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Differences by Degree: Evidence of the Net Financial Rates of Return to Undergraduate Study for England and Wales

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by

Ian Walker[*] , Yu Zhu[**]

Abstract
This paper uses the Quarterly Labour Force Survey, the latest and largest dataset available, to provide independent estimates of returns to higher education qualifications in the UK for graduates with different degree majors, class of first degree, and postgraduate qualifications. For reasons of sample size, we collapse various undergraduate degrees into four broad subject groups: STEM (Science, Technology, Engineering and Mathematics - and here we also include Medicine); LEM (Law, Economics and Management), OSSAH (other social sciences, arts and humanities which includes languages), and COMB (those with degrees that combine more than one subject).
We adopt a method which allows our data to identify the effects of experience on earnings separately from cohort effects in wages for different degree majors. We also allow for tuition fees and the tax system in calculating the NPV associated with higher education (and also the loan scheme). Ordinary Least Squares estimates show high average returns for women that does not differ by subject. For men, we find very large returns for LEM but not for other subjects. Degree class has large effects in all subjects suggesting the possibility of large returns to effort and ability. Postgraduate study has large effects, independently of first degree class. A large rise in tuition fees across all subjects has only a modest impact on relative rates of return suggesting that little substitution across subjects would occur. The strong message that comes out of this research is that even a large rise in tuition fees makes little difference to the quality of the investment – those subjects that offer high returns (LEM for men, and all subjects for women) continue to do so. And those subjects that do not (especially OSSAH for men) will continue to offer poor returns. The effect of fee rises is dwarfed by existing cross subject differences in returns.

Keywords: Rate of return, college premium

JEL codes: I 23, I 28

The data was provided by the U.K. Data Archive and is used with the permission of the Controller of Her Majesty's Stationery Office. The data are available on request, subject to registering with the Data Archive. The usual disclaimer applies.

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1. Introduction

This paper provides simple statistical estimates of the correlation between earnings and educational qualifications in England and Wales using a conventional specification of a model of the determination of earnings.[1] There is a long history of such research in economics, including work that focuses on the impact of academic qualifications – for example, on the impact of an undergraduate degree on earnings, on average: the so-called "college premium". The literature on the returns to education is well known (see Walker and Zhu (2008)) and reports either the effects of years of schooling or the effects of qualifications. This paper updates the results in Walker and Zhu (2008) with more recent data and exploits information of degree subject and the recent availability of degree class to extend that paper. Dearden *et* al (2010) also models the lifecycles of earnings of graduates and our work complements theirs by decomposing the calculations by degree subject and degree class. Our work is also more closely focused on the student and we therefore consider the impacts net of the income tax liability that applies at the simulated earnings.

The contribution of this paper is threefold. First, we provide estimates of the college premium, the effect of postgraduate qualifications, and the attainment level of first degree, broken down by the broad subject of the first degree. The focus on returns to different types of degrees is particularly novel and hence a valuable contribution to the empirical literature on the returns to higher education. Secondly, because we wish to make present value calculations and are therefore particularly interested in the lifecycle of earnings, we adopt a simple method that allows our data to identify the effects of experience on earnings separately from cohort effects in wages. Finally, we use our estimates to make crude comparisons of rates of return to higher education investments by subject and gender under alternative tuition fees.

The existing U.K. literature on the effect of "college major" is very thin (see Sloane and O'Leary (2005) and references therein) but the studies that do exist report large differentials by major of study. Only a handful of studies, almost exclusively for the U.S., make any attempt to deal with the complex selection issues associated with major choice.[2] Nor does previous work allow for the impact of taxation or tuition fees when computing rates of return.[3] The literature on the impact of postgraduate qualifications on earnings is similarly thin. A notable exception is Dolton *et al* (1990) for the U.K. but this uses a 1980 cohort of U.K. university graduates with earnings data observed just six years later so that they only identify qualification effects at a single, and early, point in the lifecycle. Our results below suggest that this is a poor guide to lifecycle effects. There is a literature on the impact of college quality (see Eide *et al* (1998)) for the U.S. But the U.K. studies (Chevalier (2009) and Hussain *et al* (2009)) are again limited to postal surveys of graduates early in their careers.

The paper aims to inform the debate on higher education funding in the U.K. We use the latest and largest available dataset and allow our specification of the effects of qualifications on wages to be as flexible as the data can sustain. Our ability to interpret our estimates as causal effects is limited by two factors. First, there may be unobservable differences between people with at least 2+ A-levels and graduates that are correlated with wages. Blundell *et al* (2005) show, using a simpler specification estimated on other U.K. data, that controlling for parental background may well be sufficient to eliminate this "ability bias" problem. Unfortunately our data does not permit this but

[1] This is the so-called human capital earnings function that restricts (log) earnings to be a linear function of a set of characteristics, X, and a quadratic function of age (to proxy for work experience). We include qualifications variables into this model as measures of human capital.

[2] See Arciadocono *et al* (2010) for the U.S. and Beffy *et al* (forthcoming) for France. The former uses earnings expectations data for a small sample of Duke students and finds that major choice does depend on differentials in expected earnings. The latter also finds a small elasticity. See also, Montmarquette *et al* (2002).

[3] See Heckman *et al* (2008) who estimates rates of return using non-parametric specifications and incorporates income taxation and tuition.

the Blundell *et al* (2005) results suggests that the bias is likely to be small given our choice of control group.

Second, there may be unobserved differences between graduates by major. In the U.K. there are sharp differences in admission requirements across institutions but, conditional on institution, the differences in admission requirements across majors are relatively small. Almost all universities cover a wide range of majors[4] and universities that are highly regarded in one subject, and so have high admission requirements, are usually highly regarded in others. It is true that there has been quite a strong (and stubborn) social gradient in university participation which might suggest that we overestimate returns to the extent that social background is correlated with wages conditional on education. This gradient may be more pronounced for subjects with greater consumption value to the extent that such consumption returns are more highly valued by students from higher social backgrounds. However, admission requirements themselves (that might capture ability differences) are broadly similar across majors – perhaps a little lower for students in Science, Technology, Engineering, and Maths (STEM) but higher for health. On the other hand STEM students will have better maths and we know this has an independent effect on future earnings. Moreover, the little evidence we have, for the U.S. and France, suggests selection by returns is weak.

