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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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Undergraduate Study for England and Wales**

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October 2010

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ABSTRACT

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

This paper provides estimates of the impact of higher education qualifications on the earnings of graduates in the UK by subject studied. We use data from the recent UK Labour Force Surveys which provide a sufficiently large sample to consider the effects of the subject studied, class of first degree, and postgraduate qualifications. Ordinary Least Squares estimates show high average returns for women that does not differ by subject. For men, we find very large returns for Law, Economics and Management but not for other subjects. Quantile Regression estimates suggest negative returns for some subjects at the bottom of the distribution, or even at the median in Other Social Sciences, Arts and Humanities for men. Degree class has large effects in all subjects suggesting the possibility of large returns to effort. 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.

JEL Classification: I23, I28

Keywords: rate of return, college premium

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* The data was provided by the UK 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.

1. Introduction

This paper provides simple statistical estimates of the correlation between earnings and educational qualifications in England and Wales¹. We adopt regression methods applied to a conventional specification of a model of the determination of earnings². 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 fourfold. 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. 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. Thirdly, we provide Quantile Regression estimates across the distribution of 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 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. No studies, to our knowledge, make any attempt to deal with the complex selection issues associated with major choice. Nor do they allow for the impact of taxation or tuition fees. The literature on the impact of postgraduate qualifications on earnings is

¹ We drop Scotland and Northern Ireland because of differences in their education systems – although including them makes little difference to our analysis.

² This is the so-called human capital earnings function that restricts (log) earnings to be a linear function of a set of characteristics, \mathbf{X} , and a quadratic function of age (to proxy for work experience). We include qualifications variables into this model as measures of human capital.

similarly thin. A notable exception is Dolton *et al* (1990) for the UK but this uses a 1980 cohort of UK 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 – which we show below is a poor guide to lifecycle effects. There is a literature on the impact of college quality (see Eide *et al* (1998)) for the US. But the UK 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 UK. 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. The major weakness of the research is that we provide estimates of only correlations, not causal effects of subject of study – the “major”. So far little progress has been made in this direction, so we share our weakness with the existing literature. There is an “ability-bias” argument that suggests that our estimates may be an upper bound to the true effect. However, there is a limited amount of evidence from elsewhere that this weakness may not be very important (see Blundell *et al* (2005)) – at least in the simpler specifications that have been a feature of the previous literature. A further weakness 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 US (see, for example, Hoxby (2009)). In the UK 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 on institution – the only systematic data is 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.

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 UK 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 achieve high school graduation with the level of qualifications to enter university – i.e. less than 2 A-level qualifications. In the UK, HE entry is rationed by achievement recorded at the end of high school and those without the absolute minimum achievements to attend university are excluded here³. We also drop Scotland and Northern Ireland residents and recent immigrants who were educated outside the UK. 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 of 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; 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.

³ 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.

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	3.035	2.902	2.999
Master	2.991	2.831	2.927
PGCE	2.824	2.734	2.765
Other PG qualification	2.957	2.784	2.869
First degree	2.881	2.662	2.779
2+ A-Level	2.684	2.350	2.515
Total	2.861	2.618	2.746

In the UK 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 Medicine which includes mathematics⁴); 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.

⁴ 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.

In the UK 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).

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

First degree major	Male	Female	Total
STEM	2.933	2.729	2.865
LEM	3.011	2.768	2.920
COMB	2.887	2.676	2.779
OSSAH	2.786	2.678	2.719

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

First degree class	Male	Female	Total
First class	2.988	2.778	2.884
Upper second	2.948	2.724	2.821
Below upper second	2.869	2.665	2.770
Degree class missing	2.937	2.754	2.847

Figures 1 and 2 shows 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 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.

