms' outcomes.

6.5. Section References

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7. Wider benefits of education

7.1 Introduction

In this section, we review economic research on the wider benefits of higher education to the individual (i.e. non-monetary benefits), and to society (both economic and non-economic). The focus of attention among labour economists has traditionally been on estimating private returns to schooling. However, there is a large literature addressing non-monetary and social benefits of schooling, though there are much fewer studies focusing specifically on the benefits of higher education. We review relevant literature under four main headings: the 'social rates of return' approach; wages in cities; macro approaches; and non-monetary outcomes.

The 'social rates of return' approach evaluates the benefits and costs of education within an accounting framework. Gross wages are used as the relevant measure of benefits. This ignores any benefits to education that are not reflected in the wage for the individual and any spill-overs to other people (e.g. learning from others) or to the economy in general (e.g. arising from greater innovation). Thus the method does not allow any assessment of whether human capital externalities exist, which is a more relevant reason for government intervention than a high internal rate of return.[49]

A literature has recently emerged that specifically focuses on whether education externalities exist at the city-level that are observable in the wages paid to workers. There are several very recent papers on this subject. However, a number of important methodological problems in this literature make it difficult to interpret results (see for example Manski (1993, 2000). So no very concrete conclusion have emerged as yet. Also, it is debatable as to whether human capital externalities are most relevant at a city-level in comparison to a lower (i.e. firm) or higher (i.e. economy) level. For example, Gemmell (1997) argues that while for graduates, it is fairly easy to accept the idea of externality effects on other employees within the same firm, it is less easy to conceptualise how spill-overs might benefit other firms in the same, and especially in different industries.[50] Sianesi and Van Reenen (2000) argue that an advantage of the macro-economic approach is its potential to capture very wide effects of educational investment on economic growth (including effects such as better public health and lower crime).

There is a vast literature on the effects of human capital on economic growth. Thirty years ago, Fritz Machlup (1970, p.1) observed 'the literature on the subject of education and economic growth is some two hundred years old, but only in the last ten years has the flow of publications taken on the aspects of a flood'.[51] There are two main theories - the neo-classical Solow model, wherein human capital is a factor of production and 'new growth theories', which give emphasis to the potential impact of human capital externalities as well as the role of human capital as a direct production input. There have been several recent reviews of this literature (Sianesi and Van Reenen, 2000; Topel, 1999; Gemmell, 1997). Although there is good

[49] It is to be expected that the market wage, to some extent, compensates individuals for their social contribution.

[50] This is distinguished from 'R&D/ideas' models where the externality argument may be more widely applicable.

[51] This is cited in a recent paper about education and growth by Krueger and Lindahl (2000).

evidence of a positive association between human capital and economic growth, the evidence is consistent with different theories. Also, methodological problems in this literature make it difficult to interpret the coefficient on education.[52] Finally, although many social benefits of education such as better public health and parenting and lower crime are likely to feed back into economic growth (Sianesi and Van Reenen, 2000), it is of interest to investigate the influence of higher education directly on these non-monetary outcomes. There is a considerable body of literature on this topic, though the unique impact of higher education (as distinct from other levels) is not often addressed.

We review the four strands of literature in turn and then draw some general conclusions.

7.2 Social rates of return: an accounting framework

7.2.1. Methodology

There is a very extensive literature attempting to estimate the private and social returns to education using an accounting framework. The main idea is to calculate the internal rate of return to education. This involves evaluating the profitability of any given investment by calculating its (discounted) flow of benefits and costs. The internal rate of return is that discount rate for which the present value of benefits less costs equals zero. It can then be compared to the reference discount rate for the decision-maker.

Compared to the computation of private rates of return, social rates of return take account of all the direct costs of schooling (not just those borne by the individual) and use pre-tax (instead of post-tax) earnings. Thus, all the costs of education are included while many of the potential benefits are excluded (e.g. externalities in the form of macroeconomic and social gains, and the lower risk of unemployment faced by individuals with more education).

Implementation of the methodology generally involves use of survey data where earnings of graduates and non-graduates can be compared. For example, Steel and Sausman (1997) use the General Household Survey (averaging over 1989-95 data) to measure the flow of benefits to the economy by looking at how much more employers are willing to pay for graduate level skills in comparison to someone with two or more A-levels. The graduate earnings premium is assumed to mainly reflect productivity differences between the two types of workers. However, to account for other determining factors (such as ability or motivation), the estimate is scaled down according to an 'alpha' factor. Following the work of Denison (1964), in many studies the alpha-coefficient is taken to be 0.66 (i.e. this is the proportion of the earnings premium attributed to education). However, this has been the cause of some controversy among researchers in this field (see discussion in Hough, 1994). For example, Psacharopoulos (1975) suggests that a figure of 0.7 or 0.8 may be more appropriate. Costs include the cost of teaching and the indirect cost of output foregone during the period of study for a first degree. Steel and Sausman (1997) base their estimate of the latter on the cost to a firm of employing a non-graduate (with two or

[52] Methodological problems are reviewed in detail by Sianesi and Van Reenen (2000).

more A levels) of comparable age to an undergraduate. They then adjust this cost to account for 'wastage' (i.e. entrants who do not complete their study). They report 'social rates of return' by gender, age group and for different values of alpha.

When used to calculate private rates of return to education, studies of this type seem far less convincing than economic studies estimating this rate of return from a wage equation. Whereas the latter type of study involves estimation of the private rate of return to higher education while controlling for all other relevant characteristics of respondents, the 'accounting' method only involves making various crude adjustments to account for uncontrolled characteristics. When estimating 'social rates of return' the same criticism applies with the strong additional disadvantage of failing to account for potentially important social benefits. So the meaningfulness of estimated 'social rates of return' is questionable. As stated by the NICHE (1997), such calculations appear to offer a narrow measure of the impact of graduates on the economy. 'It is possible, for example, that graduates raise the productivity of non-graduate colleagues and help spread technological change. It is also possible that graduate salaries are not actually an accurate measure of graduates' own productivity if the labour market works imperfectly.'

7.2.2 Social rate of return estimates

Steel and Sausman (1997) calculate the social rate of return for graduates in the UK from the General Household Survey. In table 23, we show estimates of the private and social rate of return using this accounting methodology.[53] The comparison group is employees with two or more A-levels. More recent DfES estimates of social rates of return are also shown. The latter estimates are based on earnings data from the Labour Force Survey, which has a larger sample of graduates than the General Household Survey.

Table 24: Social and private rates of return to full-time first degrees

	All ages			**18 year-olds**	
	Alpha=0.6	Alpha=0.8	Alpha=1	Alpha=0.6	Alpha=0.8
Men	6	8	-	7	9
Women	8	10	12	-	-
All	7	9	-	-	-

a) Steel and Sausman: social rates of return (%)

	All ages			**18 year-olds**	
	Alpha=0.6	Alpha=0.8	Alpha=1	Alpha=0.6	Alpha=0.8
Men	9	11	-	11	12
Women	14	17	20	-	-
All	11	14	-	-	-

b) Steel and Sausman: private rates of return (%)

[53] The private rate of return is calculated in the same way as the social rate of return except that only benefits and costs accruing to the individual are considered in this approach.

	All ages			18 year-olds	
	Alpha=0.6	Alpha=0.8	Alpha=1	Alpha=0.6	Alpha=0.8
Men	6	8	-	8	10
Women	9	11	-	9	12
All	8	10	-	9	11

b) DfES: recent estimates of social rates of return (%)

Thus social rates of return are in the region of 6-12%, varying according to gender, age, the value of alpha and the data-source/time period. This is below the private rate of return, estimated by Steel and Sausman to be between 9% and 20%. Sianesi and Van Reenen (2000) report that social rates of return are consistently found to be lower than private ones, a fact that can generally be attributed to the direct cost of schooling. Steel and Sausman (1997) draw attention to the higher rate of return estimated for women. They attribute this to the very different career pattern of graduates compared with non-graduates (who are more likely to take long career breaks) and the fact that women non-graduates are more likely to be employed in part-time work.

The OECD (1998) has used this methodology to calculate the private and social rates of return to university education in several countries. Estimates are shown in Table 25.

Table 25: Private and Social returns for university education for men, 1995

	Private rate of return (%)	Social rate of return (%)
Australia	14	11
Belgium	14	9
Canada	14	9
Denmark	8	8
France	20	13
Sweden	-	9
US	11	10

Source: OECD, 1998. From table A4.3
Note: there appears to be no adjustment for 'alpha' in these estimated returns.

Ashworth (1998) uses the 'social rates of return' methodology to cast doubt on whether further expansion of higher education in the UK is socially beneficial. He contributes to a wider debate about whether past and future expansion of higher education is a 'waste of resources' (see also Murphy 1993; Keep and Mayhew, 1996). In Ashworth's (1998) analysis, this question is addressed entirely within the framework of the 'social rates of return' methodology. He does not refer to broader literature attempting to identify the social and economic benefits from education (e.g. the growth literature). Also, this debate completely disregards the redistributional benefits of expanding higher education. However, if one lends credence to this methodology, a natural application is to consider whether higher education should be expanded.

