RS•C
ROYAL SOCIETY OF CHEMISTRY

Institute of Physics

The economic benefits of higher education qualifications

A report produced for

The Royal Society of Chemistry and

the Institute of Physics

by

PricewaterhouseCoopers LLP

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PRICEWATERHOUSECOOPERS

Executive Summary

Introduction and background

At the end of the 1990s, Ziegele[1] published a study about the rates of return on public and private investment in higher education in Germany. The Royal Society of Chemistry (RSC) and the Institute of Physics (IoP) commissioned PricewaterhouseCoopers (PWC) to undertake an analysis of the benefits of UK higher education attainment.

Using established econometric methodology and data from the Quarterly Labour Force Surveys, the economic costs and benefits associated with education to first degree standard were calculated.

The results presented here have been obtained by considering the earnings and employment benefits associated with getting a degree, taking into account a variety of other contributory factors (such as age, gender, region of residence etc). This was done to ensure the economic benefit resulting from the qualification was assessed rather than the other differentiating characteristics of the graduate population. In particular, the analysis assesses the value of degree subject rather than particular career paths.

The analysis is based on a financial cost model and it is important to note that this study does not take into account the “non-financial” or social benefits, such as the value of the experience of going to university, improved health benefits (particularly over the longer term), reduced incidence of criminal behaviour and technological progress associated with specific degree subjects. Such effects are not insignificant, but are difficult to quantify. Therefore, for the purposes of this study, they have not been included in the data.

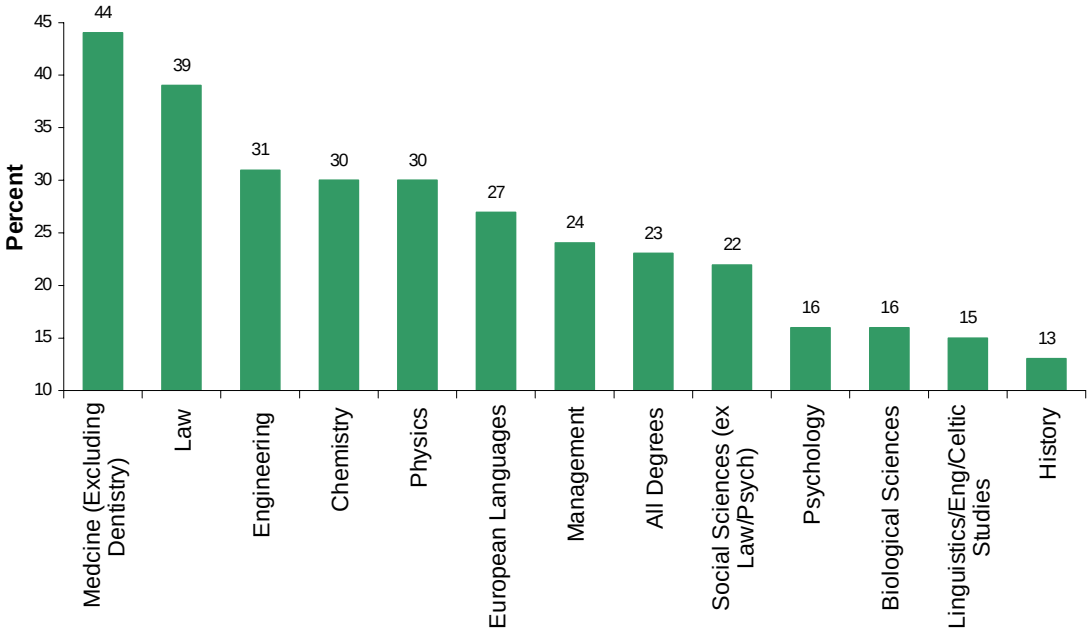
Key findings

The value of higher education to an individual

- Over a working life, the average graduate will earn around 23% more than his/her equivalent holding two or more ‘A’ levels (*see paragraph 5.1 in main report*).
- Chemistry and physics graduates will earn on average over 30% more during their working lifetimes than ‘A’ level holders (*paragraph 5.3*).
- The figure of 30% compares with between 13 and 16% for graduates in subjects including psychology, biological sciences, linguistics, and history (*paragraph 5.2*).

[1] ZIEGELE, F. (2003): "Country report: HE Finance and Cost-sharing in Germany” CHE-Centre for Higher Education Development Report.

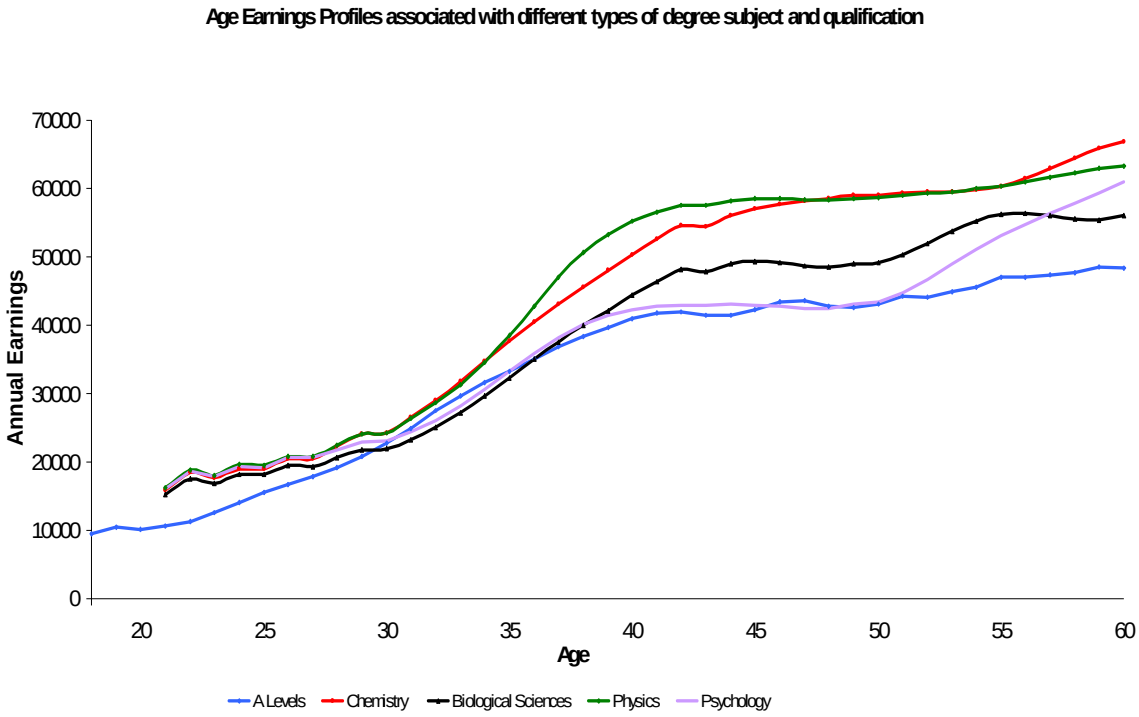
Percentage hourly earnings premium associated with different degree level subjects (21-60 year olds) compared to 2 or more 'A' Levels: Labour Force Surveys 2000-2004 pooled



- The average monetary *value*[2], in today's terms, of completing a degree over and above 2 or more 'A' Levels is approximately £129,000 (*paragraph 5.9*).
- There is wide variation in the *value* of different degree subjects. For example, the combination of enhanced employment and annual earnings suggests that graduates in chemistry and physics earn well above the average of £129,000, with the overall value for these subjects currently standing at around £185,000–190,000[3] (*paragraph 5.9*).
- The analysis also shows that graduate earnings grow at a constant rate during the first few years after graduation, regardless of the degree subject (*paragraph 5.7*).
- However, graduate earnings show marked differences in the mid-career years, with particular growth being associated with chemistry and physics degrees when compared with other subjects (*paragraph 5.8*).
- This finding suggests that the use of starting salaries as comparators for subjects, and their specific use to illustrate longer term career potential, may be misleading, as they reflect a snapshot picture rather than a lifetime estimate of potential earnings.
- Based on existing literature, the financial benefit of completing a degree is much greater for women than for men. This may be due in part to the relatively low earnings of non graduate women (*paragraph 2.10)*.

[2] The (monetary) value of a degree is defined as the difference in the present value of the after tax employment adjusted lifetime earnings of representative degree level holders compared to representative individuals in possession of 2 or more A Levels

[3] The percentage premium referred to and the monetary values are not directly comparable, as the monetary values incorporate earnings and employment effects in five year age band across the entire working life of graduates (as opposed to an overall snapshot). The monetary estimate is also discounted to provide an estimate of the value of a degree in today's money terms.



Rates of return to the individual

- The analysis also assesses the costs associated with undertaking a degree, trading them off against the economic benefits (*section 3*).

- The individual rate of return[4] to the *average* degree holder is about 12% per annum. This compares with an individual rate of return for graduates in chemistry and physics of approximately 15% per annum. Undertaking a chemistry or physics degree provides an above average investment to the individual (*paragraph 5.13*).

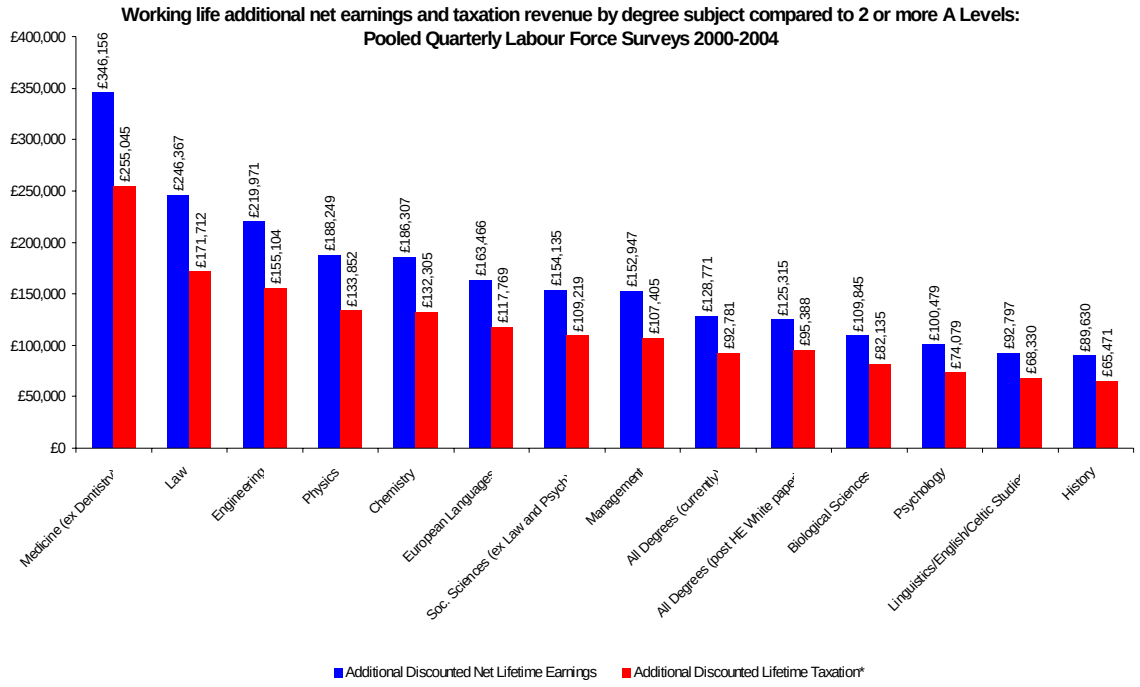
The value of higher education to the state

- During the period of study itself, there are significant costs borne by the state. However, there are also substantial tax benefits accruing to the Exchequer, particularly later in a graduate's working life, as earnings and related taxation payments increase.