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

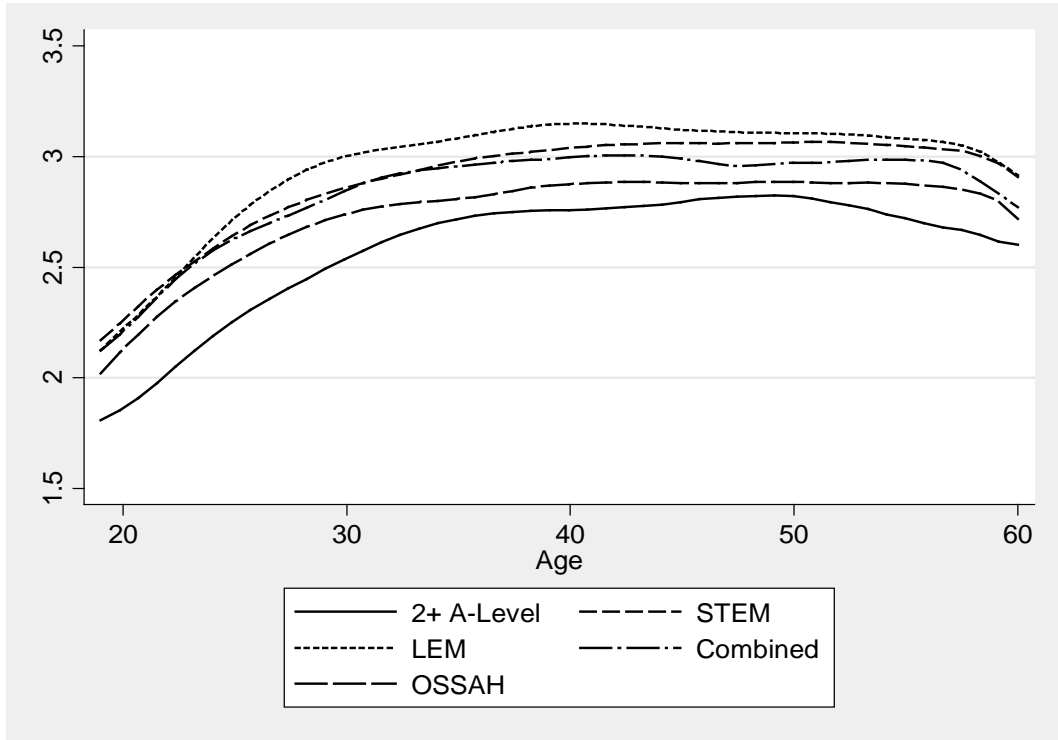
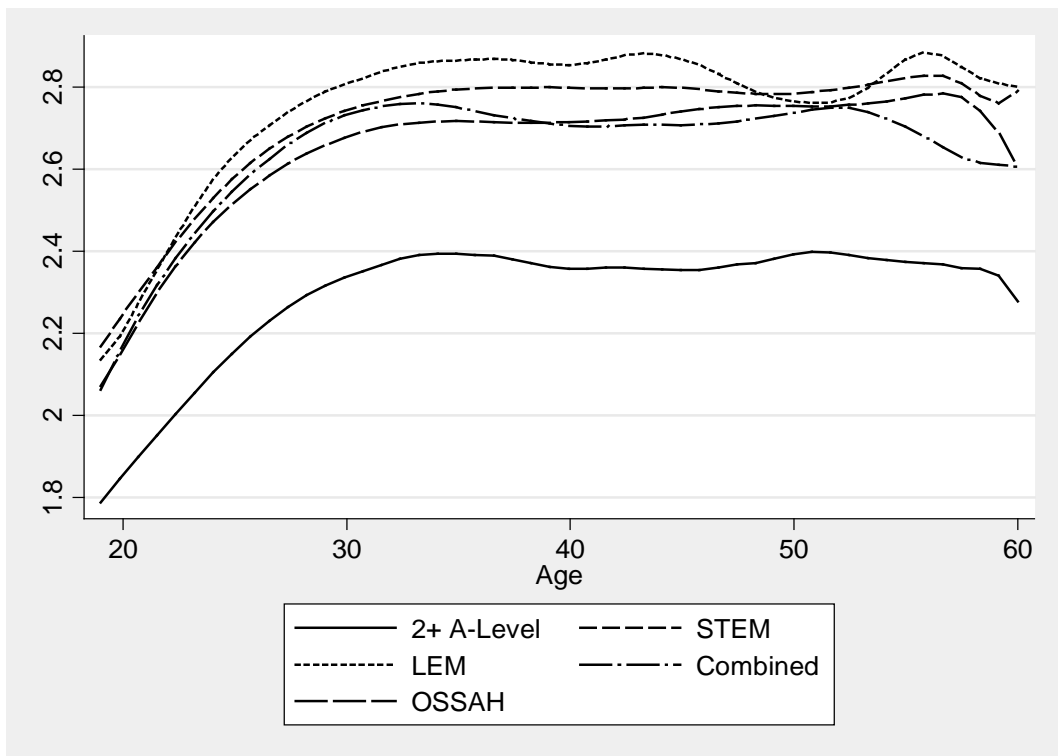