Ashworth (1998) agrees with Johnes (1993) that it is future graduates and their impact on the economy that is of importance and not the present stock. Ashworth (1998) states that in a pre-expansion world, the average and marginal graduates could be treated as being fairly close to one another. However, with a large expansion this is no longer the case. Ashworth (1998) makes a long list of assumptions to show that relative returns to 'marginal' graduates and non-graduates could change under various

scenarios in which marginal graduates are less productive than previous graduates and there is some oversupply of graduates (in which many graduates would be doing similar work to non-graduates without a corresponding increase in productivity). Detailed estimates are provided under various scenarios but the conclusion is that the returns from 'marginal' graduates are much lower (perhaps as low as 3%).

Steel and Sausman (1997) also suggest a potential difference between 'marginal' and 'average' rates of return due to the expansion of higher education, though they do not go so far as to estimate the difference. However, they suggest that the increased supply of graduates mean that rates of return for current graduates might be less than earnings differences imply.

If one were concerned that the 'social' rate of return might really have declined during the 1990s for the reasons outlined, a way of checking would be to look at whether private rates of return (estimated from wage equations) have declined over this time period. Walker and Zhu (2001) show OLS regressions estimated for men and women between 1993 and 2000. They show that the estimated private rate of return to obtaining a Bachelors degree has remained fairly constant. Since the expansion of higher education has not diminished the average private rate of return to education, it is difficult to see how it could diminish the average 'social rate' of return (in the framework of this accountancy analysis). The only possibility might be if recent graduates are very different from other graduates in their observable or unobservable characteristics (e.g. ability). Then the private and social rates of return for recent graduates may differ from the average.

7.2.3. Social rates of return by subject

This type of methodology has also been used to calculate social rates of return by degree subject. Steel and Sausman (1997) report DfES estimates from the latter half the 1980s. They are reported in table 25. They state that results show negligible returns to arts subjects and relatively high returns to social sciences (a grouping which includes law, accountancy, business studies and economics). Returns to engineering fall just below the average for all subjects and returns to the science subjects are slightly lower.

Table 26: Social rates of return to first degrees by broad subject group: young men; 1986-89

Subject	%
Social sciences	11-11.5
Engineering	5-6.5
Science	4.5-5.5
Arts	--

Source: Steel and Sausman (1997)

This pattern reflects differences in the costs of providing tuition in the different subjects and differences in the pay premia earned in the labour market. Arts subjects are generally less expensive to provide but show, on average, a low graduate pay premium. In contrast, engineering and science subjects are more expensive to provide but appear to lead to a higher premia than arts subjects. Social science subjects combine relatively low costs and, on average, high graduate pay premia. Dutta *et al.* (1999) provide more recent estimates of 'social rates of return' by subject. However,

their subject groupings are much broader, making results difficult to compare with the earlier study. Estimated rates of return are zero for graduates of biological sciences and humanities. They are about 7.5% for graduates of the group defined as 'engineering, architecture, mass communication and education'. They are highest, at 11.4%, for the group defined as 'medicine, agriculture, physical sciences, maths and computing, social studies, business studies, design and general courses'.

It is interesting to observe the difference between these findings and those reported in the growth literature (see below). In contrast to the 'social rate of return approach' (especially as reported by Steel and Sausman, 1997), studies based on the macro approach find high 'social returns' (i.e. in terms of economic growth/productivity) to measures of engineering and science graduates but a negative return to legal studies. Birdsall (1996) argues that graduate training in science is partially a public good in that successful graduates tend to enter teaching or research and receive less in salaries than the full value of their marginal social value. This shows how the definition of 'social returns' and the methodology applied can dramatically change results and potential policy implications.

7.3 Wages in cities: measuring externalities

7.3.1 Theoretical issues

This literature focuses very explicitly on externalities that may arise from education. The potential existence of human capital externalities has long been recognised in the economics literature. For example, Marshall (1890) argued that social interactions among workers in the same industry and location create learning opportunities that enhance productivity. The recent, growing literature in this area draws attention to several other mechanisms through which human capital externalities may be generated. For example, Acemoglu (1996) develops a theory in which externalities from education arise if human and physical capital are complementary factors of production and firms and workers are imperfectly matched.[54] The idea is as follows: firms' choice of jobs and physical capital depend on the education and skills of the workforce. Firms expecting to hire more educated workers will invest more in physical capital. Some workers who have not increased their human capital nonetheless obtain jobs in these firms and end up working with more physical capital, thus earning a higher rate of return on their human capital.

It has been argued that such human capital externalities should be stronger at the city-level rather than for countries or regions (Ciccone and Peri, 2000; Lucas, 1988; Glaeser *et al*., 1992). However, this is a controversial issue. Sianesi and Van Reenen (2000) point out that positive effects may accrue at a higher (national) or lower (firm) level of aggregation. Most empirical work in this area has attempted to identify human capital externalities through estimation of a wage equation that includes average schooling in cities (as well as individual schooling) as a variable. There is only one study in this literature, Moretti (1998), where human capital externalities from higher education are specifically investigated.

[54] Other theoretical work on externalities in cities includes Jacobs (1969, 1984); Henderson (1988) and Lucas (1988, 1999).

The critical assumption behind all these studies is that 'average education' affects individual wages only because of the presence of human capital externalities. There are a number of reasons why this assumption may not be tenable[55]. Firstly, a worker's education level may be endogenous due to the presence of unobserved factors that influence wages and the worker's education investment decision. Secondly, 'average education' may be endogenous if there are unobserved factors influencing wages and the proportion of educated workers in a city. For example, unobserved factors that make a city an attractive location may raise wages and attract more highly educated workers to that location. Moretti (1998) uses instrumental variables to control for the potential endogeneity of 'average education'. Acemoglu and Angrist (1999) find instruments for both individual and average education.

However, Ciccone and Peri (2000, 2001) have a more fundamental criticism of this approach. They argue that if workers with different levels of education are imperfect substitutes in production, an increase in the supply of highly educated workers will tend to increase wages of workers with lower levels of education even if there are no externalities (i.e. highly educated workers are paid their marginal social product). So individual wages will partly depend on the relative supply of workers with high and low levels of human capital in the city. Hence an effect of 'average education' on individual wages is not necessarily indicative of the existence of human capital externalities. 'Average education' only identifies the effect of human capital externalities if it is assumed that workers with different levels of education are perfectly substitutable. However, it could be argued that it is interesting to identify social returns to education, whether they come from human capital externalities or complementarities in production. In this case, one would not object in principle to the methodology applied in other studies (e.g. Moretti, 1998; Acemolgu and Angrist, 1999).

Ciccone and Peri (2000; 2001) develop an alternative theoretical framework where the effect of human capital externalities can be identified in a context where workers with different human capital are imperfect substitutes. Their idea relates to the influence of average human capital on average wages controlling for the labour force composition of cities (in terms of human capital characteristics). In this framework, a change in the average level of human capital will only influence average wages if there are human capital externalities. The intuition is as follows: consider an inflow of highly educated workers to a city. If there are no human capital externalities, workers will be paid their social marginal product. Other workers will be unaffected by this change. Wages weighted by the city's labour force composition before the human capital inflow will be the same before and after the increase in average schooling. However, if there are human capital externalities, the incoming, highly educated workers will be paid below their marginal social product and some of the benefit of higher aggregate production will accrue to workers already in the city. In this case, the inflow of human capital will increase average wages holding labour force composition constant. Ciccone and Peri's (2000; 2001) empirical work is built around this theoretical framework.

[55] See Manski (1993; 2000) for a more general discussion on the difficulties of interpreting 'average' behaviour on individual outcomes.

Thus, there are clearly difficult identification issues involved in establishing whether human capital externalities exist at the city-level. A more general problem with all these studies is the assumption that such externalities will be reflected in the worker's wage. As stated by Sianesi and Van Reenen (2000), average education may provide externalities not captured by workers through their wages. Individuals may benefit in a non-pecuniary form (e.g. type of tasks, supervisory effort, quality of working and living environment) and spill-over effects may partly accrue to employers rather than to workers. Even if externalities initially raise the market wage, this may attract people to cities (increasing labour supply) and thus reduce this effect (see Glaeser, 2000).

7.3.2 Empirical studies

Rauch (1993) is the first empirical study attempting to measure human capital externalities by estimating wage equations. He uses US Census data on wages and human capital of individuals in 237 cities in 1980. He includes 'average schooling' as a variable and assumes that this reflects the effect of human capital externalities. He estimates a premium for the latter of about 4 per cent. However, as noted by Moretti (1998), Rauch's assumption that city average education is historically predetermined is problematic if better-educated workers tend to move to cities with higher wages. Moretti (1998) deals with this problem by treating 'average education' as an endogenous variable. The demographic structure of different cities in 1970 is used as an instrument for changes in education over the 1980s.

Using data for the US 1980 and 1990 Census, Moretti (1998) uses the variation in average education across 282 metropolitan areas to measure the external effect of wages on education, after controlling for private returns. He finds that a one-year increase in average education in a city raises average wages by 8 to 15 per cent. However, Moretti (1998) raises the issue later developed by Ciccone and Perri (2000), that this result does not necessarily point to an externality effect, since it may be due to complementarity between high and low educated workers.

Moretti (1998) is the only study in this literature that considers the potential influence of externalities arising from higher education specifically. His findings are that a one per cent increase in the labour force share of college graduates increases the wages of high-school drop-outs and of high-school graduates by 1.3 and 1.2 per cent respectively. For a one-year increase in city average education, the corresponding figures are 22.2 and 11.7 per cent. It is argued that for the best-educated group, results imply that the educational externality is strong enough to out-weigh the negative impact of relative demand and supply.