- It currently costs the state approximately £21,000 to provide education to degree level for the *average* graduate. However, the value to the state in terms of the tax and national insurance associated with earning following qualification is approximately £93,000 (*paragraph 5.19*).

- Chemistry and physics are expensive subjects to teach when compared with non-laboratory intensive subjects. However, despite the additional costs to the state associated with these laboratory-based subjects, the additional taxation revenues to the Exchequer over a graduate's working lifetime approximates £130,000-£135,000. These results are highlighted in the figure above (*paragraph 5.20*).

[4] The rate of return is defined as the interest rate (or discount rate) for which the present value of the costs associated with higher education (which generally occur in the present or near future) equal the present value of the benefits derived from higher education (which occur in the more distant future)



Rates of return to the state

- Trading off the costs and benefits to the state, these monetary estimates equate to 12.1% and 13.0% rate of return for chemistry and physics respectively. These rates of return are at least as good as those associated with the average degree (*paragraph 5.21*).

Likely impact of the introduction of top-up fees in 2006/07

- The impact of the changes in student finance arrangements following the introduction of differential top-up fees in 2006/07 was modelled.

- The outcome from this exercise suggests that, despite the likely increases in repayments that will have to be made by students in the medium to longer term, the additional financial assistance from the state in the short term has the effect of ***increasing*** the benefit to the individual by approximately £2,650 over a lifetime, whilst reducing the return to the state by an equivalent amount (*paragraph 5.24*).

- This analysis therefore suggests that, in economic terms at least, undertaking higher education in the future will be even more financially worthwhile to the individual.

Comparison with Germany

The report compares UK rates of return across a range of degree subjects with a similar study undertaken in Germany.

- The economic rates of return for UK students are uniformly higher than those achieved by their German counterparts. It is suggested that the difference is accounted in a large part by the difference in degree structures, and specifically that UK degree programmes are shorter (*paragraph 6.4*).

- Regardless of the overall differential between the rates of return in the UK and Germany, the observed subject trends mirror each other closely. For example, law degrees have the highest overall individual rate of return, followed by management, engineering, chemistry and physics. The lowest rates of return are linked to graduates in history, social sciences and modern languages (*paragraphs 6.5 and 6.6*).

Contents

1 Introduction

1.1 At the end of the 1990s, Ziegele published a study about the rates of return on public and private investment in higher education in Germany. Although the scope of the study was limited, it gave some interesting insights into the value of higher education more generally. A key message was that, in most disciplines, there is a substantial private rate of return and that higher education is a worthwhile activity.

1.2 The Royal Society of Chemistry (RSC) and the Institute of Physics (IoP) wished to explore whether a similar situation could be found in the UK, and commissioned PricewaterhouseCoopers (PWC) to undertake an analysis of the benefits of UK higher education attainment. The project was specifically set up to explore the economic returns to both the individual and to the Exchequer across a range of degree subjects, and particularly for qualifications in chemistry and physics[5].

1.3 The outcomes from the analysis of UK data were also compared with those of the German study.

1.4 Using established econometric methodology[6], this report sets out the findings of the project against the context of changing take-up of science subjects at secondary and tertiary levels.

1.5 Following this introduction, section 2 provides background information on uptake of science-related subjects at secondary and tertiary levels since 1997/98 in the UK together with a review of evidence in recent academic literature on the economic benefits of degree qualifications. Section 3 sets out the background theory and definitions used, while section 4 summarises the methodology used in this study against that background.

1.6 Section 5 presents the initial findings on economic costs and benefits of tertiary education, while section 6 compares these findings with those from the Ziegele study. The final section sets out a number of conclusions resulting from the analysis.

[5] Copy of the full terms of reference is presented in Appendix 6.
[6] See sections 4 and 5 of this report.

2 Background

2.1 In recent times, there has been unprecedented growth in the proportion and numbers of young people opting to remain in education beyond the minimum school leaving age, attaining additional academic or vocational qualifications and proceeding to higher education.

2.2 Since 1997/98, there has been a 12% increase in the numbers of 16-18 year old entrants for GCE 'A' Level examinations in England and a 9% increase in the number of full time undergraduates in higher education in the UK as a whole (see Tables 1 and 2). However, these gains in education attainment have not been evenly distributed across all subject areas. In particular, there has been a decline in the numbers of students undertaking mathematics and physical sciences orientated subjects at GCE 'A' Level and carrying on to university, while there has been a significant expansion in those enrolling in subjects contained within the social sciences and psychology disciplines.

Table 1: GCE A level examination entrants: 16-18 year old students in all schools and colleges in England analysed by selected subject[7]

	1997/1998	1998/1999	1999/2000	200/2001	2001/2002	2002/2003	2003/2004	Change 97/98 -03/04
Biological Sciences	42,826	47,156	46,176	44,619	47,236	45,773	44,345	**4%**
Chemistry	32,269	35,813	35,276	33,650	33,427	32,319	32,193	**0%**
Physics	26,440	29,481	28,105	27,809	28,549	27,128	24,671	**-7%**
Other Science	5,840	6,742	6,722	6,679	8,008	4,184	3,777	**-35%**
Mathematics	54,980	61,185	58,618	58,277	50,326	51,438	51,218	**-7%**
Psychology	-	-	-	-	-	39,907	42,865	n/a
Total (All Subjects)	605,320	679,812	672,192	686,360	666,073	686,472	676,679	**12%**

Source: Department for Education and Skills

Table 2: Number of full time undergraduate students in UK higher education by (selected) subject

	1997/1998	1998/1999	1999/2000	2000/2001	2001/2002	2002/2003	Change 97/98 – 02/03
Biological sciences[8]	44,755	45,666	46,180	46,175	44,975	56,545	**26%**
Chemistry	13,714	13,728	13,110	12,030	11,645	11,625	-15%
Physics	9,731	9,706	9,480	9,025	8,605	9,045	-7%
Social Sciences	78,119	79,502	80,160	80,200	81,115	94,310	**20%**
Psychology	20,667	20,333	20,720	21,285	22,690	35,795	**73%**
All Higher Education	1,022,606	1,032,897	1,027,400	1,037,880	1,069,210	1,111,310	**9%**

Source: HESA. There is a reclassification of qualifications in 2002/2003 which leads to a minor data discontinuity.

[7] Full table is presented in Appendices
[8] Excluding Psychology

2.3 While the total number of 16-18 year old GCE 'A' Level entrants increased by 12% since 1997/1998, there has been no increase in the number undertaking chemistry at 'A' Level, a 7 percent decline in the numbers studying physics and a 7 percent decline in those undertaking mathematics. This has been translated into an even larger relative reduction in terms of the numbers undertaking the science subjects at university level. There has been a 15 and 7 percent reduction in the numbers studying chemistry and physics, respectively, at tertiary level since 1997/1998, though this is merely illustrative of the longer-term downward trend since the early 1990s. In comparison, since 1997/1998, there has been a 20% increase in the numbers studying social sciences and a 73% increase in the numbers studying psychology in higher education.

The economic benefits of degree level qualifications

2.4 As the quality of the data containing information on individual qualification attainment and earnings has improved, it has become increasingly feasible to provide robust analysis of the economic returns to higher education qualifications. The benefits associated with education attainment are many, though the majority of the studies to date have focussed on either the enhanced earnings or the improved labour market participation of those individuals with higher levels of qualification.

2.5 The academic literature has become more sophisticated and increasingly differentiates between the economic returns achieved by an individual with a qualification and the economic returns attributable to the qualification itself. Specifically, it is incorrect to compare the earnings associated with average degree holder with the earnings achieved by individuals with lower qualification levels and simply attribute the earnings difference to any difference in qualification attainment. It is entirely plausible that there are different personal characteristics associated with degree holders compared to non-degree holders, and it is these differences in personal characteristics that drive earnings gaps between the two groups.

2.6 It is for this reason that the majority of the recent studies have focused on the raw earnings benefit associated with obtaining degree level qualifications compared to those individuals in possession of university entry level qualifications but who do not go on to complete tertiary education. This is a more appropriate comparison of like for like, and in this way, the economic benefit associated with the qualification is estimated rather than the return to the innate ability or personal motivation of the individual.

2.7 In a study representative of the wider economic literature, Blundell *et al* (2003)[9] estimated that the earnings premium associated with obtaining a higher education qualification is approximately 23.5 percent compared to possession of 2 or more 'A' levels when personal, family and ability characteristics are built into the model[10].

2.8 The general result suggests that there is a significant earnings premium associated with additional qualification attainment as well as an increase in the probability of being employed. Translated into monetary terms, the most recent estimate of the discounted additional lifetime earnings associated with degree level attainment approximates £120,000[11]. In other words, the present *value* over a lifetime of undertaking and completing a degree level qualification is £120,000 compared to those with 'A' levels as their highest qualification.