Figure 2 Smoothed Local Regression Estimates of Age – Log Earnings Profiles: Women



3. Method and Estimates

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

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

where \mathbf{X} is a vector of individual characteristics such as migrant status and region of residence, and \mathbf{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 \mathbf{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 stylised 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

$$(2) \quad \log w_{iq} = \alpha + \beta_q Experience_i + \gamma_q Experience_i^2 + \delta_q \mathbf{X}_i + e_{iq} \text{ for } i = 1..N \text{ and } q = 0..4$$

which does not impose age earnings profiles to be parallel in q , qualification.

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 equation (2) we obtain

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

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). 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

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

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 (we include a cubic in year of birth)⁵. For men, in Table 5a, we find that the estimated lifecycle age-earnings parameters, the γ 's and β 's, are reassuringly similar for men whether estimated using the pooled cross-section estimates of the levels equations or from the panel data estimation of the wage difference equations. 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 flatter⁶.

⁵ 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.

⁶ See Appendix Table A7' for NPVs based on these estimated age-earnings profiles for full-time workers alone.

We have included degree class and postgraduate degrees in the specification as simple intercept shifts and we find important differences across subjects. There is a significant premium for degree class 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 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.

Tables 6a and 6b reports Quantile Regression results for equation (4) (where the estimated experience-earnings profile is drawn from OLS estimates of the wage growth equation using the panel data). Our motivation for investigating the effect of HE across quantiles of the residual wage distribution is the presumption that the latter captures the distribution of unobserved skills. Thus, it is of interest to estimate the effect of HE across this distribution. It is difficult to predict what these effects might look like. On the one hand one might argue that unobserved skills, like perseverance, might complement observed skills (like a specific HE qualification) and that we would therefore expect the Net Present Value (NPV) of a HE qualification to be higher at the top of the distribution than at the bottom. Indeed, low unobserved skills associated with poor high school performance would typically be associated with admission to a low ranked institution that may add less value than a higher rated institution. On the other hand, one might argue that those with poor unobserved skills might attempt to compensate for them by investing (unobserved) greater effort as an undergraduate student. In which case, we might see higher returns at the bottom of the distribution of unobserved skills.

The male premium for a first class is close to 10% across the quartiles for STEM, and the results for women are similar. The upper second premia are also close to 10% for STEM men, but are not significantly different from zero for women. The male LEM first class premia are large for the bottom quartile at 25% and similar for the median, but somewhat smaller for the upper quartile. The LEM bottom quartile female first class premium is very similar to the male premium and are over 30% for the median and top quartile. The LEM upper second premia is slightly smaller than the first premia for men, while for women they are similar to the male premium at the bottom decile but around 15% for the median and top quartile. The upper second effects for COMB men is small across the distribution; and the

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 (0.154)	0.435 (0.138)	-0.103 (0.254)	0.105 (0.225)	0.200 (0.200)	-0.537 (0.019)	-0.339 (0.017)	-1.407 (0.033)	-1.051 (0.028)	-0.567 (0.024)
β	0.119 (0.006)	0.107 (0.006)	0.138 (0.011)	0.129 (0.009)	0.108 (0.008)	0.121 (0.021)	0.107 (0.018)	0.168 (0.031)	0.116 (0.027)	0.131 (0.027)
γ	-0.001 (0.000)	-0.001 (0.000)	-0.001 (0.000)	-0.001 (0.000)	-0.001 (0.000)	-0.001 (0.000)	-0.001 (0.000)	-0.002 (0.000)	0.001 (0.000)	-0.001 (0.000)
1 st class	-	0.075 (0.025)	0.236 (0.062)	0.139 (0.054)	0.040 (0.046)	-	0.075 (0.025)	0.236 (0.062)	0.141 (0.054)	0.047 (0.046)
Upper 2 nd	-	0.090 (0.018)	0.185 (0.034)	0.053 (0.029)	0.050 (0.025)	-	0.088 (0.017)	0.182 (0.034)	0.053 (0.029)	0.052 (0.025)
Lower 2 nd and below	-	-	-	-	-	-	-	-	-	-
PG degree	-	0.066 (0.018)	0.094 (0.031)	0.121 (0.034)	0.072 (0.026)	-	0.050 (0.017)	0.086 (0.030)	0.106 (0.034)	0.065 (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	-0.001 (0.000)	-0.001 (0.000)	-0.001 (0.000)	-0.001 (0.000)	-0.000 (0.000)	-0.001 (0.000)	-0.001 (0.000)	-0.001 (0.000)	-0.001 (0.000)	-0.001 (0.000)
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 6a *Quantile Regression results: Men*