Sianesi and Van Reenen (2000) comment that this study offers a credible methodology for identifying and measuring the external return to education and view the main problem as the treatment of individual education as exogenous. Acemoglu and Angrist (1999) address this issue and instrument both average education and individual education in the wage equation. They show that instrumenting average schooling but not individual schooling may be misleading if instrumental variable estimates of private returns differ from OLS estimates.

Acemolgu and Angrist (1999) also use US Census data (mainly 1960-80) to look at this issue. They make use of compulsory schooling laws across states to instrument average schooling. With regard to individual schooling, the instrument chosen is the person's quarter of birth. While OLS estimates show a strong positive relationship between average education and individual wages, no significant relationship is found using the IV approach. Whereas OLS results indicate that a one-year increase in average schooling is associated with a 7 per cent increase in individual wages (which is similar to the estimated private return), IV results show statistically insignificant effects of average education on wages, ranging from between –1 to 2 per cent. In their comment on the study, Sianesi and Van Reenen (2000) provide a number of reasons for why human capital externalities might be underestimated in this approach. In particular, with regard to this particular study, estimates are only derived for secondary education. However, it is argued that for more advanced countries, interactions between individuals with higher education are likely to be most synergetic.

As discussed above, Ciccone and Peri (2000; 2001) imply that none of these papers really identify the effect of human capital externalities on individual wages because all theories implicitly or explicitly assume that workers with different levels of education are perfectly substitutable. So, in these studies, the effect of average education on wages depends not only on whether there are human capital externalities, but also on the relative supply of workers with different levels of human capital (and the extent of their substitutability). They argue that this problem can be overcome within their theoretical framework, which considers the influence of average education on average wages controlling for labour-force composition. They find small negative returns to average schooling of about 1.4 per cent.

In conclusion, this is a relatively new and developing area within which to examine the potential presence of human capital externalities. However, how to identify human capital externalities within this framework is proving very controversial. Even if this were not a problem, it could be argued that some types of human capital externality are more relevant at a different level to the city. We now discuss the effects of human capital that become apparent at a higher, macro-economic level.

7.4. Macro approaches: education and economic growth

7.4.1 Theoretical issues

Sianesi and Van Reenen (2000) review the macro-economic literature on the returns to education.[56] The two main macro approaches are the augmented Solow neo-classical approach and the 'new growth theories' with their respective empirical counterparts of growth accounting exercises and macro regressions. Higher education is not often modelled explicitly in these theories. However, Gemmell (1997) argues that there is a *prima face* case for higher education because of its twin outputs of graduates typically embodying 3-6 years of post-16 education and production-relevant research.

[56] Sub-section 4.4.1 draws strongly on reviews by Sianesi and Van Reenen (2000) and Blundell *et al.* (1999).

The augmented neo-classical model extends the basic production function framework to allow an extra input, human capital, into the production function. Specifically, the production function can be written as follows:

$Y_t = f(K_t, L_t, t)$, where Y is output; K the stock of capital; and t is time (capturing 'technical progress').

Sianesi and Van Reenen (2000) show that under the assumptions of perfect competition and constant return to scale, the following growth equation can be derived:
$g_y = \theta g_k + (1 - \theta) g_L + g_t$, where g_n is the percentage growth rate of factor n and θ is the share of output accruing to capital.[57] Thus, the rate of growth is decomposed into its constituent parts – the contribution of factor inputs and of residual total factor productivity g_t.

Growth accounting exercises are mainly aimed at assessing the relative contribution of inputs (physical and human capital) and residual total factor productivity to either growth in output or cross-country differences in output per worker. The parameters of the aggregated production function are usually imposed (typically about 0.3 for both physical and human capital) or calibrated based on micro evidence.

A seminal study by Solow (1957) showed that most output growth could not be attributed to growth in capital and labour. This stimulated a lot of empirical work in the 1960s to diminish the importance of the residual by extending the framework. In particular, the quality of these inputs was explicitly included through investment in education (i.e accumulation of human capital) and in R&D, giving rise to technical change.

In contrast to the traditional neo-classical Solow growth model, 'new growth economics' theories emphasise the endogenous determination of growth rates, which are determined within the model rather than being driven by exogenous technological progress. Unlike the traditional model, these 'new growth' theories give a more explicit role for education. There are two main strands of thought about how education affects growth. In the first one, human capital is an input to the production function. Unlike in the traditional approach, individual educational investment choices are explicitly modelled and often, human capital is allowed to have external effects (which involves relaxing the constant returns to scale assumption). In this framework, the growth rate of output depends on the *rate* at which countries accumulate human capital over time.[58] The other strand of thought is that human capital is the primary source of innovation. Thus factors leading to endogenous growth (in particular technological change) are explicitly related to the stock of human capital. This may be either because human capital directly produces new knowledge/technology or because it is an essential input into a research sector that generates new knowledge/technology. In this case, education *levels* (human capital stocks) are linked to productivity growth.[59] There is an important distinction between

[57] The growth in each input is thus weighted by its relative factor share.
[58] Lucas (1988) made the seminal contribution to this literature. For extensions, see Azariadis and Drazen (1990), Glomm and Ravikumar (1992) and Benabou (1996).
[59] Nelson and Phelps (1966) developed this approach. Also see Aghion and Howitt (1998), Romer (1990) and Redding (1996).

the two strands. In the first, any measure (such as a subsidy to education) that increases the level of human capital will have a once-and-for-all effect on output. In the second strand, such a measure would increase the growth rate of the economy forever.

There is no consensus in the empirical literature over which is the appropriate approach. In fact, Sianesi and Van Reenen (2000) comment that the evidence on neo-classical versus endogenous growth models is inconclusive since the available macro evidence does not allow an empirical basis for distinguishing between theories. Gemmell (1997) states that overall, the appropriate conclusion seems to be that of Jones (1996): 'the macro evidence…cannot distinguish between a 'neoclassical' growth model and an R&D based growth model.

7.4.2 Empirical studies

The majority of recent evidence comes from the 'macro regression' methodology, which has become more popular than growth accounting methods in the last ten years (Dutta *et al*., 1999). Whereas the latter approach involves imposing restrictions on key parameters (thus accounting for but not explaining the contribution of human capital to output growth), macro regressions involve estimating a regression where the dependent variable is a measure of economic growth and human capital variables are included in the vector of explanatory variables. Although in principle, the macro regression approach might be thought a more appropriate framework in which to identify the causal impact of measures of education on economic growth, in practice there are significant methodological problems. Sianesi and Van Reenen (2000) discuss these problems in some detail, the most important of which are problems in measuring human capital (poor proxies for theoretical concepts; measurement error), systematic differences in parameters across countries (e.g. developing versus developed countries) and reverse causality (faster growing countries invest more in education). Sianesi and Van Reenen (2000) comment that in most empirical studies, the main message authors seek to convey is whether a given factor affects growth in a positive or negative way and its importance relative to other factors. Methodological and data constraints severely hinder a precise numerical quantification of the effects. Nonetheless, they conclude that taking the studies as a whole, there is compelling evidence that human capital increases productivity.

Evidence from growth regressions suggests that increasing school enrolment rates (human capital flow) by one percentage point lead to an increase in per capita GDP growth of between 1 and 3 percentage points, while an additional year of secondary schooling in the population (human capital stock) leads to over 1 percentage point faster growth each year. Sianesi and Van Reenen (2000) argue that these effects are overstated due to methodological problems such as correlation with omitted variables and unduly imposed restrictions.

Although there is a reasonably large body of evidence on the relationship between education (or human capital) in general and economic growth, there is more limited evidence for higher education specifically (Gemmell, 1997). According to Gemmell (1997), the most comprehensive evidence from cross-section regressions comes from Barro and Sala-i-Martin (1995), who find (for male educational attainment) that higher initial secondary and tertiary education have significant, positive growth

effects and these are more strongly evident than when years of schooling are aggregated. Specifically, for their sample of countries (between 1965 and 1975), a one-standard-deviation increase in male secondary schooling (i.e. 0.68 years) raise the growth rate by 1.1 percentage points each year, whereas a one-standard-deviation increase in male higher schooling (0.09 years) raises the growth rate by 0.5 percentage points per year. However, there are no significant effects in the growth regressions if changes in the educational attainment variables are included. They suggest that this might be due to measurement error in these variables.

Sianesi and Van Reenen (2000) single out Gemmell's (1996) study for discussion with regard to the effect of tertiary education on economic growth. He finds that tertiary human capital is most relevant for explaining growth in OECD countries. In the OECD sub-sample (only 21 observations), he shows that a 1 percent increase in the annual growth of tertiary human capital increases growth in GDP by 5.9 per cent. Conditional on this growth, countries with a one percent increase in the initial (tertiary) human capital stock contribute to a 1.1 percent increase in growth.[60] This is consistent with Wolff and Gittleman (1993) who find that tertiary education is a significant determinant of growth in industrial market and upper middle-income economies. Gemmell (1995, 1996) suggests that in OECD countries, the stock of secondary human capital appears particularly important in stimulating investments, while direct growth effects come through increased tertiary human capital stock and accumulation.

Jenkins (1995) is one of the few time series studies to investigate the impact of higher education on growth. She uses time series data for the UK (1971-1992) to estimate a production function and a Total Factor Productivity equation. She finds that a one per cent increase in the proportion of workers with higher qualifications raises annual output by between 0.42 and 0.63 per cent. However these results are very sensitive to the measure of educational quality that is used. Sianesi and Van Reenen (2000) comment on the very small sample size (22 observations); sensitivity of results to assumptions made about the elasticity of the output with respect to labour; and the fact that problems due to measurement error, aggregation bias and possible endogeneity of education are ignored.