2.9 There are relatively few studies that have undertaken a detailed analysis of the economic returns associated with different degree level subjects due in part to the lack of consistent and

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[9] Blundell, R., L. Dearden and B. Sianesi (2003) *Estimating the Returns to Education: Models, Methods and Results*, IFS Working Paper No. WP03/20. See appendix for full details

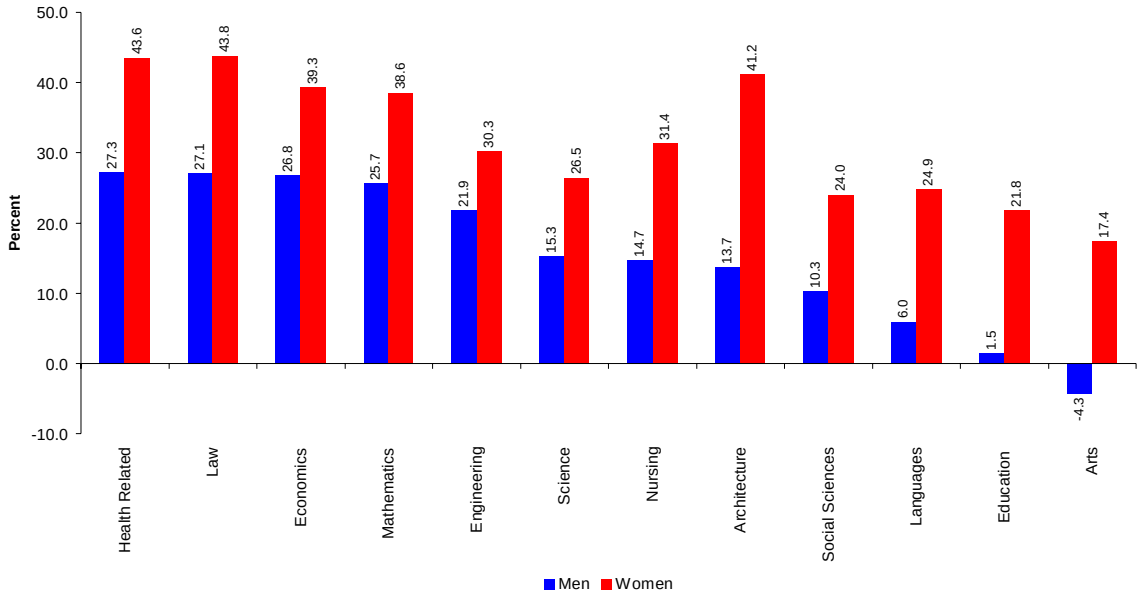
[10] This result is characteristic of the types of studies that have been undertaken and reiterates the findings of Dearden (1999), Dearden *et al* (2000), Harkness and Machin (1999), Chevalier and Walker (2001), McIntosh (2004) and Conlon (2005 forthcoming). For a full review of the literature, refer to Chevalier *et al* (2002).

[11] Hansard written answer provided by Alan Johnson, Secretary of State for Higher Education 8th December 2003.

reliable data. The main strands of work have been based on cross sectional data sources, such as the Quarterly Labour Force Surveys or longitudinal studies such as the National Child Development Study or the Graduate Cohort Studies.

2.10 The findings based on either type of data reiterate that there has been and continues to be a significant earnings premium associated with undertaking and completing tertiary level, science-related qualifications compared to GCE 'A' Levels and that the earnings premium is greater for women than for men (as with most degree level qualifications). There is some ambiguity in relation to the earnings associated with science related degrees relative to other degree subjects over time. This is in part due to the relatively limited samples of graduates that have been analysed and different methodologies adopted (see appendix 2 for details). However, one recent analysis (Walker and Zhu, 2001) illustrates that those males who are in possession of science related degrees achieve a 15.3% earnings premium over those with 'A' Levels as their highest qualification while women achieve a 26.5% earnings premium. The estimates indicate that men with science related degrees achieve approximately the same earnings premium as the average male graduate (0.4 percentage points more) while women with science degrees achieve a marginal premium over the average female graduate (5.6 percentage points). Based on current literature, the financial benefit of completing a degree is much greater for women than for men, though this may be due in part to be the relatively low earnings of non graduate women.

Figure 1: Earning Premia associated with different degree level subjects



Source: Walker and Zhu (2001)

2.11 However, these estimates are at an aggregate level and it is clear that there are considerable limitations in the evidence presented to date:

- There is clear variation within broad subject classifications of the earnings associated with different types of degree at different points in the life cycle (for instance, science degrees include graduates in physics, chemistry and biological sciences and social science graduates include those with economics, sociology, anthropology and law degrees – for whom there are widely differing outcomes).

- The estimates of earnings premia do not take into account the difference in the probabilities of employment by degree subject. An example of the different likelihoods of being employed or unemployed by degree subject is presented in Appendix 2.

- The analysis of the earnings associated with qualification attainment only takes into account

the private *benefits* to the individual. These analyses do not take into account the *direct and indirect costs*[12] of undertaking different degree subjects.

- Generally, these analyses do not take into account the cost to the Exchequer or the additional taxation revenues that might be associated with qualification attainment.

2.12 This report addresses these evidence gaps in the current academic literature and presents the most up-to-date findings on the economic costs and benefits accruing to the individual and the Exchequer depending on the degree subject studied.

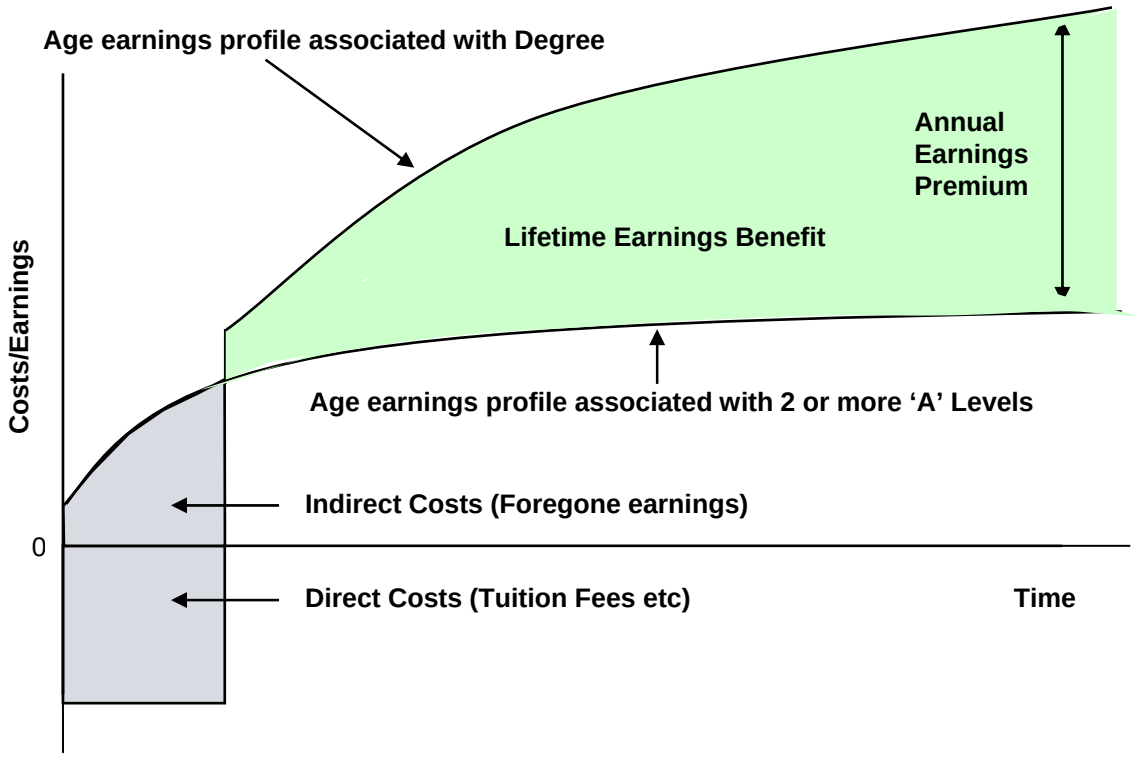
[12] Direct costs are defined as those costs associated with undertaking and completing a qualification that would otherwise not be incurred (such as tuition fees). Indirect costs consist of those economic benefits that are forgone while undertaking and completing the qualification (such as forgone earnings)

3 Private and Exchequer rates of return to higher education qualifications

3.1 To understand the relative economic benefit associated with different types of qualification attainment, this analysis compares the initial costs and lifetime benefits associated with higher education qualification attainment with the earnings associated with the next highest level of qualification. As previously mentioned, the reference category is taken as individuals in possession of two or more 'A' Levels[13], which allows comparison of individuals with university entry level qualifications who did not go on to complete higher education with those that did. The results presented here have been estimated by considering the earnings and employment benefits associated with getting a degree, taking into account a variety of other contributory factors (such as age, gender etc). This was done to ensure the economic benefit resulting from the qualification was assessed rather than the other differentiating characteristics of the graduate population. In particular, the analysis assesses the value of degree subject rather particular career paths.

3.2 Diagrammatically, the costs and benefits to the individual are represented in Figure 2 and the specific types of costs and benefits to the individual and the Exchequer are presented in detail in Appendix 3.

Figure 2: Measuring the individual costs and benefits of qualification attainment



[13] The comparison of degree holders with those in possession of 2 or more A Levels does not take into account all the differences in innate ability between the two groups. It would be preferable to compare various graduates with those in possession of 3 or more A Levels, though the numbers with 3 A levels not progressing to university would restrict the sample size and the accuracy of the results considerably.

Definitions

3.3 The costs associated with degree level education attainment to the individual comprise the foregone earnings associated with undertaking and completing the qualification and the direct costs (such as tuition fees and loan repayments)[14].

3.4 The benefits to the individual are made up of the additional post-taxation earnings associated with the qualification, the increased probability of being in employment, any fee remission or maintenance grant and the interest rate subsidy that is received on any student loan taken by the student while in university.

3.5 The private rate of return is defined as the discount rate at which the net present value of the costs and benefits equals zero. In non-technical terms, the private rate of return is used to trade off the current costs against the future benefits associated with qualification attainment. It illustrates the extent to which an investment (in time and resources) is economically worthwhile to the person undertaking the qualification.

Exchequer rate of return

3.6 The Exchequer also makes a significant investment in the education of young people. Specifically, there is a contribution towards the cost of teaching students (via the HEFCE teaching grant), foregone taxation while the individual progresses in higher education, tuition fee and maintenance grant contribution for the most needy and the cost of providing a generous interest rate subsidy on student loans. The Exchequer recoups this investment though the increased tax and national insurance paid following enhanced graduate earnings.

3.7 The Exchequer rate of return is defined as the discount rate at which the net present value of these costs and benefits equals zero. As with the individual rate of return, the Exchequer rate of return is used to trade off the current costs against the future benefits associated with higher education provision and illustrates the extent to which the investment by the state in higher education is economically worthwhile.