An important source of unobserved heterogeneity in our analysis is that we are not able to control for institutional differences: the data does not identify the higher education institution that granted the qualifications obtained. Again, this is a weakness that we share with the existing literature although there is a small literature on the effect of attending an elite college in the U.S. (see, for example, Hoxby (2009)). In the U.K. this is also an important issue because it seems likely that there are important differences in the quality of student entrant by institution. Unfortunately, there is very limited data available that records institution – the only systematic dataset has earnings recorded some six years after graduation but the response rate is poor and, as we will see below, early wages are not a good guide to lifecycle effects. There would be a correlation between institutional quality and wages but it seems unlikely that this would bias estimates of major effects because almost all institutions teach most majors and conditional on institutional quality, admission requirements are similar.

Section 2 reviews the data used here. Section 3 provides econometric estimates of the effects of the key determinants of wages. Section 4 uses these estimates to simulate crude lifecycles of earnings net of tax and tuition fees to allow us to compute private financial rates of return. Section 5 concludes.

2. Data

Our estimation uses a large sample of graduates (i.e. individuals in the data have successfully completed a first degrees) together with individuals who do not have a degree but who completed high school and attained sufficient qualifications to allow them, in principle, to attend university. We think of the latter group as our controls. The data is drawn from the Labour Forces Surveys – the LFS is the largest survey that U.K. National Statistics conduct, with slightly less than 1% of the population, and contains extensive information about labour market variables at the individual level. We drop all observations who did not graduate from high school with the level of qualifications to enter university – i.e. less than 2 A-level qualifications.[5] Higher Education entry in the UK is

[4] The important exceptions are medicine and vetinary studies which tend to be concentrated in the higher quality institutions.

[5] The LFS does not contain information on parental background such as education or social class. Moreover, it is also hard to distinguish between university dropouts and others whose highest qualifications are A-levels. Fortunately, the former group is relatively small in the U.K. The completion rate for tertiary-type A (academic) programmes is 81% for the U.K., which is significantly higher than the OECD average of 70%, see OECD (2010). Montmarquette *et al.* (2001) suggests that key determinants of university dropout rates include students' interests and abilities, as well as number of students in first-year compulsory courses. None of these variables are observable in the LFS.

rationed by achievement recorded at the end of high school and those without the absolute minimum achievements to attend university are excluded for our analysis.[6] We also drop Scotland and Northern Ireland residents and recent immigrants who were educated outside the U.K.[7] We use data pooled from successive Labour Force Surveys from 1994 (although information about class of degree was first collected only from 2005) to 2009 (the latest currently available). The resulting sample size of 25-60 year olds is 82,002. Wage data is derived from earnings and hours of work (converted to January 2010 prices using the RPI). Importantly for this work, LFS is a (albeit short) panel dataset from 1997 onwards. Postgraduate qualifications are categorised as either Masters level, PhD level, PGCE (a one year professional training for those entering teaching), and Other (we believe this will be largely qualifications associated with professional training that results in membership of chartered institutes and degrees such as MBA). Table 1 shows the simple breakdown by gender and postgraduate qualification and Table 2 shows the corresponding average log wages. Women are twice as likely to have PGCE's as men, but less likely to have Master or Doctoral degrees. Overall 29% of graduates in our data have postgraduate qualifications and around half of these are to Masters level. Average hourly wage differentials are pronounced: males (females) with first degrees only earn 20% (31%) more than those with 2+ A-levels only – reflecting the lower gender discrimination in the graduate labour market;[8] males (females) with a Masters degree earn 12% (17%) more than those with a first degree alone; male (female) PhDs earn 4% (7%) more than Masters; male (female) PGCEs earn 6% less (7% more) than those with first degrees alone.

In the U.K. it is common for undergraduate students to study only a single subject – although this tendency is becoming less pronounced over time. Undergraduate degrees in the data are categorised into 12 subject areas which we, for reasons of sample size, collapse into four broad subject groups: STEM (Science, Technology, Engineering and Mathematics - and here we also include Medicine[9]); LEM (Law, Economics and Management), OSSAH (other social sciences, arts and humanities which includes languages), and COMB (those with degrees that combine more than one subject - but we do not know what these combinations are in our data).

Table 3 shows the simple breakdown of log wage by gender and first degree subject of major. The average college premium for OSSAH majors relative to 2+ A-levels (in Table 3) is 10% (33%) for males (females); while for COMB it is 20% (33%) for males (females); for STEM it is 25% (38%) for males (females); and for LEM it is 33% (42%) for males (females). Table 3 is for all graduates, but similar differentials are obtained just looking at those with a first degree alone.

In the U.K. first degrees are classified by rank: first class (9.7% of non-missing degrees), upper second class (45.5%), lower second class (33.8%), third class (5.0%) and pass (6.1%). Table 4 shows the simple breakdown of log wage by gender and class of first degree. The premium for an upper second class degree over a lower second degree or worse is 8% (6%) for males (females), and the premium for a first over an upper second is 4% (5%) for males (females).

Figures 1 and 2 show the observed relationship between log wages and age for A-level students and by degree major for men and women respectively. We use local regression methods to smooth the

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[6] We would like to be able to test the stability of our estimates to this threshold but this is, unfortunately, all the data will allow us to do.

[7] LFS only contains country of birth for those born outside the U.K. We drop residents in Scotland and Northern Ireland because of differences in their education systems – although including them makes little difference to our analysis.

[8] Blundell *et al* (2000) make the same observation in the context of U.K. higher education returns. The latest evidence based on Annual Survey of Hours and Earnings shows that while the gender pay gap for full-time employees in the U.K. is widest in the Skilled Trades (ranging between 26.0 to 31.4 per cent), it is narrowest for Professional Occupations (ranging between 1.6 to 4.2 percent), see ONS (2010). Olsen *et al* (2010) suggests that high levels of formal education for women significantly decreases the incidence of family care work and so tends to maintain women's wages.