7.4.3 Growth and the type of higher education

Wolff and Gittleman (1993) and Wolff (1994) investigate the impact of human capital on labour productivity growth for OECD countries during 1950-88. They find that university enrolment rates are positively associated with labour productivity growth and that 'a variable measuring the number of scientists and engineers per capita is found to be significant across a wide range of specifications' (Wolff, 1994, p.24). Gemmell (1997) comments on a puzzling feature of their analysis in that similarly strong effects for years of university educational attainment of the labour force are not found and that the university enrolment effect appears to be stronger in the first half of the period studied.

[60] Sianesi and Van Reenen (2000) warn against comparing the relative size of increases in flows and stocks of human capital. They are measured in different units. They also state that there is no reliable information on the relative growth returns of different levels of education (p.26).

Murphy *et al.* (1991) investigates whether the type of education is important in influencing growth. They look at this issue for a sub-sample of countries with a large student population and find that the relative importance of engineering in education has a positive impact on growth while the relative importance of legal studies has a negative effect.[61] However, the former effect is not statistically significant while the latter just borders on significance. Thus, Sianesi and Van Reenen (2000) comment that these results are not very reliable (being based on a very small sample). They also note the potential problem of reverse causality, where an expected increase in economic growth may trigger an increase in relative enrolment in engineering since the attractiveness of innovation and entrepreneurship would be enhanced in those circumstances.

7.5 Non-monetary outcomes

7.5.1 Methodology

It seems likely that private benefits to education are not entirely reflected in the market wage. Furthermore, social benefits are clearly not fully represented by the relationship between education and economic performance. There are many papers that might fit into this 'wider' literature. We review papers investigating the relationship between education and non-market outcomes and also papers attempting to value non-market aspects of education, although there are few that refer specifically to higher education.

There are many possible non-market outcomes associated with education and several reviews of existing literature (e.g. McMahon, 1998; Behrman and Stavey, 1997; Haveman and Wolfe, 1986). The general approach is to regress the non-market outcome of interest (e.g. health) on a range of explanatory variables, including measure(s) of education. In a review of the book by Behrman and Stavey (1997), Leigh (1998) outlines some of the difficult issues arising in this literature. A principal problem is whether the correlation between education and non-market outcomes really reflect causality. For example, with regard to health, causality may run in both directions or an unobserved variable, such as time preference, might be responsible for the correlation. Leigh (1998) also draws attention to the many mechanisms through which health might affect education, many of which are ignored by economists investigating this subject (despite the fact there are decades of research on the issue by psychologists, sociologists and epidemiologists). McMahon (1998) emphasises the importance of controlling for income in such regressions. Otherwise it is not possible to draw any distinction between monetary and non-monetary outcomes. For example, in the case of 'better health', those with more education generally enjoy better health, in part because their higher earnings enable them to purchase better health and a higher consumption-nutrition standard. In this case, one cannot consider the health outcome as independent of the monetary returns to education.

Haveman and Wolfe (1984) produced an early paper attempting to value 'non-market' effects of education. They say that ideally a demand function would be estimated for

[61] Relative importance of engineering in education is measured by the ratio of college enrolments in engineering to total college enrolments.

homogeneous units of schooling services, conditioning on a series of socio-economic variables. Such a function would yield estimates of willingness to pay for schooling that would capture both marketed and non-marketed impacts. In the absence of such information, it may still be possible to obtain an estimate of the marginal value of schooling at the existing level (i.e. one point on the demand curve) based on an estimate of the marginal cost (which is assumed equal to the marginal benefit). The general idea behind this approach is that schooling may be substitutable with other types of input in producing a given non-market outcome. The example that they give is an own-health production function where this includes visits to a private physician for preventive purposes and years of schooling. Suppose the contribution of each preventive visit were estimated to add one unit to own health and each incremental year of schooling added 5 units to own health. Further assume that each visit to the doctor had a direct private cost of $30, which would be the equilibrium willingness-to-pay value. Then, in equilibrium, the consumer would be willing to pay $150 (i.e. $30 x 5) for the additional year of schooling in its role as contributor to his/her own health. Haveman and Wolfe (1984) explain their model in some detail and its underlying assumptions. For example, consumers must be utility-maximisers who can freely choose the level of schooling and the other input of interest (e.g. visits to the doctor), which must have a non-distorted, market price. It must be possible to accurately estimate the marginal products of these inputs to health production and the market input must not contribute jointly to the health outcome and the production of other services. In some contexts, such assumptions are likely to be very strong.

This type of framework appears to be the basis for making quite crude estimates of the value of schooling in regressions where income and schooling are included as explanatory variables and used to explain a non-market outcome. For example, Plewis and Preston (2001) give the example of a study by Angrist and Lavy (1996) where the outcome variable of interest is the number of times a child repeats a grade at school. Plewis and Preston (2001) report results that an additional dollar of household income reduces the odds that a child will repeat a grade by 0.002; a mother's high school diploma reduces the odds that a child will repeat a grade by 0.62. So the private benefit (P_b) is[62]: $P_b = (0.62 / 0.002) * \$1 = \$310$

This is interpreted as suggesting that the mother's high school diploma is equivalent to an additional $310 of household income and might be thought of as the 'value' of schooling in this context. A major problem with such an approach is that the estimating equation is not based on a structural model of child performance. It isn't clear whether household income and the mother's education have a causal (and independent) effect on child performance or whether they are proxies for a lot of other variables. Furthermore, in this paper, the coefficients are sensitive to how the equation is specified (e.g. whether using IV or OLS). In fact, the focus of the paper is on something completely different – the effect of teen childbearing and single parenthood on childhood disabilities and performance in schools. If one is to take such values seriously, it is important to have an underlying structural model and to be able to demonstrate the robustness of results to changes in model specification.

[62] There is some inaccuracy in how the regression results are reported by Plewis and Preston (2001) compared to how they are reported by Angrist and Lavy (1996). More importantly, the latter do not make this calculation in their paper. It seems very likely that Plewis and Preston (2001) are citing an early version of the paper/conference proceedings.

Hedonic price methods have a strong theoretical basis (see Rosen, 1974) and have been used to value goods/services with some non-traded dimensions. For example, a common application has been to estimate the relationship between house prices and environmental amenities (controlling for all other relevant factors that determine house prices). One then obtains the implicit price for the good/service of interest, which under certain conditions is equal to its marginal value. This approach has recently been applied to value improvements in school performance. For example, Gibbons and Machin (2001) apply the approach to show how parents value improvements in primary school performance in England. The approach will only be valid if school performance is a relevant factor in influencing parents' decisions to move house. While this is a credible assumption with regard to primary schooling, it would certainly not be applicable with regard to choice of university. However, this is an interesting example of how goods/services with some non-traded characteristics can be valued.

7.5.2 Some empirical findings

There is a long list of potential non-monetary benefits that may accrue to the individual as a result of schooling. Haveman and Wolfe (1984) and McMahon (1998) review the potential outcomes and the many studies investigating these issues.

Duncan's (1976) study considers the importance of years of schooling in determining a variety of non-pecuniary benefits. He categorises such benefits as fringe benefits (e.g. medical insurance; pension plans), general working conditions (e.g. health and safety characteristics) and consumption benefits. He finds that years of schooling are significant predictors for most of the non-pecuniary variables. Furthermore, when he combines pecuniary and non-pecuniary benefits into a single composite earnings measure, the estimated coefficient on education is considerably higher.

There are fewer studies that consider the specific impact of higher education on non-monetary outcomes. Bowen (1977) provides a detailed account of research in the social sciences investigating the individual and social value of American higher education. However, in many cases, the influence of higher education is not clearly separated from outcomes that might also result from a lower level of education.

Bynner and Egerton (2000) provide some recent evidence for the UK of the influence of higher education on a range of outcomes, controlling for lower levels of educational attainment (among many other relevant variables). They use the National Child Development Study, which is a panel study of all the children born in the first week of March 1958. Outcome variables include employment; skills improvement; health and vulnerability (e.g. general health; psychological state); parenting (e.g. number of books owned by children), civic participation (e.g. voting; membership of voluntary organisation) and attitudes. Using multi-variate analysis, they find distinctive social benefits of higher education over and above those based on family and earlier education experience.

With regard to health, Bynner and Egerton (2000) find that compared with A-level qualifiers, graduates are more likely to perceive themselves in 'excellent' physical health and less likely to show depression. However, there are some difficulties in the interpretation of such findings. As the authors acknowledge, some of this association

could be attributed to 'selection effects' whereby people who are entering higher education are already more healthy than those who do not enter higher education. Even if the association were to be interpreted as causal, since the authors do not control for income, it isn't clear to what extent the effect of higher education is entirely attributable to its effect on raising respondents' incomes (enabling them to purchase better health care). Hartog and Oosterbeek (1998) use Dutch data to look at the impact of higher education on health, wealth and happiness. Although there is a positive association between higher education and all these outcomes, individuals whose highest level of education is 'higher secondary education of a general, non-vocational nature' do best in all these respects. Again the interpretation of 'education' effects is problematic since the explanatory variables may be endogenous to the outcome variables and income is not controlled for.