Table 3: The financial cost and benefits to the Individual from degree level attainment

Individual	
Costs (Direct and Indirect)	**Benefits**
Foregone net earnings during HE	Additional post taxation income (adjusted for the likelihood of being employed)
Tuition fee paid by student	Interest rate subsidy on loan
Loan Repayment post graduation	

[14] The earnings foregone crucially depend on the subject of study and the time taken to complete a particular degree. For each degree subject, the methodology incorporates the time required to complete a degree level qualification. In addition, the content and equivalency of particular qualifications has changed over time. In specific subjects (such as chemistry, physics and engineering), individuals previously in possession of four year bachelor degrees are comparable to more recent graduates with three year undergraduate degrees and one year postgraduate degrees. To ensure comparability in the age-earnings profiles over time, we have weighted the sample of recent graduates in these subjects to include the proportion that complete one year postgraduate degrees.

Table 4: The financial cost and benefits to the Exchequer from degree level attainment

Exchequer	
Costs (Direct and Indirect)	**Benefits**
Foregone Taxation during studies Resource cost associated with provision of higher education distributed by the (HEFCE) Component of tuition fee not paid by student Interest rate subsidy on loan	Additional income tax and national insurance contributions

3.8 It is important to note that all the costs and benefits that have been included in this analysis are financial. They do not incorporate any non monetary benefits that may occur from having a more educated population.

3.9 In other words, there are substantial benefits associated with the attainment of particular degree level subjects, which are difficult to quantify. The assessment of these benefits is beyond the scope of this report, but they should be remembered when discussing the results. For example, there are clear benefits associated with an increasingly educated population in the form of improved health (Sabates and Feinstein, 2004), reduced incidence of depression and obesity (Feinstein, 2002a) reduced crime rates (Feinstein, 2002b), social cohesion (Preston and Green, 2003), and the intergenerational transmission of skills between parents and children (Blanden, 2002)[15]. In addition to the benefits associated with all graduates, it is also likely that there are differences in the economic benefits associated with different types of degrees. For example, science-orientated degrees are likely to be associated with significant research and development activity or more technologically driven production.

[15] A recent review of the wider benefits of education attainment (Chevalier *et al* 2002) provides substantial information on the topic.

4 Methodology

4.1 To undertake this analysis and to ensure that the results are statistically robust, pooled information from the Quarterly Labour Force Surveys between 2000 and 2004 was used. This data source has unique coverage and detailed information on qualifications as well as earnings and employment status at an individual level.

4.2 Detailed econometric modelling was undertaken to update and improve the estimates produced by Walker and Zhu (2001), and to assess the economic returns associated with specific degree subjects at the most disaggregated level possible.

4.3 The steps in the analysis were as follows:

- To estimate the earnings premia associated with different degree level subjects across the entire working age population (in 5 year age bands) compared to those in possession of 2 or more 'A' Levels (taking into account a range of personal, regional and job related characteristics).
- To estimate the relative likelihood of employment for each degree level subject (taking into account a range of personal and regional characteristics).
- To adjust the earnings premia by the probability of being employed.
- To construct an age-earnings profile for representative individuals in possession of 2 or more 'A' Levels and specific degree subjects.
- To estimate direct and indirect costs associated with undertaking a higher education qualification to the individual and the Exchequer.
- To estimate the additional income and taxation revenue associated with the earnings premia accruing to degree holders and the Exchequer respectively by specific degree subject.
- For the individual and Exchequer, to estimate the rate of return in such a way that trades off the short term costs and long term benefits associated with qualification attainment.

4.4 A full and detailed methodology is available upon request.

5 Findings

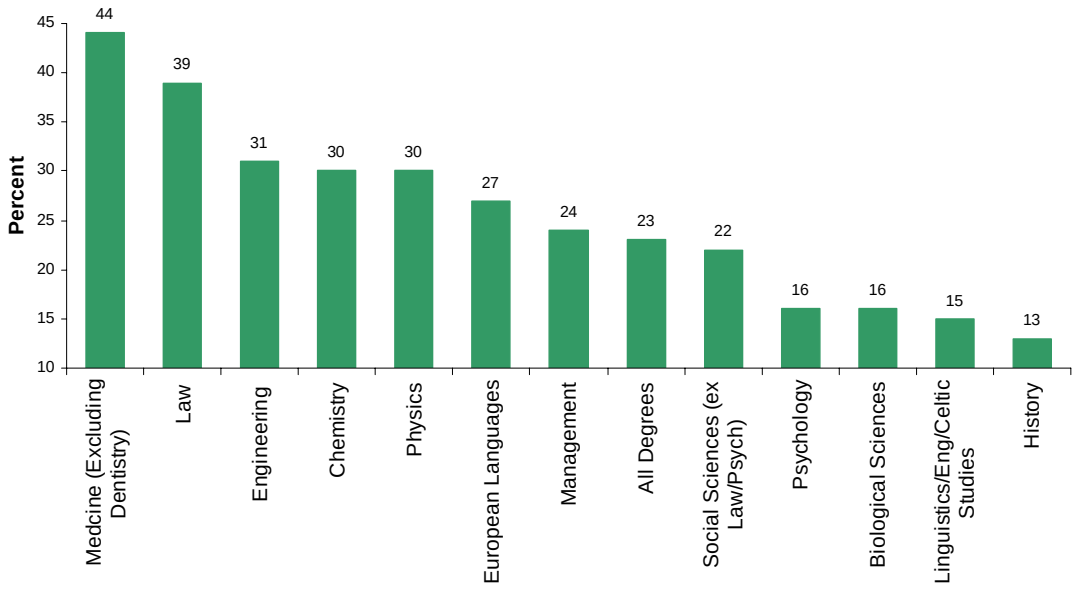
The value of higher education to the individual

5.1 The results of the econometric modelling indicate the return to a degree holder, averaging over all subjects, is 23 percent, compared to those in possession of two or more 'A' levels as their highest qualification. This finding replicates those presented earlier by Blundell *et al* (2003).

5.2 It was also found that there is significant variation in the earnings associated with different degree subjects. For example, the findings show that those students in possession of medicine or law degrees achieve an hourly earnings premium of 44 and 39 percent respectively over those in possession of 2 or more 'A' levels (see Figure 3). At the lower end of the scale, those in possession of history, English/ linguistics, biological sciences and psychology degrees achieve hourly earnings premia of 13, 15, 16 and 16 percent respectively over those with 2 or more 'A' levels.

5.3 Individuals in possession of engineering, chemistry and physics degrees achieve a premium of approximately 30-31% over those with 2 or more 'A' Levels.

Figure 3: Percentage hourly earnings premium associated with different degree level subjects (21-60 year olds) compared to 2 or more 'A' Levels: Labour Force Surveys 2000-2004 pooled



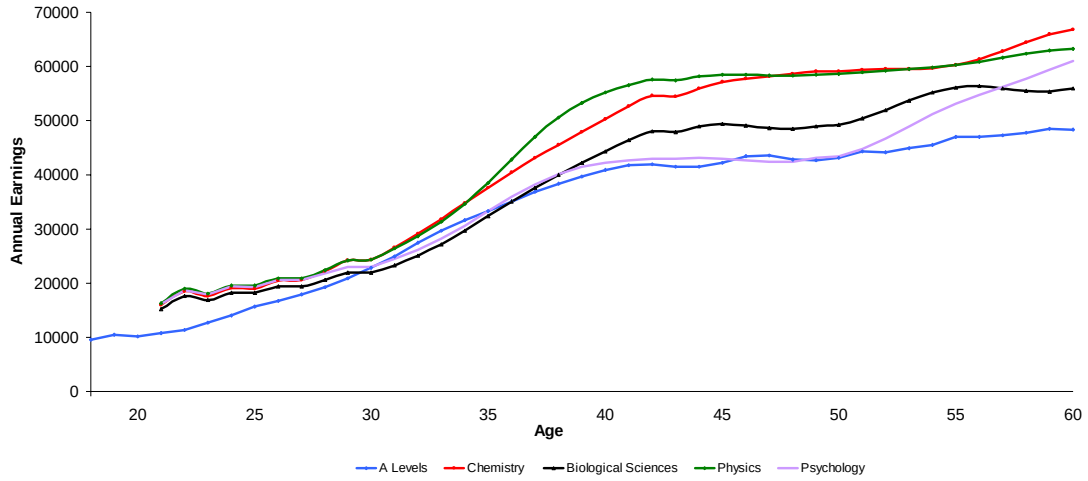
5.4 The same analysis was undertaken in five-year age bands across the entire age spectrum to assist with the assessment of lifetime earnings. This is because earnings (and earnings premia) are likely to vary with age, and the results presented above only provide an average across all ages of the outcomes associated with degree level attainment.

5.5 The probability of being employed was estimated in five-year age bands and the two sets of results were combined to create age-earnings profiles that an average individual in possession of a particular degree level qualification (or two or more 'A' Levels) might achieve[16].

[16] These age earnings profiles have been adjusted for real earnings growth to reflect that fact that an individual aged 21 (say) would expect to earn more in 9 years time than a similar graduate currently aged 30. In line with HM

5.6 The age-earnings profiles associated with representative individuals in possession of chemistry, physics, psychology and biological sciences[17] degrees are presented in Figure 4. To interpret the figure, the earnings benefit to the representative individual in possession of a specific degree subject is the area between their own age earnings profile and the age earnings profile associated with 2 or more 'A' Levels (see Figure 2 for a stylised illustration).

Figure 4: Age Earnings Profiles associated with different types of degree subject and qualification



5.7 Figure 4 illustrates the importance of considering earnings across the entire age spectrum. There is little difference between the earnings of those in possession of any of these degree types between the ages of 21 and 30. However, beyond this point, there is a marked divergence.

5.8 In particular, both chemistry and physics graduates pull away from their counterparts beyond the age of 30. By the age of 60, chemistry or physics graduates might be expected to earn approximately £10,000 per annum more than an individual in possession of a degree in biological sciences and £7,000 more per annum than an individual in possession of a psychology degree. These differences are even more extreme during the period between 40 and 50 years of age, when chemistry and physics graduates' annual earnings exceed those achieved by graduates in biological sciences and psychology by approximately £10,000 and £13,000 per annum respectively.

5.9 Clearly, the cumulative effect of these annual earnings premia can be very significant over the entire working lifetime. The *monetary value* of completing a degree level qualification in today's money terms stands at approximately £129,000. At the higher end of the scale, chemistry and physics graduates achieve additional lifetime earnings benefit (in today's money terms) of between £185,000 and £190,000, while history and linguistics/English/celtic studies students achieve a premium of less than £100,000. These estimates are presented in Figure 5.