[9] We have grouped architects and graduate nurses into STEM, although their sample size is small enough for this to make no difference to our broad conclusions.

relationship. There are very clear differences between graduates and non-graduates and these differences vary by age for both men and women. There are also differences between majors for graduates which again differ by age. Age-earnings profiles differ and the differences are complicated: they do not appear to be parallel, which is what typical specifications assume. The figure for males suggests that the usual quadratic specification for the age-earnings profile would be a reasonable approximation to the data – but that a single quadratic relationship would be unlikely to fit each major equally well. For example, male LEM students enjoy faster growth in wages early in the lifecycle compared to other majors including STEM. There is no single college premium: wage premia seem to differ by major and by age.

These figures suggest that econometric analysis will need to be sufficiently flexible to capture these differences across majors. Moreover, Figure 2 looks quite different from Figure 1. The age-earnings profiles for women are much flatter - age is a poorer proxy for work experience for women because of time spent outside the labour market. This suggests that the conventional cross-section methods are probably not going to be able to provide a good guide to how the earnings of women evolve over the lifecycle.

3. Method and Estimates

The conventional approach to estimating the private financial return to education typically uses a simple specification such as:

$$(1) \qquad \log w_i = \alpha + \beta Experience_i + \gamma Experience_i^2 + \boldsymbol{\delta}\mathbf{X}_i + \boldsymbol{\chi}\mathbf{Q}_i + e_i \text{ for } i = 1..N$$

where X is a vector of individual characteristics such as migrant status and region of residence, and Q is a vector that records qualifications but, in many studies, simply measures years of completed full-time education. Age is often used as a proxy for work experience.

Here, we focus on graduates, postgraduates and a subset of non-graduates (those that could, in principle, have attended university) and allow differentiation by major studies in Q. Using a control group that consists of those who might have attended university seems likely to reduce the impact of ability bias on our estimates, and so get us closer to estimating causal effects, although it seems unlikely that it would eliminate it altogether and this needs to be borne in mind when interpreting the estimates.

Our estimates of such a simple specification as (1) reflect the stylized facts that we reported in Section 2 and are not reported here. Rather, since we wish to use our estimates to inform public policy we need to ensure that the specification has the flexibility to reflect the policy issues as well as the realities of the raw data. Section 2 strongly suggests that we should not impose parallel age – earnings profiles so we will provide estimates broken down by highest qualification: that is, separate estimates for those with 2+ A-levels from those with STEM first degree, LEM, etc. That is, we would prefer to estimate

$$(2) \qquad \log w_{iq} = \alpha_q + \beta_q Experience_i + \gamma_q Experience_i^2 + \boldsymbol{\delta}_q \mathbf{X}_i + e_{iq} \text{ for } i = 1..N \text{ and } q = 0..4$$

that does not impose age earnings profiles to be parallel in qualifications.

There are two further difficulties. First, as we saw in Section 2, age is a poor proxy for work experience for women. If we wish to model how wages evolve over the lifecycle, conditional on continuous participation, estimating such a cross section model is not likely to be helpful. The second problem is that it seems likely that there are cohort effects on wages and identifying cohort effects separately from lifecycle effects is impossible with a single cross-section of data and problematic with pooled cross sections over a relatively short span of time. We can resolve both of these difficulties by exploiting the panel element of the data. If we time difference[10] equation (2) we obtain

(3) $$\Delta \log w_{iq} = (\beta_q - \gamma_q) + 2\gamma_q Experience_i + u_{iq} \text{ for } i = 1..N \text{ and } q = 0..4$$

which allows us to estimate the parameters of the age-earnings profiles, by major (and for the 2+ A-level group) separately from cohort effects providing such cohort effects are additive in equation (2).[11] Indeed, it seems likely that differencing will eliminate some of the unobservable determinants of wage levels that might otherwise contaminate the estimates of the age earnings profile. This then provides independent panel data estimates that can then be imposed in equation (2) which can then be estimated on the pooled cross section data. Moreover, panel data estimation for employed women provides estimates that are likely to be much closer to the effects of experience. That is, we can then estimate

(4) $$\log w_{iq} = \alpha_q(c_i) + \hat{\beta}_q Experience_i + \hat{\gamma}_q Experience_i^2 + \boldsymbol{\delta}_q \mathbf{X}_i + v_{iq} \text{ for } i = 1..N \text{ and } q = 0..4$$

from the pooled cross-section data. Tables 5a (men) and 5b (women) report our baseline OLS pooled cross-section estimates of equation (2) without cohort effects; together with estimates of (3), from the panel, and (4) from the pooled cross sections which include additive cohort effects (ci, we include a cubic in year of birth).[12] For men, in Table 5a, we find that the estimated lifecycle age-earnings parameters, the γ's and β's, are reassuringly similar whether estimated using the pooled cross-section estimates of the levels equations or from the panel data estimation of the wage difference equations.[13] Nonetheless we find statistically important cohort effects when we impose the lifecycle coefficients from the panel estimation on the pooled cross section estimation of the levels equations. However, for women in Table 5b, we find that the panel estimation provides much steeper age earnings profile estimates – the estimated β's are, on average, approximately 20% higher than those found in the pooled cross section estimates of the levels equation. Moreover, there are larger differences in profiles across majors. Thus, separating the estimation of lifecycle and cohort effects is important, at least for women. The estimates age-experience profiles are plotted in Appendix Figures A1a and A1b - for men the profile for LEM starts higher and is steeper and dominates all other subjects until late in the lifecycle when COMB catches up; for women, OSSAH and COMB are very close but, while other subjects are slightly higher at an early age, their profiles are flatter.

We have included degree class and postgraduate degrees in the specification as simple intercept shifts and we find important differences across subjects in these. There is a significant premium for degree class[14] that varies across majors: there are particularly large effects for LEM graduates for both men and women; although the differences between first class and upper second class are generally not significant. There is an effect of having PG qualifications over and above the effect of

[10] It does not make a big difference whether we treat time as discrete or continuous in practice, as the β term in the constant dominates the γ term.