There are a number of studies investigating the influence of parents' educational attainment on their children's attainment. Bynner and Egerton (2000) find that graduate families appear to have significant educational benefits for children in so far as absence of educational problems and evidence of children's reading is concerned. They suggest that part of the association is due to higher education experience, which lays the foundations for educationally effective parenting. However, again they do not control for income, so the extent to which higher education is really picking up an income effect is unclear. Rudd (1987) investigates the impact of graduate parental education on their children's entry to university and finds that this has a significant influence that is net of parental social class. However, he does not have information on more general measures of parental education. Burnhill *et al*. (1990) re-examine this issue and find that all levels of parental schooling beyond the minimum increase the probability that the child would qualify for higher education. They suggest that most of this effect comes from parental education up to 16 years, rather than whether the parents have a third-level qualification.

There is no doubt that many non-monetary outcomes benefit members of society other than the direct recipients. As McMahon (1998) states, the net benefits of average education levels in the community are usually positive, as suggested by their net effects on poverty, lower average crime rates after controlling for other factors. However, what is in question is how much such social outcomes arise from higher education specifically and how much benefits arise at lower levels of education. For example, Birdsall (1996) states that positive externalities of higher education are less likely to arise directly from the existence of more people in a society with higher education than is the case with primary education since most of those people capture the full benefits of their additional education in the form of higher wages or personal non-pecuniary benefits. The type of 'higher education' externalities emphasised by Birdsall (1996) include those arising from basic research; training in fields such as science where social returns may exceed private returns; and service activities that have social returns (e.g. demonstration projects in education).[63] Although high private returns have been found to basic research undertaken by firms in the US (Mansfield, 1980; Griliches, 1986), Birsdall (1996) is unable to identify a study where social returns to basic research have been estimated.

[63] Such externalities are important within the 'new growth' literature and also in the literature about 'knowledge spillovers' within regions (see chapter on regional returns to higher education).

7.6. Conclusion

We have reviewed literature relevant to the wider benefits of education under four main headings: the 'social rates of return' approach; wages in cities; macro approaches; and non-monetary outcomes.

The 'social rates of return' approach is an accountancy method where private pre-tax benefits of education are compared with all costs (whether they are incurred by the individual or the taxpayer). The most important problem with this methodology is that any social benefits of education not reflected in the wage (i.e. externalities) are excluded from the analysis. Hence the policy relevance of this type of measure is highly questionable. An example of how this method might lead to particularly misleading conclusions is where it has been used to estimate returns by degree subject. Estimates show a relatively low 'social rate of return' for science degrees, yet there are *a priori* reasons for expecting positive externalities arising from graduate training in science (Birdsall, 1996) and the number of scientists has been shown, at least in one study, to be positively associated with labour productivity growth (Wolff, 1994).

A new literature is developing that attempts to identify whether human capital externalities are observable at the city-level, as reflected in workers' wages. The general idea is to test for whether average human capital (in the city) has an effect on an individual's wages over and above his/her individual level of human capital. Only one study (Moretti, 1998) has specifically investigated the potential effects of higher education, which were found to be strongly positive in generating human capital externalities. However, there are serious problems with identification in these studies. There is certainly no consensus in this literature that education produces any externalities at all.

A strength of macro approaches is the potential to capture the effects of human capital externalities observable at an economy-wide level. There is a very extensive literature on the effect of education on economic growth. This is based on two theoretical frameworks: the Solow neo-classical approach and the new growth theories. Although reviewers of this literature agree that there is good evidence of a positive relationship between human capital and economic growth (e.g. Gemmell, 1997; Sianesi and Van Reenen, 2000), serious methodological problems in this literature make it difficult to give credence to any precise numerical quantification of the effects. A number of studies suggest that higher education is likely to be relatively important for growth in more developed countries (e.g. Gemmell, 1996; Wolff and Gittleman, 1993). Also, there is some evidence to suggest that the type of higher education matters for growth, with possibly higher growth for countries with more scientists and engineers per capita. Sianesi and Van Reenen (2000) develop a number of ideas for future research topics in this literature.

Finally, the private benefits of education are unlikely to be fully reflected in workers' wages and it seems important to investigate the potential social benefits of education on outcomes other than economic performance measures. We review some of the literature on non-monetary outcomes associated with education. Although there are some methods available that might be used to value non-monetary outcomes, they do not seem to have been applied very often (and not with regard to higher education).

Also, they make assumptions which might be difficult to defend in many contexts. Studies investigating the impact of higher education on non-monetary outcomes use a regression-based approach where the outcome (e.g. health) is the dependent variable and human capital variables are included among the explanatory variables. Although studies have shown a positive association between higher education and outcomes such as health and parenting, there are some problems with interpretation since it is difficult to deal fully with potential endogeneity. Even if the effect of higher education is causal, available studies don't say very much about the mechanism through which higher education affects the relevant outcome. For example, in a number of studies, it isn't clear whether higher education has a direct impact on the outcome (e.g. health) or whether its primary effect is through raising household income (allowing individuals to 'purchase' better health). Some studies suggest that these types of externality are more important at lower levels of education, whereas in higher education, externalities arising from basic research and training in fields such as science are likely to be more relevant.

7.7 Section References

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8. Regional returns from higher education

8.1 Introduction

There are a number of ways in which the benefits of Higher Education Institutes (HEIs) may be geographically localised. Firstly, in their role as educators, HEIs increase the knowledge and skills of participants. This potentially increases the pool of skilled labour available to local businesses, though the willingness of graduates to migrate diminishes the extent to which this benefit disproportionately affects the region where higher education is obtained. Secondly, as originators of research, HEIs may be the source of new job creation and income growth within regions, to the extent that knowledge spillovers depend on the proximity of academic researchers to industrial users of this research. In the US, the observation that rapid growth of high-tech industries has occurred in areas that have top research universities has motivated research in this area (Beeson and Montgomery, 1993), of which there has been a recent upsurge. In general this research seems to emphasise proximity to knowledge creation rather than proximity to a skilled labour force, though in practice it might be difficult to separate the two. Employment of graduates from good research departments may be one of the mechanisms through which new ideas are communicated to industry. Thirdly, as with any type of institution, HEIs will have direct employment effects (i.e. staff recruitment) and may benefit the local economy through their spending patterns.[64] This is the most commonly examined impact of universities on the local economy, though these effects are independent of the teaching and research role of HEIs. Hence they might be similar for any large employer.

We discuss all these types of impact, though we focus on the recent literature in the US, which investigates the extent to which higher education outputs are captured locally through job creation and measures of innovative activity.

8.2. Economic Impact Studies

'Economic impact studies' are the most common approach to analysing the role of HEIs in economic development. Thanki (1999), Florax (1992) and Becker and Lewis (1992) are among the studies that discuss these techniques and give examples of relevant studies. Such studies involve assessing expenditure impacts as they relate to the outlay by the university, faculty, staff and visitors (Florax, 1992). They generally involve using an 'input-output' technique or a multiplier approach, thereby estimating an employment or income effect associated with the presence of a HEI. Approaches have been much criticised for their restrictive assumptions, the lack of rigour with which they have been applied (in many studies) and most especially for their narrow focus.

Restrictive assumptions include the assumption of fixed prices and the absence of any supply constraints. Thus expenditure always increases output and employment in these models. Thanki (1999) suggests that the multiplier technique may be more applicable to a depressed local economy where there is under-utilised capacity in industry. In a review of studies using these methodologies, the CVCP (1994) criticise many studies

[64] See HEFCE (1999) for figures on employment, research contracts etc. at HEIs in England.

for how the research had been conducted. Many studies were characterised by few efforts at data collection and a reliance on borrowed rather than calculated multipliers.

However, the most important criticism of such studies is the narrow definition of economic benefit arising from higher education. Such approaches ignore the educational and research function of HEIs, taking no account of benefits that might arise to the local economy through the supply of highly skilled graduates and/or through 'knowledge transfer' of research outputs. Hence, such methods are clearly inadequate for examining regional returns to higher education.

8.3 Regional benefits from the 'research and teaching': The role of Higher Education Institutions

8.3.1. Employment effects

There is increasing evidence that the overall skill level of an area's workforce has fundamental effects on the local economy. For example, Glaeser *et al.* (1995) and Glendon (1998) find that cities with well-educated workforces tend to grow faster than cities with less well-educated workforces. Audretsch and Felman (1996) find 'skilled workers' to be one of several 'knowledge' variables to have an impact on the propensity for innovative activity to cluster spatially. However, this does not mean that graduates necessarily choose to stay in the local labour market, thereby benefiting the local economy. Bound *et al.* (2001) investigate whether the production of higher education in US state affects the local stock of human capital in that state. They suggest that the relationship may not be strong given the mobility of college graduates (Long, 1988; Bound and Holzer, 2000). A central finding is that the relative flow of degrees conferred within a state only has a modest effect on the relative stock of university-educated workers within the state and, as such, states have only a limited capacity to influence human capital levels in their workforces by investing in higher education degree outputs.

Results by Beeson and Montgomery (1993) also imply that university graduates do not have a high probability of retention within regional labour markets (i.e. US Standard Metropolitan Statistical Areas). They show that gross migration flows, both into and out of a region, are higher in areas with universities that have large amounts of R&D funding, indicating active labour markets with a high turnover. On the other hand, they find regional employment growth rates to be positively associated with changes in university R&D funding, as well as to the number of nationally rated science and engineering programs at local universities. They also show a positive relationship between the percentage of the workforce employed as scientists and engineers and variables measuring university R&D funding and the proportion of bachelors' degrees awarded in science and engineering at local universities.