The trade off between costs and benefits

5.10 The exclusive focus on the outcomes associated with different types and levels of qualification attainment has been on the benefits associated with qualification attainment. There is little consideration of costs or the trade off between costs and benefits. For example, the findings in Figure 3 illustrate that the earnings premia associated with medicine, engineering, physics and

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Treasury Green Book guidance, earnings have been grossed at 2% per annum to reflect this fact.

[17] The analysis has focused on those in possession of Biological Sciences as the sample sizes of those in possession of pharmacy, pharmacology and materials degree are not sufficient for a robust analysis.

chemistry degrees are very substantial. However, it is also true that these degrees can take longer to complete. As a result, the foregone income incurred by the individual undertaking these degree subjects is much larger than for the average degree holder.

5.11 The estimate of the *opportunity* costs associated with undertaking a degree level qualification adopted for this analysis is defined as the earnings that would have been achieved by the individual if they had not undertaken the degree level qualification, i.e. the earnings associated with those in possession of two or more GCE 'A' Levels for the period while the degree is being studied for. In Figure 4, these opportunity costs, which are labelled "age-earnings profiles associated with 'A' Levels", are approximately £10,000 per annum. It may be the case that some degree subjects offer high earnings after graduation while the overall rate of return remains depressed because of the relatively high costs of degree completion.

5.12 The total direct and indirect costs accruing to the representative graduate and the Exchequer as a result of undertaking different types of degree have been aggregated and estimates made of the various rates of return to each from each type of degree. These results are presented in Table 5 and Figure 5.

Rates of return to the individual

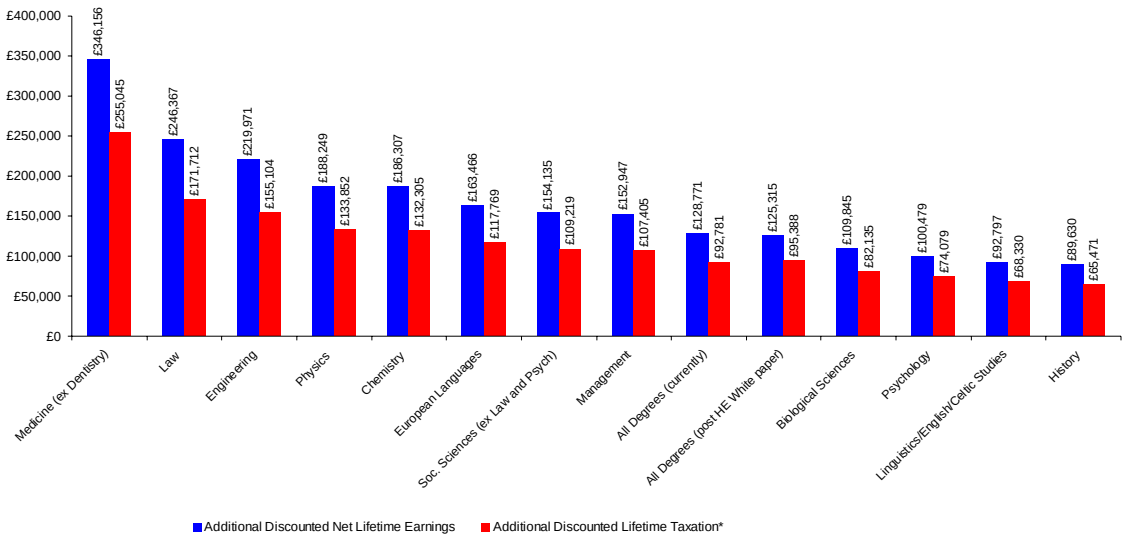
5.13 Trading off the costs and benefits, the results indicate the individual rate of return to a degree level qualification (at an aggregate level) approximates 12.1%. Again, there is considerable variation around this average estimate. Law degrees offer the highest rate of return (17.2%) while history offers the lowest rate of return (8.8%). Chemistry and physics degrees offer rates of return that are significantly above average despite the fact that they may be slightly longer in duration than the average degree. The individual rates of return to chemistry and physics degrees stand at 15.0% and 14.9%, respectively.

5.14 Psychology degrees have a relatively low rate of return (10.1%). Given the relative increase in the numbers of students undertaking psychology degrees at undergraduate level, it might be expected that the returns associated with this degree level subject would fall in future unless there is an equal increase in the demand for psychology graduates.

5.15 The trade off between costs and benefits is most apparent when considering medicine degrees. Although medicine degrees offer the highest earnings premia, the opportunity cost of undertaking this type of degree is also greatest (approximately £53,000). Consequently, the rate of return associated with medicine degrees stands at 11.6%, which is marginally below the average rate of return to a degree.

5.16 The estimates of the returns to the individual and the Exchequer are presented in Figure 6.

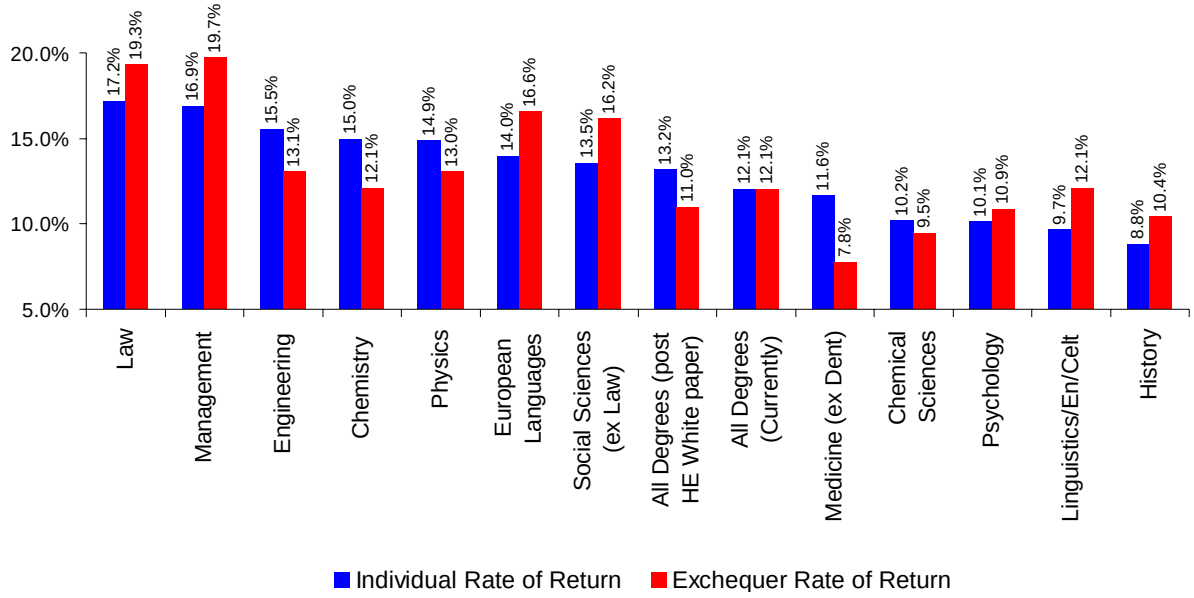
Figure 5: Working life additional net earnings and taxation revenue by degree subject compared to 2 or more A Levels: Pooled Quarterly Labour Force Surveys 2000-2004



	Public and Private Investment in Higher Education					
	Individual			Exchequer		
	Direct and Indirect Costs	Additional Discounted Net Lifetime Earnings	Rate of return	Subsidy	Additional Discounted Lifetime Taxation*	Rate of Return
Law	-£24,026	£246,367	17.2%	-£15,624	£171,712	19.3%
Management	-£24,026	£152,947	16.9%	-£15,624	£107,405	19.7%
Engineering	-£32,809	£219,971	15.5%	-£30,742	£155,104	13.1%
Chemistry	-£28,037	£186,307	15.0%	-£26,705	£132,305	12.1%
Physics	-£26,661	£188,249	14.9%	-£25,156	£133,852	13.0%
European Languages	-£32,809	£163,466	14.0%	-£21,167	£117,769	16.6%
Soc. Sciences (ex Law and Psych)	-£24,026	£154,135	13.5%	-£15,624	£109,219	16.2%
Medicine (ex Dentistry)	-£53,165	£346,156	11.6%	-£78,126	£255,045	7.8%
Biological Sciences	-£24,026	£109,845	10.2%	-£22,762	£82,135	9.5%
Psychology	-£24,026	£100,479	10.1%	-£18,682	£74,079	10.9%
Linguistics/English/Celtic Studies	-£24,026	£92,797	9.7%	-£15,624	£68,330	12.1%
History	-£24,026	£89,630	8.8%	-£15,624	£65,471	10.4%
All Degrees (currently)	-£26,208	£128,771	12.1%	-£21,218	£92,781	12.1%
All Degrees (following current student finance reforms)	-£22,974	£125,315	13.2%	-£24,556	£95,388	11.0%

Table 5: Total costs and revenues associated with obtaining alternative degree level qualifications

Figure 6: Individual and Exchequer rates of return associated with different degree level subjects



The value of higher education to the Exchequer

5.17 On the benefit side, the returns to the Exchequer are driven by the increases in taxation that are derived from enhanced earnings after graduation. It would be expected that those subjects with augmented earnings would result in relatively high Exchequer returns. Counteracting this is the fact that some degrees cost the Exchequer more than others. For example, laboratory-based subjects are more expensive to provide than non laboratory-based subjects. Using the most recent HEFCE teaching grant formula, it is possible to estimate the relative costs incurred by the state in the provision of different degree level subjects (see appendix 3).

5.18 The most expensive subject to provide is medicine (£5,923 per annum during the pre-clinical stages and £13,936 per annum during the clinical stages), followed by the laboratory-based subjects of chemistry and physics (£5,923 per annum). The least expensive subjects are those in the social sciences and law where there is essentially little or no laboratory-based component (£3,484 per annum).

5.19 It currently costs the state approximately £21,000 to provide education to degree level for the "average" graduate. However, the value to the state in terms of the tax and national insurance associated with earning following qualification is approximately £93,000 over the graduate's working life.

5.20 Chemistry and physics are relatively expensive subjects to teach when compared with non-laboratory intensive subjects. However, despite the additional costs to the state associated with these laboratory-based subjects (between £4,000 and £6,000), the additional taxation revenues to the Exchequer over the graduates' working lifetime approximate £130,000-£135,000. These results are highlighted in the Figure 5.

Rates of return to the Exchequer

5.21 The combination of these factors results in law and management degrees offering a very high return to the Exchequer (19.3% and 19.7% respectively) and the lowest returns being associated with medicine degrees (7.8%). The average rate of return to the Exchequer stands at 12.1%. The rates of return associated with chemistry and physics degrees are 12.1% and 13.0% respectively, while the rates of return to psychology and the biological sciences are 10.9% and 9.5% respectively.