	Bottom quartile					Median					Top quartile				
	2+ As	STEM	LEM	COMB	OSSAH	2+ As	STEM	LEM	COMB	OSSAH	2+ As	STEM	LEM	COMB	OSSAH
Constant	-0.920 (0.027)	-0.574 (0.019)	-1.663 (0.032)	-1.332 (0.041)	-0.840 (0.028)	-0.484 (0.022)	-0.309 (0.016)	-1.412 (0.035)	-1.021 (0.027)	-0.530 (0.027)	-0.156 (0.024)	-0.062 (0.021)	-1.036 (0.043)	-0.694 (0.034)	-0.260 (0.027)
1 st class	-	0.092 (0.029)	0.243 (0.063)	-0.003 (0.079)	0.007 (0.053)	-	0.102 (0.024)	0.231 (0.064)	0.110 (0.052)	0.093 (0.051)	-	0.089 (0.030)	0.208 (0.078)	0.149 (0.066)	0.085 (0.050)
Upper 2nd	-	0.103 (0.020)	0.157 (0.034)	0.014 (0.042)	0.002 (0.029)	-	0.098 (0.017)	0.225 (0.035)	0.018 (0.028)	0.076 (0.027)	-	0.082 (0.021)	0.168 (0.042)	0.060 (0.035)	0.103 (0.027)
Sub upper 2 nd	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PG degree	-	0.043 (0.021)	0.092 (0.031)	0.194 (0.051)	0.158 (0.030)	-	0.027 (0.017)	0.071 (0.032)	0.128 (0.033)	0.070 (0.028)	-	0.057 (0.021)	0.110 (0.038)	0.090 (0.039)	0.049 (0.029)
N	2202	3668	1405	1474	1807	2202	3668	1405	1474	1807	2202	3668	1405	1474	1807

Note: Estimates of β and γ are imposed from the right hand blocks of Table 5a. Cohort effects are included throughout. Region and immigrant controls and missing degree class also included. Standard errors in parentheses.

Table 6b *Quantile Regression results: Women*

	Bottom quartile					Median					Top quartile				
	2+ As	STEM	LEM	COMB	OSSAH	2+ As	STEM	LEM	COMB	OSSAH	2+ As	STEM	LEM	COMB	OSSAH
Constant	-0.274 (0.022)	-0.234 (0.033)	-0.924 (0.051)	-0.542 (0.033)	-0.766 (0.024)	-0.020 (0.018)	0.048 (0.023)	-0.551 (0.036)	-0.186 (0.031)	-0.412 (0.020)	0.340 (0.024)	0.276 (0.027)	-0.229 (0.035)	0.013 (0.028)	-0.128 (0.018)
1 st class	-	0.116 (0.044)	0.247 (0.079)	0.054 (0.058)	0.128 (0.043)	-	0.043 (0.032)	0.314 (0.056)	0.114 (0.055)	0.092 (0.037)	-	0.061 (0.037)	0.380 (0.055)	0.097 (0.048)	0.040 (0.032)
Upper 2nd	-	0.040 (0.030)	0.196 (0.043)	0.057 (0.031)	0.130 (0.023)	-	0.005 (0.021)	0.125 (0.030)	0.056 (0.029)	0.068 (0.020)	-	0.005 (0.025)	0.145 (0.030)	0.075 (0.026)	0.030 (0.017)
Sub upper 2 nd	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PG degree	-	0.159 (0.028)	0.208 (0.042)	0.211 (0.040)	0.228 (0.024)	-	0.157 (0.020)	0.181 (0.030)	0.159 (0.037)	0.112 (0.020)	-	0.161 (0.022)	0.129 (0.030)	0.130 (0.031)	0.073 (0.016)
N	2514	2472	1198	1975	3438	2514	2472	1198	1975	3438	2514	2472	1198	1975	3438