However, showing that measures of economic performance (e.g. employment growth) are positively associated with university characteristics does not necessarily mean that firms are locating near universities specifically to take advantage of a skilled labour force. Another motivation might be to take advantage of research conducted at universities, possibly facilitating this through some graduate recruitment. Subsequent higher productivity might raise local graduate recruitment in relevant disciplines. If knowledge transfer depends on proximity (whether the transfer mechanism is

recruitment of graduates or other links to universities) and this leads to higher productivity, then one would expect to see a positive relationship between variables such as employment growth and university characteristics (e.g. R&D funding). Available evidence does not clearly indicate that employment of graduates is the mechanism through which firms benefit from locating near universities.

8.3.2. Firm opening and survival rates

Bania *et al.* (1993) investigate whether the opening rate of manufacturing firms within US regions is influenced by university characteristics: total university research; the number of research universities and the percentage of employees who are scientists and engineers. The only consistent evidence concerning the effect of university research on new business start-ups was found for 18 prominent high-technology industries in Electrical and Electronic equipment. They suggest that this is consistent with the view that universities have been particularly important in the development of the microelectronics industry. However, they could show no evidence that a more technical workforce (i.e. a higher percentage of scientists and engineers) increased the start-up rate. They speculate that a more detailed measure may be required to capture the effect of a technical workforce on the formation of new manufacturing firms. For example, the start-up rate of firms in the Electrical and Electronic Equipment industries may depend more on the concentration of electrical engineers than on all engineers.

Chen and Williams (1999) provide evidence that is consistent with Bania *et al.* (1993) when they show significant effects of university R&D funds (measured in per capita terms) on the survival rates of some industries.[65] However, the relevant industries in this case are Chemicals, Transportation Equipment and Food. They interpret their findings as consistent with the view that university research and development activity has spillover effects to the region through technical innovation processes. For example, small firms can lower the cost of production by adopting any new processes or products and enhance their survival once they obtain 'the spillover knowledge'.

Finally, Zucker *et al.* (1998) examine start-up of US biotechnology firms. Adoption of biotechnology has increased rapidly in the last two decades, transforming the nature of the pharmaceutical industry and significantly influencing other industries such as food processing, brewing and agriculture. They present strong evidence that the timing and location of initial usage of the biotechnology is primarily explained by the presence at a particular time and place of scientists who are actively contributing to basic science as represented by publications reporting genetic-sequence discoveries in academic journals. They also quantify separable (and positive) effects of major universities and federal research support. They state that at least for this high-tech industry, the growth and location of intellectual human capital was the principal determinant of the growth and location of the industry itself and is testament to the value of basic research.

[65] It is worth noting that their empirical procedure does take account of 'fixed effects' so it seems unlikely that the association between university R&D funds and industry survival rates reflects the influence of a non-time-varying unobserved variable.

8.3.3. Creation of 'innovative activity'

A number of studies investigate the extent to which university research 'spills over' into the generation of inventions and innovations by private firms. Using surveys of research managers, Nelson (1986) finds university research to be an important source of innovation in some industries, particularly for those relating to the biological sciences. Jaffe (1989) develops a 'knowledge production function' framework where corporate patents are used as a proxy for economically useful knowledge. In an analysis of state-level corporate patent activity, he provides some evidence of the importance of geographically mediated commercial spillovers from university research, especially in Drugs, Chemicals and Electronics. However, as discussed by Acs *et al.* (1992), results concerning the role of geographic proximity in spillovers from university research are clouded by the lack of evidence that geographic proximity matters within states. They cite literature enumerating the weaknesses of using patented inventions as a measure of innovative output. For example, Pakes and Griliches (1980) argue that 'patents are a flawed measure (of innovation output); particularly since not all new innovations are patented and since patents differ greatly in their economic impact'. Acs *et al.* (1992) use another measure of innovative activity: the number of innovations recorded in 1982 by the US Small Business Administration from the leading technology, engineering and trade journals in each manufacturing industry. They then use the same framework as Jaffe (1989) with a new dependent variable. Using this measure of innovation, they show a more important impact of university spillovers and provide stronger evidence of the importance of spillovers arising from geographic proximity. Thus, spillovers are facilitated by the geographic coincidence of universities and research labs within the state.

Using more disaggregated data (i.e. US Standard Metropolitan Statistical Areas), Jaffe *et al.* (1993) use patent citations to provide evidence on the importance of the localisation of knowledge spillovers. The general idea is that if regional localisation of spillovers is important, patent citations should come disproportionately from the same state or metropolitan area as the originating patent. They attempt to control for the pre-existing pattern of geographic concentration of technologically related activities. Their results suggest that geographic localisation effects are large and statistically significant. However, they also find evidence that geographic localisation weakens over time. Furthermore, they acknowledge that *ex post*, the vast majority of patents are seen to generate negligible private (and probably) social returns. They suggest that case studies of a small number of highly cited patents could prove informative about the mechanisms of knowledge transfer and the extent to which citations correspond to externalities in an economic sense.

Audretsch and Feldman (1996) provide further evidence of the importance of higher education as a determinant of regional concentration of innovative activity. They construct a measure of the spatial distribution of innovative activity (using the same data source as Acs *et al.* 1992) and regress this on various 'knowledge measures' (i.e. industry R&D, skilled labour and university research) while controlling for the degree of concentration of production across states. They show that innovative activity is more likely to occur within close geographic proximity to the source of that knowledge, be it a university research laboratory, the R&D department of a corporation or exposure to the knowledge embodied in a skilled worker.

8.3.4 Why and when is geographic proximity important?

Although there is evidence suggesting the benefits of geographic proximity between universities and firms, there is less information about why exactly this is important and in what context. Zucker *et al*. (1994) note that the standard notion of geographically localised knowledge spillovers is based on the idea that university scientists are pursuing disinterested basic research, the results of which can be most quickly put to commercial use by those enterprises located nearby who can most readily learn novel results from social ties between employees and university scientists or by attending informal seminars at the university. However, they show that the process has not worked like that for biotechnology, where all the parties involved (government and other funding agencies, universities, professors and enterprises) are or can be connected by contractual and/or ownership ties in competitive markets. Thus knowledge has not inadvertently 'spilled over' to the commercial sector but has resulted from scientists entering into contractual arrangements with firms or starting their own firms to extract returns on their intellectual capital. Zucker *et al*. (1994) believe that this geographically localised impact, like intellectual capital itself, is a transitory phenomenon during the important initial period of industry development resulting from a major, commercially valuable scientific breakthrough.

Audretsch and Stephan (1996) have investigated the company-scientist locational link for biotechnology in great detail. They use a data set, which includes almost the entire population of biotechnology firms that prepared an initial public offering in the early 1990s to examine the extent to which firms and the university-based scientists involved with the firms are located in the same region. They show that while a substantial number of university-based scientists participate in networks that are geographically bounded, approximately 70 per cent of the links between biotechnology companies and the university-based scientists are non-local. They conclude that 'while proximity matters in establishing formal ties between university-based scientists and companies, its influence is anything but over-whelming'. However, they also show the context in which proximity is relatively more important for these companies. For example, proximity matters more in the case of founders than for members of scientific advisory boards, presumably reflecting the qualitative difference in the services provided by the scientist. They argue that while geographic proximity matters when knowledge spillovers are informal, it is not so important when knowledge is transmitted through formal ties between researchers and firms since face-to-face contact does not occur by chance but instead is carefully planned.

Whether university-based research affects regional economic or innovative activity through market channels (e.g. formal contacts between academic scientists and firms) or 'knowledge spillovers' (i.e. positive externalities from university research that affect the performance of nearby firms) is the subject of on-going, recent research. For example, Mowery and Ziedonis (2001) attempt to look at this using university patent citations. As they state, their study highlights the importance of additional research on how firms manage the acquisition of technologies through contractual agreements and spillovers. Knowledge flows embodied in patent licences and citations co-exist within a broader environment of technology outflows from universities and through other channels that include the dissemination of research finding through publications and conferences, sponsorship of research, employment of university graduates and faculty consulting.

8.4 Conclusions

There is much theory and evidence suggesting beneficial regional impacts of higher education. However, apart from 'economic impact studies' (which define benefits very narrowly), this research has been conducted within the US. It is not clear to what extent findings are transferable to regions within the UK, or perhaps more appropriately, to European regions. For example, in several studies 'regions' are defined as States. It isn't clear to what extent similar localised benefits might arise for regions within a smaller country.

Even for the US, while it appears that higher education generates beneficial effects at a regional level, there is less evidence about the mechanism through which these benefits come about. For example, the distinction between 'spillovers' and 'market channels' of knowledge transfer has been explored recently in the literature. It seems likely that the two sources of knowledge transfer will vary in importance between industries, though this has not yet been investigated. Also, the extent to which firms deliberately recruit graduates from local universities in order to facilitate 'knowledge transfer' does not seem to have been explored.

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9 CONCLUSIONS

1. This review has highlighted the fact that graduates cannot be considered a homogenous population. The subject choice substantially affects earnings, the propensity of obtaining a "graduate" job and unemployment.