5.22 It is important to reiterate that the analysis presented here deals only with the financial flows associated with different degree subjects. There are significant wider benefits associated with different types of degree that are not considered.

Rates of return post the 2004 Higher Education Bill

5.23 In addition to estimating the individual and Exchequer rates of return, we have also modelled the impact of the proposed student finance reforms (set out in the 2004 Higher Education Bill) to assess the impact of this policy on economic returns. This additional modelling work assumes that there is *no change* to current higher education participation rates or the distribution of students between subjects (i.e. students are not discouraged from applying to enter university and do not opt for 'cheaper' subjects or universities as a result of differential top up fees).

5.24 The results indicate that the rate of return to the individual actually *increases* following the introduction of the student finance reforms. For a representative degree holder, the individual rate of return *increases* from 12.1% to 13.2%, which is equivalent to approximately £2,650 overall in monetary terms over the graduate's working life.

5.25 This outcome is a result of putting together a number of factors:

- The removal of the need to pay for fees up front (as is currently the case).
- The re-introduction of a small maintenance grant for the poorest students.
- An increase in the threshold for loan repayments (from £10,000 to £15,000).
- An increase in the interest rate subsidy associated with the maintenance and tuition fee.

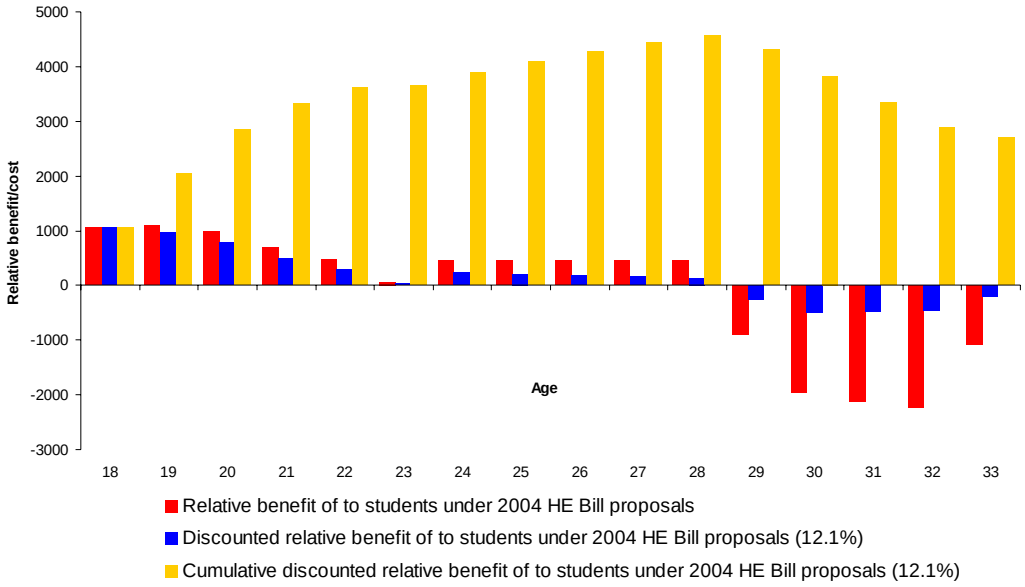
5.26 These factors outweigh the additional repayments that must be incurred later in the working life of graduates.

5.27 The finding that the rate of return to the individual increases is sensitive to the assumed interest rate (which trades off the current costs and the future benefits of higher education) and the assumptions that need to be made about the fees that higher education institutions eventually decide to charge (assumed to be £2,500 per annum for this analysis).

5.28 Conversely, in this model, the rate of return to the Exchequer for a representative graduate falls from 12.1% to 11.0% as many of the new benefits that accrue to the individual are due to transfers essentially from the Exchequer to the individual.

5.29 The year–on-year effect of the student finance reforms for a representative student (compared to the current system) is presented in Figure 7.

Figure 7: Relative Benefits of Current Student Finance System and Higher Education Bill Proposals



6 International comparison

6.1 One of the primary objectives of this work is to establish the results relative to recent international findings and specifically the work undertaken on the costs and benefits associated with degree level qualification attainment in Germany. Despite the fact that the education and student finance systems are very different between the two countries, there are clear parallels in the results presented.

6.2 The academic literature has compared the economic returns to schooling between the two countries and it has been clearly established that the returns to education in the UK significantly exceed those achieved in Germany. Trostel *et al.* (2001) illustrated that the earnings return to a single year of schooling approximate 12.5 (13.0) percent in the UK compared to 3.6 (4.3) percent in Germany for men (women). The difference in the rates of return between the two countries is largely explained by the fact that the time taken to complete the qualification in Germany is significantly greater than in the UK and, as a result, there are significantly higher costs associated with attending university in Germany. These estimates for the UK are at the higher end of recent estimates with the more recent estimates of the return to an additional year of schooling for the UK approximating 7-8%. The OECD has also produced some cross country estimates of the returns to degree level qualifications and found that the individual rates of return to higher education are approximately 11-14% in the UK and 8-9% in Germany (OECD, 2003).

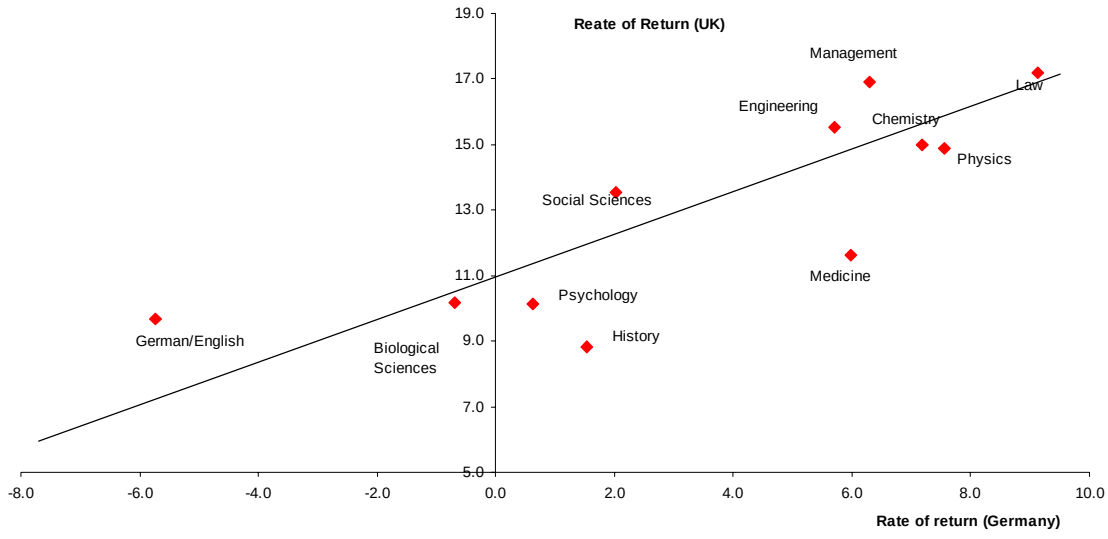
6.3 There is no exact comparison of the economic costs and benefits in the Ziegele study and those presented here and the methodologies relating to the estimation of the earnings and employment effects are different. However, Table 6 sets out a comparison of subject categories which can, in the broadest sense only, be taken as equivalent. The relative individual and Exchequer rate of returns to various degree subjects are presented in Figures 8 and 9.

6.4 As would be expected from the academic literature in the area, the results indicate that the individual rate of return achieved by individuals in the UK is higher than that achieved in Germany. In particular, the individual rates of return to degree level subjects in the UK are for the most-part between 7 and 10 percentage points higher than their counterparts in Germany. In terms of the dispersion of returns around the average (with the exception of those German (English) graduates with degrees in German (English)), the difference in rates of return between the highest and lowest degree subjects is broadly similar (7.5 percentage points in the UK and 9.8 percentage points in Germany).

Table 6: Comparison of subject categories of analysis

Subject of Study (Ziegele, 2003)	Subject of Study (Royal Society of Chemistry/ Institute of Physics, 2004)
Psychology	**Psychology**
Education	
Social Work	
Theology	
History	**History**
German/English	**Linguistics/English and Celtic Studies**
	European Languages
Politics/Sociology	**Social Sciences (excluding Law and Psychology)**
Law	**Law**
Business Administration	**Management**
Chemistry/Chemical Engineering	**Chemistry**
	Pharmacy
	Pharmacology
	Material Sciences
Physics	**Physics**
Biology	**Biological Sciences**
Mathematics	
Information Technology	
Medicine	
Dentistry	**Medicine (not including Dentistry)**
Veterinary Medicine	
Architecture	
Building Engineering	
Mechanical Engineering	**Engineering**
Electronic Engineering	
Production Engineering	
Art	
Music	

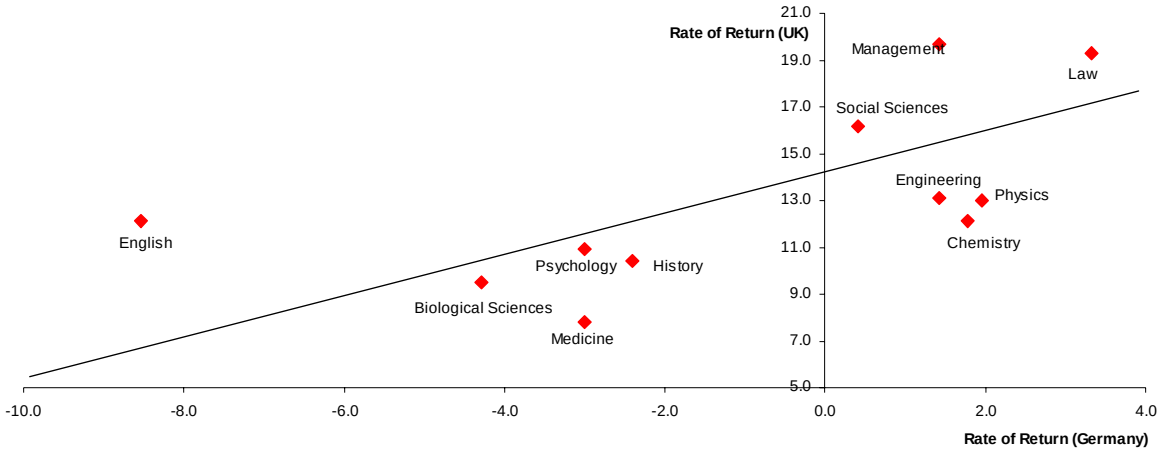
Figure 8: Correlation between individual return in Germany and UK by degree subject



6.5 Perhaps most interesting is the relative ranking of subjects by the individual rate of return to the subject of study. In each country, graduates with law degrees, followed by those students in possession of science, engineering and management degrees achieve the highest individual rates of return. Overall, there is a strong positive correlation between the two sets of returns and the relationship between the two sets of returns is presented in Figure 8. There is a significant difference between the returns achieved by these graduates and graduates in possession of qualifications related to the humanities, languages, psychology and biological sciences. In fact, for German graduates, there is an essentially zero or even a negative return associated with university degrees in political sociology, history, psychology, biology and German.