Note: Estimates of β and γ are imposed from the right hand blocks of Table 5b. Cohort effects are included throughout. Region and immigrant controls and missing degree class included. Standard errors in parentheses.

same is true for women. The first class effect for OSSAH is badly determined for men, while for women there is a 13% effect at the bottom, 9% at the median, but insignificant at the top. The PG effect is small for STEM men across the quartiles, but around 15% for STEM women across the quartiles. The PG effect for LEM males is 9% for the bottom quartile, slightly lower at the median and slightly higher at the upper quartile; while for women, the effect is 20% at the bottom, lower at the median and about half at the upper quartile. The effect of COMB women is in the mid to upper teen, and somewhat lower for men. The effect for OSSAH is 14% for men at the lower quartile, half this at the median, and half again at the upper quartile. A similar pattern holds for OSSAH women but from a higher level.

4. Lifetime impacts and rates of return

The implied college premia will vary with experience, degree class, cohort, and presence of PG qualifications⁷. Thus, in Table 7 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 pa 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 schedules⁸. We assume that individuals intend to work full-time throughout their working age lives⁹. We view this as a *prospective* simulation and focus on a current cohort looking forward. The simulations in Table 7 are for an “up-front” fee scheme since it does not allow for the presence of a loan scheme. In Table 10 and Appendix Table A7 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 forgiveness) we are underestimating the NPVs (except when the discount rate is zero) and IRRs in Table 7. However, even at a 10% discount rate the differences in NPVs in Table A7 compared to Table 7 are proportionately very small - just 3 to 4 thousand pounds.

⁷ 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.

⁸ Welfare programmes and the minimum wage are hardly relevant over the range of data being considered here.

⁹ One might also want to incorporate some part of subsistence costs while studying. For example, many UK students study away from home and incur additional housing costs.

Table 7: 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%
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 8: *Quantile Regression Estimates of NPVs (graduates are all relative to 2+ A-levels) at 5% Discount Rate, £,000.*

Gender Quantile	Men			Women		
	25 th	50 th	75 th	25 th	50 th	75 th
Baseline (2+ A Levels)	580	517	483	615	491	384
Tuition Fee = £3290 p.a.:						
STEM: 2II	-111	16	161	-42	124	314
STEM: 2I	-72	60	212	-18	123	314
LEM: 2II	110	235	44	-29	-34	89
LEM: 2I	215	374	111	70	13	152
Combined: 2II	136	62	-43	30	223	350
Combined: 2I	148	80	-17	49	257	389
OSSAH: 2II	-175	-47	84	9	163	370
OSSAH: 2I	-178	-20	117	78	201	391
Tuition Fee = £7000 p.a.:						
STEM: 2II	-122	5	150	-53	112	303
STEM: 2I	-83	49	201	-30	112	302
LEM: 2II	99	223	33	-41	-45	78
LEM: 2I	204	363	100	58	2	141
Combined: 2II	125	51	-54	18	212	339
Combined: 2I	137	69	-28	38	245	378
OSSAH: 2II	-186	-59	73	-2	152	359
OSSAH: 2I	-189	-31	106	67	190	380

Table 9: Internal Rate of Returns (IRRs) for Quantile Regression Estimates of NPVs, %.