   Broadly speaking, graduates from Mathematics and Social Sciences have higher returns to their degree subject but are more at risk of unemployment than Education graduates and in the case of Social Scientists they may experience over-education. Graduates from Education backgrounds have lower returns but do not face much risk of unemployment. Finally, Graduates from Humanities are the worst off financially following graduation and are more at risk than other graduates to experience unemployment and over-education. However, one should keep in mind that none of these results account for the selection of subject. Researchers have so far had to assume that the choice of subject is a random event. This is an obvious simplification that may bias the results substantially.

2. There are a wide variety of estimates of the returns to alternative higher education qualifications depending on the nature of the data used and the methodological approaches adopted. Extreme care should be taken when comparing results from different studies, however, there are some broad similarities across studies. Generally it is has been found that the returns to higher education qualifications are greater for women than men, and that the returns associated with Instrumental Variable techniques are greater than those derived from OLS estimating methods. There is evidence that standard OLS estimates do to some extent provide estimates of joint returns to qualifications and unobserved factors (such as ability or motivation). The explicit inclusion of ability proxies has the effect of reducing the estimates of the returns to qualifications substantially, compared to studies where these proxies are omitted. This is the case when there is no attempt to control for selection into employment (composition bias). When the econometric specification is augmented to account for both ability and composition bias, it is found that these biases effectively negate each other and that OLS estimates provide acceptable estimates of the returns to schooling. Instrumental Variables estimates of the returns to additional years of schooling or qualifications exceed to a substantial extent the conventional OLS estimates. This is due to the fact that Instrumental Variables seem to capture the marginal rate of return to education for individuals with high discount rates or lower preferences for education or the people most likely to be affected by the intervention (instrument). There appears to be evidence that the dispersion of returns to qualifications in the United Kingdom is greater than in other Western European countries, though again care should be taken due to the fundamentally different nature of the education systems in these countries.

3. The discussions relating to the estimation of the returns from education to businesses emphasises the importance in empirical analysis of having access to a sufficiently rich dataset. Given the substantial importance of multiple causality relationships, the most promising results have been derived from using matched employer-employee panel datasets, which are sufficiently

representative for the whole economy. The results have been presented for countries other than the UK to date.

The available empirical evidence seems to confirm the hypothesis that wages are not a sufficient measure of a worker's productivity. This indicates that firms perceive significant returns from their worker's qualifications that are normally not taken into account when evaluating the benefits of skill accumulation. However, there is no evidence on the relative importance of higher education in shaping this productivity-wage gap. Nevertheless, it would be wrong to conclude that the pure returns to higher education to firms are negligible.

4. We have reviewed literature relevant to the wider benefits of education under four main headings:

- 'Social rates of return' approach

The 'social rates of return' approach is an accountancy method where private pre-tax benefits of education are compared with all costs (whether they are incurred by the individual or the taxpayer). The most important problem with this methodology is that any social benefits of education not reflected in the wage (i.e. externalities) are excluded from the analysis. The policy relevance of this type of measure is highly questionable.

- Wages in cities

A new literature is developing that attempts to identify whether human capital externalities are observable at the city-level, as reflected in workers' wages. The general idea is to test for whether average human capital (in the city) has an effect on an individual's wages over and above his/her individual level of human capital. Only one study has specifically investigated the potential effects of higher education, which were found to be strongly positive in generating human capital externalities. However, there are serious problems with identification in these studies. There is certainly no consensus in this literature that education produces any externalities at all.

- Macro approaches

A strength of macro approaches is the potential to capture the effects of human capital externalities observable at an economy-wide level. There is a very extensive literature on the effect of education on economic growth. This is based on two theoretical frameworks: the Solow neo-classical approach and the new growth theories. Although reviewers of this literature agree that there is good evidence of a positive relationship between human capital and economic growth, serious methodological problems in this literature make it difficult to give credence to any precise numerical quantification of the effects. A number of studies suggest that higher education is likely to be relatively important for growth in more developed countries and there is some evidence to suggest that the type of higher education also matters for growth.

- Non-monetary outcomes

  Finally, the private benefits of education are unlikely to be fully reflected in workers' wages and it seems important to investigate the potential social benefits of education on outcomes other than economic performance measures. Although there are some methods available that might be used to value non-monetary outcomes, they do not seem to have been applied very often (and not with regard to higher education). Studies investigating the impact of higher education on non-monetary outcomes use a regression-based approach where the outcome (e.g. health) is the dependent variable and human capital variables are included among the explanatory variables. Although studies have shown a positive association between higher education and outcomes such as health and parenting, there are some problems with interpretation since it is difficult to deal fully with potential endogeneity. Even if the effect of higher education is causal, available studies don't say very much about the mechanism through which higher education affects the relevant outcome. Some studies suggest that these types of externality are more important at lower levels of education, whereas in higher education, externalities arising from basic research and training in fields such as science are likely to be more relevant.

5. There is much theory and evidence suggesting beneficial regional impacts of higher education. However, apart from 'economic impact studies' (which define benefits very narrowly), this research has been conducted within the US. It is not clear to what extent findings are transferable to regions within the UK, or perhaps more appropriately, to European regions. For example, in several studies 'regions' are defined as States. It isn't clear to what extent similar localised benefits might arise for regions within a smaller country.

   Even for the US, while it appears that higher education generates beneficial effects at a regional level, there is less evidence about the mechanism through which these benefits come about. For example, the distinction between 'spillovers' and 'market channels' of knowledge transfer has been explored recently in the literature. It seems likely that the two sources of knowledge transfer will vary in importance between industries, though this has not yet been investigated. Also, the extent to which firms deliberately recruit graduates from local universities in order to facilitate 'knowledge transfer' does not seem to have been explored.

Table 27: Relative earnings of the population with income from employment

By level of educational attainment and gender for the populations 25 to 64 and 30 to 44 years of age (upper secondary education =100)

			Below upper secondary education		Tertiary-type B education		Tertiary-type A and advanced research programmes		Tertiary education	
			25-64	30-44	25-64	30-44	25-64	30-44	25-64	30-44
Australia	**1997**	Men	87	83	120	116	144	138	136	131
		Women	85	84	113	112	154	154	137	138
		M+W	79	75	103	101	136	131	124	120
Canada	1997	Men	84	81	109	112	148	143	130	128
		Women	76	69	116	118	164	165	137	138
		M+W	83	79	106	109	152	149	128	128
Czech Republic	1999	Men	75	77	177	182	178	176	178	177
		Women	72	75	127	124	172	176	170	174
		M+W	68	70	151	151	180	182	179	181
Denmark	1998	Men	87	85	122	118	148	143	132	129
		Women	89	90	118	114	144	146	124	121
		M+W	86	85	113	108	149	145	124	120
Finland	1997	Men	94	91	128	124	186	172	159	149
		Women	100	98	122	121	176	170	143	139
		M+W	97	95	120	115	183	170	148	139
FRANCE	1999	Men	88	86	128	137	178	181	159	163
		Women	79	81	131	139	158	165	145	152
		M+W	84	84	125	133	169	174	150	155
Germany	1998	Men	77	63	105	101	149	131	126	116
		Women	85	68	104	106	160	167	128	134
		M+W	78	62	106	104	157	144	130	123
Hungary	1999	Men	72	74	240	220	218	222	218	222
		Women	67	71	138	141	159	160	159	160
		M+W	68	70	178	158	184	182	184	182
Ireland*	1997	Men	72	72	100	104	149	136	131	123
		Women	57	55	129	142	171	155	156	151
		M+W	75	75	114	124	165	150	146	140
Italy	1998	Men	54	55	x	x	x	x	138	142
		Women	61	56	x	x	x	x	115	114
		M+W	58	57	x	x	x	x	127	126

Korea	1998	Men	88	90	105	109	143	136	132	129
		Women	69	75	118	138	160	181	141	164
		M+W	78	80	106	113	147	142	135	134
Nether-lands	1997	Men	86	85	142	128	138	130	139	130
		Women	71	71	128	133	145	150	143	148
		M+W	83	83	136	129	141	136	141	135
New Zealand	1999	Men	76	74	x	x	x	x	137	135
		Women	74	73	x	x	x	x	129	130
		M+W	76	74	x	x	x	x	136	136
Norway	1998	Men	85	89	125	130	133	135	133	134
		Women	84	88	142	144	136	137	136	138
		M+W	84	90	129	135	132	132	132	132
Portugal	1998	Men	61	57	149	153	188	192	178	183
		Women	62	59	131	136	190	209	171	186
		M+W	62	58	140	144	192	201	177	186
Spain	1996	Men	75	76	96	101	178	156	154	139
		Women	68	66	82	90	155	156	143	148
		M+W	80	77	97	103	167	152	151	141
Sweden	1998	Men	87	87	x	x	x	x	136	138
		Women	89	87	x	x	x	x	125	121
		M+W	89	89	x	x	x	x	130	129
Switzerland	1999	Men	81	77	122	124	144	140	135	133
		Women	73	80	131	133	154	160	145	151
		M+W	75	76	140	142	161	157	153	151
United Kingdom	1999	Men	73	73	126	123	159	165	149	151
		Women	68	63	139	137	193	195	173	173
		M+W	65	65	128	125	171	176	157	158
United States	1999	Men	65	63	119	123	183	180	176	173
		Women	63	65	120	120	170	177	163	170
		M+W	67	66	118	120	180	178	173	171
Country mean		Men	78	77	130	130	163	157	149	146
		Women	75	74	123	126	162	166	144	147
		M+W	77	76	124	124	163	159	146	144

Source: OECD.