6.6 A similar trend is presented in Figure 9, where the two sets of Exchequer returns are presented. Again a similar relative ranking of rates of return by degree subject occurs, though there is a slightly weaker correlation between the two countries. Law and management related degrees have the highest Exchequer rates of return in both countries, followed by a cluster of engineering and science degrees. In both countries, medicine has a relatively low rate of return (due to the high resource costs to the state) as do psychology, biological sciences and history degrees (due to low earnings and taxation revenue).

Figure 9: Correlation between Exchequer rate of return in Germany and UK by degree subject



7 Summary and further analysis

7.1 This research report has compared the economic costs and benefits to the individual and the Exchequer for a variety of higher education degrees by subject. The report does not consider the non-economic benefits associated with qualification attainment such as improved health and well-being, reduced crime rates or positive technological spillovers to the rest of the economy.

7.2 The findings are in line with recent academic literature both in the UK and in Germany on the topic. They illustrate that there are significant economic costs incurred and benefits associated with qualification attainment at this level.

7.3 Based on the current student finance arrangements, the rate of return associated with an average degree stands at 12.1%. However, there is considerable variance depending on the subject of study.

7.4 In particular, law and management graduates do particularly well. Chemistry, physics and engineering graduates form a cluster of subjects whose rates of return are well above those achieved by the average graduate.

7.5 Despite the additional opportunity costs of undertaking chemistry or physics degrees, the individual rate of return with these degrees is approximately 15%. In contrast, graduates in the humanities and psychology achieve a lower than average rate of return.

7.6 In monetary terms, the *value* of undertaking and completing a higher education qualification is approximately £129,000 in today's money terms over and above a representative individual with 2 or more GCE 'A' Levels.

7.7 There is significant variation in the *value* of a degree depending on the subject studied. The combination of enhanced annual earnings and labour market status suggests that chemistry and physics graduates do significantly better than the average graduate. The *value* associated with completing either chemistry or physics degrees stands at approximately £185,000-£190,000.

7.8 For an average graduate, the current cost to the Exchequer of providing a degree level qualification is approximately £21,000. However, the *value* of the additional taxation and national insurance as a result of the qualification is approximately £93,000. Trading off these costs and benefits (and taking into account when they occur), this equates to an Exchequer rate of return of 12.1%, which is well above the long run cost of borrowing (currently 4.5%).

7.9 Despite the additional resource cost of to the state of providing chemistry and physics degrees, there is a better than average rate of return to the Exchequer associated with the provision of these degrees. In particular, the Exchequer rate of return to chemistry and physics degrees stands at 12.1% and 13.0% respectively.

7.10 Although there are significant costs to the individual in undertaking a chemistry or physics degree and to the Exchequer in providing them, these particular qualifications are economically worthwhile as they offer higher than average rates of return to the individual and the Exchequer.

7.11 An additional finding of the report is that, assuming there is no change in the composition of the student body following the introduction of differential tuition fees in 2006/07, the rate of return to the individual is expected to *increase*. In other words, over a lifetime, it will become more worthwhile to complete higher education than is currently the case (by approximately £2,650 overall). This is due to the fact that many of the up-front costs associated with the current system will have been removed and 'replaced' by additional graduate repayments well into a graduates working life.

Appendix 1: Glossary of selected terms

Direct costs: Direct costs are defined as those costs associated with undertaking and completing a qualification that would otherwise not be incurred (such as tuition fees).

Discount Rate: The rate of interest used to convert future cash flows to an equivalent present day value. It is used to account for the declining value of money over time.

Exchequer: Used to mean the government or public sector and used interchangeably with the term *state*

Indirect costs: Indirect costs consist of those economic benefits that would have been achieved if undertaking and completing the qualification had not taken place (such as forgone earnings).

Premium: Throughout this analysis, premium refers to the percentage by which the hourly earnings achieved by degree holders exceed that achieved by individuals in possession of two or more 'A' Levels.

Present Value: The discounted value of a payment or stream of payments to be made or received in the future, taking into consideration a specific interest or discount rate. Present Value represents a series of future cash flows expressed in today's currency.

Rate of return: The rate of return is defined as the interest rate (or discount rate) for which the present value of the costs associated with higher education (which generally occur in the present or near future) equals the present value of the benefits derived from higher education (which occur in the more distant future).

State: Used to mean the government or public sector and used interchangeably with the term Exchequer.

Value: The (monetary) value of a degree is defined as the difference in the present value of the after tax employment adjusted lifetime earnings of representative degree level holders compared to representative individuals in possession of 2 or more 'A' Levels

Appendix 2: Background material

GCE A level examination entrants: 16-18 year old students in all schools and colleges in England analysed by subject

	1997/1998	1998/1999	1999/2000	200/2001	2001/2002	2002/2003	2003/2004	Change 97/98-03/04
Biological Sciences	42,826	47,156	46,176	44,619	47,236	45,773	44,345	**4%**
Chemistry	32,269	35,813	35,276	33,650	33,427	32,319	32,193	**0%**
Physics	26,440	29,481	28,105	27,809	28,549	27,128	24,671	**-7%**
Other Science	5,840	6,742	6,722	6,679	8,008	4,184	3,777	**-35%**
Mathematics	54,980	61,185	58,618	58,277	50,326	51,438	51,218	**-7%**
Psychology						39,907	42,865	
Computer Studies	8,450	14,699	17,138	20,341	24,844	8,464	6,866	**-19%**
ICT						16,665	14,464	
Design and Technology	11,156	12,483	13,687	14,952	14,221	15,442	15,517	**39%**
Home Economics	1,650	1,664	1,338	1,207	691	602	538	**-67%**
Business Studies	25,612	30,623	31,076	31,013	33,115	33,560	31,276	**22%**
Geography	36,324	37,055	33,012	33,437	31,286	31,475	29,903	**-18%**
History	31,627	33,420	33,140	34,001	36,245	37,265	38,183	**21%**
Economics	16,088	18,294	17,280	16,853	13,649	13,742	13,419	**-17%**
Social Studies	47,333	58,962	57,638	59,122	69,925	44,400	45,104	**-5%**
Physical Education	12,027	14,740	15,853	17,137	16,823	18,931	19,266	**60%**
Vocational Studies	2,158	3,051	2,911	2,797	2,447	2,756	2,675	**24%**
Art and Design	27,840	32,494	32,230	33,975	32,915	35,384	34,582	**24%**
English	73,700	79,691	77,079	78,151	87,620	88,259	86,983	**18%**
Communication Studies	23,224	27,162	27,713	29,701	24,467	8,105	8,297	**-64%**
Media/Film/TV Studies						19,716	21,007	
French	18,152	17,775	15,214	15,229	14,261	13,544	12,501	**-31%**
German	8,233	8,527	7,581	7,528	6,618	6,362	5,638	**-32%**
Spanish	4,174	4,640	4,516	4,452	4,951	5,042	4,646	**11%**
Other Modern Languages	2,475	3,499	3,660	3,496	5,097	5,279	4,314	**74%**
Classical Studies	5,055	5,147	5,019	4,769	5,064	5,448	5,272	**4%**
Music	5,429	6,218	6,127	6,318	6,934	7,834	8,245	**52%**
Religious Studies	6,235	5,044	7,161	7,586	8,660	10,260	11,742	**88%**
General Studies	73,536	84,188	87,765	93,236	58,685	57,160	57,172	**-22%**
Other	2,487							
Total	**605,320**	**679,812**	**672,192**	**686,360**	**666,073**	**686,472**	**676,679**	**12%**

Number of Full time undergraduate students in UK higher education by (selected) subject

	1997/1998	1998/1999	1999/2000	2000/2001	2001/2002	2002/2003	Change 97/98 – 02/03
Biological sciences[11]	44,755	45,666	46,180	46,175	44,975	56,545	**26%**
Chemistry	13,714	13,728	13,110	12,030	11,645	11,625	**-15%**
Physics	9,731	9,706	9,480	9,025	8,605	9,045	**-7%**
Social Sciences	78,119	79,502	80,160	80,200	81,115	94,310	**20%**
Psychology	20,667	20,333	20,720	21,285	22,690	35,795	**73%**
All Higher Education	**1,022,606**	**1,032,897**	**1,027,400**	**1,037,880**	**1,069,210**	**1,111,310**	**9%**

Source: HESA: There is a reclassification of qualifications in 2002/2003 which leads to a minor data discontinuity.

Recent estimates of the earning premia associated with 'science' degrees (relative to 'A' Levels)

Study	Data	Method	Returns to Science[18] (percent)
Harkness and Machin (1999)	General Household Survey 1980-1995 N=3,000 per period Age 16-60	Mincer equation, 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
Walker and Zhu (2001)	Quarterly Labour Force Surveys 1993-1999 N=4,500 per year Age 25-59	Mincer equation, 13 subjects, returns relative to A-levels.	1993: Men: 0.13 Women: 0.31 1999: Men: 0.14 Women: 0.25 All years: Men: 0.15 Women: 0.26

Recent estimates of the returns to science degrees (relative to Humanities Degrees)

Study	Data	Method	Returns to science vs. Humanities (percent)	Returns to social science vs. Humanities (percent)
Chevalier *et al* (2002)	Graduate 1980, Pay 1996 N=1818 (female) 3097 (male)	Mincer, 5 subjects, returns relative to other (education)	Men: 0.016 Women: 0.016	Men: 0.058 Women: 0.078
Battu et al. (1999)	Graduate survey 1985, pay 1991 N=3,693	Regression, 8 subjects, returns relative to education	Men: 0.21 Women: -0.13	Men: 0.24 Women: -0.01

[18] In this analysis, Science is defined as consisting of physics and mathematics