[11] This specification seems to be adequate, as a quadratic term is only statistically significant for male OSSAH graduates and female LEM and OSSAH graduates. We will explore complex specification issues in future work with longer panel data.

[12] We also include controls for region and immigrant status which are not reported but there are no significant differences in the estimates when we include them. We find that our estimates of the crucial effects are not affected by aggregating the PG qualifications so we group all PG qualifications into a single variable to capture the average effect across all PG qualifications. We experimented with the grouping of majors into the definitions used here and find no substantive differences. In particular, we explored whether Medicine should be grouped with STEM.

[13] Note that the γ coefficients and standard errors in Table 5a/b have been multiplied by 100.

[14] It seems likely that degree class reflects unobserved ability so these coefficients are likely to be upper bounds on the causal effects of study effort. However, there is little evidence that study effort responds to economic incentives so the bias is probably not large – see Leuven *et al* (2007) for experimental results.

degree class: with PG premia at around 15% in all subjects for women. For men, the corresponding PG premia range between 5-10%, with higher returns for LEM and COMB.

4. Lifetime impacts and rates of return

The implied college premia will vary with experience, degree class, cohort, and presence of PG qualifications.[15] Thus, in Table 6 we present, using the estimates of equations (3) and (4) from Tables 5a and 5b, the NPVs associated with a lifetime (from 22 to 65) with each major and a lifetime with 2+ A-levels (from 19 to 65) using various discount rates. We also include the internal rate of return (IRR), obtained from grid search. The assumption throughout is that there are tuition fees of either £3,290 (the level for 2010/11) or £7,000 p.a. for three years and opportunity costs are the (discounted) net of tax earnings that they would have received had they not entered university (i.e. those given by the estimates for 2+ A-levels) from 19 to 21. We allow for income taxes and employee social security contributions using the 2010 schedules.[16] We assume that individuals intend to work full-time throughout their working age lives.[17] We view this as a prospective simulation and focus on a current cohort looking forward. While Table 6 does not allow for the presence of a loan scheme, in Table 7 and Appendix Table A6 we make allowance for this - to the extent that this scheme allows students to shift their tuition costs forward in time with no virtually interest penalty (and that the scheme contains an element of debt forgives) we are underestimating the NPVs (except when the discount rate is zero) and IRRs in Table 6. However, even at a 10% discount rate the differences in NPVs in Table A6 compared to Table 6 are just 3 to 4 thousand pounds.[18]

The IRRs are large for women for all majors and for both good and bad degrees. The increase in tuition fee makes a not economically insignificant dent in the IRR - around 2 to 2.5%. The differences across majors are quite small. For men, there is substantially more variation. The returns to LEM are large for both good and bad degrees, and the tuition fee rise makes a sizeable difference of around 3%. STEM, Combined and OSSAH all return modest levels according to the calculated IRRs.

We also analyze the impact of the additional maintenance costs that might reasonably be associated with higher education participation. It would not be appropriate for all of subsistence expenditure during studying for a degree to be counted as an opportunity cost – only that expenditure that is over and above what would normally be spent had the individual not attended university. We know little about what these expenditures might be but a convenient figure would be £3340 p.a. taken from the Government's proposals in response to the Browne Review (say £2800 p.a. for rent[19] and £540 p.a. for study materials). Under the current loan scheme students from low income backgrounds are eligible to a maximum maintenance grant of £2906 p.a., while students from higher income backgrounds are eligible to only a loan to cover such costs. So, in Table 7, we simulate the effect of adding this expenditure to the opportunity costs of a degree and the comparison between two adjacent columns tells us about the value of being eligible to a grant, as opposed to a loan, to cover such spending. That is, the column headed "without maintenance" assumes that there is a grant to cover such costs, (i.e. this corresponds to a student from a low income household) while the column headed "with maintenance" assumes that students borrow (i.e. from a higher income household). Comparing the figures for the current loan scheme in Table 7 for

[15] Surprisingly, we find that the effects of qualifications do not differ across regions. In particular, the impact of major does not vary across regions: which is surprising given the concentration of LEM majors in London.

[16] Welfare programmes and the minimum wage are hardly relevant over the range of data being considered here.

[17] One might also want to incorporate some part of subsistence costs while studying. For example, many U.K. students study away from home and incur additional housing costs.

[18] We further examine the stability of the estimates in Table A7 where we drop part-time women. The results are essentially unchanged.

[19] £70 per week for 30 weeks plus half rent for the summer vacation.

those "without maintenance" (i.e. whose maintenance cost are covered by a grant) with the figures in the top half of Table 6 we see the effect of this additional expenditure makes very little difference to the IRR. Having to borrow to cover this maintenance expenditure (i.e. comparing the first and second columns of Table 7 for men, and the fifth and sixth for women) rather than having a grant to cover this, lowers the IRR - but by less than one percentage point in all cases. Table 7 also simulates a version of the Government's proposals in response to the Browne Review (Browne, 2010). In those proposals a fee level of £9000 becomes a focal point (as opposed to the current £3290) and we adopt the other proposals – a tapered real interest rate of up to 3% (as opposed to zero currently), debt write-off after 30 years (rather than 25), and payable at 9% of earnings above £18,840 p.a[20] (as opposed to £15,000). The results suggest a small, almost always less than one percentage point, fall in the IRR.

Conclusion

This paper has used the latest and largest dataset available to estimate as flexible specification as possible. We allowed for tuition fees and the tax system in calculating the NPV associated with higher education (and also the loan scheme). And we provide independent estimates for graduates with different degree majors. The results are large for women - reflecting the greater discrimination that women face in the sub-degree labour market. Indeed, they are large across the board.

The results for men vary considerably across majors: with LEM having very large returns for both good and bad degrees, although higher tuition fees knock around 3% off these figures. The return to STEM is around 7% for a bad degree and 9% for a good one; COMB degrees are slightly higher; while OSSAH degrees are only 5% in the case of a bad degree. The first notable feature of the results is that the scale of tuition fee rise envisaged does not change the relative IRRs across subjects very much. Such a rise is dwarfed by the scale of lifecycle earnings differentials. These results suggest that we might not see much substitution across majors in the face of even quite large tuition fee changes.[21] The second feature is that, while there is little variation in returns across majors for women, STEM subjects do not seem to exhibit large returns for men. They are dominated in this respect by COMB degrees and greatly so by LEM degrees. Indeed, if we imagined that the IRR reflected relative scarcity there would not seem to be a compelling case for thinking that there was a STEM shortage. On the contrary, there would seem to be a case for wanting to encourage a switch from OSSAH to LEM for men.