Table 28: Wage premium of tertiary qualification

	Specification 1		Specification 2		Specification 3		Specification 4	
	Returns	**Robust SE**	**Returns**	**Robust SE**	**Returns**	**Robust SE**	**Returns**	**Robust SE**
Country:								
Denmark	0.1461	*0.0111*	0.1372	*0.0116*	0.1518	*0.0117*	0.0718	*0.0144*
Netherlands	0.2606	*0.0115*	0.2565	*0.0116*	0.2516	*0.0121*	0.1647	*0.0159*
Belgium	0.1883	*0.0130*	0.1815	*0.0127*	0.1771	*0.0125*	0.1041	*0.0176*
Luxemburg	0.2176	*0.0307*	0.2369	*0.0326*	0.2157	*0.0328*	0.1307	*0.0347*
France	0.3722	*0.0253*	0.3702	*0.0255*	0.3622	*0.0259*	0.1559	*0.0306*
United Kingdom	0.2860	*0.0162*	0.2653	*0.0162*	0.2669	*0.0165*	0.1713	*0.0181*
Ireland	0.2783	*0.0167*	0.2654	*0.0163*	0.2476	*0.0159*	0.1031	*0.0196*
Italy	0.2760	*0.0152*	0.2838	*0.0155*	0.2736	*0.0153*	0.1458	*0.0178*
Greece	0.2022	*0.0204*	0.2220	*0.0199*	0.2164	*0.0200*	0.0828	*0.0230*
Spain	0.2250	*0.0143*	0.2131	*0.0138*	0.2001	*0.0138*	0.0757	*0.0150*
Portugal	0.6094	*0.0356*	0.5949	*0.0356*	0.5782	*0.0357*	0.3936	*0.0532*
Austria	0.2947	*0.0418*	0.2957	*0.0418*	0.3022	*0.0437*	0.1463	*0.0530*
Finland	0.2169	*0.0181*	0.1890	*0.0185*	0.1932	*0.0189*	0.1054	*0.0263*
Specificaton:								
Occupation	yes		no		no		no	
Public sector	yes		yes		no		no	
Training and tenure	yes		yes		yes		no	

Table 29: Labour force participation rates (1999)

By level of educational attainment and gender for populations 25 to 64 and 55 to 64 years of age

		Ages 25-64				
		Below upper secondary education	**Upper secondary and post-secondary non-tertiary education**	**Tertiary-type B**	**Tertiary-type A and advanced research programmes**	**All levels of education**
AUSTRALIA	Men	79	89	91	93	86
	Women	54	66	81	73	63
Austria[1]	Men	71	86	89	94	84
	Women	48	68	82	84	63
Belgium	Men	71	88	92	93	82
	Women	42	70	84	86	62
Canada	Men	74	88	91	90	86
	Women	48	73	80	84	72
Czech Republic	Men	72	89	n.a	95	88
	Women	51	74	n.a	82	70
Denmark	Men	74	88	93	93	87
	Women	60	80	88	91	77
Finland	Men	70	86	88	93	83
	Women	64	78	86	90	77
France	Men	77	89	92	90	85
	Women	58	76	84	83	70
Germany	Men	76	84	88	92	84
	Women	47	70	82	83	66
Greece	Men	82	89	87	92	86
	Women	41	57	81	84	53
Hungary	Men	48	83	n.a	88	74
	Women	35	68	n.a	79	57
Iceland	Men	96	96	99	99	97
	Women	84	84	98	90	86
Ireland[1]	Men	81	92	93	95	87
	Women	38	63	81	80	55
Italy	Men	75	86	n.a	92	81
	Women	33	66	n.a	81	48
Japan	Men	88	96	97	98	95
	Women	56	62	64	65	61
Korea	Men	86	90	95	91	89
	Women	61	50	55	54	55
Luxembourg	Men	77	87	90	92	84
	Women	41	60	81	76	54
Mexico	Men	94	96	98	94	94
	Women	38	53	65	72	43
Netherlands	Men	78	88	91	92	86
	Women	45	72	83	84	64
New Zealand	Men	79	91	89	92	88
	Women	54	74	77	81	70

Norway[1]	Men	81	90	98	93	90
	Women	59	81	93	89	80
Poland[1]	Men	69	85	n.a	92	82
	Women	48	71	n.a	87	68
Portugal	Men	89	91	93	97	90
	Women	69	82	88	92	73
Spain	Men	82	91	93	90	86
	Women	39	68	78	84	52
Sweden	Men	80	88	88	94	87
	Women	67	84	86	92	81
Switzerland	Men	91	94	96	97	94
	Women	63	74	88	81	73
Turkey	Men	87	90	n.a	89	88
	Women	28	34	n.a	73	31
United Kingdom	Men	67	88	92	93	86
	Women	52	76	86	88	74
United States	Men	74	87	90	92	87
	Women	50	72	82	81	73
Country mean	Men	76	86	89	90	84
	Women	49	67	78	79	62

1. Year of reference 1998.

Source: OECD. See notes on Indicator A2 in Annex 3.

Table 30: Unemployment rates (1999)

By level of educational attainment and gender for populations 25 to 64 and 30 to 44 years of age

		AGE 25-64				
		Below upper secondary education	**Upper secondary and post-secondary non-tertiary education**	**Tertiary-type B**	**Tertiary-type A and advanced research programmes**	**All levels of education**
Australia	Men	9.2	5.2	5.0	2.9	6.1
	Women	7.6	5.4	4.7	1.8	5.4
Austria[1]	Men	8.0	3.4	2	1.9	3.9
	Women	6.0	4.0	2.1	2.3	4.3
Belgium	Men	10.0	4.6	2.6	2.0	6.0
	Women	15.6	8.3	3.6	4.4	8.8
Canada	Men	10.7	6.7	4.4	3.9	6.4
	Women	10.3	6.5	4.5	4.1	6.0
Czech Rep	Men	20.0	5.0	n.a	2.1	5.7
	Women	18.0	8.4	n.a	3.4	9.2
Denmark	Men	6.8	3.3	2.4	3.1	3.6
	Women	7.2	5.1	2.7	6.7	5.0
Finland	Men	12.0	9.3	3.7	2.9	8.1
	Women	14.4	9.8	7.0	4.3	9.3
France	Men	14.1	7.2	5.7	5.0	9.0
	Women	16.7	12.0	6.6	7.6	12.3
Germany	Men	17.7	8.4	4.9	4.3	8.4
	Women	14.1	9.4	7.0	5.1	9.5
Greece	Men	5.5	6.6	6.6	4.8	5.9
	Women	13.7	17.3	10.3	10.3	14.1
Hungary	Men	12.6	6.0	a	1.5	6.5
	Women	9.5	5.2	a	1.1	5.4
Iceland	Men	1.6	0.5	n	0.2	0.7
	Women	2.8	1.9	1.3	1.0	2.1
Ireland[1]	Men	11.7	4.2	2.5	2.9	7.4
	Women	11.4	4.8	3.0	3.9	6.5
Italy	Men	7.8	5.7	n.a	4.9	6.7
	Women	16.6	11.1	n.a	9.3	13.0
Japan	Men	6.4	4.5	4.1	2.3	4.2
	Women	4.3	4.2	4.9	3.1	4.3
Korea	Men	7.6	7.0	6.8	4.6	6.6
	Women	3.5	5.0	4.9	2.9	4.1
Luxembourg	Men	2.8	0.8	n	0.8	1.4
	Women	5.0	1.7	2.3	1.3	2.8
Mexico	Men	1.3	0.9	5.2	2.7	1.5
	Women	1.6	2.5	2.6	3.1	1.9
Netherlands	Men	3.6	1.4	1.3	1.5	2.1
	Women	6.7	3.6	1.7	2.1	4.1

New Zealand	Men	9.2	4.5	5.5	3.7	5.5
	Women	8.3	4.8	3.7	3.8	5.2
Norway[1]	Men	3.4	2.2	1.6	1.6	2.2
	Women	2.4	2.5	1.2	1.4	2.1
Poland[1]	Men	12.7	7.2	n.a	2.2	7.5
	Women	15.1	11.5	n.a	2.8	10.8
Portugal	Men	3.9	4.1	2.4	3.1	3.8
	Women	4.6	6.2	1.4	2.4	4.5
Spain	Men	10.5	7.8	6.8	6.9	9.2
	Women	22.8	19.8	20.6	14.6	20.1
Sweden	Men	8.5	6.7	5.6	3.8	6.5
	Women	9.7	6.3	3.8	2.2	5.8
Switzerland	Men	4.1	2.3	n.a	1.3	2.2
	Women	5.7	2.4	n.a	2.9	3.1
Turkey	Men	5.6	6.7	n.a	4.6	5.7
	Women	4.5	14.2	n.a	5.9	5.9
United King.	Men	12.7	5.3	3.8	2.6	5.5
	Women	7.3	4.1	1.8	2.7	4.1
United States	Men	7.0	3.9	2.6	2.0	3.5
	Women	8.8	3.6	2.9	1.9	3.5
Country mean	Men	8.2	4.7	3.9	2.9	5.1
	Women	9.1	6.7	4.4	4.0	6.4

1. Year of reference 1998.S*ource:* OECD.

Centre for the Economics of Education
London School of Economics
Houghton Street, London WC2A 2AE
Tel 020 7955 7285; Fax 020 7955 7595
http://cee.lse.ac.uk