Study	Data	Method	Returns to science vs. Humanities (percent)	Returns to social science vs. Humanities (percent)
Battu et al. (1999)	Graduate survey 1990, pay 1996 N=6,253	Regression, 8 subjects, returns relative to education	Men: 0.17 Women: -0.19	Men: -0.20 Women: -0.09
Chevalier (2000)	Graduate survey 1985 & 1990 N= 5,552	Mincer, 12 subjects, returns relative to education	All: 0.18	All: 0.14
Chevalier *et al* (2002	Graduate 1995, Pay 1999 N=4,563 (female) 3,701 (male)	Mincer, 5 subjects, returns relative to other (education)	Men: 0.145 Women: 0.093	Men: 0.114 Women: 0.002
Naylor et al. (2000)	FDS 1993, Occupational earnings	Regression, 21 subjects	Men: 0.11 Women: 0.10	Men: 0.10 Women: 0.06

Employment (unemployment) by HE subject 6months after graduation

Data	Year	Maths (% employed)	Social Science (% employed)	Humanities (% employed)	Education (% employed)
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)
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)
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
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)

Source: Chevalier *et al* (2002)

Appendix 3: The costs and benefits of degree level qualification attainment

The financial cost and benefits to the Individual from degree level attainment

Individual	
Costs (Direct and Indirect)	**Benefits**
Foregone net earnings	Post taxation income • Additional post taxation income (adjusted for the relative probability of being employed)
Average tuition fee paid by representative student	Resource Accounting and Budgeting (RAB) charge • Assumption that the current RAB charge on student loan approximates 29% and that current student loan take-up is approximately 81%. The RAB charge accounts for the economic cost (to the Exchequer) of the student loan interest rate subsidy as well as the likelihood of default.
Loan repayment post graduation Assumed to be 9% of income over £10,000	

The financial cost and benefits to the Exchequer from degree level attainment

Exchequer	
Costs (Direct and Indirect)	**Benefits**
Foregone Taxation during studies • equivalent to the average annual income tax and national insurance contributions by those in possession of A Levels as their highest qualification (no longer in education)	Additional income tax and national insurance contributions • Additional income tax and national insurance contributions (adjusted for the relative probability of being employed)
Resource Cost associated with provision of higher education distributed by the Higher Education Funding Council of England (HEFCE) Assumption that the *standard* resource costs associated with the following price bands are as follows Band A £13,936 per annum Band B £5,923 per annum Band C £4,529 per annum Band D £3,484 per annum This total resource is adjusted to account for the assumed resources contributed by the individual, employers of the Local Education Authority (£1,150 per annum)	
Average tuition fee paid not paid by representative student • Assumption that 42% of students pay full fee, 15% pay partial fee and 43% pay no fee • Assumption that remainder is paid by Local Education Authority. This assumption marginally overestimates the cost to the Exchequer	
RAB charge • Assumption that the current RAB charge on student loan approximates 29% and that current student loan take-up is approximately 81%. The RAB charge accounts for the economic cost (to the Exchequer) of the student loan interest rate subsidy as well as the likelihood of default.	

Appendix 4: Data Sources: Quarterly 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.

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. During the period from spring 1992 to autumn 1994 interviewing was conducted in Northern Ireland only in the spring, with no quarterly element. However in the winter of 1994/95 a quarterly Labour Force Survey was introduced to Northern Ireland.

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 for 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

Appendix 5: Results

Hourly earnings premia associated with alternative degree level subjects relative to individuals in possession of 2 or more A Levels

	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	21-60
Chemistry	0.28	0.33	0.30	0.31	0.29	0.24	0.37	0.25*	0.30
Biological Sciences	0.09*	0.10*	0.17	0.25	0.06^	0.30	0.04^	0.20	0.16
Law	0.22	0.36	0.43	0.28	0.25	0.30	0.76	0.50	0.39
Physics	0.32	0.33	0.35	0.32	0.27	0.24	0.31	0.27	0.30
Management	0.19	0.21	0.25	0.13*	0.15^	0.21	0.22	0.22	0.24
Engineering	0.30	0.32	0.22	0.19	0.26	0.30	0.37*	0.34	0.31
Psychology	0.11*	0.20	0.20	0.05	0.15^	0.21	0.27	0.32*	0.16
Linguistics/En/Celt	0.10^	0.17	0.14	0.04^	0.05^	0.24	0.28	0.30	0.15
European Languages	0.35	0.17*	0.16^	0.42	0.25	0.48	0.22	0.05^	0.27
Social Sciences (ex Law)	0.21	0.13	0.17	0.10*	0.16	0.29	0.31	0.52	0.22
Medicine (ex Dent)	0.23	0.30	0.46	0.46	0.51	0.89	0.53	0.55	0.44
History	0.13	0.18	0.00^	0.06^	0.11^	0.26	0.22	0.20^	0.13
All Degrees	0.19	0.23	0.18	0.20	0.18	0.26	0.29	0.28	0.23
n	**3154**	**4317**	**5363**	**5692**	**5187**	**4545**	**4390**	**2872**	**37012**
R squared	**0.2011**	**0.2639**	**0.301**	**0.3054**	**0.3209**	**0.2944**	**0.2975**	**0.2745**	**0.2887**

All coefficients are significant at the 5% level of confidence except those denoted by * which are significant at 10% and ^ which are insignificant at 10%

Relative Employment probabilities associated with 2 or more A Levels and different degree level subjects

	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60
Chemistry	1.5*	3.6	2.7	3.8	7.5	9.1	6.2	3.9
Biological Sciences	9.5	5.4	2.4	-1.9^	4.8	2.5	8.4	11.6
Law	10.7	8.4	6.4	2.6	2.1	9.0	0.8^	18.0
Physics	0.5*	7.3	13.4	7.2	7.3	10.4	4.8	-1.0^
Management	12.2	8.5	7.5	6.8	5.2	6.7	9.4	-1.3^
Engineering	11.3	9.7	11.3	9.8	8.6	9.1	7.5	8.1
Psychology	12.5	1.3^	1.7	1.0^	0.0^	2.6*	2.0*	6.6
Linguistics/English/Celt	10.3	9.3	-1.4^	-0.6^	2.2*	0.7*	1.5*	-0.2^
European Languages	16.5	9.5	-3.9	-1.1^	3.5	-3.5^	3.3	10.3
Social Sciences (ex Law)	16.6	6.7	1.3*	1.0*	2.7	5.8	1.3	10.1
Medicine (ex Dent)	2.6	9.5	7.5	7.4	7.0	12.5	13.6	12.0
History	11.3	5.9	-0.4^	-3.1^	1.5^	2.7	0.8^	11.8
All Degrees	5.8	6.3	4.5	2.5	3.7	3.9	4.0	4.4
n	**5730**	**7555**	**7488**	**7561**	**6684**	**5633**	**5046**	**3285**
R squared	**0.236**	**0.342**	**0.354**	**0.362**	**0.361**	**0.321**	**0.293**	**0.301**

All coefficients are significant at the 5% level of confidence except those denoted by * which are significant at 10% and ^ which are insignificant at 10%

Appendix 6: Terms of Reference

ROYAL SOCIETY OF CHEMISTRY: CAMPAIGN FOR CHEMICAL SCIENCES

Economic benefits of education and research in the Chemical Sciences – proposal for research – invitation to tender

The Royal Society of Chemistry is inviting proposals for a report on the economic benefits of education and research in UK Chemical Sciences to both the individual and the state. This would enable the RSC to compare and contrast UK findings with those published by Ziegele et al (2003).

Background

At the end of the 1990s, Ziegele[19] published a study about the rates of return on public and private investment in higher education in Germany. Although the scope of the study was limited, it gave some interesting insights into the value of higher education more generally. A key message was that, in most disciplines, there is a substantial private rate of return and that higher education is a worthwhile activity. Balanced against this positive conclusion, it also noted that:

- Individual opportunity cost (foregone income) is rather high because of the length of studies (an average of six to seven years until completion of degree); and,
- Total public cost is also quite high since the German tax payer bears all the institutional costs.

The German data has been widely used by the RSC as providing economic data supporting investment in people studying the chemical sciences in HE. Having data for the UK would strengthen the RSC's case and make available UK data.

Key requirements

The report must answer the following questions:

1 What is the return on investment to an individual from studying chemistry at tertiary (Higher Education) level in the UK?

2 What is the return on investment to the state from an individual studying chemistry at tertiary level in the UK?

3 What is the return on investment to an individual studying subjects in the chemical sciences[20] at tertiary level in the UK?

4 What is the return on investment to the state studying subjects in the chemical sciences at tertiary level in the UK?

5 What is the return on investment to an individual studying law, physics, management, or engineering at tertiary level in the UK?

6 What is the return on investment to the state studying law, physics, management, or engineering at tertiary level in the UK?

7 What conclusions can be made from analysing the outcomes from 1 – 6 from a UK perspective?

8 What conclusions can be made from comparing the outcomes from 1 – 6 with those in the Ziegele report?

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[19] ZIEGELE, F. (2003): "Country report: HE Finance and Cost-sharing in Germany" CHE-Centre for Higher Education Development Report.

[20] Defined to include Biological Sciences, Pharmacy, Pharmacology, Materials

Methodology

To be defined in the response to the invitation to tender. However, it is essential that direct comparisons can be made with the figures quoted in the Ziegele report.

Project Management

The project will be overseen by the RSC Professional Affairs and Membership Board. Day-to-day management will be the responsibility of the Campaign for Chemical Sciences project manager.

Costings and scheduling

Detailed costing for the project costs must be included in the response.

Subject to approval of a formal plan, work should commence on the initial project outline by September 2004, with a full report for consideration by the Professional Affairs and Membership Board of the RSC being ready by 31 December 2004.

Tendering Process

Responses to the invitation must be received **in hard copy** by **16.00hrs, Monday 9th August**. Any responses received after that time and date cannot be accepted.

All responses will be considered at the same time by a tender board comprising RSC officials and representatives of the Professional Affairs and Membership Board. Subject to that group's views on the responses, you may be invited to present your proposal to the tender board at a further meeting after which a final decision will be made.

Two paper copies of your response to this invitation should be sent in confidence to

Ms Lynda Thrift
Project Manager
Campaign for Chemical Sciences
Royal Society of Chemistry
Burlington House
Piccadilly
London
W1J 0BA

telephone no: 0207-440-3316
fax no: 0207-437-8883
email: thriftl@rsc.org.

RSC Timetable (subject to availability of tender board)

Thursday 12 August	Tender board meets to consider responses
Friday 13 August	Letters advising respondents of next stages sent out
Wednesday 18 August	Presentations to tender board
Thursday 19 August	Letters advising on outcome sent out

Further Information

If you have any questions concerning this specification please contact Lynda Thrift. (details above).

Attachments (not included here)

ZIEGELE, F. (2003): "Country report: HE Finance and Cost-sharing in Germany" CHE-Centre for Higher Education Development Report.

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