We might imagine that the prime factor behind these unobservable effects is "ability" – there is likely to be wide variation across individuals in their unobserved abilities to make money. This will be conflated with institutional effects and family background – low ability students are likely to attend institutions of lower perceived quality. Unfortunately, we have no way of knowing how much of the large variation in returns is due to individual differences and how much because of institutional differences. Only richer data would allow us to address this point. However, we find consistently strong coefficients on attaining an Upper Second vs Lower Second class of degree – it would appear that, in all subjects, there is a strong return to ability and effort. A good degree raises the IRR by about 1-5% - although we are unable to say how much effort is required to generate such a better result for given ability.[22]

Finally, a rise in tuition fees to £9000 would lower returns by about 1-3% relative to the current position - not economically significant when average returns are high. The strong message that

[20] We use £18,840 rather than the £21,000 in the proposals because the proposals are due to come on stream from 2012 so that loans do not become repayable until 2015 by which time 3% p.a. inflation will have devalued the proposed £21,000 to £18,840.

[21] In any event, Beffy *et al* (forthcoming) provide estimates that suggest little sensitivity of choice of college major to differentials in returns for France. No such research is available for the U.K.

[22] Strinebricker and Strinebricker (2009) show that effort has a large effect on U.S. degree GPA scores. We know of no U.K. work on this topic.

comes out of this research is that even a large rise in tuition fees makes relatively little difference to the quality of the investment – those subjects that offer high returns (LEM for men, and all subjects for women) will continue to do so. And those subjects that do not (especially OSSAH for men) will continue to offer poor returns. Our analysis suggests that this policy would have only modest detrimental effects on the soundness of an investment in higher education - but large cross subject differences will remain.[23]

[23] Institutions will be free to set their own fees, subject to a £9000 maximum, and may want to take advantage of the continued taxpayer subsidy offered for the teaching of STEM students (which historically existed to reflect the differential costs of teaching STEM) to price discriminate across subjects. Moreover, lower quality institutions might want to set fees at a lower point than the maximum to exploit cross price elasticities across institutions - although institutions will still be subject to a cap on student numbers and this would limit their ability to exploit an elastic demand curve.

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Appendix

The 82,002 observations in Section 2 is a sample of 25-60 year olds pooled from 1994-2009 Wave 5. This is effectively the same sample as was used in Walker and Zhu (2008), updated with 3 further years.
The cross-sectional estimation sample relaxes the age range to 19-60 (22-60 for graduates), with the sample size increased to 90,388.
The panel data is a panel of addresses and ensuring it is a panel of individuals results in some attrition. The wage panel is based on post 1997 LFS, N=43,545 which can be matched to almost 75% of the post-1997 cross-sectional sample.
The sample with degree class information is post-2005, N=22,153. This sample of 19-60 (22-60 for graduates) year olds is the actual sample used for simulation. The age range 61-65 in the simulation results are extrapolated from the 19-60 sample, but we think we are probably justified in doing so because of selectivity issues (the data contain too few women who are still working above 60, and the is differential pension ages in public/private sectors for men that will not be relevant in the future).

Table 1 Distribution of Highest Qualifications by Gender, %

Qualification	Male	Female	Total
Doctoral	4.71	2.00	3.43
Master	12.11	9.02	10.65
PGCE	3.80	7.96	5.77
Other PG qualification	2.60	2.99	2.78
First degree	56.28	54.60	55.49
2+ A-Levels	20.49	23.43	21.88
Total	100.00	100.00	

Table 2 Mean Log Wages by Highest Qualification and Gender

Qualification	Male	Female	Total
Doctoral	3.04	2.90	3.00
Master	2.99	2.83	2.93
PGCE	2.82	2.73	2.77
Other PG qualification	2.96	2.78	2.87
First degree	2.88	2.66	2.78
2+ A-Level	2.68	2.35	2.52
Total	2.86	2.62	2.75

Table 3 Mean Log Wages by First Degree Major by Gender: All Graduates

First degree major	Male	Female	Total
STEM	2.93	2.73	2.87
LEM	3.01	2.77	2.92
COMB	2.89	2.68	2.78
OSSAH	2.79	2.68	2.72

Table 4 Mean Log Wages by First Degree Class by Gender: All Graduates

First degree class	Male	Female	Total
First class	2.99	2.78	2.88
Upper second	2.95	2.73	2.82
Below upper second	2.87	2.67	2.77
Degree class missing	2.94	2.76	2.85

Table 5a *Estimated Age Earnings Profiles by Qualification: Men*

	Equation (2)					Equations (3) and (4)				
	2+ A's	STEM	LEM	COMB	OSSAH	2+ A's	STEM	LEM	COMB	OSSAH
Constant	0.158	0.435	-0.103	0.105	0.200	-0.537	-0.339	-1.407	-1.051	-0.567
	(0.154)	(0.138)	(0.254)	(0.225)	(0.200)	(0.019)	(0.017)	(0.033)	(0.028)	(0.024)
β	0.119	0.107	0.138	0.129	0.108	0.121	0.107	0.168	0.116	0.131
	(0.006)	(0.006)	(0.011)	(0.009)	(0.008)	(0.021)	(0.018)	(0.031)	(0.027)	(0.027)
γ (x100)	-0.129	-0.110	-0.150	-0.139	-0.114	-0.113	-0.084	-0.164	-0.078	-0.129
	(0.008)	(0.007)	(0.013)	(0.011)	(0.010)	(0.026)	(0.022)	(0.038)	(0.032)	(0.031)
1st class	-	0.075	0.236	0.139	0.040	-	0.075	0.236	0.141	0.047
		(0.025)	(0.062)	(0.054)	(0.046)		(0.025)	(0.062)	(0.054)	(0.046)
Upper 2nd	-	0.090	0.185	0.053	0.050	-	0.088	0.182	0.053	0.052
		(0.018)	(0.034)	(0.029)	(0.025)		(0.017)	(0.034)	(0.029)	(0.025)
Lower 2nd and below	-	-	-	-	-	-	-	-	-	-
PG degree	-	0.066	0.094	0.121	0.072	-	0.050	0.086	0.106	0.065
		(0.018)	(0.031)	(0.034)	(0.026)		(0.017)	(0.030)	(0.034)	(0.025)
Cohort effects	N	N	N	N	N	Y	Y	Y	Y	Y
Adj-R^2	0.311	0.242	0.226	0.211	0.214	0.142	0.257	0.189	0.452	0.127

Notes: Region and immigrant controls and missing degree class included. Standard errors in parentheses.