Gender Quantile	25 th	Men 50 th	75 th	25 th	Women 50 th	75 th
Baseline (2+ A Levels)	-	-	-	-	-	-
Tuition Fee = £3290 p.a.:						
STEM: 2II	<0	6.0	15.3	0.8	14.4	27.8
STEM: 2I	<0	8.9	18.2	3.4	14.4	27.8
LEM: 2II	11.6	18.6	8.5	3.0	2.0	11.7
LEM: 2I	16.5	24.6	12.8	8.8	6.0	15.8
Combined: 2II	10.0	7.6	2.9	6.1	15.2	23.5
Combined: 2I	10.4	8.4	4.2	6.8	16.7	25.4
OSSAH: 2II	<0	<0	13.4	5.3	12.1	23.5
OSSAH: 2I	<0	0.5	15.9	7.7	13.6	24.4
Tuition Fee = £7000 p.a.:						
STEM: 2II	<0	5.3	13.2	0.2	12.5	23.8
STEM: 2I	<0	7.8	15.7	2.7	12.5	23.8
LEM: 2II	10.3	16.3	7.3	2.5	1.4	10.1
LEM: 2I	14.7	21.6	11.1	7.9	5.1	13.7
Combined: 2II	9.2	6.9	2.5	5.6	13.6	20.3
Combined: 2I	9.5	7.6	3.8	6.3	14.9	21.9
OSSAH: 2II	<0	<0	11.3	4.9	10.9	20.4
OSSAH: 2I	<0	<0	13.5	7.1	12.3	21.2

The *IRRs* are large for women for all majors and for both good and bad degrees. This increase in tuition fee, on the scale envisaged in the Browne Report, 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 return to LEM is 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*.

In Table 8 we use the corresponding estimates from Tables 6a and 6b to show how the NPV results vary by quantile of the distribution at a given discount rate, 5%, by gender, degree class and major. The median figures in Table 8 are close to the average figures that OLS yields in Table 7. However, there are huge differences across the quantiles within Table 8. Even for women, it would appear that the effects of STEM on NPV at the bottom quartile are much lower and even negative. At higher fees even the LEM median goes negative for women. Huge negative effects are associated with OSSAH for men. Note that the table demonstrates NPVs that rise across the distribution in some cases but not all. For example, for STEM and OSSAH, NPVs rise as we move up the distribution, but the opposite is true for Combined. There is no strongly theoretical presumption that any particular pattern should manifest itself and the estimates allow for all possibilities. Table 9 translates the NPV findings across the quantiles into rates of return. This confirms the relatively modest effects of the tuition rise on the returns on student investments. Those subjects that offer low returns at fees of £3290, offer somewhat lower returns at fees of £7000. Subjects that offer high returns at £3290 suffer larger falls if fees rise to £7000, but still offer handsome returns.

We also analyse 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 £3250 p.a. (say £2800 p.a. for rent¹⁰ and £450 p.a. for study materials). Under the current loan scheme students from low income backgrounds are eligible to a maximum maintenance grant of £2906 pa, while students from higher income backgrounds are eligible to a loan to cover such costs. So, in Table 10, 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

¹⁰ £70 per week for 30 weeks plus half rent for the summer vacation.

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 10 for those “without maintenance” (i.e. whose maintenance cost are covered by a grant) with the figures in the top half of Table 7 we see the effect of this additional expenditure makes very little difference to the *IRR*. Having to borrow to cover this maintenance expenditure (comparing the first and second columns of Table 10 for men, and the fifth and sixth form women) rather than having a grant to cover this, lowers the *IRR* - but by less than one percentage point in all cases. Figure 10 also simulates a version of the proposals put forward by the Browne Review (Browne, 2010). In those proposals a fee level of £7000 becomes a focal point (as opposed to the current £3290) and we adopt the other proposals – an interest rate of 2.2% (as opposed to zero), debt write off after 30 years (rather than 25), and payable at 9% of earnings above £21,000 p.a. (as opposed to £15,000). The results suggests a small, almost always less than one percentage point, fall in the *IRR*.

5. 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 rises are dwarfed by the scale of life earnings differentials. These results suggest that we might not see much substitution across majors in the face of even quite large tuition fee changes¹¹. The second feature is that, while there is little variation in returns across majors for women, STEM

¹¹ Arciadiacono *et al* (2010) provide estimates of the sensitivity of choice of college major to perceptions of differentials in returns of the US. No such research is available for the UK.

subjects do not seem to exhibit large returns for men. They are dominated by COMB degrees and vastly 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. The results are, of course, simulations using averages. There is likely to be wide variation around the averages and this is confirmed when we use Quantile Regression to look *across* quantiles of the residual log wage distribution. The best way to think of these quantiles is differences in wages that reflect unobservable differences across individuals. We might imagine that the prime suspect 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 lower perceived quality institutions. Unfortunately, we have no way of knowing how much of the large variation in returns across quantiles is due to individual differences and how much because of institutional differences. Only richer data will allow us to address this point.