Table 5b Estimated Age Earnings Profiles by Qualification: Women

	Equation (2)					Equations (3) and (4)				
	2+ As	STEM	LEM	COMB	OSSAH	2+ As	STEM	LEM	COMB	OSSAH
Constant	0.807 (0.132)	0.959 (0.156)	0.533 (0.257)	1.121 (0.185)	0.979 (0.131)	0.029 (0.017)	-0.001 (0.022)	-0.580 (0.039)	-0.268 (0.025)	-0.460 (0.017)
β	0.075 (0.005)	0.079 (0.007)	0.107 (0.011)	0.078 (0.008)	0.074 (0.005)	0.089 (0.020)	0.108 (0.024)	0.125 (0.035)	0.085 (0.025)	0.089 (0.020)
γ (x100)	-0.085 (0.007)	-0.0868 (0.008)	-0.122 (0.014)	-0.085 (0.010)	-0.078 (0.007)	-0.087 (0.025)	-0.108 (0.030)	-0.122 (0.048)	-0.057 (0.031)	-0.058 (0.025)
1^{st} class	-	0.098 (0.031)	0.251 (0.060)	0.069 (0.043)	0.097 (0.031)	-	0.095 (0.031)	0.261 (0.060)	0.079 (0.043)	0.100 (0.031)
Upper 2nd	-	0.021 (0.021)	0.133 (0.033)	0.060 (0.023)	0.079 (0.017)	-	0.022 (0.021)	0.134 (0.033)	0.064 (0.023)	0.080 (0.017)
Lower 2^{nd} and below	-	-	-	-	-	-	-	-	-	-
PG degree	-	0.166 (0.020)	0.201 (0.033)	0.176 (0.030)	0.158 (0.017)	-	0.155 (0.019)	0.188 (0.033)	0.154 (0.029)	0.130 (0.017)
Cohort effects	N	N	N	N	N	Y	Y	Y	Y	Y
Adj-R^2	0.147	0.160	0.195	0.122	0.179	0.148	0.139	0.192	0.362	0.419

Notes: Region and immigrant controls and missing degree class included. Standard errors in parentheses.

Table 6: NPVs relative to 2+ A-levels (£,000) and IRRs (%)) by Gender, Major, Degree Class, and Discount Rate

Gender	Men						Women					
Discount Rate	0%	2.5%	5%	7.5%	10%	*IRR(%)*	0%	2.5%	5%	7.5%	10%	*IRR(%)*
Baseline (2+ A Levels)	1583	887	552	378	280	-	1333	767	492	346	262	-
Upfront Tuition Fee = £3290 p.a.:												
STEM: 2II	290	105	26	-9	-26	*6.6*	561	296	165	94	53	*17.0*
STEM: 2I	431	179	71	20	-6	*9.2*	591	313	176	102	58	*17.6*
LEM: 2II	1242	647	361	213	131	*23.1*	652	332	177	97	51	*15.9*
LEM: 2I	1694	892	508	308	197	*28.6*	872	454	252	146	87	*19.7*
Combined: 2II	727	286	105	26	-11	*9.0*	1081	502	248	127	64	*16.3*
Combined: 2I	827	337	134	44	2	*10.1*	1203	566	285	151	81	*17.9*
OSSAH: 2II	65	25	1	-14	-23	*5.1*	1044	473	226	109	50	*14.7*
OSSAH: 2I	129	61	23	2	-12	*7.7*	1201	556	273	140	71	*16.6*
Upfront Tuition Fee = £7000 p.a.:												
STEM: 2II	279	93	15	-20	-37	*5.8*	549	285	154	83	42	*14.8*
STEM: 2I	419	168	60	9	-17	*8.2*	580	302	165	90	47	*15.3*
LEM: 2II	1231	636	350	202	119	*20.4*	641	321	166	85	40	*14.0*
LEM: 2I	1683	881	497	297	185	*25.6*	861	443	241	135	75	*17.3*
Combined: 2II	716	275	94	15	-22	*8.3*	1069	491	236	115	53	*14.5*
Combined: 2I	816	326	123	33	-9	*9.3*	1192	555	274	139	70	*15.9*
OSSAH: 2II	54	14	-10	-25	-34	*3.8*	1032	462	214	98	39	*13.2*
OSSAH: 2I	118	50	12	-10	-23	*6.2*	1190	545	262	129	60	*14.9*

Table 7: A Comparison of IRRs (relative to A-levels) under Current Scheme and Government's Proposals, %

	MEN				WOMEN			
	Current loan scheme		Government proposal		Current Loan Scheme		Government Proposal	
	Without maintenance	With maintenance	Without maintenance	With maintenance	Without maintenance	With maintenance	Without maintenance	With maintenance
STEM: 2II	7.0	6.6	6.2	5.8	18.1	17.4	17.0	16.6
STEM: 2I	9.7	9.3	8.9	8.6	18.7	18.0	17.6	17.3
LEM: 2II	24.8	24.2	23.8	23.4	16.8	16.3	15.9	15.6
LEM: 2I	30.8	30.0	29.5	29.2	20.9	20.2	19.9	19.5
Combined: 2II	9.4	9.1	8.9	8.7	17.2	16.7	16.3	16.1
Combined: 2I	10.6	10.3	10.1	9.8	18.9	18.4	18.0	17.8
OSSAH: 2II	5.5	4.7	3.6	2.3	15.4	15.0	14.7	14.4
OSSAH: 2I	8.2	7.5	6.7	6.0	17.6	17.1	16.8	16.5

Notes: Current loan scheme: Fee of £3290, repayment on 9% of annual earnings over £15k and writing-off after 25 years, 0% real interest rate; Government's Proposals: Fee of £9000, repayment on 9% of annual earnings over the repayment threshold of £18,840k and writing-off after 30 years, 0% real interest rate if earning less than the repayment threshold, tapered between 0% at threshold and 3% if earning above £36,780; Maintenance: £2906 (£3340) added to tuition fees under current loan scheme (Government's Proposal).

Table A6: Relative NPVs (£,000) and IRRs (%)) by Gender, Major, Degree Class, and Discount Rate: with Income Contingent Loans

Gender	Men						Women					
Discount Rate	0%	2.5%	5%	7.5%	10%	*IRR(%)*	0%	2.5%	5%	7.5%	10%	*IRR(%)*
Baseline (2+ A Levels)	1583	887	552	378	280	-	1333	767	492	346	262	-
Tuition Fee = £3290 p.a.:												
STEM: 2II	290	106	29	-5	-22	*7.0*	561	297	167	97	56	*18.1*
STEM: 2I	431	181	73	23	-2	*9.7*	591	314	177	104	61	*18.7*
LEM: 2II	1242	648	363	216	133	*24.8*	652	333	179	99	54	*16.8*
LEM: 2I	1694	893	509	310	199	*30.8*	872	455	254	149	90	*20.9*
Combined: 2II	727	287	108	30	-6	*9.4*	1081	503	249	129	67	*17.2*
Combined: 2I	827	339	137	48	6	*10.6*	1203	567	287	153	84	*18.9*
OSSAH: 2II	65	26	3	-10	-19	*5.5*	1044	474	227	112	54	*15.4*
OSSAH: 2I	129	62	26	5	-8	*8.2*	1201	557	275	142	75	*17.6*
Tuition Fee = £7000 p.a.:												
STEM: 2II	273	94	21	-10	-25	*6.4*	546	285	158	90	51	*17.4*
STEM: 2I	414	169	65	18	-5	*9.2*	576	302	168	97	56	*18.1*
LEM: 2II	1227	636	354	208	127	*24.2*	637	321	170	92	49	*16.3*
LEM: 2I	1680	882	499	302	192	*30.0*	857	443	245	141	84	*20.3*
Combined: 2II	709	276	100	25	-9	*9.1*	1065	491	241	123	62	*16.7*
Combined: 2I	810	327	129	43	3	*10.3*	1188	555	278	146	79	*18.4*
OSSAH: 2II	48	14	-5	-16	-23	*4.2*	1028	463	219	106	49	*15.0*
OSSAH: 2I	112	50	17	-1	-12	*7.3*	1186	545	266	136	70	*17.1*

Table A7: NPVs relative to 2+ A-levels (£,000) and IRRs (%)) by Gender, Major, Degree Class, and Discount Rate, Women only

Discount Rate	0%	2.5%	5%	7.5%	10%	*IRR(%)*
Baseline (2+ A Levels)	1308	737	463	321	241	-
Upfront Tuition Fee = £3290 p.a.:						
STEM: 2II	1680	902	526	329	218	*32.7*
STEM: 2I	1699	912	532	333	220	*32.9*
LEM: 2II	162	34	-18	-40	-50	*3.9*
LEM: 2I	310	114	30	-9	-28	*6.7*
Combined: 2II	877	391	181	84	35	*13.5*
Combined: 2I	980	444	212	103	48	*14.9*
OSSAH: 2II	1221	564	278	144	75	*17.3*
OSSAH: 2I	1347	630	316	168	92	*19.0*
Upfront Tuition Fee = £7000 p.a.:						
STEM: 2II	1669	891	515	318	206	*28.6*
STEM: 2I	1688	901	521	322	209	*28.8*
LEM: 2II	151	23	-29	-51	-61	*3.3*
LEM: 2I	299	103	19	-20	-39	*6.0*
Combined: 2II	866	380	170	73	23	*12.1*
Combined: 2I	969	433	201	92	37	*13.3*
OSSAH: 2II	1210	553	267	133	64	*15.4*
OSSAH: 2I	1336	619	305	157	81	*16.8*