However, we find consistently strong returns to a 2.1 vs a 2.2 – it would appear that, in all subjects, there is a strong return to effort. A good degree raises the IRR, ranging from 1% to 5.5% - although we are unable to say how much effort is required to generate such a better degree result¹².

Finally, a rise in tuition fees to £7000 would lower returns by about 1-3% - not economically insignificant. The strong message that 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) continue to do so. And those subjects that do not (especially OSSAH for men) will continue to offer poor returns. The Browne Report proposes slightly lower fees (£7000 is a focal point of the report) than originally envisaged but suggests an unsubsidized interest rate (of 2.2%) which is repayable only when incomes exceed a higher threshold (£21,000 rather than £15,000). Our analysis suggests that this proposal would have somewhat more modest detrimental effects on the soundness of an investment in higher education - but large cross subject differences will remain.

¹² Strinebricker and Strinebricker (2009) show that effort has a large effect on US degree scores – the GPA. We know of no UK work on this topic.

Table 10: A Comparison of IRRs (relative to A-levels) under Current Scheme and Browne Proposal, %

	MEN				WOMEN			
	Current Loan Scheme		Browne Proposal		Current Loan Scheme		Browne Proposal	
	Without maintenance	With maintenance	Without maintenance	With maintenance	Without maintenance	With maintenance	Without maintenance	With maintenance
STEM: 2II	7.0	6.6	6.4	6.1	18.1	17.4	17.4	17.0
STEM: 2I	9.7	9.3	9.2	8.9	18.7	18.0	18.1	17.7
LEM: 2II	24.8	24.2	24.2	23.8	16.8	16.3	16.3	15.9
LEM: 2I	30.8	30.0	30.0	29.5	20.9	20.2	20.3	19.9
Combined: 2II	9.4	9.1	9.1	8.9	17.2	16.7	16.7	16.4
Combined: 2I	10.6	10.3	10.3	10.0	18.9	18.4	18.4	18.1
OSSAH: 2II	5.5	4.7	4.2	3.2	15.4	15.0	15.0	14.7
OSSAH: 2I	8.2	7.5	7.3	6.6	17.6	17.1	17.1	16.8

Notes: Current loan scheme: Fee of £3290, 0% real interest rate, repayment on 9% of annual earnings over £15k and writing-off after 25 years; Browne Proposal: Fee of £7000, 2.2% real interest rate, repayment on 9% of annual earnings over £21k and writing-off after 30 years; Maintenance: £2906 (£3250) added to tuition fees under current loan scheme (Browne Proposal).

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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 more 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 (too few women are still working above 60 and the differential pension age in public/private sectors for men).