Figure 1 Smoothed Local Regression Estimates of Age – Log Earnings Profiles: Men

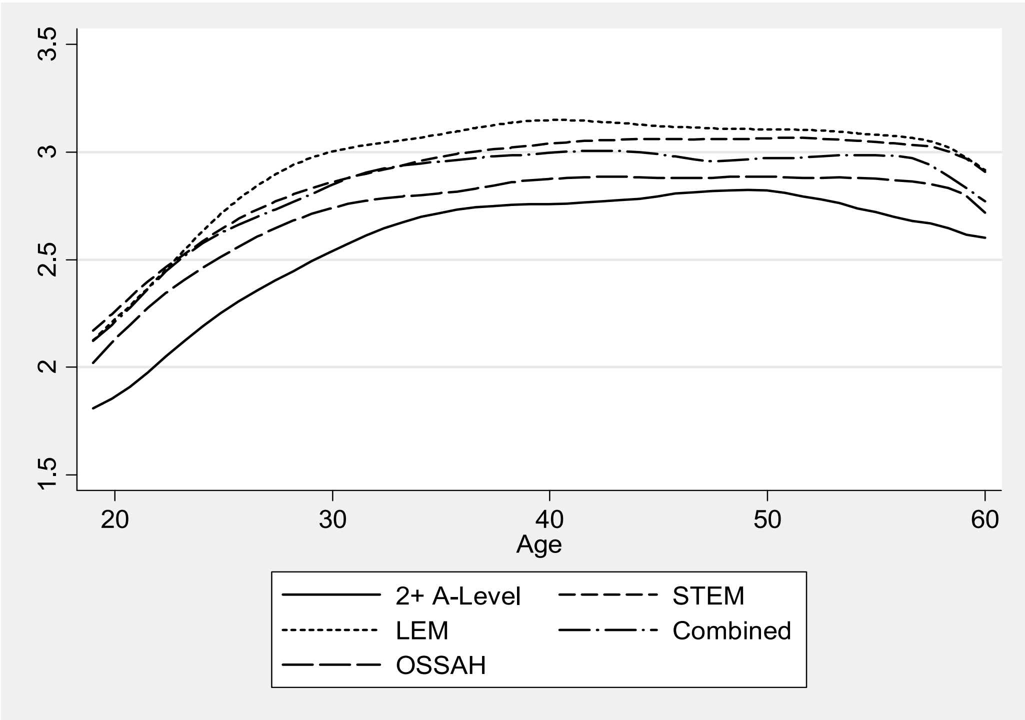

Figure 2 Smoothed Local Regression Estimates of Age – Log Earnings Profiles: Women

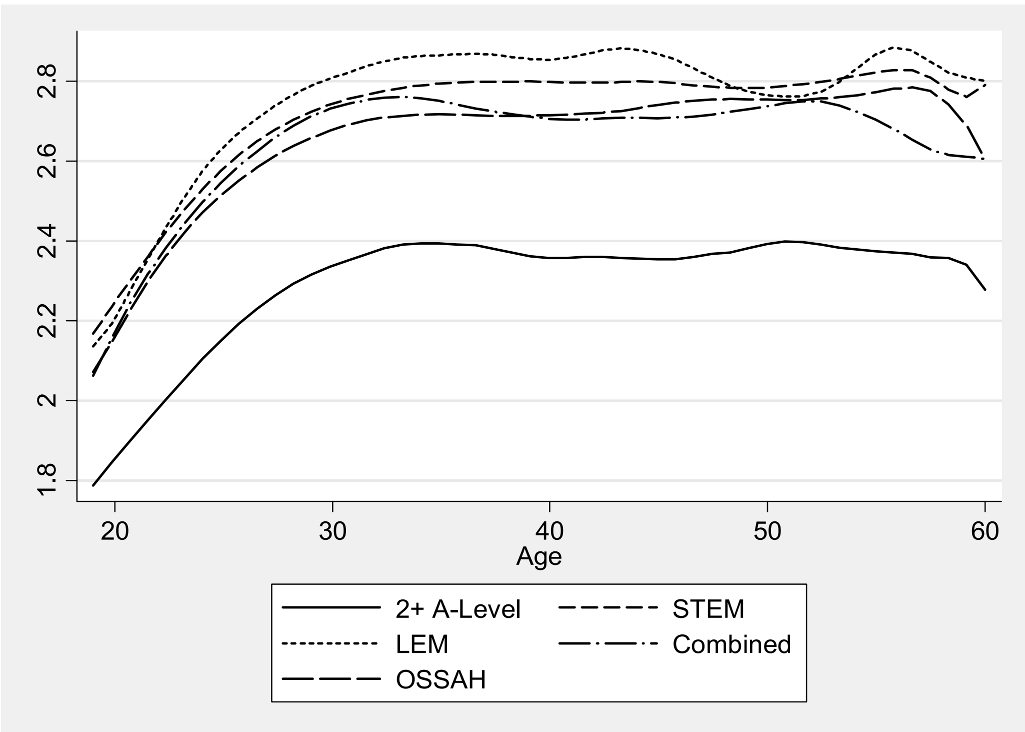

Figure A1a: Estimated age - earnings profiles by subject (2II for graduates), men

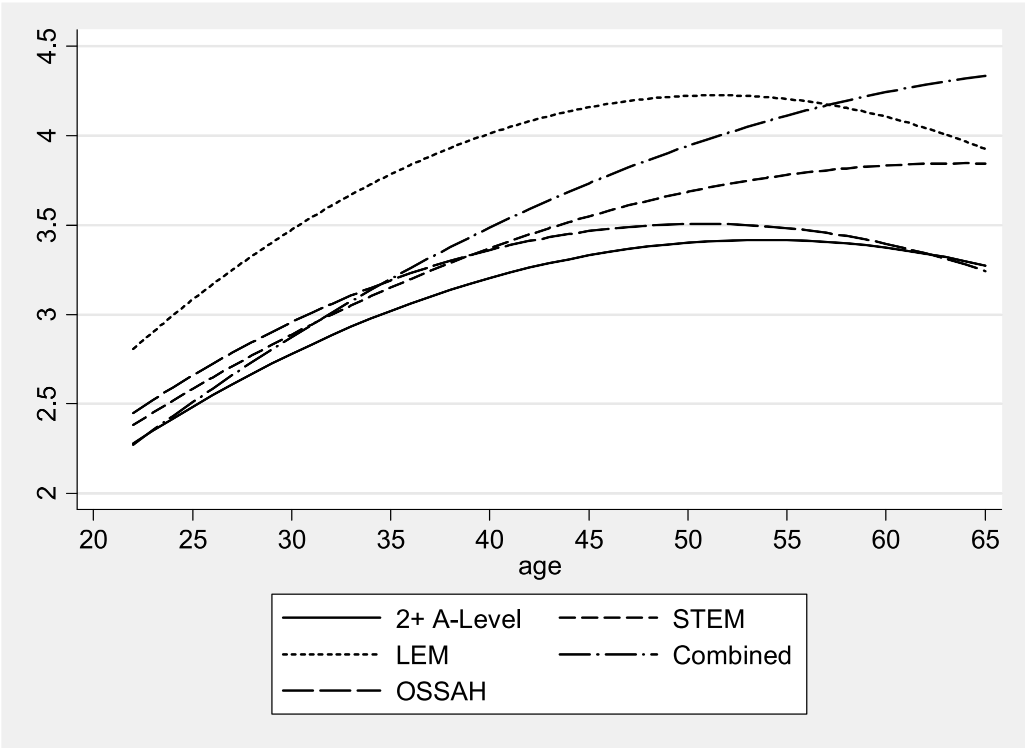

Figure A1b: Estimated age - earnings profiles by subject (2II for graduates), women