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

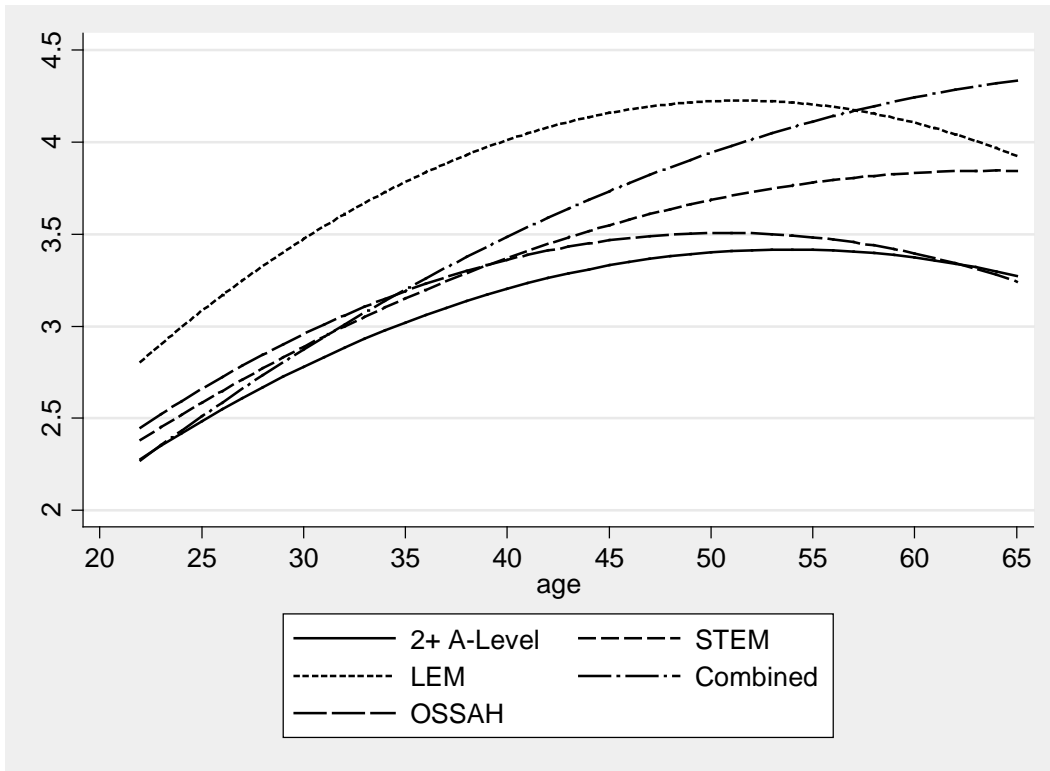


Figure A1b: Estimated age - earnings profiles by subject (2II for graduates), women

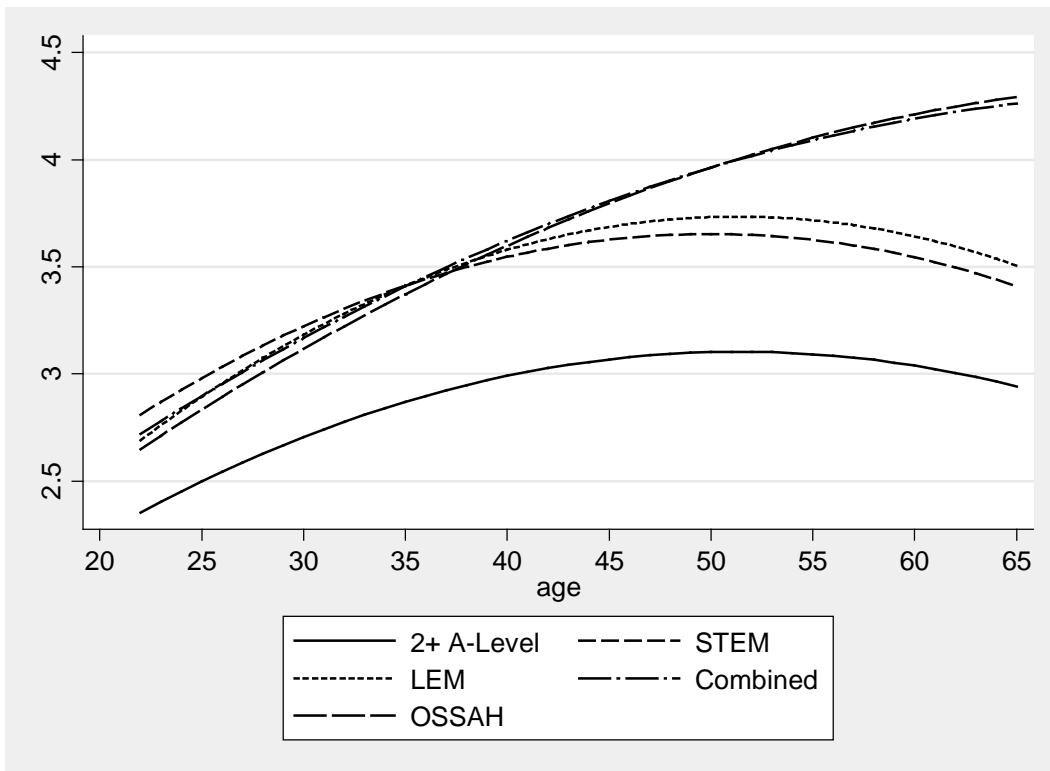


Table A7: Relative NPVs (£,000) and IRRs (%) by Gender, Major, Degree Class, and Discount Rate: with Income Contingent Loans

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, Full-time employed 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